Vinoba Bhave University, Hazaribag
Hazaribag – 825301 (Jharkhand)

REGULATIONS- 2017
FOR THE UNDER – GRADUATE PROGRAMMES
IN
ENGINEERING COURSES LEADING TO B. TECH. DEGREE

These regulations are applicable to the students from the Academic Year 2017-18 onwards

As per the recommendations of the National Knowledge Commission , University Grants Commission and all Indian council for Technical Education (AICTE) , Institution of Higher Technical Education need to carry out Academic Reforms in all areas including admission policy , uniform Academic Calendar , Continuous Assessment and Grading system. Incepting with these recommendations, Vinoba Bhave University, Hazaribagh had adopted the new academic regulation in the faculty of engineering in the year of 2017 which will be called as ACADEMIC REGULATIONS - 2017.

Preamble

1. The regulations herein specified apply to undergraduate programmes offered by the Vinoba Bhave University, Hazaribagh, hereinafter referred to as the University, Department, wherever mentioned refers to a Department of an institute, Academic section wherever mentioned refers to the Academic section of an institute.

2. 'Degree' means that academic award conferred upon a student on successful completion of a four-year programme designed to achieve the defined attributes. It is referred to as Under-Graduate (UG) Degree, that is "Bachelor of Technology" also known as "B.Tech. Degree".

3. 'Programme' means cohesive arrangement of courses, co-curricular and extracurricular activities to accomplish predetermined objectives leading to the awarding of a degree. It also means branch or discipline of B.Tech. Degree programme like Mechanical Engineering, Electrical Engineering, Civil Engineering etc. **The Students registered in programme can opt for additional MOOCS courses of 20 credits. On successful completion of MOOCS courses the concerned student shall be awarded B.Tech. Degree with "Honours"**

4. 'Course' means a combination of theory, tutorials and practice sessions of a subject studied in a semester.

5. A participant of the programme is a student who is duly admitted to an institute of the University and who has registered himself / herself for a course of study and attends the same.

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List of Programmes: The B.Tech. Degree Programmes Offered By VBU, Hazaribagh,
are as follows:

1	Mechanical Engineering (ME)
2	Electrical Engineering (EE)
3	Production Engineering (PE)
4	Metallurgical Engineering (MET.E)
5	Chemical Engineering (CHEM. ENGG)
6	Civil Engineering (CE)
7	Electronics and Communication Engineering (ECE)
8	Mining Engineering (MIN ENGG.)
9	Computer Science and Engineering (CSE)
10	Information Technology (IT)
11	Electrical and Electronics Engineering (EEE)

Time scale for academic activity

6. Each semester of study shall normally consist of 14 weeks exclusive of end-semester final examinations. A student is ordinarily expected to complete the B.Tech. programme in eight semesters for regular programme and in 6 semesters under lateral entry scheme. However, a student may complete the programme at a slower pace by taking more time as specified below:

Regular Students: Within time duration of 16 semesters or 8 years for students admitted in particular year.

Lateral Entry Students within the time duration of 14 semesters or 7 years for students admitted in particular year.

The above mentioned time duration shall be counted including semesters withdrawn on medical grounds etc.

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7. In compliance with the rules and norms of UGC, no student will be allowed to complete the degree in less than 08 full-semesters for regular and 06 semester for lateral entry.

8. The institute may schedule a summer programme during long vacation of the institute. There will be formal classes in the summer programme for all these papers where failure in the particular papers is more than 10%.
(The eligibility to register in the summer programme shall be restricted to clause 26 of this regulation. The examination / evaluations in the summer programme will be conducted as per clause 16 and 17).

Measure of Academic Achievement

9. The academic achievement of the participating students in the undergraduate programme shall be measured in terms of credits earned and grades obtained. Norms for the evaluation of credits earned shall be as specified hereinafter under the appropriate academic activity. The overall performance of the student in a semester examination shall be evaluated in terms of grade point average as specified later.

Scheme of Instruction

10. The scheme of instruction in the undergraduate programme shall be of the following forms of academic activity.
    a. Theory
    b. Sessional
    c. Extra academic activities (NSS,NCC,SPORTS,YOGA ETC.)

Theory

11. A theory shall involve concepts, fundamental ideas, and techniques well laid out in text books or open literature and which can be grasped through lectures, tutorials and home- work.

Sessional

12. The following types of academic works will be covered in sessional
    a. Laboratory Experiments,
    b. Design Exercise,
    c. Project,
    d. Any other academic work, the purpose of which would be to train the student by practice, repeated use and hands on experience.

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Extra academic activities NSS,NCC,SPORTS,YOGA etc.

Attendance Requirement

13. Attendance is the physical presence and active learning participation of a student in the class /laboratory/ field work etc., It is a well-observed fact that the students who score good grades are those who attend and participate in all the assigned learning activities in the class / laboratory / field work, regularly. Therefore, the students must strive to attend and sincerely participate in all the assigned learning activities without fail.

14. In each course a minimum attendance of 75 percent is required. Those who do not Fulfill the requirement have to submit the medical/relevant certificate for shortage of attendance.

15. On due recommendation of the concerned Head of the department, the Principal / Director of the Institute shall have the right to review the attendance requirements after examining the reasons for absence of the students from the class(Theory, Sessional & Extra academic activities).

Examination Assessment

16. Each Theory type of course will be evaluated for a maximum of 100 marks per course through mid-semester examination (20 marks), class-test [10 marks (best of 02 class test out of 03 class test)] and end semester (University) Examinations (70 marks).

17. Each Sessional course will be evaluated for maximum of 50 marks per course. The distributation of the sessional marks will be as follows:-

Sessional records ---------------------------- 20 marks
Attendance ----------------------------- 05 marks
Viva-Voce (By 3 membered board) --------25 marks

The viva-voce examination from semester 01 to semester 04 will be conducted by a board of 03 internal examiners (preferably the teacher who have conducted/assisted in the lab work), whereas the viva-voce examination from semester 05 to semester 08 shall be conducted by a board of two internal and one **external** examiner. The external examiner will preside the board.

N.B:- The list of examiners should be duly approved by the concerned Principal/Director of the Institute from semester 01 to semester 04 and for the rest of the semesters by Dean, faculty of Engineering, VBU Hazaribag.

18. To earn Academic credit in a subject / course, A student should get a grading of 'C' or above i.e. 35% and above marks in a particular paper whether theory type or sessional type.

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19. The absolute grading systems will be used from converting percentage marks to grades, which is as under:

% of marks obtained	Letter Grade
90% and above	A+
80% to 89%	A
70 % to 79%	B+
60% to 69%	B
50% to 59%	C+
35% to 49%	C
<35%	F

Grading of Performance in Examinations

20. Based on the results of the examinations, the performance of the students shall be graded as under

Grade	Grade Point
A+	10
A	9
B+	8
B	7
C+	6
C	5
F	0

The method of converting the percentage of marks to letter grades will be as given in clause 21.

Records of Academic Progress

21. (i) Semester Grade point Average (SGPA) shall be calculated as under:

$$\text{SGPA} = \frac{\Sigma_{\text{semester}} \text{(Course credits x Grade point) for all courses}}{\Sigma_{\text{semester}} \text{(Course credits)}}$$

(ii) The academic progress of the students in each semester shall be maintained in a grade card or transcript, wherein the grades awarded to students as well as

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the points secured by the students in the examinations shall be entered. The transcript given to the students at the end of their complete undergraduate program shall indicate the cumulative grade point average (CGPA), which shall be calculated as follows :

$$\text{CGPA} = \frac{\Sigma_{\text{All Sem}}(\text{Course credits x Grade point) for all points}}{\Sigma_{\text{All Sem}}\text{(Course credits)}}$$

The CGPA shall be rounded off to 2nd place of decimal.

Re-appearing for backlog papers

22. (a) Students who have secured 'F' (Fail) / 'Ab' (Absent) grade in a particular course can re-appear when the end semester/special semester examination for that course is again conducted provided they satisfied other eligibility conditions such as shortage of attendance overcome by attending compensatory classes.

(b) For the first two attempts of re-appearing in semester examinations, excluding special examinations, the internal marks obtained in the first attempt only be considered and will be combined with the marks obtained in the end semester examinations for the award of appropriated grade.

(c) However if a student obtains 'F'/'Ab' grade in a course in the first two attempts, then from the third attempts onwards, full weightage (100%) shall be assigned to marks scored in the university examinations and the internal assessment marks they have scored during the regular course of study will be ignored.

(d) The special examinations (from semester 01 to semester 08) will be arranged once in a year after the publication of result of end semester examinations.

(e) In case of students with backlog papers, the date of passing the B.Tech programme shall be that on which he/she has cleared the backlog papers.

Condition for Promotion to 3rd Semester

23. If a student fails in more than 04 papers of theory and or sessional in the first year (including both winter & summer semesters) and special examinations for first year, he/she will not be promoted to 3rd semester.

Provision of Grace Marks

24. Passing marks would be 35 in theory paper and maximum upto 5 marks would be given as grace marks in maximum of 02 theory papers(may be backlog papers) which will be applicable only at the time of declaration of result of B.Tech. Final examination.

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Facilities for failed students

25. (a) Students who have been duly exposed to all the credits for B.Tech. Degree, but have not completed successfully all the course after the 8th semester may be permitted to appear at the University examinations in the courses in which they have got F grade in their regular programme.

(b) The maximum duration for completion of the programme shall be 16 semester, excluding special examinations or 08 years from the year of their admission(Academic Session).

The above mention time duration is counted excluding semester withdrawn on medical ground or any other valid reasons.

(c) In case any student feels aggrieved on the final outcome of learning assessment in any course, for a maximum of 02 courses, the student shall apply to the controller of examinations, VBU Hazaribagh through Academic Section of their institute, along with the prescribed fee, for the scruitiny of only the end semester answer scripts. If any discrepancy is noticed during the scrutiny the same shall be rectified and the originally awarded grade would be accordingly amended.

(d) If a student having backlog after 08 semesters (4 years), he/she will be treated as Non-collegiate candidate.

Graduation Requirement

26. a) In order to qualify for B.Tech. degree a student must earn a minimum of 160 credits within a specified time period of 08 years/16 semesters for regular students and 07 years / 14 semesters for students of lateral entry.

b) The credits earned by an engineering student must conform to the minimum numbers specified by the courses of study in Engineering with reference to the following:

1) Theory type credits
2) Sessional type credits
3) Project sessional type of credits
4) Core courses for engineering
5) Departmental core
6) Sciences
7) Language, Humanities, social sciences and Management
8) Extra academic activities (EAA)

c) The students who will not be able to fulfill the above requirement will be dropped from the programme.

d) The student must complete all the non –credit requirements as

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specified by the institute/university from time to time.

e) The student must complete the requirements within the maximum time allowed as specified in clause 6.

f) For the purpose of awarding class, the CGPA shall be converted to percentage marks using the following formula :

Percentage marks = (CGPA X 10).

Thus CLASS shall be awarded on the basis of the following score of CGPA:

i) Ist class with Distn. = CGPA of 7.50 and above
ii) Ist class = CGPA of 6.00 to 7.49
iii) IInd class = CGPA of 4. 50 to 5.99

Provision for temporary withdrawal from the programme

27. A students registered in a semester may be permitted to withdraw from the Academic Programme for a semester for reasons of illness for long period or other valid grounds. Normally students will be permitted to discontinue temporarily from the degree programme only for continuous period of two (02) consecutive semesters or for maximum of 03 regular semesters during his entire Academic programme.

28. A student who had availed the facility of temporary withdrawal from regular semester will have to take readmission in the appropriate programme

Provision for Re-admission:

29. Readmission of the student shall be allowed to those students who have been duly allowed for temporary withdrawal by the Director /Principal of the institute, provided one has been sent up and filled up the form of 1st and 2nd semester examinations.

Transitory Regulation for B.Tech.

30. This regulation will be implemented for the students who have been admitted before 2017-18 batch.

31. The students obtaining F Grade in any course of the programme, he/she will get 03 chances (exclusive of special examination), in

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continuity i.e. 03 regular years as per the old syllabus to clear the backlog/backlogs.

32. If a candidate does not clear the backlog paper/papers even after availing 3 chances will be allowed to appear in the equivalent papers decided by the concerned board with the due permission of the Dean, faculty of Engineering.

33. In any circumstances the student having backlog paper/papers will have to clear all the papers in 08 years or 16 regular semesters from his/her year of admission. The special semester examination will not be counted in the above said sixteen semesters. If the student fails to fulfill the academic requirements for B.Tech. degree in 08 years he/she will be dropped from the programme.

*** Note**

The Vice-Chancellor of the university, in consultation with the Dean faculty of engineering shall have the right to change / modify any regulation or part thereof in the academic interest of the students as and when required.

DIRECTOR
B. I. T. SINDRI
DHANBAD

Director (E), VBU
BIT Sindri-cum-
Dean, Faculty of Engineering
Vinoba Bhave University
Hazaribagh

Course Structure of Undergraduate
Vinoba Bhave University , Hazaribagh

Mechanical Engineering

Semester - V

Branch: Mechanical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	ME501	Heat Transfer	3	1	0	4
2	ME502	Design of Machine Elements	3	0	0	3
3	PEC-I		3	0	0	3
4	PEC-II		3	0	0	3
5	OEC- I		3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	ME551	Lab I (HMT / Manufacturing Processes (SIEMENS))	0	0	3	1
8	ME552	Lab II (Machine Design)	0	0	3	1
9	ME553	Lab III (I.C. Engine)	0	0	3	1
10	ME554	Internship Assessment	0	0	2	2
					Total Credits	21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
ME511	Principles of Management	ME521	Advanced Materials
ME512	Total Quality Management	ME522	Internal Combustion Engines
ME513	Project Management	ME523	Advanced Welding Technology

Code	**Open Elective-I (Any One)**
ME531	Operations Research
ME532	Non-Conventional Energy Sources
ME533	Design for Manufacturing
ME534	New Venture Creation
ME535	Design and Analysis of Experiments

Semester - VI
Branch: Mechanical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ME601	Solid Mechanics	3	1	0	4
2	PEC-III		3	0	0	3
3	PEC-IV		3	0	0	3
4	OEC II		3	0	0	3
5	OEC III		3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	ME651	Lab IV (Machine Design / CAD / SIEMENS)	0	0	3	1
8	ME652	Lab V (MOS)	0	0	3	1
9	ME653	Lab VI (Automobile Engg.)	0	0	3	1
				Total Credits		21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
ME611	Manufacturing Technology	ME621	Design of Transmission System
ME612	Mechatronics Systems	ME622	Computational Fluid Dynamics
ME613	Microprocessor in Automation	ME623	Machine Tool Design

Code	**Open Elective-II (Any One)**	Code	**Professional Elective-IV**
ME631	Industrial Robotics	ME641	Automobile Engineering
ME632	Computer Aided Design	ME642	Engineering Economics and Accountancy
ME633	Production Planning and Control	ME643	Reliability Engineering
ME634	Innovative Design	ME644	Theory of Constraints
ME635	Supply Chain Management	ME645	Environmental Impact Assessment

Semester -VII

Branch: Mechanical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ME701	Automation in Manufacturing	3	0	0	3
2	PEC-V		3	0	0	3
3	PEC-VI		3	0	0	3
4	OEC IV		3	0	0	3
5	OEC V		3	0	0	3
6	ME751	Lab VII (RAC)	0	0	3	1
7	ME752	Project-I	0	0	4	2
8	ME753	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
ME711	Refrigeration and Air Conditioning	ME721	Power Plant Engineering
ME712	Cryogenics	ME722	Finite Element Analysis
ME713	Gas Dynamics	ME723	Tool Design

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
ME731	Mechanical Vibrations	ME741	Rapid Prototyping
ME732	Convective Heat Transfer	ME742	Industrial Automation
ME733	Micro and Nano Manufacturing	ME743	Technology management
ME734	Energy Systems and Management	ME744	Computer Aided Manufacturing
ME735	Condition Monitoring	ME745	Maintenance Engineering & management

Semester -VIII

Branch: Mechanical Engineering

S.N.	Code	Course Title	L	T	P	Credits
5	ME851	Project-II			17	08
					Total Credit	08

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Electrical Engineering

Semester - V

Branch: Electrical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	EE501	Electrical Machines-II	3	1	0	4
2	EE502	Control Systems	3	0	0	3
3	PEC-I	**Professional Elective-I**	3	0	0	3
4	PEC-II	**Professional Elective-II**	3	0	0	3
5	OEC- I	**Open Elective-I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	EE551	Electrical Machines-II Lab.	0	0	3	1
8	EE552	Control Systems Lab.	0	0	3	1
9	EE553	Professional Elective-I Lab.	0	0	3	1
10	EE554	Internship Assessment	0	0	2	2
					Total Credits	21

	Professional Elective-I (Any one)		**Professional Elective-II (Any one)**
EE511	Microprocessor and Microcontroller	EE521	Signals and Systems
EE512	Electrical Machine Design	EE522	Transforms in Electrical Engineering
EE513	Applied Electrical Engineering	EE523	Electrical Engineering Materials

	Open Elective-I (Any One)
EE531	Control Systems*
EE532	Microprocessor and Microcontroller*
EE533	Electromechanical Energy Conversion and Transformers*
EE534	Power Plant Engineering

* Not for EE Students

Semester - VI

Branch: Electrical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EE601	Power Electronics	3	1	0	4
2	PEC-III	**Professional Elective-III**	3	0	0	3
3	PEC-IV	**Professional Elective-IV**	3	0	0	3
4	OEC II	**Open Elective-II**	3	0	0	3
5	OEC III	**Open Elective-III**	3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	EE651	Power Electronics Lab.	0	0	3	1
8	EE652	Professional Elective-III Lab.	0	0	3	1
9	EE653	Electrical Workshop	0	0	3	1
Total Credits						21

	Professional Elective-III		**Professional Elective-IV**
EE611	Power Systems-II	EE621	High Voltage Engineering
EE612	Power System Restructuring	EE622	Industrial Electrical Systems
EE613	Electrical Estimation and Costing	EE623	Special Electrical Machines
EE614	Electrical Energy Conservation and Auditing	EE624	Power System Transient

	Open Elective-II (Any One)		**Professional Elective-IV**
EE631	Power Electronics*	EE641	Special Electrical Machines*
EE632	Green Energy Technology	EE642	Soft Computing Techniques
EE633	Mine Electrical Engineering*	EE643	Energy Storage Systems

* Not for EE Students

Semester -VII

Branch: Electrical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EE701	Protection of Power Apparatus	3	0	0	3
2	PEC-V	**Professional Elective-V**	3	0	0	3
3	PEC-VI	**Professional Elective-VI**	3	0	0	3
4	OEC IV	**Open Elective-IV**	3	0	0	3
5	OEC V	**Open Elective-V**	3	0	0	3
6	EE751	Power System Protection and	0	0	3	1
7	EE752	Project Part - I	0	0	4	2
8	EE753	Internship Assessment	0	0	2	2
Total credits						20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
EE711	Electrical Drives and Control	EE721	High Power Converters
EE712	Utilization of Electrical Power	EE722	HVDC Transmission and FACTS
EE713	Power System Dynamics and Control	EE723	Smart Grid Technology
EE714	Power Quality	EE724	Electrical and Hybrid Vehicles

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
EE731	Soft Optimization Techniques	EE741	High Power Converters *
EE732	Illumination Technology	EE742	Digital Control Systems
EE733	Process Instrumentation and Control	EE743	Electrical machine and Power Systems*

* Not for EE Students

Semester -VIII

Branch: Electrical Engineering

S.N.	Code	Course Title	L	T	P	Credits
5	EE851	Project-II			17	08
					Total Credits	08

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Electrical & Electronics Engineering

Semester - V

Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	EEE501	Electrical Machines-II	3	1	0	4
2	EE502	Control Systems	3	0	0	3
3	PEC-I	**Professional Elective-I**	3	0	0	3
4	PEC-II	**Professional Elective-II**	3	0	0	3
5	OEC- I	**Open Elective-I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	EEE551	Electrical Machines-II Lab.	0	0	3	1
8	EEE552	Control Systems Lab.	0	0	3	1
9	EEE553	Professional Elective-I Lab.	0	0	3	1
10	EEE554	Internship Assessment	0	0	2	2
					Total Credits	21

	Professional Elective-I (Any one)		**Professional Elective-II (Any one)**
EEE511	Microprocessor and Microcontroller	EEE521	Signals and Systems
EEE512	Electrical Machine Design	EEE522	Transforms in Electrical Engineering
EEE513	Applied Electrical Engineering	EEE523	Electrical Engineering Materials

	Open Elective-I (Any One)
EEE531	Control Systems*
EEE532	Microprocessor and Microcontroller*
EEE533	Electromechanical Energy Conversion and Transformers*
EEE534	Power Plant Engineering

* Not for EEE Students

Semester - VI
Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EEE601	Power Electronics	3	1	0	4
2	PEC-III	**Professional Elective-III**	3	0	0	3
3	PEC-IV	**Professional Elective-IV**	3	0	0	3
4	OEC II	**Open Elective-II**	3	0	0	3
5	OEC III	**Open Elective-III**	3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	EEE651	Power Electronics Lab.	0	0	3	1
8	EEE652	Professional Elective-III Lab.	0	0	3	1
9	EEE653	Electrical Workshop	0	0	3	1
				Total Credits		21

	Professional Elective-III		**Professional Elective-IV**
EEE611	Power Systems-II	EEE621	Analog and Digital Communication
EEE612	Power System Restructuring	EEE622	Digital Signal Processing
EEE613	Electrical Estimation and Costing	EEE623	Digital Image Processing
EEE614	Electrical Energy Conservation and Auditing		

	Open Elective-II (Any One)		**Professional Elective-IV**
EEE631	Power Electronics*	EEE641	Special Electrical Machines*
EEE632	Green Energy Technology	EEE642	Soft Computing Techniques
EEE633	Mine Electrical Engineering*	EEE643	Energy Storage Systems

* Not for EEE Students

Semester -VII

Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EEE701	Protection of Power Apparatus	3	0	0	3
2	PEC-V	Professional Elective-V	3	0	0	3
3	PEC-VI	Professional Elective-VI	3	0	0	3
4	OEC IV	Open Elective-IV	3	0	0	3
5	OEC V	Open Elective-V	3	0	0	3
6	EEE751	Power System Protection and	0	0	3	1
7	EEE752	Project Part - I	0	0	4	2
8	EEE753	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
EEE711	Electrical Drives and Control	EEE721	Antennae & Wave Propagation
EEE712	Utilization of Electrical Power	EEE722	Smart Grid Technology
EEE713	Power Quality	EEE723	Electrical and Hybrid Vehicles
EEE714	HVDC Transmission and FACTS		

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
EEE731	Soft Optimization Techniques	EEE741	High Power Converters *
EEE732	Illumination Technology	EEE742	Digital Control Systems
EEE733	Process Instrumentation and Control	EEE743	Electrical machine and Power Systems

* Not for EEE Students

Semester -VIII

Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	L	T	P	Credits
5	EEE851	Project-II			17	08
					Total Credits	08

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Production Engineering

Semester - V

Branch: Production Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	PE501	Manufacturing Process-II	3	1	0	4
2	PE502	Metrology & Measurement	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	PE551	Metrology & Measurement Lab	0	0	3	1
8	PE552	Lab II	0	0	3	1
9	PE553	Lab III	0	0	3	1
10	PE554	Internship Assessment	0	0	2	2
Total Credits						21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
PE511	Engineering Economy	PE521	Value Engineering
PE512	Lean Manufacturing	PE522	Work Study and Ergonomics
PE513	Process Engineering	PE523	Eco-Friendly Manufacturing

Code	**Open Elective-I (Any One)**
PE531	Automobile Engineering
PE532	CAD/CAM
PE533	Industrial Pollution

Semester - VI
Branch: Production Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	PE601	Machine Tool Design	3	1	0	4
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC II	**Open Elective -II**	3	0	0	3
5	OEC III	**Open Elective -III**	3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	PE551	**Lab-1**	0	0	3	1
8	PE552	**Lab-2**	0	0	3	1
9	PE553	**Lab-3**	0	0	3	1
Total Credits						21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
PE511	Manufacturing Process-III (TMCF + PM)	PE521	Modern Manufacturing Process (MMP+RP)
PE512	Processing of Non-Metals.	PE522	Product Development and Design
PE513	Surface Engineering	PE523	Competitive Manufacturing Strategies

Code	**Open Elective-II (Any One)**	Code	**Open Elective-III**
PE531	Operation Research	PE541	Industrial Automation & Robotics
PE532	Mathematical Modelling and Simulation	PE542	Computer Integrated Manufacturing
PE533	Maintenance Technology and Safety Engineering (MTSE)	PE543	System Dynamics

Semester -VII

Branch: Production Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	PE701	Production Planning and Control	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	PE651	Optimization Lab	0	0	3	1
7	PE652	Project-I	0	0	4	2
8	PE653	Internship Assessment	0	0	2	2
					Total credits	20

Code	Professional Elective-V (Any one)	Code	Professional Elective-VI (Any one)
PE711	Statistical Quality Control	PE721	Tool Design
PE712	Total Quality Management	PE722	Advance Casting and Welding
PE713	Quality and Reliability Engineering	PE723	Material Deformation Process

Code	Open Elective-IV (Any one)	Code	Open Elective-V (Any one)
PE731	Supply Chain Management	PE741	Finite Element Method
PE732	Enterprises Resource Planning	PE742	Modern Optimization Technique
PE733	Management Information System	PE743	Mechatronics
PE734	Marketing Management	PE744	Project Engineering
PE735	Intelligent Manufacturing Systems		

Semester -VIII

Branch: Production Engineering

S.N.	Code	Course Title	L	T	P	Credits
5	PE851	Project-II			17	08
					Total Credit	08

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Metallurgical Engineering

Semester - V
Branch: Metallurgical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	ML501	Material Characterization (Professional Core course)	3	1	0	4
2	ML502	Degradation of Materials (Professional Core course)	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	ML551	Corrosion Lab	0	0	3	1
8	ML552	Heat Treatment Lab	0	0	3	1
9	ML553	**Met. Lab-I** (Material Characterization & Physics of Material Lab)	0	0	3	1
10	ML554	Internship Assessment	0	0	2	2
Total Credits						21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
ML511	Heat Treatment of Metallic Materials	ML511	Physics of Materials
ML512	Deformation Theory of Metals	ML522	Casting and Solidification of Materials
ML513	Unit process of Extraction	ML523	Mechanical working of Materials
ML514	Non-ferrous Extractive Metallurgy	ML524	Alternative route of Iron Production
ML515	Phase Transformation	ML525	Electronic, Optical and Magnetic Materials

Code	**Open Elective-I (Any One)**
ML531	Powder Metallurgy
ML532	Nuclear Materials
ML533	Ceramic and Polymer Materials
ML534	Pollution in Metallurgical industries and its control
ML535	Material Technology

Semester - VI
Branch: Metallurgical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ML601	Iron and Steel Making	3	1	0	4
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC II	**Open Elective -II**	3	0	0	3
5	OEC III	**Open Elective -III**	3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	ML651	**Met. Lab.-II** (Extractive Metallurgy & Joining of Metals Lab)	0	0	3	1
8	ML652	Mechanical Testing Lab	0	0	3	1
9	ML653	Computational Engg. Lab	0	0	3	1
				Total Credits		21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
ML611	Metal Forming Technology	ML621	Non-ferrous Technology
ML612	Sponge Iron Technology	ML632	Creep, Fatigue and Fracture Mechanics
ML613	Computational Material Engineering	ML643	Experimental Techniques in Materials Engineering
ML614	X- Ray Diffraction and Electron Microscopy	ML654	Energy Materials
ML615	Secondary Steel Making	ML665	Functional Materials

Code	**Open Elective-II (Any One)**	Code	**Open Elective-III**
ML631	Mechanical Behavior of Materials	ML641	Joining of Materials
ML632	Advanced Materials	ML642	Nano Science and Nano Technology
ML633	Bio-Materials	ML643	Surface Engineering
ML634	Polymer Technology	ML644	Industrial Automation and Control
ML635	Electronic Materials		

Semester -VII

Branch: Metallurgical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ML701	Foundry Technology	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	ML751	Foundry Lab.	0	0	3	1
7	ML752	Project-I	0	0	4	2
8	ML753	Internship Assessment	0	0	2	2
Total credits						20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
ML711	Advances in Steel Making	ML721	Principles of Management
ML712	Non Destructive Testing	ML722	Alloys Steels and High Temperature Alloys
ML713	Light Metal Alloys Steels	ML723	High Temperature Materials
ML714	Special Steels and Cast Irons	ML724	Computer applications in materials and Engineering
ML715	Non Metallic Materials	ML725	Physical Chemistry of Iron and Steel Making

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
ML731	Composite Materials	ML741	Nano Materials
ML732	Advanced Engineering Materials	ML742	Nanostructured Materials
ML733	Emerging Materials	ML743	Nano Materials

Semester -VIII

Branch: Metallurgical Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	ML851	Project-II			17	08
					Total Credit	08

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Chemical Engineering

Semester - V

Branch: Chemical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	CL501	Mass Transfer operation	3	1	0	4
2	CL502	Chemical Reaction Engineering	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	CL551	Mass Transfer Lab	0	0	3	1
8	CL552	Fluidization Engineering Lab	0	0	3	1
9	CM553	Chemical Reaction Engineering Lab	0	0	3	1
10	CL554	Internship Assessment	0	0	2	2
				Total Credits		21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
CL511	Instrumentation and Process Control	CL521	Numerical Methods in Chemical Engineering
CL512	Process Dynamics andcontrol	CL522	Mathematical Methodism Chemical Engineering
CL513	Computer Aided Process Control	CL523	Optimization of Chemical Processes
		CL524	Fluidization Engineering

Code	**Open Elective-I (Any One)**
CL531	Environmental Engineering
CL532	Industrial Pollution Control

Semester - VI
Branch: Chemical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CL601	Process Equipment Design	3	1	0	4
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC II	**Open Elective -II**	3	0	0	3
5	OEC III	**Open Elective -III**	3	0	0	3
6	HU601	Entrepreneurship	2	0	0	2
7	CL651	Chemical Engineering Thermodynamics	0	0	3	1
8	C652	Process Equipment Design	0	0	3	1
9	CL653	Instrumentation and Control Lab	0	0	3	1
				Total Credits		21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
CL611	Chemical Engineering Thermodynamics	CL621	Advance Mass Transfer
CL612	Solutions Thermodynamics	CL622	Separation Processes
CL613	Physical and Chemical Equilibria	CL623	Multi Component Separations

Code	**Open Elective-II (Any One)**	Code	**Open Elective-III**
CL631	Heterogeneous Catalysis	CL641	Energy Option
CL632	Chemical Reactor Analysis	CL642	Fuel and combustion Technology
C633	Material Characterization	CL643	Fertilizer Technology
CL634	Reactor Design		

Semester -VII

Branch: Chemical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CL701	Transport Phenomenon	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	CL751	Chemical Engineering Lab II (PRE+ EO)	0	0	3	1
7	CL752	Project-I	0	0	4	2
8	CL753	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
CL711	Computer Aided Design	CL721	Chemical Process & Operational Safety
CL712	Process Modelling and Simulation	CL722	Chemical Plant Management
CL713	Computational Fluid Dynamics	CL723	Solid Waste Management

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
CL731	Polymer Science & Technology	CL741	Bio Chemical Engineering
CL732	Mineral Beneficiation	CL742	Petrochemical Technology
CL733	Fuel Cell Technology	CL743	Petroleum Refining Engineering

Semester -VIII

Branch: Chemical Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	CL851	Project-II			17	08
					Total Credit	08

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Civil Engineering

Semester - V

Branch: Civil Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	CE501	Mechanics of Materials	3	1	0	4
2	CE502	Environmental Engineering	3	0	0	3
3	CM713	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	CE551	Concrete Lab	0	0	3	1
8	CE552	Geotechnical Engineering lab	0	0	3	1
9	CE553	Environmental Engineering lab	0	0	3	1
10	CE554	Internship Assessment	0	0	2	2
Total Credits						21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
CE511	Water Resources Engineering-1	CE521	Steel Structures-I
CE512	Solid waste management	CE522	Advance Geotechnical
CE513	Hydropower engineering	CE523	Industrial Structures
CE514	Advance surveying	CE524	Design of Structural Systems
CE515	Water resources system	CE525	Geotechnical Design
		CE526	Environmental Geo-technology

Code	**Open Elective-I (Any One)**
CE531	Air Pollution & its Control Measures
CE532	Advance Engineering System
CE533	Global Positioning System
CE534	Disaster Management
CE535	Environmental Management System

Semester - VI

Branch: Civil Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CE601	STRUCTURAL ANALYSIS II	3	1	0	4
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC II	**Open Elective -II**	3	0	0	3
5	OEC III	**Open Elective -III**	3	0	0	3
6	HU501	Entrepreneurship	2	0	0	2
7	CE651	Transportation Engineering Lab	0	0	3	1
8	CE652	STEEL Structures	0	0	3	1
9	CE653	STRUCTURAL ANALYSIS lab	0	0	3	1
Total Credits						21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
CE611	Transportation Engineering	CE621	Steel Structures-II
CE612	Soil dynamics	CE622	Water Resources Engineering-II
CE613	Modern surveying techniques	CE623	Structural Dynamics
CE614	Airport Planning and Design	CE624	Systems Engineering & Economics
CE615	Bridge engineering	CE625	Metal Structure Behaviour
		CE626	Masonry Structures

Code	**Open Elective-II (Any One)**	Code	**Open Elective-III**
CE631	Environment Impact Assessment	CE641	Remote Sensing & Its Application,
CE632	Operational Research Technique	CE642	Decision and Risk Analysis
CE633	Rock Mechanics	CE643	Engineering Materials for Sustainability
CE634	Environmental Laws and Policy	CE644	Industrial Structure
CE635	Value and Ethics in engineering	CE645	Construction Technology and Management

Semester -VII
Branch: Civil Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CE701	CONCRETE STRUCTURE-II	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	CE751	CONCRETE STR. DETAILING	0	0	3	1
7	CE752	Project-I	0	0	4	2
8	CE753	Internship Assessment	0	0	2	2
					Total credits	20

Code	Professional Elective-V (Any one)	Code	Professional Elective-VI (Any one)
CE711	Hydraulic Structures	CE721	Construction Planning And Management
CE712	Composite Materials	CE722	Industrial waste treatment
CE713	Prestressed Concrete	CE723	Sustainable Construction Methods
CE714	Ground Water Hydrology	CE724	Elements of fluivial hydraulics
CE715	Earthquake Engineering	CE725	Railway Engineering

Code	Open Elective-IV (Any one)	Code	Open Elective-V (Any one)
CE731	Reliability Engineering	CE741	Basics of computational hydraulics
CE732	Geographical Information System	CE742	Urban Hydrology and Hydraulics
CE733	Quality Control and Management	CE743	Intelligent Transportation Systems
CE734	Repairs & Rehabilitation of Structure	CE744	Structural geology
CE735	Engineering Economics and Accounts	CE745	Environmental Health and Safety Management

Semester -VIII

Branch: Civil Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	CE851	Project-II			17	08
					Total Credit	08

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Electronics & Communication Engineering

Semester - V

Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	EC501	Microprocessor& Interfacing	3	1	0	4
2	EC502	Digital Communication System	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	ECE551	Microprocessor Lab	0	0	3	1
8	EC552	Digital Communication Lab	0	0	3	1
9	EC553	**Elective-I** Lab	0	0	3	1
10	EC554	Internship Assessment	0	0	2	2
Total Credits						21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
EC511	Linear Control System	EC521	Signal and System
EC512	Radar Engineering	EC522	Digital Switching and Multiplexing
EC513	Linear Integrated Circuit	EC523	Biosensors

Code	**Open Elective-I (Any One)**
EC531	Electronics Instrumentation
EC532	Digital System Design*
EC533	Materials for Engineering Applications

* Not For ECE Students

Semester - VI
Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EC601	VLSI Design	3	1	0	4
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC II	**Open Elective -II**	3	0	0	3
5	OEC III	**Open Elective -III**	3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	EC651	VLSI Lab	0	0	3	1
8	EC652	**Elective-III** Lab	0	0	3	1
9	EC653	**Elective-IV** Lab	0	0	3	1
					Total Credits	21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
EC611	Digital Signal Processing	EC621	Microcontrollers and their Applications
EC612	System on Chip Design	EC622	Microwave Engineering
EC613	Digital Image Processing	EC623	Wireless Communication

Code	**Open Elective-II (Any One)**	Code	**Open Elective-III**
EC631	Analog and Digital Communication*	EC641	Digital Signal Processing*
EC632	Nano Electronics	EC642	Value and Ethics
EC633	Communication Protocols for Instrumentation	EC643	Analog Integrated Electronics*

* Not for ECE Students

Semester -VII

Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EC701	Optical Fiber Communication	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	EC751	Optical Fiber Communication	0	0	3	1
7	EC752	Project-I	0	0	4	2
8	EC753	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
EC711	Mobile Communication	EC721	Antenna & Wave Propagation
EC712	Satellite Communication	EC722	RF IC Design
EC713	Nanotechnology and Applications	EC723	Real Time Embedded System

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
EC731	Internet of things	EC741	Low Power VLSI Circuits
EC732	VLSI Design *	EC742	Biomedical Instrumentation
EC733	5G Communication	EC743	MEMs Technology
		EC744	Smart Antenna

* Not for ECE Students

Semester -VIII

Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	EC851	Project-II			17	08
					Total Credit	08

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Mining Engineering

Semester - V

Branch: Mining Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	MN501	Underground Coal Mining	3	1	0	4
2	MN502	Mine Ventilation Engineering	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	MN551	Mine Ventilation Engineering Lab	0	0	3	1
8	MN552	Mining Machinery Lab	0	0	3	1
9	MN553	Computer Application in Mining Lab	0	0	3	1
10	MN554	Internship Assessment	0	0	2	2
Total Credits						21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
MN511	Mining Machinery	MN521	Metalliferous Mining Methods
MN512	Drilling & Blasting	MN522	In -situ Exploitation Methods
MN513	Small Scale Mining	MN523	Waste Management in Mines
MN514	Heavy Earth Moving Machinery (HEMM)	MN524	Marine Exploration & Mining

Code	**Open Elective-I (Any One)**
MN531	Mineral Process Engineering
MN532	Bulk Material Handling
MN533	Clean Coal Technology

Semester - VI

Branch: Mining Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	MN601	Surface Mining Technology	3	1	0	4
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC II	**Open Elective -II**	3	0	0	3
5	OEC III	**Open Elective -III**	3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	MN651	Rock Mechanics Lab	0	0	3	1
8	MN652	Mine Environmental Engineering Lab	0	0	3	1
9	MN653	Mine Electrical Engineering Lab	0	0	3	1
				Total Credits		21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
MN611	Rock Mechanics	MN621	Mine Environmental Engineering
MN612	Rock Fragmentation Engineering	MN622	Mine Ventilation Planning
MN613	Rock Excavation Engineering	MN623	Environmental Impact Assessment
MN614	Rock Slope Engineering	MN624	Mine Environment Administration and Management

Code	**Open Elective-II (Any One)**	Code	**Open Elective-III**
MN631	Mine System Engineering	MN641	Operation Research
MN632	Reliability Engineering	MN642	Tunneling Engineering

Semester -VII

Branch: Mining Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	MN701	Mine Legislation & Safety Engineering	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	MN751	Mine Design Exercise II Lab Lab	0	0	3	1
7	MN752	Project-I	0	0	4	2
8	MN753	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
MN711	Applied Rock Mechanics	MN721	Mine Planning and Design
MN712	Numerical Methods in Geomechanics	MN722	Mine Closure Planning
MN713	Geo - statistics	MN723	Mine Reclamation & Rehabilitation
MN714	Instrumentation in Rock Mechanics	MN724	Sustainable Mining Practices

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
MN731	Mine Economics & Resource Management	MN741	Remote Sensing & GIS
MN732	Mine Management	MN742	Socio-Environmental Impacts of Opencast Mines
		MN743	Sustainable Energy Resources
		MN744	Opencast Mine Machinery

Semester -VIII

Branch: Mining Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	MN851	Project-II			17	08
					Total Credit	08

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Computer Science & Engineering

Semester - V

Branch: Computer Science & Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	CS501	Operating Systems	3	1	0	4
2	CS502	Data Base Management Systems	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	CS551	Operating Systems Lab.	0	0	3	1
8	CS552	DBMS Lab.	0	0	3	1
9	CS553	Programming Lab I	0	0	3	1
10	CS554	Internship Assessment I	0	0	2	2
Total Credits						21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
CS511	Compiler Design	EC524	Analog and Digital Communication
IT511	Internetworking	IT521	Principles of Programming Languages
CS512	System Analysis and Design	IT522	Semantic Web

Code	**Open Elective-I (Any One)**
CS531	Web Technology
CS532	*Computer Architecture
CS533	* Data Structure and Algorithms

* Not for CSE Students

Semester - VI

Branch: Computer Science & Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CS601	Computer Networks	3	1	0	4
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC II	**Open Elective -II**	3	0	0	3
5	OEC III	**Open Elective -III**	3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	CS651	Computer Networks Lab.	0	0	3	1
8	CS652	Programming Lab II	0	0	3	1
9	CS653	Programming Lab III	0	0	3	1
					Total Credits	21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
CS611	Computer Graphics	CS621	Soft Computing.
IT611	System Software	CS622	Natural Language Processing
CS612	Distributed System	IT621	Internet Of Things

Code	**Open Elective-II (Any One)**	Code	**Open Elective-III**
CS631	* Data Base Management Systems	IT641	Information Retrieval Techniques
CS632	*AI and Machine Learning	CS641	*Computer Networks
CS633	Image Processing	CS642	Cloud computing

* Not for CSE Students

Semester -VII

Branch: Computer Science & Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CS701	Artificial Intelligence	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	CS751	Artificial Intelligence Lab.	0	0	3	1
7	CS752	Project-I	0	0	4	2
8	CS753	Internship Assessment II	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
CS711	Machine Learning	IT721	Data Mining and Data Warehousing.
CS712	Multimedia and Applications	IT722	Information Security.
CS713	Human Computer Interaction	CS721	Natural Language Processing

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
IT701	Software Engineering	IT741	Information Security
CS732	Values and Ethics in Profession.	CS741	Cryptography
CS733	*Data Mining	IT742	Knowledge Domain Development

* Not for CSE Students

Semester -VIII

Branch: Computer Science & Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	CS851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Information Technology

Semester - V

Branch: Information Technology

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	CS501	Operating Systems	3	1	0	4
2	CS502	Data Base Management Systems	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	IT551	Operating Systems Lab.	0	0	3	1
8	IT552	DBMS Lab.	0	0	3	1
9	IT553	Programming Lab I	0	0	3	1
10	IT554	Internship Assessment I	0	0	2	2
				Total Credits		21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
CS511	Compiler Design	EC524	Analog and Digital Communication
IT511	Internetworking	IT521	Principles of Programming Languages
CS512	System Analysis and Design	IT522	Semantic Web

Code	**Open Elective-I (Any One)**
CS531	Web Technology
CS532	*Computer Architecture
CS533	*Data Structure and Algorithms

* Not for IT Students

Semester - VI

Branch: Information Technology

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CS601	Computer Networks	3	1	0	4
2	PEC-III	**Professional Elective -III**	3	0	0	3
3	PEC-IV	**Professional Elective -IV**	3	0	0	3
4	OEC II	**Open Elective -II**	3	0	0	3
5	OEC III	**Open Elective -III**	3	0	0	3
6	IC601	Entrepreneurship	2	0	0	2
7	IT651	Computer Networks Lab.	0	0	3	1
8	IT652	Programming Lab II	0	0	3	1
9	IT653	Programming Lab III	0	0	3	1
					Total Credits	21

Code	**Professional Elective-III**	Code	**Professional Elective-IV**
IT612	Management Information System	CS621	Soft Computing.
IT613	E-Commerce	CS622	Natural Language Processing
IT614	Enterprise Resource Planning	IT621	Internet Of Things

Code	**Open Elective-II (Any One)**	Code	**Open Elective-III**
CS631	*Data Base Management Systems	IT641	Information Retrieval Techniques
CS632	*AI and Machine Learning	CS641	*Computer Networks
CS633	Image Processing	CS642	Cloud computing

* Not for IT Students

Semester -VII

Branch: Information Technology

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	IT701	Software Engineering	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	IT751	Software Engineering Lab.	0	0	3	1
7	IT752	Project-I	0	0	4	2
8	IT753	Internship Assessment II	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
CS711	Machine Learning	IT721	Data Mining and Data Warehousing.
CS712	Multimedia and Applications	IT722	Information Security.
CS713	Human Computer Interaction	CS721	Natural Language Processing

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
CS701	Artificial Intelligence	IT741	Information Security
CS732	Values and Ethics in Profession.	CS741	Cryptography
CS733	*Data Mining	IT742	Knowledge Domain Development

* Not for IT Students

Semester -VIII

Branch: Information Technology

S.N.	Code	Course Title	L	T	P	Credits
1.	IT851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Course Structure of Undergraduate
Vinoba Bhave University , Hazaribagh

Semester - V

Branch: Mechanical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	ME501	Heat Transfer	3	1	0	4
2	ME502	Design of Machine Elements	3	0	0	3
3	PEC-I		3	0	0	3
4	PEC-II		3	0	0	3
5	OEC- 1		3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	ME551	Lab I (HMT / Manufacturing Processes (SIEMENS))	0	0	3	1
8	ME552	Lab II (Machine Design)	0	0	3	1
9	ME553	Lab III (I.C. Engine)	0	0	3	1
10	ME554	Internship Assessment	0	0	2	2
				Total Credits		21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
ME511	Principles of Management	ME521	Advanced Materials
ME512	Total Quality Management	ME522	Internal Combustion Engines
ME513	Project Management	ME523	Advanced Welding Technology

Code	**Open Elective-I (Any One)**
ME531	Operations Research
ME532	Non-Conventional Energy Sources
ME533	Design for Manufacturing
ME534	New Venture Creation
ME535	Design and Analysis of Experiments

Semester - V

Branch: Electrical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	EE501	Electrical Machines-II	3	1	0	4
2	EE502	Control Systems	3	0	0	3
3	PEC-I	**Professional Elective-I**	3	0	0	3
4	PEC-II	**Professional Elective-II**	3	0	0	3
5	OEC- I	**Open Elective-I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	EE551	Electrical Machines-II Lab.	0	0	3	1
8	EE552	Control Systems Lab.	0	0	3	1
9	EE553	Professional Elective-I Lab.	0	0	3	1
10	EE554	Internship Assessment	0	0	2	2
				Total Credits		21

	Professional Elective-I (Any one)		**Professional Elective-II (Any one)**
EE511	Microprocessor and Microcontroller	EE521	Signals and Systems
EE512	Electrical Machine Design	EE522	Transforms in Electrical Engineering
EE513	Applied Electrical Engineering	EE523	Electrical Engineering Materials

	Open Elective-I (Any One)
EE531	Control Systems*
EE532	Microprocessor and Microcontroller*
EE533	Electromechanical Energy Conversion and Transformers*
EE534	Power Plant Engineering

* Not for EE Students

Semester - V

Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	EEE501	Electrical Machines-II	3	1	0	4
2	EE502	Control Systems	3	0	0	3
3	PEC-I	**Professional Elective-I**	3	0	0	3
4	PEC-II	**Professional Elective-II**	3	0	0	3
5	OEC- I	**Open Elective-I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	EEE551	Electrical Machines-II Lab.	0	0	3	1
8	EEE552	Control Systems Lab.	0	0	3	1
9	EEE553	Professional Elective-I Lab.	0	0	3	1
10	EEE554	Internship Assessment	0	0	2	2
				Total Credits		21

	Professional Elective-I (Any one)		**Professional Elective-II (Any one)**
EEE511	Microprocessor and Microcontroller	EEE521	Signals and Systems
EEE512	Electrical Machine Design	EEE522	Transforms in Electrical Engineering
EEE513	Applied Electrical Engineering	EEE523	Electrical Engineering Materials

	Open Elective-I (Any One)
EEE531	Control Systems*
EEE532	Microprocessor and Microcontroller*
EEE533	Electromechanical Energy Conversion and Transformers*
EEE534	Power Plant Engineering

* Not for EEE Students

Semester - V

Branch: Production Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	PE501	Manufacturing Process-II	3	1	0	4
2	PE502	Metrology & Measurement	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	PE551	Metrology & Measurement Lab	0	0	3	1
8	PE552	Lab II	0	0	3	1
9	PE553	Lab III	0	0	3	1
10	PE554	Internship Assessment	0	0	2	2
Total Credits						21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
PE511	Engineering Economy	PE521	Value Engineering
PE512	Lean Manufacturing	PE522	Work Study and Ergonomics
PE513	Process Engineering	PE523	Eco-Friendly Manufacturing

Code	**Open Elective-I (Any One)**
PE531	Automobile Engineering
PE532	CAD/CAM
PE533	Industrial Pollution

Semester - V

Branch: Metallurgical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	ML501	Material Characterization (Professional Core course)	3	1	0	4
2	ML502	Degradation of Materials (Professional Core course)	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	ML551	Corrosion Lab	0	0	3	1
8	ML552	Heat Treatment Lab	0	0	3	1
9	ML553	**Met. Lab-I** (Material Characterization & Physics of Material Lab)	0	0	3	1
10	ML554	Internship Assessment	0	0	2	2
	Total Credits					21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
ML511	Heat Treatment of Metallic Materials	ML511	Physics of Materials
ML512	Deformation Theory of Metals	ML522	Casting and Solidification of Materials
ML513	Unit process of Extraction	ML523	Mechanical working of Materials
ML514	Non-ferrous Extractive Metallurgy	ML524	Alternative route of Iron Production
ML515	Phase Transformation	ML525	Electronic, Optical and Magnetic Materials

Code	**Open Elective-I (Any One)**
ML531	Powder Metallurgy
ML532	Nuclear Materials
ML533	Ceramic and Polymer Materials
ML534	Pollution in Metallurgical industries and its control
ML535	Material Technology

Semester - V

Branch: Chemical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	CL501	Mass Transfer operation	3	1	0	4
2	CL502	Chemical Reaction Engineering	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	CL551	Mass Transfer Lab	0	0	3	1
8	CL552	Fluidization Engineering Lab	0	0	3	1
9	CM553	Chemical Reaction Engineering Lab	0	0	3	1
10	CL554	Internship Assessment	0	0	2	2
				Total Credits		21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
CL511	Instrumentation and Process Control	CL521	Numerical Methods in Chemical Engineering
CL512	Process Dynamics andcontrol	CL522	Mathematical Methodism Chemical Engineering
CL513	Computer Aided Process Control	CL523	Optimization of Chemical Processes
		CL524	Fluidization Engineering

Code	**Open Elective-I (Any One)**
CL531	Environmental Engineering
CL532	Industrial Pollution Control

Semester - V

Branch: Civil Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	CE501	Mechanics of Materials	3	1	0	4
2	CE502	Environmental Engineering	3	0	0	3
3	CM713	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	CE551	Concrete Lab	0	0	3	1
8	CE552	Geotechnical Engineering lab	0	0	3	1
9	CE553	Environmental Engineering lab	0	0	3	1
10	CE554	Internship Assessment	0	0	2	2
	Total Credits					21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
CE511	Water Resources Engineering-I	CE521	Steel Structures-I
CE512	Solid waste management	CE522	Advance Geotechnical
CE513	Hydropower engineering	CE523	Industrial Structures
CE514	Advance surveying	CE524	Design of Structural Systems
CE515	Water resources system	CE525	Geotechnical Design
		CE526	Environmental Geo-technology

Code	**Open Elective-I (Any One)**
CE531	Air Pollution & its Control Measures
CE532	Advance Engineering System
CE533	Global Positioning System
CE534	Disaster Management
CE535	Environmental Management System

Semester - V

Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	EC501	Microprocessor& Interfacing	3	1	0	4
2	EC502	Digital Communication System	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	ECE551	Microprocessor Lab	0	0	3	1
8	EC552	Digital Communication Lab	0	0	3	1
9	EC553	**Elective-I** Lab	0	0	3	1
10	EC554	Internship Assessment	0	0	2	2
Total Credits						21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
EC511	Linear Control System	EC521	Signal and System
EC512	Radar Engineering	EC522	Digital Switching and Multiplexing
EC513	Linear Integrated Circuit	EC523	Biosensors

Code	**Open Elective-I (Any One)**
EC531	Electronics Instrumentation
EC532	Digital System Design*
EC533	Materials for Engineering Applications

* Not For ECE Students

Semester - V

Branch: Mining Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	MN501	Underground Coal Mining	3	1	0	4
2	MN502	Mine Ventilation Engineering	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	MN551	Mine Ventilation Engineering Lab	0	0	3	1
8	MN552	Mining Machinery Lab	0	0	3	1
9	MN553	Computer Application in Mining Lab	0	0	3	1
10	MN554	Internship Assessment	0	0	2	2
	Total Credits					21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
MN511	Mining Machinery	MN521	Metalliferous Mining Methods
MN512	Drilling & Blasting	MN522	In -situ Exploitation Methods
MN513	Small Scale Mining	MN523	Waste Management in Mines
MN514	Heavy Earth Moving Machinery (HEMM)	MN524	Marine Exploration & Mining

Code	**Open Elective-I (Any One)**
MN531	Mineral Process Engineering
MN532	Bulk Material Handling
MN533	Clean Coal Technology

Semester - V

Branch: Computer Science & Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	CS501	Operating Systems	3	1	0	4
2	CS502	Data Base Management Systems	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	CS551	Operating Systems Lab.	0	0	3	1
8	CS552	DBMS Lab.	0	0	3	1
9	CS553	Programming Lab I	0	0	3	1
10	CS554	Internship Assessment I	0	0	2	2
	Total Credits					21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
CS511	Compiler Design	EC524	Analog and Digital Communication
IT511	Internetworking	IT521	Principles of Programming Languages
CS512	System Analysis and Design	IT522	Semantic Web

Code	**Open Elective-I (Any One)**
CS531	Web Technology
CS532	*Computer Architecture
CS533	* Data Structure and Algorithms

* Not for CSE Students

Semester - V

Branch: Information Technology

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credit
1	CS501	Operating Systems	3	1	0	4
2	CS502	Data Base Management Systems	3	0	0	3
3	PEC-I	**Professional Elective -I**	3	0	0	3
4	PEC-II	**Professional Elective -II**	3	0	0	3
5	OEC- I	**Open Elective -I**	3	0	0	3
6	HU501	Professional Communication	1	0	2	0
7	IT551	Operating Systems Lab.	0	0	3	1
8	IT552	DBMS Lab.	0	0	3	1
9	IT553	Programming Lab I	0	0	3	1
10	IT554	Internship Assessment I	0	0	2	2
				Total Credits		21

Code	**Professional Elective-I (Any one)**	Code	**Professional Elective-II (Any one)**
CS511	Compiler Design	EC524	Analog and Digital Communication
IT511	Internetworking	IT521	Principles of Programming Languages
CS512	System Analysis and Design	IT522	Semantic Web

Code	**Open Elective-I (Any One)**
CS531	Web Technology
CS532	*Computer Architecture
CS533	*Data Structure and Algorithms

* Not for IT Students

Vinoba Bhave University , Hazaribagh

Mechanical Engineering			
Code: ME501	**Heat Transfer**	**L**	**T**
		3	**1**

Objectives:

(1) The aim of the course is to build a solid foundation in heat transfer exposing students to the three basic modes namely conduction, convection and radiation.
(2) Rigorous treatment of governing equations and solution procedures for the three modes will be provided, along with solution of practical problems using empirical correlations.
(3) The course will also briefly cover boiling and condensation heat transfer, and the analysis and design of heat exchangers.

Contents:

Module 1

Introduction to three modes of heat transfer, Derivation of heat balance equation- Steady one dimensional solution for conduction heat transfer in Cartesian, cylindrical and spherical geometry, concept of conduction and film resistances **(7)**

Module 2

Critical thickness of insulation, lumped system approximation and Biot number, heat transfer through pin fins- Two dimensional conduction solutions for both steady and unsteady heat transfer-approximate solution to unsteady conduction, heat transfer by the use of Heissler charts.

(6)

Module 3

Heat convection, basic equations, boundary layers- Forced convection, external and internal flows-Natural convective heat transfer- Dimensionless parameters for forced and free convection heat transfer-Correlations for forced and free convection. **(7)**

Module 4

Approximate solutions to laminar boundary layer equations (momentum and energy) for both internal and external flow-Estimating heat transfer rates in laminar and turbulent flow situations using appropriate correlations for free and forced convection. **(6)**

Module 5

Interaction of radiation with materials, definitions of radiative properties, Stefan Boltzmann's law, black and gray body radiation, Calculation of radiation heat transfer between surfaces using radiative properties, view factors and the radiosity method. **(10)**

Module 6

Types of heat *exchangers, Analysis and design of heat exchangers using both LMTD and ε-* NTU methods. Exposure of numerical technique of heat transfer. **(7)**

Module 7

Boiling and Condensation heat transfer, Pool boiling curve
Introduction mass of transfer, Fick's law, Similarity between heat and mass transfer. **(7)**

Course Outcomes:

1. After completing the course, the students will be able to formulate and analyze a heat transfer problem involving any of the three modes of heat transfer.

2. The students will be able to obtain exact solutions for the temperature variation using analytical methods where possible or employ approximate methods or empirical correlations to evaluate the rate of heat transfer.
3. The students will be able to design devices such as heat exchangers and also estimate the insulation needed to reduce heat losses where necessary.

Text Books:

1. P. K. Nag, Heat and Mass Transfer
2. Yunus A Cengel, Heat Transfer : A Practical Approach, McGraw Hill, 2002
3. Frank Kreith, Raj M. Manglik, Mark S. Bohn: Principles of Heat Transfer, Cengage Learning

References Books:

1. A. Bejan, Heat Transfer John Wiley, 1993
2. J.P.Holman, Heat Transfer, Eighth Edition, McGraw Hill, 1997.
3. F.P.Incropera, and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, John Wiley, Sixth Edition, 2007.
4. MassoudKaviany, Principles of Heat Transfer, John Wiley, 2002

Vinoba Bhave University , Hazaribagh

Mechanical Engineering			
Code: ME502	**Design of Machine Elements**	**L**	**T**
		3	**0**

Objectives:

This course seeks to provide an introduction to the design of machine elements commonly encountered in mechanical engineering practice, through

1. A strong background in mechanics of materials based failure criteria underpinning the safety-critical design of machine components
2. An understanding of the origins, nature and applicability of empirical design principles, based on safety considerations
3. An overview of codes, standards and design guidelines for different elements
4. An appreciation of parameter optimization and design iteration
5. An appreciation of the relationships between component level design and overall machine system design and performance

Course Contents:

Design considerations - limits, fits and standardization, Review of failure theories for static and dynamic loading (including fatigue failure), Design of shafts under static and fatigue loadings, Analysis and design of sliding and rolling contact bearings, Design of transmission elements: spur, helical, bevel and worm gears; belt and chain drives, Design of springs: helical compression, tension, torsional and leaf springs, Design of joints: threaded fasteners, pre-loaded bolts and welded joints, Analysis and applications of power screws and couplings, Analysis of clutches and brakes, Engine Components. (40)

Course Outcomes:

Upon completion of this course, students will get an overview of the design methodologies employed for the design of various machine components

Text Books:

[1] Shigley, J.E. and Mischke, C.R., Mechanical Engineering Design, Fifth Edition, McGraw-Hill International; 1989.
[2] Deutschman, D., Michels, W.J. and Wilson, C.E., Machine Design Theory and Practice, Macmillan, 1992.
[3] Juvinal, R.C., Fundamentals of Machine Component Design, John Wiley, 1994.
[4] Spottes, M.F., Design of Machine elements, Prentice-Hall India, 1994.
[5] R. L. Norton, Mechanical Design – An Integrated Approach, Prentice Hall, 1998

Vinoba Bhave University , Hazaribagh

Mechanical Engineering			
HU501	**Professional Communication**	**L**	**P**
		1	**2**

Course Overview:

This course is designed to help one develop communication skills in English with a sense of language. It will be of help to improve clarity, precision and overall impact in both oral as well as written communication. It will also enable one to produce clear and effective scientific and technical documents required for professional communication. We will focus on basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations. One can learn how to gather, organize, and present information effectively according to audience and purpose. Moreover, emphasis will be on sustainable communication that will facilitate an understanding of one's role and help to align with the mission of the organization.

Objective:

To provide you with the communication skills one needs to advance in a field, keeping in mind that, in career, one may be involved with design, development, field service and support, management, sales, customer liaison, or all of the above.

Course Outcomes:

CO 1: Demonstrate effective oral and written communication with diverse audiences and produce variety in professional written documents to better support and communicate.
CO 2: Plan and deliver a formal presentation on a topic with confidence and poise.
CO 3: Appraise ethics and social responsibility as a professional.
CO 4: Apply analytical skills and critical thinking to solve problems and can express using sound logical arguments utilizing the best available resources for communication.
CO 5: Exhibit an understanding of multiculturalism and be able to work well in teams.

Lecture 1-10

<u>Introduction to Communication</u>

Communication and Self Concept
Role of Emotions
Basics of Communication
Purpose of communication- to inform, to express feelings, to imagine, to influence, to meet social expectations and others
Audience analysis- identifying audience to determine the content, language usage and listener expectations for ensuring effective communication
Cross Cultural Communication and Multi Cultural Communication
Effective Communication: Modes/ Models/Networks

LSRW Skills
Non-Verbal Communication

<u>Barriers to Communication</u>

Introduction
Intrapersonal and Interpersonal Barriers

Organizational Barriers
Information Gap Principle, Noise, Filters

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<u>Effective Listening and Speaking</u> Traits of a good listener Phonetics – Basic Sounds of English – Word Accent - Intonation Achieving confidence, clarity and fluency as a speaker, paralinguistic features, barriers to speaking, types of speaking, Persuasive Speaking, Public Speaking etc. **Additional exercises and activities based on developing Listening and Speaking skills**
Lecture 11-15 Planning, Outlining and Structuring Choosing the mode of delivery Guidelines for effective delivery, Body Language and Voice, Visual Aids etc. **Activities and practice on developing Presentation skills**
Lecture 16-20 Introduction, Objectives, Types, Samples and Examples Problem Solving, Networking in English Meetings and Conferences Minutes of Meeting, Agenda of Meeting **Activities and exercise based on developing GD and Business Networking skills in English**
Lecture 21-30 Introduction, Audience Recognition, Language, Grammar, Style, Techniques The Art of Condensation Note Making and Note Taking Guidelines and Samples **<u>Business/Official Communication</u>** Letters, Resumes, Memos, and e-mails Rules, formats, Style, Etiquette Sales and Credit letters Letter of Enquiry Letter of Quotation, Order, Claim and Adjustment Government Letters, Semi- Government Letters to Authorities etc. Characteristics, Categories, Formats, Structures, Types, Samples Job Application Curriculum vitae Resumes- Chronological, Combination, Functional etc. Reports and Proposals of different kinds **Exercise and activities based on developing Writing skills**
Lecture 31-35 Right Words and Phrases, Sentence Patterns Paragraph Comprehension Passage etc. **Activities and Strategies to engage in active thinking about word meanings, the relationships among words, and use of words in different situations**

Lecture 36-40 Types: Skimming, Scanning, Intensive, Extensive Value Based/Motivational Materials: Articles, Prose, Text Reading **Activities and exercise based on developing Reading skills**
Lecture 41-45 Types and Overview Emotional Intelligence Decision Making and Time Management **Activities and exercise based on developing Leadership and Management skills**

Recommended Texts:

1. Raman , Meenakshi and Sangeeta Sharma. *Technical Communication: Principles and Practice.* 2nd ed. OUP India, 2012.
2. Markel, Mike. *Technical Communication*. 7th ed. New York, NY: Bedford/St. Martin's, 2003. ISBN: 9780312403386.
3. Gamble, Teri Kwal and Michael Gamble. *Communication Works.* 9th Ed. New Delhi: Tata-McGraw-Hill, 2010.
4. Hacker, Diana. *A Pocket Style Manual*. 4th ed. New York, NY: Bedford/St. Martin's, 1999. ISBN: 9780312406844.
5. Perelman, Leslie C., James Paradis, and Edward Barrett. *The Mayfield Handbook of Technical and Scientific Writing*. New York, NY: McGraw-Hill, 1997. ISBN: 9781559346474.
6. **David F. Beer and** David McMurrey**, *Guide to Writing as an Engineer*, 2nd ed., Wiley, 2004,** ISBN: 0471430749.
7. Dale Jungk, *Applied Writing for Technicians*, McGraw-Hill, 2005, ISBN 0-07-828357-4.

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Mechanical Engineering			
ME511	**Principles of Management**	**L**	**T**
		3	**0**

Objectives:
To understand the principles of management and their application to the functioning of an organization
Contents:
Module 1
Definition of management, science or art, manager vs entrepreneur; Types of managers managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches. **(5)**

Module 2
Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management. **(7)**

Module 3
Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes. Nature and purpose of Organizing, formal and informal organization. **(5)**

Module 4
organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management. **(7)**

Module 5
Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication.
Controlling, system and process of controlling, budgetary and non-budgetary control techniques. **(7)**

Module 6
use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.
Inventory Management. **(11)**

Module 7
Financial Management: Cost concepts and clarification; CUP and Break Even Analysis; Basic Concept of Financial statement; Balance sheet; Profit loss account, Cash flow statement, Sources of long term finance, Capital budgeting techniques. **(10)**

Course Outcomes:
Upon completion of this course, the students will get a clear understanding of management functions in an organization
Text Books:
1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999

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Mechanical Engineering			
ME512	**Total Quality Management**	**L**	**T**
		3	**0**

Objectives:
To facilitate the understanding of total quality management principles and processes.

Contents:

Module 1
Introduction, need for quality, evolution of quality; Definitions of quality, product quality and service quality; Basic concepts of TQM, TQM framework, contributions of Deming, Juran and Crosby. **(5)**

Module 2
Barriers to TQM; Quality statements, customer focus, customer orientation & satisfaction, customer complaints, customer retention; cost of quality. **(6)**

Module 3
TQM principles; leadership, strategic quality planning; Quality councils- employee involvement, motivation; Empowerment; Team and Teamwork; Quality circles, recognition and reward, performance appraisal. **(6)**

Module 4
Continuous process improvement; PDCA cycle, 5S, Kaizen; Supplier partnership, Partnering, Supplier rating & selection. **(6)**

Module 5
The seven traditional tools of quality; New seven management tools; Six sigma- concepts, methodology, applications to manufacturing, service sector including IT, Bench marking process; FMEA- stages, types. **(7)**

Module 6
TQM tools and techniques, control charts, process capability, concepts of six sigma, Quality Function Development (QFD), Taguchi quality loss function; TPM- concepts, improvement needs, performance measures; TQM implementation in manufacturing and service sectors. **(12)**

Module 7
Quality systems, need for IS/ISO 9000 / ISO 9001; Quality system- elements, documentation; Quality auditing, ISO 14000- concepts, requirements and benefits; ISO 45001 (OHSMS). **(8)**

Course Outcomes:
Upon completion of this course, the students will be able to use the tools and techniques of TQM in manufacturing and service sectors.

Text Books:

1. Besterfield D.H. et al., Total quality Management, 3rd ed., Pearson Education Asia, 2006.
2. Evans J.R. and Lindsay W.M., The management and Control of Quality, 8th ed., first Indian edition, Cengage Learning, 2012.
3. Janakiraman B. and Gopal R.K., Total Quality Management, Prentice Hall India, 2006.
4. Suganthi L. and Samuel A., Total Quality Management, Prentice Hall India, 2006.

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Mechanical Engineering			
ME513	**Project Management**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the importance of projects and its phases.
2. Analyze projects from marketing, operational and financial perspectives.
3. Evaluate projects based on discount and non-discount methods.
4. Develop network diagrams for planning and execution of a given project.
5. Apply crashing procedures for time and cost optimization.

Contents:

Module 1

Introduction: Introduction to Project Management, History of Project Management, Project Life Cycle. Project Analysis: Facets of Project Analysis. **(5)**

Module 2

Strategy and Resource Allocation, Market and Demand Analysis, Technical Analysis, Economic and Ecological Analysis. **(7)**

Module 3

Financial Analysis: Financial Estimates and Projections, Investment Criteria, Financing of Projects; Capital Budgeting. **(9)**

Module 4

Network Methods in PM: Origin of Network Techniques, Project Scheduling Techniques, CPM network, PERT network, Other network models. **(10)**

Module 5

Optimisation in PM: Time and Cost trade-off in CPM, Crashing procedure, Scheduling when resources are limited. **(6)**

Module 6

Project Risk Management: Scope Management, Work Breakdown Structure, Earned Value Management, Project Risk Management. **(9)**

Module 7

Project Information System. **(2)**

Text Books:

1. Prasanna Chandra, Project: A Planning Analysis, Tata McGraw Hill Book Company, New Delhi, 4th Edition, 2009.
2. Cleland, Gray and Laudon, Project Management, Tata McGraw Hill Book Company, New Delhi, 3rd Edition, 2007.
3. Jack R. Meredith., Samuel J. Jr. Mantel., Project Management - A Managerial Approach, John Wiley, 6th Edition, 2011.

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Mechanical Engineering			
ME521	**Advanced Materials**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the synthesis and properties of nanomaterials
2. Evaluate the usefulness of nanomaterials in medicine, biology and sensing
3. Understand modeling of composite materials by finite element analysis
4. Differentiate superconducting materials CO5 Understand the characteristics and uses of functional materials

Contents:

Module 1

Nano Materials: Origin of nano technology, Classification of nano materials, Physical, chemical, electrical, mechanical properties of nano materials. Preparation of nano materials by plasma arcing, physical vapour deposition, chemical vapour deposition (CVD), Sol-Gel, electro deposition, ball milling, carbon nano tubes(CNT).Synthesis, preparation of nanotubes, nano sensors, Quantum dots, nano wires, nano biology, nano medidcines. **(8)**

Module 2

Biomaterials: Overview of biomaterials. Biomaterials, bioceramics, biopolymers, tissue grafts, soft tissue applications, cardiovascular implants, biomaterials in ophthalmology, orthopeadiacimplants, dental materials. **(7)**

Module 3

Composites: General characteristics of composites, composites classes, PMCs, MMCs, CMCs, CCCs, IMCs, hybrid composites, fibers and matrices, different types of fibers, whiskers, different matrices materials, polymers, metal, ceramic matrices, toughening mechanism, interfaces, blending and adhesion, composite modeling, finite element analysis and design. **(8)**

Module 4

Optical materials: Mechanisms of optical absorption in metals, semiconductors and insulators. Nonlinear optical materials, optical modulators, optical fibers. Display devices and materials photo-emissive, photovoltaic cells, charge coupled devices(CCD), laser materials. **(7)**

Module 5

Super conducting materials: Types of super conductors, an account of mechanism of superconductors, effects of magnetic field currents, thermal energy, energy gap, acoustic attenuation, penetration depth, BCS theory, DC and AC Josephson effects, high Tc superconductors, potential applications of superconductivity, electrical switching element, superconductor power transmission and transformers, magnetic mirror, bearings, superconductor motors, generators, SQUIDS etc. **(8)**

Module 6

Smart materials: An introduction, principles of smart materials, input – output decision ability, devices based on conductivity changes, devices based on changes in optical response, biological systems smart materials. Devices based on magnetization, artificial structures, surfaces, hetero structures, polycrystalline, amorphous, liquid crystalline materials. **(7)**

Module 7

Surface Acoustic Wave (SAW) Materials and Electrets: Delay lines, frequency filters, resonators, Pressure and temperature sensors, Sonar transducers. Comparison of electrets with permanent magnets, Preparation of electrets, Application of electrets. **(5)**

Text Books:

1. T.Pradeep, Nano: The Essentials; TaTa McGraw-Hill,2008.
2. B.S. Murthy et al., Textbook of Nano science and Nanotechnology, University press
3. Krishan K Chawla, Composite Materials; 2nd Ed., Springer 2006

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Mechanical Engineering			
ME522	**Internal Combustion Engines**	**L**	**T**
		3	**0**

Internal Combustion Engines

Objectives:

1. To familiarize with the terminology associated with IC engines.
2. To understand the basics of IC engines.
3. To understand combustion, and various parameters and variables affecting it in varioustypes of IC engines.
4. To learn about various systems used in IC engines and the type of IC engine required forvarious applications

Course Contents:

Review of ideal cycles; Details of fuel-air cycles. Combustion in SI andCI engines, Combustion stages, Combustion chambers and Abnormal combustion. Fuelsupply systems in SI and CI engines, carburettors, Port fuel injection, Direct injection andCommon rail injection. Ignition system, Lubrication system and Cooling system. Testing ofIC engines. Engine emissions and control. Advanced IC Engine concepts. (40)

Course Outcomes:

Students who have done this course will have a good idea of the basics of IC engines andhow different parameters influence the operational characteristics of IC Engines

Text Books:

1. Obert E. F, "Internal Combustion Engines and Air Pollution", Harper and Row PublicationInc. NY, 1973.

2. Heisler H, "Advanced Engine Technology", Edward Arnold, 1995.3. Heywood J. B, "Internal Combustion Engine Fundamentals", McGraw Hill Book Co. NY,1989

4. Heldt P. M, "High Speed Combustion Engines", Oxford &IBH publishing Co. India,1985.

5. Stockel M W, Stockel T S and Johanson C, "Auto Fundamentals", The Goodheart, WilcoxCo. Inc., Illinois, 1996.

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Mechanical Engineering			
ME523	**Advanced Welding Technology**	**L**	**T**
		3	**0**

Advanced Welding Technology

Course Outcomes: At the end of the course, the student will be able to:

1. Understand solid state welding processes and applications.
2. Identify suitable reinforcement and matrix materials for preparation of composites using friction stir processing.
3. Understand basic principle of electron beam and laser beam processes and its application.
4. Understand weldability of cast iron and high carbon steel.
5. Select welding power sources.
6. Understand the importance of grain growth mechanism and related properties.

Contents:

Module 1
Solid state welding: classification of solid state welding processes, Adhesive bonding , advantages and applications. **(5)**

Module 2
Friction welding: Friction welding process variables, welding of similar and dissimilar materials, Defective analysis of friction welded components, Friction welding of materials with inter layer. **(9)**

Module 3
Friction stir welding: Processes parameters, tool geometry, welding of Aluminium alloys, Friction stir welding of Aluminum alloys and Magnesium alloys. **(9)**

Module 4
Electron Beam welding (EBW): Electron Beam welding process parameters, atmospheric affect Defective analysis of Electron beam welds and Electron Beam welding dissimilar materials. **(6)**

Module 5
Laser Beam welding (LBW): Laser Beam welding process parameters, atmospheric affect and Laser Beam welding of steels. **(8)**

Module 6
Selection power source : Constant voltage and constant current power sources. **(6)**

Module 7
Weldability of cast iron and steel : weldability studies of cast iron and steel. **(7)**

Text Books:

1. Nadkarni S.V., Modern Welding Technology, Oxford IBH Publishers, 1996.
2. Parmar R. S., Welding Engineering and Technology, Khanna Publishers, 2005.
3. D. L. Olson, T. A. Siewert, Metal Hand Book, Vol 06, Welding, Brazing and Soldering, ASM International Hand book Metals Park, Ohio USA, 2008.

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Mechanical Engineering			
ME531	**Operations Research**	**L**	**T**
		3	**0**

Course Objectives **:** This course enables the students:

(1) Formulate a real-world problem as a mathematical programming model
(2) Know the theoretical workings of the simplex method for linear programming and perform iterations of it
(3) Analyze the relationship between a linear program and its dual, including strong duality and complementary slackness
(4) Solve specialized linear programming problems like the transportation, assignment, sequencing, games theory, and queuing model problems
(5) The use of Operations Research approaches in solving real problems in industry; mathematical models for analysis of real problems in Operations Research.

Course Outcomes **:** After completion of the course, the learners will be able to:

(1) Capability to recognize the importance and value of Operations Research and mathematical modeling.
(2) Ability formulate a managerial decision problem into a mathematical model;
(3) Recognize Operations Research models and apply them to real-life problems;
(4) Use various approaches to solve a mathematical model for various practical problems in industry.

Syllabus

Module 1
Introduction**:** Scope and limitations of O.R., **Linear Programming:** Mathematical formulation of the problem. Graphic solution. **(5)**

Module 2
Linear Programming**:** The simplex method. Big-M Method, Concept of duality, Dual simplex method. **(7)**

Module 3
Transportation Model**:** Basic feasible solution by different methods, Finding optimal solutions, Degeneracy in transportation problems, Unbalanced transportation problems. **(8)**

Module 4
Assignment Model**:** Balanced and unbalanced assignments, Assignment to given schedules. **(6)**

Module 5
Sequencing**:** Processing of 2 jobs through machines –graphical method, Processing of n jobs through two machines, Processing n jobs through three machines. **(10)**

Module 6
Games Theory**:** Two-persons zero sum games, Pure and mixed strategies, Rules of dominance, Solution methods without saddle point. **(7)**

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Module 7

Queuing Model**:** Queuing systems and their characteristics, The M/M/1/FIFO/∞ Queuing system. Basic concept and applications of Non-linear programming. **(7)**

Text Books:

1. P. Rama Murthy , Operations Research, New Age, New Delhi
2. P.K. Gupta & D. S. Hira , Operations Research, S.Chand & Company Ltd, New Delhi.

References Books:

1. Hamdy A Taha, 1999. Introduction to Operations Research, PHI Limited, New Delhi.
2. Sharma, J.K., 1989. Mathematical Models in Operations Research, Tata McGraw Hill publishing Company Ltd., New Delhi.
3. Beer, Stafford, 1966. Decision and Control, John Wiley & Sons, Inc., New York.

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Mechanical Engineering			
ME532	**Non-Conventional Energy Sources**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Identify renewable energy sources and their utilization.
2. Understand the basic concepts of solar radiation and analyze the working of solar PV and thermal systems.
3. Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, biogas and hydrogen.
4. Understand the concepts and applications of fuel cells, thermoelectric convertor and MHD generator.
5. Identify methods of energy storage for specific applications.

Contents:

Module 1
Introduction: Overview of the course; Examination and Evaluation patterns; Global warming; Introduction to Renewable Energy Technologies **(5)**

Module 2
Energy Storage: Introduction; Necessity of Energy Storage; Energy Storage Methods
Solar Energy: Fundamentals; Solar Radiation; Estimation of solar radiation on horizontal and inclined surfaces; Measurement of solar radiation data. **(10)**

Module 3
Solar Thermal systems: Introduction; Basics of thermodynamics and heat transfer; Flat plate collector; Evacuated Tubular Collector; Solar air collector; Solar concentrator; Solar distillation; Solar cooker; Solar refrigeration and air conditioning; Thermal energy storage systems. **(8)**

Module 4
Solar Photovoltaic systems: Introduction; Solar cell Fundamentals; Characteristics and classification; Solar cell: Module, panel and Array construction; Photovoltaic thermal systems. **(7)**

Module 5
Wind Energy: Introduction; Origin and nature of winds; Wind turbine siting; Basics of fluid mechanics; Wind turbine aerodynamics; wind turbine types and their construction; Wind energy conversion systems. **(6)**

Module 6
Fuel cells: Overview; Classification of fuel cells; Operating principles; Fuel cell thermodynamics. Biomass Energy: Introduction; Photosynthesis Process; Biofuels; Biomass Resources; Biomass conversion technologies; Urban waste to energy conversion; Biomass gasification. **(4)**

Module 7
Other forms of Energy: Introduction: Nuclear, ocean and geothermal energy applications; Origin and their types; Working principles. **(4)**

Text Books:

1. Sukhatme S.P. and J.K.Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill, New Delhi, 2008.
2. Khan B.H., Non-Conventional Energy Resources,Tata McGraw Hill, New Delhi, 2006.
3. J.A. Duffie and W.A. Beckman, Solar Energy - Thermal Processes, John Wiley, 2001.
4. H. P. Garg, J. Prakash. Solar Energy – Fundamentals and Applications, Mc. Graw Hill.

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Mechanical Engineering			
ME533	**Design for Manufacturing**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the design principles of design for manufacturing processes
2. Estimates the cost of dies, molds and machined components based on die life.
3. Understand the design for manual assembly and automated assembly.
4. Design typical assemblies using principles of design for X concepts.
5. Understand the design rules for machining with single point and multi point cutting tools.

Contents:

Module 1
Introduction: Overview of the course, Design for manufacturing, Typical Case studies, Innovative product and service designs. **(5)**

Module 2
Material Selection: Requirements for material selection, systematic selection of processes and materials, ASHBY charts. **(5)**

Module 3
Design for Casting: Basic characteristics and Mold preparation, Sand casting alloys, Design rules for sand castings, Example calculations, Investment casting overview, Cost estimation, Number of parts per cluster, Ready to pour liquid metal cost, Design guidelines for Investment casting, Die casting cycle, Determination of optimum number of cavities, appropriate machine size, Die cost estimation, Design principles. **(10)**

Module 4
Design for Injection molding: Injection molding systems, Molds, molding cycle time, mold cost estimation, estimation of optimum number of cavities, Assembly techniques, Design Guidelines.
Design for Hot Forging: Characteristics of the forging process, forging allowances, flash removal, die cost estimation,Die life and tool replacement costs. **(12)**

Module 5
Design for Sheet metal working: Press selection, press brake operations, Design rules.
Design for Powder Metal processing: Powder metallurgy, tooling and presses for Compaction, Sintering, materials, heat treatments, Design guidelines. **(6)**

Module 6
Design for machining: Machining using single point cutting tools, multipoint cutting tools, abrasive wheels, Assembly, cost estimation for machined components, Design guidelines. **(6)**

Module 7
Design for Assembly: Design guidelines for manual assembly, large assemblies, analysis of an assembly, rules for product design for automation, design for robot assembly, Design for manufacture and Computer aided design. **(6)**

Text Books:

1. Geoffrey Boothroyd, Dewhurst.P, Knight.W, roduct design for manufacture and assembly, CRC press, 2002
2. George E Dieter, Engineering Design- A material processing approach, 5/E. Mc Graw hill international, 2003.
3. ASM Handbook, Design for manufacture, 2000.

Mechanical Engineering			
ME534	**New Venture Creation**	**L**	**T**

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	3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand entrepreneurship and entrepreneurial process and its significance in economic development.
2. Develop an idea of the support structure and promotional agencies assisting ethical entrepreneurship.
3. Identify entrepreneurial opportunities, support and resource requirements to launch a new venture within legal and formal frame work.
4. Develop a framework for technical, economic and financial feasibility.
5. Evaluate an opportunity and prepare a written business plan to communicate business ideas effectively.
6. Understand the stages of establishment, growth, barriers, and causes of sickness in industry to initiate appropriate strategies for operation, stabilization and growth.

Contents:

Module 1

Entrepreneur and Entrepreneurship: Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises. **(12)**

Module 2

Establishing Small Scale Enterprise: Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site. **(8)**

Module 3

Planning a Small Scale Enterprsies: Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership. **(10)**

Module 4

Operational Issues in SSE: Financial management issues; Operational/project management issues in SSE; Marketing management issues in SSE; Relevant business and industrial Laws. **(10)**

Module 5

Performance appraisal and growth strategies: Management performance assessment and control; Causes of Sickness in SSI, Strategies for Stabilization and Growth. **(10)**

Text Books:

1. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013.
2. D.F. Kuratko and T.V. Rao, Entrepreneurship: A South-Asian Perspective, Cengage Learning, 2013
3. Dr. S.S. Khanka, Entrepreneurial Development (4th ed.), S Chand & Company Ltd., 2012.
4. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.

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Mechanical Engineering			
ME535	**Design and Analysis of Experiments**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Identify objectives and key factors in designing experiments.
2. Develop appropriate experimental design to conduct experiments.
3. Analyze experimental data and draw valid conclusions.
4. Develop empirical models using experimental data to optimize process parameters.
5. Design robust products and processes using parameter design approach.
6.

Contents:

Module 1

Fundamentals of Experimentation: Role of experimentation in rapid scientific progress, Historical perspective of experimental approaches, Steps in experimentation, Principles of experimentation. **(10)**

Module 2

Simple Comparative Experiments: Basic concepts of probability and statistics, Comparison of two means and two variances, Comparison of multiple (more than two) means & ANOVA; Z- test, x^2 test, F- test. **(12)**

Module 3

Experimental Designs: Factorial designs, fractional factorial designs, orthogonal arrays, standard orthogonal arrays & interaction tables, modifying the orthogonal arrays, selection of suitable orthogonal array design, analysis of experimental data. **(12)**

Module 4

Response Surface Methodology: Concept, linear model, steepest ascent, second order model, regression. **(8)**

Module 5

Taguchi's Parameter Design: Concept of robustness, noise factors, objective function & S/N ratios, inner-array and outer-array design, data analysis. **(8)**

Text Books:

1. Montgomery DC, Design and Analysis of Experiments, 7th Edition, John Wiley & Sons, NY, 2008.
2. Ross PJ, Taguchi Techniques for Quality Engineering, McGraw-Hill Book Company, NY, 2008.

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Electrical Engineering			
EE501	**Electrical Machines-II**	**L**	**T**
		3	**1**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the construction and principle of operation of synchronous machines.
CO2	**Analyze** the effects of excitation and mechanical input on the operation of synchronous Machine.
CO3	**Understand** the operation principles of Reluctance motor, shaded pole, Hysteresis motor, and Universal motor, PMBLDC, tachometer, synchro and identify the suitable applications.
CO4	**Analyze** single phase induction motors and **identify** the suitable methods of starting.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2		1					2
CO2	3	3	2	2	2		1					2
CO3	3	3	2	2	2		1					2
CO4	3	3	2	2	2		1					2
Avg.	**3**	**3**	**2**	**2**	**2**		**1**					**2**

DETAILED SYLLABUS

Module I: Fundamentals of A.C. Machines (8 Lectures)

Fundamental principles of A.C. machines: E.M.F equation of an elementary alternator, single & three phase, factors affecting the induced e.m.f, full pitch & fractional pitch windings, winding factors, armature reaction, concept of time phasor & space phasor.

Module-II: Synchronous Generator (16 Lectures)

Various types and construction, cylindrical rotor theory, phasor diagram, open circuit & short circuit characteristics, armature reaction, synchronous reactance, SCR, load characteristics, potier reactance, voltage regulation, E.M.F. method, MMF method, ZPF method, power angle characteristics.

Theory of salient pole machine: Blondel's two reaction theory, phasor diagram, direct axis and quadrature axis synchronous reactance, power angle characteristics, slip test, parallel operation: Synchronizing method, effect of wrong synchronization, load sharing between alternators in parallel, transient & sub-transient reactances.

Module-III: Synchronous motor (8 Lectures)

General physical consideration, torque & power relations in salient and non-salient pole motors, V-curves & inverted V-curves, effect of change of excitation, synchronous condenser, stating of synchronous motor, performance characteristics of synchronous motor, hunting.

Module-IV: Single phase motors **(7 Lectures)**
Induction type, Double revolving field theory, equivalent circuit, characteristics & starting of single phase motor, shaded pole machine, synchronous type, hysteresis motor, reluctance motor.

Module V: Single phase special type of machines **(3 Lectures)**
Switched reluctance motor, PMBLDC motor, tachometer, two phase control motor, Synchro.

Text Books:

[1]. Electric Machines by I.J.Nagrath & D.P.Kothari,Tata Mc Graw Hill, 7th Edition.2005
[2]. Electrical machines by PS Bhimbra, Khanna Publishers.
[3]. Electric machinery by A.E. Fitzgerald, C.Kingsley and S.Umans, Mc Graw Hill Companies, 5^{th} edition.
[4]. Electric Machinery Fundamentals by Stephen Chapman Mc Graw Hill Company.

Reference Books:

[1]. Theory of Alternating Current Machinery- by Langsdorf, Tata McGraw-Hill Companies, 2^{nd} edition.
[2]. Performance and Design of AC Machines by M G. Say, BPB Publishers.

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Electrical Engineering			
EE502	**CONTROL SYSTEMS**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyze** electromechanical systems by mathematical modeling.
CO2	**Determine** Transient and Steady State behavior of systems using standard test signals.
CO3	**Analyze** linear systems for steady state errors, absolute stability and relative stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: **(8 Lectures)**

Concepts of system, open loop and closed loop systems, Benefits of Feedback, Mathematical modeling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams; Signal flow graphs and Mason's gain formula.

Module II **(12 Lectures)**

Time domain performance criterion, transient response of first order, second order systems; Steady state errors: static and dynamic error constants, system types, steady state errors for unity and non unity feedback systems, performance analysis for P, PI and PID controllers.

Concept of stability by Routh stability criterion, root-loci and root contours.

Module III **(8 Lectures)**

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module IV: **(7 Lectures)**

Compensation - lag, lead and lag-lead networks, design of compensation networks using time response and frequency response of the system.

Module V: **(7 Lectures)**

Concepts of state, state variables, state variable representation of system, dynamic equations, merits for higher order differential equations and solution. Concept of controllability and observability and techniques to test them.

Text/References:

[1]. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009

[2]. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.

[3]. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.

[4]. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.

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Electrical Engineering			
HU50I	**Professional Communication**	**L**	**T**
		1	**2**

Course Overview:

This course is designed to help one develop communication skills in English with a sense of language. It will be of help to improve clarity, precision and overall impact in both oral as well as written communication. It will also enable one to produce clear and effective scientific and technical documents required for professional communication. We will focus on basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations. One can learn how to gather, organize, and present information effectively according to audience and purpose. Moreover, emphasis will be on sustainable communication that will facilitate an understanding of one's role and help to align with the mission of the organization.

Objective:

To provide you with the communication skills one needs to advance in a field, keeping in mind that, in career, one may be involved with design, development, field service and support, management, sales, customer liaison, or all of the above.

Course Outcomes:

CO 1: Demonstrate effective oral and written communication with diverse audiences and produce variety in professional written documents to better support and communicate.
CO 2: Plan and deliver a formal presentation on a topic with confidence and poise.
CO 3: Appraise ethics and social responsibility as a professional.
CO 4: Apply analytical skills and critical thinking to solve problems and can express using sound logical arguments utilizing the best available resources for communication.
CO 5: Exhibit an understanding of multiculturalism and be able to work well in teams.

Lecture 1-10

<u>Introduction to Communication</u>

Communication and Self Concept
Role of Emotions
Basics of Communication
Purpose of communication- to inform, to express feelings, to imagine, to influence, to meet social expectations and others
Audience analysis- identifying audience to determine the content, language usage and listener expectations for ensuring effective communication
Cross Cultural Communication and Multi Cultural Communication
Effective Communication: Modes/ Models/Networks

LSRW Skills
Non-Verbal Communication

<u>Barriers to Communication</u>

Introduction
Intrapersonal and Interpersonal Barriers

Organizational Barriers
Information Gap Principle, Noise, Filters

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<u>Effective Listening and Speaking</u>
Traits of a good listener
Phonetics – Basic Sounds of English – Word Accent - Intonation Achieving confidence, clarity and fluency as a speaker, paralinguistic features, barriers to speaking, types of speaking, Persuasive Speaking, Public Speaking etc.

Additional exercises and activities based on developing Listening and Speaking skills

Lecture 11-15
Planning, Outlining and Structuring
Choosing the mode of delivery
Guidelines for effective delivery,
Body Language and Voice, Visual Aids etc.
Activities and practice on developing Presentation skills

Lecture 16-20
Introduction, Objectives, Types, Samples and Examples
Problem Solving, Networking in English
Meetings and Conferences
Minutes of Meeting, Agenda of Meeting
Activities and exercise based on developing GD and Business Networking skills in English

Lecture 21-30
Introduction, Audience Recognition, Language, Grammar, Style, Techniques
The Art of Condensation
Note Making and Note Taking
Guidelines and Samples
<u>Business/Official Communication</u>
Letters, Resumes, Memos, and e-mails
Rules, formats, Style, Etiquette
Sales and Credit letters
Letter of Enquiry
Letter of Quotation, Order, Claim and Adjustment
Government Letters, Semi- Government Letters to Authorities etc.
Characteristics, Categories, Formats, Structures, Types, Samples
Job Application
Curriculum vitae
Resumes- Chronological, Combination, Functional etc.
Reports and Proposals of different kinds
Exercise and activities based on developing Writing skills

Lecture 31-35
Right Words and Phrases,
Sentence Patterns
Paragraph
Comprehension Passage etc.
Activities and Strategies to engage in active thinking about word meanings, the relationships among words, and use of words in different situations

Lecture 36-40 Types: Skimming, Scanning, Intensive, Extensive Value Based/Motivational Materials: Articles, Prose, Text Reading **Activities and exercise based on developing Reading skills**
Lecture 41-45 Types and Overview Emotional Intelligence Decision Making and Time Management **Activities and exercise based on developing Leadership and Management skills**

Recommended Texts:

1. Raman , Meenakshi and Sangeeta Sharma. *Technical Communication: Principles and Practice*. 2nd ed. OUP India, 2012.
2. Markel, Mike. *Technical Communication*. 7th ed. New York, NY: Bedford/St. Martin's, 2003. ISBN: 9780312403386.
3. Gamble, Teri Kwal and Michael Gamble. *Communication Works.* 9th Ed. New Delhi: Tata-McGraw-Hill, 2010.
4. Hacker, Diana. *A Pocket Style Manual*. 4th ed. New York, NY: Bedford/St. Martin's, 1999. ISBN: 9780312406844.
5. Perelman, Leslie C., James Paradis, and Edward Barrett. *The Mayfield Handbook of Technical and Scientific Writing*. New York, NY: McGraw-Hill, 1997. ISBN: 9781559346474.
6. **David F. Beer and** David McMurrey**, *Guide to Writing as an Engineer*, 2nd ed., Wiley, 2004,** ISBN: 0471430749.
7. Dale Jungk, *Applied Writing for Technicians*, McGraw-Hill, 2005, ISBN 0-07-828357-4.

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Electrical Engineering			
EE511	**Microprocessor and Microcontroller**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	**CO Description**
CO1	**Categorize** the basic concepts of microprocessor & microcontrollers
CO2	**Interpret** different addressing modes and types of registers in processor or controller
CO3	**Execute** simple programs on microprocessor & microcontroller
CO4	**Illustrate** how the different peripherals are interfaced with 8086 microprocessor
CO5	**Illustrate** how memory or I/O interfaced with 8051 microcontroller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1.Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	2	2	2									
CO3	3	3	3	2					1			2
CO4	3		2	2	2				1			2
CO5	3		2	2	2				1			2
Avg.	**2.6**	**2.0**	**2.25**	**2.0**	**2.0**				1.0			2.0

DETAILED SYLLABUS

Module-I **(6 Lectures)**

Brief introduction to 8085 CPU Architecture, Pin configuration, Addressing Modes, Registers, Memory Addressing Instructions Set.

Module-II **(10 Lectures)**

THE 8086 ARCHITECTURE: Pin diagram of 8086 and description of various signals. Architecture block diagram of 8086 & description of sub-blocks such as EU & BIU & of various registers; Description of address computations & memory segmentation; addressing modes; Instruction formats.

Module-III **(4 Lectures)**

Interfacing of memory and peripherals with microprocessor, 8255.

Module-IV **(10 Lectures)**

Microcontrollers– Type, processor architecture memory type, hardware features, 8051 Processor architecture, Memory mapping. Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction

Module-V **(12 Lectures)**

Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction. 8051 microcontroller: Memory interfacing and address decoding, programming Input/ Output port/ timer programming and Serial data communication controller.

Suggested Readings:

[1]. Brey , The Intel Microprocessors 8086- Pentium processor, PHI
[2]. Badri Ram, Advanced Microprocessors and Interfacing, TMH
[3]. Triekel & Singh, The 8088 & 8086 Microprocessors-Programming, Interfacing, Hardware & Applications: PHI.
[4]. D. B. Hall , Microprocessor and Interfacing, McGraw Hill
[5]. M. A. Mazidi & J. G. Mazidi,The 8051 Microcontroller & Embedded System, Pearson Education.

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Electrical Engineering			
EE512	**Electrical Machine Design**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of this course, student should be able to:

CO's	CO Description
CO1	**Understand** the construction and performance characteristics of electrical machines.
CO2	**Understand** the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines.
CO3	**Understand** the principles of electrical machine design and carry out a basic design of an ac machine
CO4	**Analyze** design aspects of rotating electrical machines.
CO5	**Use** software tools to do design calculations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2							2
CO2	3	2	2	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	2	2							2
CO5	3	3	2	2	2							2
Avg.	**3**	**2.6**	**2.4**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Factors in Design **(8 Lectures)**

Specifications for machines, output equation, limitations in design, electric and magnetic loadings, space factor, winding factor and their effects on machine performance, mechanical and high speed problems.

Module II: Design of Poly phase Asynchronous Machines **(10 Lectures)**

Details of construction, stator design, output equation, separation of D and L ,specific loadings, leakage reactance, rotor design, slip ring and squirrel cage motors, harmonic effects and slot combination, magnetizing current and losses, prediction of characteristics.

Module III: Design of Synchronous Machines **(10 Lectures)**

Details of construction, generators, salient and non salient pole machines, specific loadings and output equation, stator design, harmonics and reduction, armature reaction, design of field winding, short circuit ratio, voltage regulation, efficiency, differences in design between salient and non salient pole machine.

Module IV: Design of Transformers **(8 Lectures)**

Design of single and three phase transformers, output equation, specific loadings, electro mechanical stresses on windings, no load current, temperature rise.

Module V: Thermal aspects of Design **(6 Lectures)**

Generation, flow and dissipation of heat losses, thermal capacity, temperature rise curves, ratings of machines, cooling media, ventilation, types of cooling, standard enclosures.

Text / References Books:

[1]. A.K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.
[2]. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.
[3]. Ion Boldea, Syed A. Nasar, "The Induction Machines Design Handbook", CRC Press.
[4]. Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, "Design of Rotating Electrical Machines",Wiley
[5]. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.

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Electrical Engineering			
EE513	**Applied Electrical Engineering**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	**CO Description**
CO1	**Capable** to model the physical system into electrical system
CO2	**Apply** mathematics for electrical systems to analysis
CO3	**Select** simulation technique for DC and AC system analysis
CO4	**Able** to design the electro-mechanical systems

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3		2								
CO3				2	3							
CO4			2									
Average	**3**	**3**	**2**	**2**	**3**							

DETAILED SYLLABUS

Module I: Model of Physical Systems **(8 Lectures)**

Introduction to physical systems: Mass-spring-damper system, accelerometer, rotational mechanical system, gear trains, liquid level system; Circuit models: RL, RC, LC,RLC series and parallel circuits with sinusoidal and non-sinusoidal excitations, diode rectifier.

Module II: Solution of Differential Equations **(12 Lectures)**

Systems of linear equations, homogeneous and non-homogeneous linear equations, Polynomial equations, least squares fit; ordinary differential equations: Euler's method, Runge-Kutta method, Newton-Raphson method, Predictor-Corrector methods; Numerical integration: Forward and backward integration rules, Trapezoidal rule, Simpson's rule, Errors of integration.

Module III: Simulation Techniques **(6 Lectures)**

Continuous state simulation: circuit level simulators, Discrete-event simulation: Fixed time step, variable time step; Response analysis of circuits: DC analysis, AC Analysis, Transient analysis.

Module IV: Programming in MATLAB **(8 Lectures)**

Programming a function, repetitive and conditional control structures, Iterative solution of equations, polynomial interpolation; Plotting and analysis: two-dimensional and three-dimensional plots, Histograms, Polar plots, Function evaluation; Handling external files: saving and loading data.

Module V: PSPICE Circuit Simulator **(6 Lectures)**

Introduction, circuit descriptions, Input files, nodes, circuit elements, element values, sources, output variables; Analysis: DC sweep, Transient and AC analysis. PSPICE models.

Text/Reference Books:

[1]. Biran A. and Breiner M., “MATLAB 5 for Engineers”, 2nd edition, Addison Wesley,1999
[2]. Rashid M. H. and Rashid H. M., “SPICE for Power Electronics and Electric Power”, 2nd edition, Taylor & Francis,2009
[3]. William J. P., “Introduction to MATLAB for Engineers”, 3rd edition,McGraw Hill,2010.

Vinoba Bhave University , Hazaribagh

Electrical Engineering			
EE521	**Signals and Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Analyze** systems in complex frequency domain.
CO3	**Understand** sampling theorem and its implications

.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	3	2								2
Avg.	**3**	**2.66**	**3**	**2**								**2**

DETAILED SYLLABUS

Module I **(5 Lectures)**

Introduction to signals and systems - Classification of signals - Basic operations on signals – Elementary signals - Concept of system - Properties of systems - Stability, invertability, time invariance - Linearity - Causality - Memory - Time domain description - Convolution - Impulse response.

Module II **(5 Lectures)**

Representation of LTI systems - Differential equation and difference equation representations of LTI systems, Continuous Time LTI systems and Convolution Integral, Discrete Time LTI systems and linear convolution.

Module III **(5 Lectures)**

Frequency Domain Representation of Continuous Time Signals- Continuous Time Fourier Series: Convergence. Continuous Time Fourier Transform: Properties.

Module IV **(9 Lectures)**

Frequency Domain Representation of Discrete Time Signals- Discrete Time Fourier Transform: Properties, Sampling Theorem, aliasing, reconstruction filter, sampling of band pass signals. Fourier Series Representation of Discrete Time Periodic Signals.

Module V **(10 Lectures)**

Laplace Transform – ROC – Inverse transform – properties – Analysis of Continuous LTI systems using Laplace Transform – unilateral Laplace Transform. Relation between Fourier and Laplace Transforms.

Laplace transform analysis of systems - Relation between the transfer function and differential equation - Causality and stability - Inverse system - Determining the frequency response from poles and zeros.

Module VI **(8 Lectures)**

Z Transform - Definition - Properties of the region of convergence - Properties of the Z transform - Analysis of LTI systems - Relating the transfer function and difference equation - Stability and causality - Inverse systems - Determining the frequency response from poles and zeros.

Text Books

[1]. Haykin. S., Venn B. V. Signals and Systems
[2]. Oppenheim A.V., Willsky A.S. &Nawab S.H., Signals and Systems, Tata McGraw Hill
[3]. Taylor F.H, Principles of Signals and Systems, McGraw Hill

R**eferences**

[1]. Bracewell R.N., Fourier Transform & Its Applications, McGraw Hill
[2]. Haykin S., Communication Systems, John Wiley
[3]. Lathi B.P., Modern Digital& Analog Communication Systems, Oxford University Press
[4]. Papoulis A., Fourier Integral & Its Applications, McGraw Hill

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Electrical Engineering			
EE522	**Transforms in Electrical Engineering**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Understand** the concepts of different discrete transforms.
CO3	**Analyze** systems in complex frequency domain.
CO4	**Design** of different types of filters.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I: Discrete-Time Signals **(4 Lectures)**

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences,-periodic, energy, power, unit-sample, unit step, unit ramp &complex exponentials, arithmetic operations on sequences..

Module II: LTI Systems **(6 Lectures)**

Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non recursive systems.

Module III: Discrete Fourier Transform **(10 Lectures)**

Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises.

Module IV: Discrete Time Fourier Transform **(5 Lectures)**

Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain.

Module V: Fast Fourier Transforms **(4 Lectures)**
Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.

Module VI: Z- Transforms **(8 Lectures)**
Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Perseval's relation, inverse Z transform by contour integration, power series & partial-fraction expansions with examples and exercises.

Module VII: Filter Design **(5 Lectures)**
Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization.

Text Books:

[1]. Digital Signal Processing-A computer based approach, S. Mitra, TMH
[2]. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis& M.G. Manslakis, PHI
[3]. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.
[4]. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Leasrning.

Reference Books

[1]. Digital Signal Processing, Chen, OUP
[2]. Digital Signal Processing, Johnson, PHI
[3]. Digital Signal Processing using MATLAB, Ingle, Vikas.

Vinoba Bhave University , Hazaribagh

Electrical Engineering			
EE523	**Electrical Engineering Materials**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, the students will be able to:

CO's	CO Description
CO1	**Understand** various types of dielectric materials, their properties in various conditions.
CO2	**Evaluate** magnetic materials and their behavior.
CO3	**Evaluate** semiconductor materials and technologies.
CO4	**Acquire** Knowledge on Materials used in electrical engineering and applications.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I Dielectric Materials
Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

Module II Magnetic Materials
Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and hysteresis.

Module III Semiconductor Materials

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI).

Module IV Materials for Electrical Applications

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

Module V Special Purpose Materials

Refractory Materials, Structural Materials, Radioactive Materials, Galvanization and Impregnation of materials, Processing of electronic materials, Insulating varnishes and coolants, Properties and applications of mineral oils, Testing of Transformer oil as per ISI.

Text Books:

[1]. "R K Rajput", " A course in Electrical Engineering Materials", Laxmi Publications, 2009
[2]. "T K Basak", " A course in Electrical Engineering Materials", New Age Science Publications 2009

Reference Books:

[1]. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
[2]. "AdrianusJ.Dekker", Electrical Engineering Materials, PHI Publication, 2006.
[3]. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.

Vinoba Bhave University , Hazaribagh

Electrical Engineering			
EE531	**Control Systems***	**L**	**T**
		3	**0**

(This course is not offered to Electrical Engg. students)

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyze** electromechanical systems by mathematical modeling.
CO2	**Determine** Transient and Steady State behavior of systems using standard test signals.
CO3	**Analyze** linear systems for steady state errors, absolute stability and relative stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: **(8 Lectures)**

Concepts of system, open loop and closed loop systems, Benefits of Feedback, Mathematical modeling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams; Signal flow graphs and Mason's gain formula.

Module II **(12 Lectures)**

Time domain performance criterion, transient response of first order, second order systems; Steady state errors: static and dynamic error constants, system types, steady state errors for unity and non unity feedback systems, performance analysis for P, PI and PID controllers.

Concept of stability by Routh stability criterion, root-loci and root contours.

Module III **(8 Lectures)**

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module IV: **(7 Lectures)**

Compensation - lag, lead and lag-lead networks, design of compensation networks using time response and frequency response of the system.

Module V: **(7 Lectures)**

Concepts of state, state variables, state variable representation of system, dynamic equations, merits for higher order differential equations and solution. Concept of controllability and observability and techniques to test them.

Text/References:

[5]. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

[6]. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.

[7]. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.

[8]. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

Vinoba Bhave University , Hazaribagh

Electrical Engineering			
EE532	**Microprocessor and Microcontroller***	**L**	**T**
		3	**0**

(This course is not offered to Electrical Engg. students)

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Categorize** the basic concepts of microprocessor & microcontrollers
CO2	**Interpret** different addressing modes and types of registers in processor or controller
CO3	**Execute** simple programs on microprocessor & microcontroller
CO4	**Illustrate** how the different peripherals are interfaced with 8086 microprocessor
CO5	**Illustrate** how memory or I/O interfaced with 8051 microcontroller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1.Slight (low)   2. Moderate (Medium)   3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	2	2	2									
CO3	3	3	3	2					1			2
CO4	3		2	2	2				1			2
CO5	3		2	2	2				1			2
Avg.	**2.6**	**2.0**	**2.25**	**2.0**	**2.0**				1.0			2.0

DETAILED SYLLABUS

Module-I **(5 Lectures)**

Brief introduction to 8085 CPU Architecture, Pin configuration, Addressing Modes, Registers, Memory Addressing Instructions Set.

Module-II **(5 Lectures)**

THE 8086 ARCHITECTURE: Pin diagram of 8086 and description of various signals. Architecture block diagram of 8086 & description of sub-blocks such as EU & BIU & of various registers; Description of address computations & memory segmentation; addressing modes; Instruction formats.

Module-III **(2 Lectures)**

Interfacing of memory and peripherals with microprocessor, 8255.

Module-IV **(12 Lectures)**

Microcontrollers– Type, processor architecture memory type, hardware features, 8051 Processor architecture, Memory mapping. Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction

Module-V **(16 Lectures)**

Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction. 8051 microcontroller: Memory interfacing and address decoding, programming Input/ Output port/ timer programming and Serial data communication controller.

Suggested Readings:

[6]. Brey , The Intel Microprocessors 8086- Pentium processor, PHI

[7]. Badri Ram, Advanced Microprocessors and Interfacing, TMH

[8]. Triekel & Singh, The 8088 & 8086 Microprocessors-Programming, Interfacing, Hardware & Applications: PHI.

[9]. D. B. Hall , Microprocessor and Interfacing, McGraw Hill.

[10]. M. A. Mazidi & J. G. Mazidi,The 8051 Microcontroller & Embedded System, Pearson Education.

Vinoba Bhave University , Hazaribagh

Electrical Engineering			
EE533	**Electromechanical Energy Conversion and Transformers***	**L**	**T**
		3	**0**

(This course is not offered to Electrical Engg students)

Course Outcome:
After successful completion of the course students will able to:

CO's	CO Description
CO1	**Understand** the principle of operation of Electromechanical energy conversion
CO2	**Understand** the construction and principle of operation of DC machines, single phase and three phase transformers and auto transformers.
CO3	**Analyze** starting methods and speed control of DC machines.
CO4	**Analyze** parallel operation of DC Generators, single phase and three phase transformers.
CO5	**Evaluate** the performance of DC machines.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	2			1			2
CO2	3	3	3	1	1	2			1			2
CO3	3	3	3	2	1	2			1			2
CO4	3	3	3	2	1	2			1			2
CO5	3	3	3	2	1	2			1			2
Avg.	**3**	**3**	**3**	**1.6**	**1**	**2**			**1**			**2.0**

DETAILED SYLLABUS

Module I: Principle of Electromechanical Energy Conversion (4 Lectures)
Energy stored in electric and magnetic fields, energy conversion in single and multi excited systems and torque production, reluctance torque; Reluctance and hysteresis motors.

Module II: General Description of Electrical Machines (5 Lectures)
Constructional details of dc and ac machines, description of magnetic and electric circuits in cylindrical rotor and salient pole machines, mmf distribution of current carrying single and multiple coils; Armature winding as a current sheet, associated mmf and flux density waves.

Module III: DC Machines and Commutations (9 Lectures)
Simplex lap and wave windings, emf and torque equations, interaction of the fields produced by field and armature circuits.

Module IV: DC Generators (4 Lectures)
Methods of excitation, shunt, series and compound generators, characteristics, testing.

Module V: DC Motors **(4 Lectures)**
Methods of excitation, characteristics, starting and speed control methods; Losses and their estimation, efficiency.

Module VI: Single-phase Transformers **(9 Lectures)**
Principle of operation, equivalent circuit, voltage regulation and efficiency; Parallel operation. Principle of operation and comparison with two winding transformer.
Autotransformers: Principle of operation and comparison with two winding transformer

Module VII: Three Phase Transformers **(6 Lectures)**
Various connections and their comparative features, harmonics in emf and magnetizing current, effect of connections and construction on harmonics; Parallel operation of three-phase transformers, sharing of load, 3-phase to 2-phase conversion, 3-phase to 6-phase conversion.

Text/Reference Books:

[1]. Fitzgerald A. E., Kingsley C. and Kusko A., “Electric Machinery”, 6th Ed., McGraw-Hill International Book Company,2008.
[2]. Say M. G., “The Performance and Design of Alternating Current Machines”, CBS Publishers and Distributors,2005.
[3]. Say M. G. and Taylor E. O., “Direct Current Machines”, 3rd Ed.,ELBS and Pitman.1986
[4]. Nagrath I. J. and Kothari D. P., “Electrical Machines”, 3rd Ed., Tata McGraw-Hill Publishing Company Limited,2008.
[5]. Chapman S. J., “Electric Machinery Fundamentals”, 4th Ed.,McGraw-Hill International Book Company, 2005
[6]. Clayton A. E. and Hancock N., “The Performance and Design of DC Machines”, CBS Publishers and Distributors, 2003.
[7]. Langsdorf A. S., “Theory of AC Machines”, 2nd Ed., Tata McGraw-Hill Publishing Company Limited, 2008.

Vinoba Bhave University , Hazaribagh

Electrical Engineering			
EE534	**Power Plant Engineering**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Descriptions
CO1	**Describe** and **analyze** different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.
CO2	**Analyze** the working and layout of thermal power plants and the different systems comprising the plant and **discuss** about its economic and safety impacts
CO3	To **define** the working principle of diesel power plant, its layout, safety principles and compare it with plants of other types.
CO4	**Discuss** and **analyze** the mathematical and working principles of different electrical equipment involved in the generation of power and to **understand** co-generation.
CO5	Discuss and analyze the mathematical and working principles of different electrical equipment involved in the generation of power and to understand co-generation.

CO's-PO's Mappings Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	1		2					1
CO2	2	2	3	1	2		1					1
CO3	2		2	1		1	2					1
CO4	2		2	1		1	2					1
CO5	2	2	1	2	1	2	1					1
Avg.	**2**	**2.33**	**2**	**2.67**	**1.33**	**1.33**	**1.66**					**1**

DETAILED SYLLABUS

Module I: Introduction **(10 Lectures)**

Conventional & Non-Conventional Sources of Energy and their availability in India, Different Types of Power Plants, Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine power plants, Combined Power cycles – comparison and selection , Load duration Curves, Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidized Bed Boilers.

Module II: Thermal Power Plants **(10 Lectures)**

Basic thermodynamic cycles, various components of steam power plant-layout-pulverized coal burners-Fluidized bed combustion-coal handling systems-ash handling systems- Forced draft and induced draft fans- Boilers-feed pumps super heater- regenerator-condenser- de-aerators, cooling towers, electrostatic precipitators.

Module III: Hydel Power Plant **(8 Lectures)**
Principle of working, Classification, Site selection; Different components & their functions; Types of Dams;Types, Characteristics & Selection of Hydro-Turbines; Mini & Micro Hydro Power Plants, Pumped Storage Power Plants.

Module IV: Diesel And Gas Turbine Power Plant **(8 Lectures)**
Types of diesel plants, components, Selection of Engine type, applications. Gas turbine power plant- Fuels- Gas turbine material, open and closed cycles, reheating, Regeneration and inter cooling, combines cycle.

Module V: Co-Generation **(6 Lectures)**
Concept; Schemes; Brief Description; Benefits & Limitations; Applications. Non-Conventional Energy Sources, Types, Brief Description, Advantages & Limitations.

Text/Reference Books:

[1]. P.K.Nag, “Power Plant Engineering”, Tata McGraw Hill Publications.2007
[2]. EI-Wakil M.M, “Power Plant Technology,” Tata McGraw-Hill 1984
[3]. Power Plant Engineering, Gautam S, Vikas Publishing House. 2012
[4]. Power station Engineering and Economy by Bernhardt
[5]. G.A.Skrotzki and William A. Vopat- Tata McGraw Hill Publishing Company Ltd.2002
[6]. “Modern Power Station Practice”, Volume B, British Electricity International Ltd., Central Electricity Generating Board,Pergamon Press, Oxford.1991
[7]. ‘Power Plant Familiarization – Vol. II’, NPTI Publication.

Vinoba Bhave University , Hazaribagh

Electrical & Electronics Engineering			
EEE501	**Electrical Machines-II**	**L**	**T**
		3	**1**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the construction and principle of operation of synchronous machines.
CO2	**Analyze** the effects of excitation and mechanical input on the operation of synchronous Machine.
CO3	**Understand** the operation principles of Reluctance motor, shaded pole, Hysteresis motor, and Universal motor, PMBLDC, tachometer, synchro and identify the suitable applications.
CO4	**Analyze** single phase induction motors and **identify** the suitable methods of starting.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	2		1					2
CO2	3	3	2	2	2		1					2
CO3	3	3	2	2	2		1					2
CO4	3	3	2	2	2		1					2
Avg.	**3**	**3**	**2**	**2**	**2**		**1**					**2**

DETAILED SYLLABUS

Module I: Fundamentals of A.C. Machines (8 Lectures)

Fundamental principles of A.C. machines: E.M.F equation of an elementary alternator, single & three phase, factors affecting the induced e.m.f, full pitch & fractional pitch windings, winding factors, armature reaction, concept of time phasor & space phasor.

Module-II: Synchronous Generator (16 Lectures)

Various types and construction, cylindrical rotor theory, phasor diagram, open circuit & short circuit characteristics, armature reaction, synchronous reactance, SCR, load characteristics, potier reactance, voltage regulation, E.M.F. method, MMF method, ZPF method, power angle characteristics.

Theory of salient pole machine: Blondel's two reaction theory, phasor diagram, direct axis and quadrature axis synchronous reactance, power angle characteristics, slip test, parallel operation: Synchronizing method, effect of wrong synchronization, load sharing between alternators in parallel, transient & sub-transient reactances.

Module-III: Synchronous motor (8 Lectures)

General physical consideration, torque & power relations in salient and non-salient pole motors, V-curves & inverted V-curves, effect of change of excitation, synchronous condenser, stating of synchronous motor, performance characteristics of synchronous motor, hunting.

Module-IV: Single phase motors **(7 Lectures)**
Induction type, Double revolving field theory, equivalent circuit, characteristics & starting of single phase motor, shaded pole machine, synchronous type, hysteresis motor, reluctance motor.

Module V: Single phase special type of machines **(3 Lectures)**
Switched reluctance motor, PMBLDC motor, tachometer, two phase control motor, Synchro.

Text Books:

[1]. Electric Machines by I.J.Nagrath & D.P.Kothari,Tata Mc Graw Hill, 7th Edition.2005
[2]. Electrical machines by PS Bhimbra, Khanna Publishers.
[3]. Electric machinery by A.E. Fitzgerald, C.Kingsley and S.Umans, Mc Graw Hill Companies, 5th edition.
[4]. Electric Machinery Fundamentals by Stephen Chapman Mc Graw Hill Company.

Reference Books:

[1]. Theory of Alternating Current Machinery- by Langsdorf, Tata McGraw-Hill Companies, 2nd edition.
[2]. Performance and Design of AC Machines by M G. Say, BPB Publishers.

Vinoba Bhave University , Hazaribagh

Electrical & Electronics Engineering			
EEE502	**CONTROL SYSTEMS**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyze** electromechanical systems by mathematical modeling.
CO2	**Determine** Transient and Steady State behavior of systems using standard test signals.
CO3	**Analyze** linear systems for steady state errors, absolute stability and relative stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

3. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: **(8 Lectures)**

Concepts of system, open loop and closed loop systems, Benefits of Feedback, Mathematical modeling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams; Signal flow graphs and Mason's gain formula.

Module II **(12 Lectures)**

Time domain performance criterion, transient response of first order, second order systems; Steady state errors: static and dynamic error constants, system types, steady state errors for unity and non unity feedback systems, performance analysis for P, PI and PID controllers.

Concept of stability by Routh stability criterion, root-loci and root contours.

Module III **(8 Lectures)**

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module IV: **(7 Lectures)**

Compensation - lag, lead and lag-lead networks, design of compensation networks using time response and frequency response of the system.

Module V: **(7 Lectures)**

Concepts of state, state variables, state variable representation of system, dynamic equations, merits for higher order differential equations and solution. Concept of controllability and observability and techniques to test them.

Text/References:

[1]. J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009

[2]. M. Gopal, "Control Systems: Principles and Design", McGraw Hill Education, 1997.

[3]. B. C. Kuo, "Automatic Control System", Prentice Hall, 1995.

[4]. K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

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Electrical Engineering			
HU50I	**Professional Communication**	**L**	**T**
		1	**2**

Course Overview:

This course is designed to help one develop communication skills in English with a sense of language. It will be of help to improve clarity, precision and overall impact in both oral as well as written communication. It will also enable one to produce clear and effective scientific and technical documents required for professional communication. We will focus on basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations. One can learn how to gather, organize, and present information effectively according to audience and purpose. Moreover, emphasis will be on sustainable communication that will facilitate an understanding of one's role and help to align with the mission of the organization.

Objective:

To provide you with the communication skills one needs to advance in a field, keeping in mind that, in career, one may be involved with design, development, field service and support, management, sales, customer liaison, or all of the above.

Course Outcomes:

CO 1: Demonstrate effective oral and written communication with diverse audiences and produce variety in professional written documents to better support and communicate.
CO 2: Plan and deliver a formal presentation on a topic with confidence and poise.
CO 3: Appraise ethics and social responsibility as a professional.
CO 4: Apply analytical skills and critical thinking to solve problems and can express using sound logical arguments utilizing the best available resources for communication.
CO 5: Exhibit an understanding of multiculturalism and be able to work well in teams.

Lecture 1-10

Introduction to Communication

Communication and Self Concept
Role of Emotions
Basics of Communication
Purpose of communication- to inform, to express feelings, to imagine, to influence, to meet social expectations and others
Audience analysis- identifying audience to determine the content, language usage and listener expectations for ensuring effective communication
Cross Cultural Communication and Multi Cultural Communication
Effective Communication: Modes/ Models/Networks

LSRW Skills
Non-Verbal Communication

Barriers to Communication

Introduction
Intrapersonal and Interpersonal Barriers

Organizational Barriers
Information Gap Principle, Noise, Filters

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<u>Effective Listening and Speaking</u>
Traits of a good listener
Phonetics – Basic Sounds of English – Word Accent - Intonation Achieving confidence, clarity and fluency as a speaker, paralinguistic features, barriers to speaking, types of speaking, Persuasive Speaking, Public Speaking etc.

Additional exercises and activities based on developing Listening and Speaking skills

Lecture 11-15
Planning, Outlining and Structuring
Choosing the mode of delivery
Guidelines for effective delivery,
Body Language and Voice, Visual Aids etc.
Activities and practice on developing Presentation skills

Lecture 16-20
Introduction, Objectives, Types, Samples and Examples
Problem Solving, Networking in English
Meetings and Conferences
Minutes of Meeting, Agenda of Meeting
Activities and exercise based on developing GD and Business Networking skills in English

Lecture 21-30
Introduction, Audience Recognition, Language, Grammar, Style, Techniques
The Art of Condensation
Note Making and Note Taking
Guidelines and Samples
<u>Business/Official Communication</u>
Letters, Resumes, Memos, and e-mails
Rules, formats, Style, Etiquette
Sales and Credit letters
Letter of Enquiry
Letter of Quotation, Order, Claim and Adjustment
Government Letters, Semi- Government Letters to Authorities etc.
Characteristics, Categories, Formats, Structures, Types, Samples
Job Application
Curriculum vitae
Resumes- Chronological, Combination, Functional etc.
Reports and Proposals of different kinds
Exercise and activities based on developing Writing skills

Lecture 31-35
Right Words and Phrases,
Sentence Patterns
Paragraph
Comprehension Passage etc.
Activities and Strategies to engage in active thinking about word meanings, the relationships among words, and use of words in different situations

Lecture 36-40 Types: Skimming, Scanning, Intensive, Extensive Value Based/Motivational Materials: Articles, Prose, Text Reading **Activities and exercise based on developing Reading skills**
Lecture 41-45 Types and Overview Emotional Intelligence Decision Making and Time Management **Activities and exercise based on developing Leadership and Management skills**

Recommended Texts:

1. Raman , Meenakshi and Sangeeta Sharma. *Technical Communication: Principles and Practice.* 2nd ed. OUP India, 2012.
2. Markel, Mike. *Technical Communication*. 7th ed. New York, NY: Bedford/St. Martin's, 2003. ISBN: 9780312403386.
3. Gamble, Teri Kwal and Michael Gamble. *Communication Works.* 9th Ed. New Delhi: Tata-McGraw-Hill, 2010.
4. Hacker, Diana. *A Pocket Style Manual*. 4th ed. New York, NY: Bedford/St. Martin's, 1999. ISBN: 9780312406844.
5. Perelman, Leslie C., James Paradis, and Edward Barrett. *The Mayfield Handbook of Technical and Scientific Writing*. New York, NY: McGraw-Hill, 1997. ISBN: 9781559346474.
6. **David F. Beer and** David McMurrey**, *Guide to Writing as an Engineer*, 2nd ed., Wiley, 2004,** ISBN: 0471430749.
7. Dale Jungk, *Applied Writing for Technicians*, McGraw-Hill, 2005, ISBN 0-07-828357-4.

Vinoba Bhave University , Hazaribagh

Electrical & Electronics Engineering			
EEE511	**Microprocessor and Microcontroller**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Categorize** the basic concepts of microprocessor & microcontrollers
CO2	**Interpret** different addressing modes and types of registers in processor or controller
CO3	**Execute** simple programs on microprocessor & microcontroller
CO4	**Illustrate** how the different peripherals are interfaced with 8086 microprocessor
CO5	**Illustrate** how memory or I/O interfaced with 8051 microcontroller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1.Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	2	2	2									
CO3	3	3	3	2					1			2
CO4	3		2	2	2				1			2
CO5	3		2	2	2				1			2
Avg.	**2.6**	**2.0**	**2.25**	**2.0**	**2.0**				1.0			2.0

DETAILED SYLLABUS

Module-I **(6 Lectures)**

Brief introduction to 8085 CPU Architecture, Pin configuration, Addressing Modes, Registers, Memory Addressing Instructions Set.

Module-II **(10 Lectures)**

THE 8086 ARCHITECTURE: Pin diagram of 8086 and description of various signals. Architecture block diagram of 8086 & description of sub-blocks such as EU & BIU & of various registers; Description of address computations & memory segmentation; addressing modes; Instruction formats.

Module-III **(4 Lectures)**

Interfacing of memory and peripherals with microprocessor, 8255.

Module-IV **(10 Lectures)**

Microcontrollers– Type, processor architecture memory type, hardware features, 8051 Processor architecture, Memory mapping. Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction

Module-V **(12 Lectures)**

Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction. 8051 microcontroller: Memory interfacing and address decoding, programming Input/ Output port/ timer programming and Serial data communication controller.

Suggested Readings:

[1]. Brey , The Intel Microprocessors 8086- Pentium processor, PHI
[2]. Badri Ram, Advanced Microprocessors and Interfacing, TMH
[3]. Triekel & Singh, The 8088 & 8086 Microprocessors-Programming, Interfacing, Hardware & Applications: PHI.
[4]. D. B. Hall , Microprocessor and Interfacing, McGraw Hill
[5]. M. A. Mazidi & J. G. Mazidi,The 8051 Microcontroller & Embedded System, Pearson Education.

Vinoba Bhave University , Hazaribagh

Electrical & Electronics Engineering			
EEE512	**Electrical Machine Design**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of this course, student should be able to:

CO's	CO Description
CO1	**Understand** the construction and performance characteristics of electrical machines.
CO2	**Understand** the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines.
CO3	**Understand** the principles of electrical machine design and carry out a basic design of an ac machine
CO4	**Analyze** design aspects of rotating electrical machines.
CO5	**Use** software tools to do design calculations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	2							2
CO2	3	2	2	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	2	2							2
CO5	3	3	2	2	2							2
Avg.	**3**	**2.6**	**2.4**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Factors in Design (8 Lectures)

Specifications for machines, output equation, limitations in design, electric and magnetic loadings, space factor, winding factor and their effects on machine performance, mechanical and high speed problems.

Module II: Design of Poly phase Asynchronous Machines (10 Lectures)

Details of construction, stator design, output equation, separation of D and L ,specific loadings, leakage reactance, rotor design, slip ring and squirrel cage motors, harmonic effects and slot combination, magnetizing current and losses, prediction of characteristics.

Module III: Design of Synchronous Machines (10 Lectures)

Details of construction, generators, salient and non salient pole machines, specific loadings and output equation, stator design, harmonics and reduction, armature reaction, design of field winding, short circuit ratio, voltage regulation, efficiency, differences in design between salient and non salient pole machine.

Module IV: Design of Transformers (8 Lectures)

Design of single and three phase transformers, output equation, specific loadings, electro mechanical stresses on windings, no load current, temperature rise.

Module V: Thermal aspects of Design (6 Lectures)

Generation, flow and dissipation of heat losses, thermal capacity, temperature rise curves, ratings of machines, cooling media, ventilation, types of cooling, standard enclosures.

Text / References Books:

[1]. A.K. Sawhney, "A Course in Electrical Machine Design", Dhanpat Rai and Sons, 1970.

[2]. M.G. Say, "Theory & Performance & Design of A.C. Machines", ELBS London.

[3]. Ion Boldea, Syed A. Nasar, "The Induction Machines Design Handbook", CRC Press.

[4]. Juha Pyrhonen, Tapani Jokinen, Valeria Hrabovcova, "Design of Rotating Electrical Machines",Wiley

[5]. K. M. V. Murthy, "Computer Aided Design of Electrical Machines", B.S. Publications, 2008.

Vinoba Bhave University , Hazaribagh

Electrical & Electronics Engineering			
EEE513	**Applied Electrical Engineering**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Capable** to model the physical system into electrical system
CO2	**Apply** mathematics for electrical systems to analysis
CO3	**Select** simulation technique for DC and AC system analysis
CO4	**Able** to design the electro-mechanical systems

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3		2								
CO3				2	3							
CO4			2									
Average	**3**	**3**	**2**	**2**	**3**							

DETAILED SYLLABUS

Module I: Model of Physical Systems (8 Lectures)

Introduction to physical systems: Mass-spring-damper system, accelerometer, rotational mechanical system, gear trains, liquid level system; Circuit models: RL, RC, LC,RLC series and parallel circuits with sinusoidal and non-sinusoidal excitations, diode rectifier.

Module II: Solution of Differential Equations (12 Lectures)

Systems of linear equations, homogeneous and non-homogeneous linear equations, Polynomial equations, least squares fit; ordinary differential equations: Euler's method, Runge-Kutta method, Newton-Raphson method, Predictor-Corrector methods; Numerical integration: Forward and backward integration rules, Trapezoidal rule, Simpson's rule, Errors of integration.

Module III: Simulation Techniques (6 Lectures)

Continuous state simulation: circuit level simulators, Discrete-event simulation: Fixed time step, variable time step; Response analysis of circuits: DC analysis, AC Analysis, Transient analysis.

Module IV: Programming in MATLAB (8 Lectures)

Programming a function, repetitive and conditional control structures, Iterative solution of equations, polynomial interpolation; Plotting and analysis: two-dimensional and three-dimensional plots, Histograms, Polar plots, Function evaluation; Handling external files: saving and loading data.

Module V: PSPICE Circuit Simulator (6 Lectures)

Introduction, circuit descriptions, Input files, nodes, circuit elements, element values, sources, output variables; Analysis: DC sweep, Transient and AC analysis. PSPICE models.

Text/Reference Books:

[1]. Biran A. and Breiner M., “MATLAB 5 for Engineers”, 2nd edition, Addison Wesley,1999

[2]. Rashid M. H. and Rashid H. M., “SPICE for Power Electronics and Electric Power”, 2nd edition, Taylor & Francis,2009

[3]. William J. P., “Introduction to MATLAB for Engineers”, 3rd edition,McGraw Hill,2010.

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Electrical & Electronics Engineering			
EEE521	**Signals and Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Analyze** systems in complex frequency domain.
CO3	**Understand** sampling theorem and its implications

.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	3	2								2
Avg.	**3**	**2.66**	**3**	**2**								**2**

DETAILED SYLLABUS

Module I **(5 Lectures)**

Introduction to signals and systems - Classification of signals - Basic operations on signals – Elementary signals - Concept of system - Properties of systems - Stability, invertability, time invariance - Linearity - Causality - Memory - Time domain description - Convolution - Impulse response.

Module II **(5 Lectures)**

Representation of LTI systems - Differential equation and difference equation representations of LTI systems, Continuous Time LTI systems and Convolution Integral, Discrete Time LTI systems and linear convolution.

Module III **(5 Lectures)**

Frequency Domain Representation of Continuous Time Signals- Continuous Time Fourier Series: Convergence. Continuous Time Fourier Transform: Properties.

Module IV **(9 Lectures)**

Frequency Domain Representation of Discrete Time Signals- Discrete Time Fourier Transform: Properties, Sampling Theorem, aliasing, reconstruction filter, sampling of band pass signals. Fourier Series Representation of Discrete Time Periodic Signals.

Module V **(10 Lectures)**

Laplace Transform – ROC – Inverse transform – properties – Analysis of Continuous LTI systems using Laplace Transform – unilateral Laplace Transform. Relation between Fourier and Laplace Transforms.

Laplace transform analysis of systems - Relation between the transfer function and differential equation - Causality and stability - Inverse system - Determining the frequency response from poles and zeros.

Module VI **(8 Lectures)**

Z Transform - Definition - Properties of the region of convergence - Properties of the Z transform - Analysis of LTI systems - Relating the transfer function and difference equation - Stability and causality - Inverse systems - Determining the frequency response from poles and zeros.

Text Books

[1]. Haykin. S., Venn B. V. Signals and Systems
[2]. Oppenheim A.V., Willsky A.S. &Nawab S.H., Signals and Systems, Tata McGraw Hill
[3]. Taylor F.H, Principles of Signals and Systems, McGraw Hill

References

[1]. Bracewell R.N., Fourier Transform & Its Applications, McGraw Hill
[2]. Haykin S., Communication Systems, John Wiley
[3]. Lathi B.P., Modern Digital& Analog Communication Systems, Oxford University Press
[4]. Papoulis A., Fourier Integral & Its Applications, McGraw Hill

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Electrical & Electronics Engineering			
EEE522	**Transforms in Electrical Engineering**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	Description
CO1	**Understand** the concepts of continuous time and discrete time systems.
CO2	**Understand** the concepts of different discrete transforms.
CO3	**Analyze** systems in complex frequency domain.
CO4	**Design** of different types of filters.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I: Discrete-Time Signals (4 Lectures)

Concept of discrete-time signal, basic idea of sampling and reconstruction of signal, sampling theorem, sequences,-periodic, energy, power, unit-sample, unit step, unit ramp &complex exponentials, arithmetic operations on sequences..

Module II: LTI Systems (6 Lectures)

Definition, representation, impulse response, derivation for the output sequence, concept of convolution, graphical, analytical and overlap-add methods to compute convolution supported with examples and exercise, properties of convolution, interconnection of LTI systems with physical interpretations, stability and causality conditions, recursive and non recursive systems.

Module III: Discrete Fourier Transform (10 Lectures)

Concept and relations for DFT/IDFT, Relation between DTFT & DFT. Twiddle factors and their properties, computational burden on direct DFT, DFT/DFT as linear transformation, DFT/IDFT matrices, computation of DFT/IDFT by matrix method, multiplication of DFTs, circulation convolution, computation of circular convolution by graphical, DFT/IDFT and matrix methods, linear filtering using DFT, aliasing error, filtering of long data sequences-Overlap-Save and Overlap-Add methods with examples and exercises.

Module IV: Discrete Time Fourier Transform (5 Lectures)

Concept of frequency in discrete and continuous domain and their relationship (radian and radian/sec), freq. response in the discrete domain. Discrete system's response to sinusoidal/complex inputs (DTFT), Representation of LTI systems in complex frequency domain**.**

Module V: Fast Fourier Transforms (4 Lectures)
Radix-2 algorithm, decimation-in-time, decimation-in-frequency algorithm, signal flow graph, Butterflies, computations in one place, bit reversal, examples for DIT & DIF FFT Butterfly computations and exercises.

Module VI: Z- Transforms (8 Lectures)
Definition, mapping between s-plane & z-plane, unit circle, convergence and ROC, properties of Z-transform, Z-transform on sequences with examples & exercises, characteristic families of signals along with ROC, convolution, correlation and multiplication using Z- transform, initial value theorem, Perseval's relation, inverse Z transform by contour integration, power series & partial-fraction expansions with examples and exercises.

Module VII: Filter Design (5 Lectures)
Basic concepts of IIR and FIR filters, difference equations, design of Butterworth IIR analog filter using impulse invariant and bilinear transform, design of linear phase FIR filters no. of taps, rectangular, Hamming and Blackman windows. Effect of quantization.

Text Books:

[1]. Digital Signal Processing-A computer based approach, S. Mitra, TMH
[2]. Digital Signal Processing: Principles, Algorithms & Application, J.C. Proakis& M.G. Manslakis, PHI
[3]. Fundamental of Digital Signal Processing using MATLAB , Robert J. Schilling, S.L. Harris, Cengage Learning.
[4]. Digital Signal Processing-implementation using DSP microprocessors with examples from TMS320C54XX, Avtar Singh & S. Srinivasan, Cengage Leasrning.

Reference Books

[1]. Digital Signal Processing, Chen, OUP
[2]. Digital Signal Processing, Johnson, PHI
[3]. Digital Signal Processing using MATLAB, Ingle, Vikas.

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Electrical & Electronics Engineering			
E5E523	**Electrical Engineering Materials**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, the students will be able to:

CO's	CO Description
CO1	**Understand** various types of dielectric materials, their properties in various conditions.
CO2	**Evaluate** magnetic materials and their behavior.
CO3	**Evaluate** semiconductor materials and technologies.
CO4	**Acquire** Knowledge on Materials used in electrical engineering and applications.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1								2
CO2	3	2	3	1								2
CO3	3	3	2	2								2
CO4	3	2	2	2								2
Avg.	**3**	**2.5**	**2.5**	**1.5**								**2**

DETAILED SYLLABUS

Module I Dielectric Materials
Dielectric as Electric Field Medium, leakage currents, dielectric loss, dielectric strength, breakdown voltage, breakdown in solid dielectrics, flashover, liquid dielectrics, electric conductivity in solid, liquid and gaseous dielectrics, Ferromagnetic materials, properties of ferromagnetic materials in static fields, spontaneous, polarization, curie point, anti-ferromagnetic materials, piezoelectric materials, pyroelectric materials.

Module II Magnetic Materials
Classification of magnetic materials, spontaneous magnetization in ferromagnetic materials, magnetic Anisotropy, Magnetostriction, diamagnetism, magnetically soft and hard materials, special purpose materials, feebly magnetic materials, Ferrites, cast and cermet permanent magnets, ageing of magnets. Factors effecting permeability and hysteresis.

Module III Semiconductor Materials

Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI).

Module IV Materials for Electrical Applications

Materials used for Resistors, rheostats, heaters, transmission line structures, stranded conductors, bimetals fuses, soft and hard solders, electric contact materials, electric carbon materials, thermocouple materials. Solid, Liquid and Gaseous insulating materials, Effect of moisture on insulation.

Module V Special Purpose Materials

Refractory Materials, Structural Materials, Radioactive Materials, Galvanization and Impregnation of materials, Processing of electronic materials, Insulating varnishes and coolants, Properties and applications of mineral oils, Testing of Transformer oil as per ISI.

Text Books:

[1]. "R K Rajput", " A course in Electrical Engineering Materials", Laxmi Publications, 2009
[2]. "T K Basak", " A course in Electrical Engineering Materials", New Age Science Publications 2009

Reference Books:

[1]. TTTI Madras, "Electrical Engineering Materials", McGraw Hill Education, 2004.
[2]. "AdrianusJ.Dekker", Electrical Engineering Materials, PHI Publication, 2006.
[3]. S. P. Seth, P. V. Gupta "A course in Electrical Engineering Materials", Dhanpat Rai & Sons, 2011.

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Electrical & Electronics Engineering			
EEE531	**Control Systems***	**L**	**T**
		3	**0**

(This course is not offered to Electrical & Electronics Engineering students)

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Analyze** electromechanical systems by mathematical modeling.
CO2	**Determine** Transient and Steady State behavior of systems using standard test signals.
CO3	**Analyze** linear systems for steady state errors, absolute stability and relative stability using time domain and frequency domain techniques.
CO4	**Identify** and **design** a control system satisfying specified requirements.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

4. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	3		1	1				2
CO2	3	3	2	3	3		1	1				2
CO3	3	3	2	3	3		1	1				2
CO4	3	3	3	3	3		1	1				2
Avg.	3	3	2.33	3	3		1	1				2

DETAILED SYLLABUS

Module I: **(8 Lectures)**

Concepts of system, open loop and closed loop systems, Benefits of Feedback, Mathematical modeling and representation of physical systems, analogous systems.

Transfer functions for different types of systems, block diagrams; Signal flow graphs and Mason's gain formula.

Module II **(12 Lectures)**

Time domain performance criterion, transient response of first order, second order systems; Steady state errors: static and dynamic error constants, system types, steady state errors for unity and non unity feedback systems, performance analysis for P, PI and PID controllers.

Concept of stability by Routh stability criterion, root-loci and root contours.

Module III **(8 Lectures)**

Relationship between time and frequency response, Polar plots, Bode plots. Nyquist stability criterion. Relative stability using Nyquist criterion – gain and phase margin. Closed-loop frequency response.

Module IV: **(7 Lectures)**

Compensation - lag, lead and lag-lead networks, design of compensation networks using time response and frequency response of the system.

Module V: **(7 Lectures)**

Concepts of state, state variables, state variable representation of system, dynamic equations, merits for higher order differential equations and solution. Concept of controllability and observability and techniques to test them.

Text/References:

[1]. J. Nagrath and M. Gopal, “Control Systems Engineering”, New Age International, 2009

[2]. M. Gopal, “Control Systems: Principles and Design”, McGraw Hill Education, 1997.

[3]. B. C. Kuo, “Automatic Control System”, Prentice Hall, 1995.

[4]. K. Ogata, “Modern Control Engineering”, Prentice Hall, 1991.

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Electrical & Electronics Engineering			
EEE532	**Microprocessor and Microcontroller***	**L**	**T**
		3	**0**

(This course is not offered Electrical & Electronics Engineering students)

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Categorize** the basic concepts of microprocessor & microcontrollers
CO2	**Interpret** different addressing modes and types of registers in processor or controller
CO3	**Execute** simple programs on microprocessor & microcontroller
CO4	**Illustrate** how the different peripherals are interfaced with 8086 microprocessor
CO5	**Illustrate** how memory or I/O interfaced with 8051 microcontroller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1.Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										
CO2	2	2	2									
CO3	3	3	3	2					1			2
CO4	3		2	2	2				1			2
CO5	3		2	2	2				1			2
Avg.	**2.6**	**2.0**	**2.25**	**2.0**	**2.0**				1.0			2.0

DETAILED SYLLABUS

Module-I **(5 Lectures)**

Brief introduction to 8085 CPU Architecture, Pin configuration, Addressing Modes, Registers, Memory Addressing Instructions Set.

Module-II **(5 Lectures)**

THE 8086 ARCHITECTURE: Pin diagram of 8086 and description of various signals. Architecture block diagram of 8086 & description of sub-blocks such as EU & BIU & of various registers; Description of address computations & memory segmentation; addressing modes; Instruction formats.

Module-III **(2 Lectures)**

Interfacing of memory and peripherals with microprocessor, 8255.

Module-IV **(12 Lectures)**

Microcontrollers– Type, processor architecture memory type, hardware features, 8051 Processor architecture, Memory mapping. Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction

Module-V **(16 Lectures)**

Addressing modes, 8051 Instruction Set – Data movement Instruction, arithmetic instruction, Logic instruction, Branch group Instruction. 8051 microcontroller: Memory interfacing and address decoding, programming Input/ Output port/ timer programming and Serial data communication controller.

Suggested Readings:

[1]. Brey , The Intel Microprocessors 8086- Pentium processor, PHI
[2]. Badri Ram, Advanced Microprocessors and Interfacing, TMH
[3]. Triekel & Singh, The 8088 & 8086 Microprocessors-Programming, Interfacing, Hardware & Applications: PHI.
[4]. D. B. Hall , Microprocessor and Interfacing, McGraw Hill.
[5]. M. A. Mazidi & J. G. Mazidi,The 8051 Microcontroller & Embedded System, Pearson Education.

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Electrical & Electronics Engineering			
EEE533	**Electromechanical Energy Conversion and Transformers***	**L**	**T**
		3	**0**

(This course is not offered to Electrical & Electronics Engineering students)

Course Outcome:

After successful completion of the course students will able to:

CO's	CO Description
CO1	**Understand** the principle of operation of Electromechanical energy conversion
CO2	**Understand** the construction and principle of operation of DC machines, single phase and three phase transformers and auto transformers.
CO3	**Analyze** starting methods and speed control of DC machines.
CO4	**Analyze** parallel operation of DC Generators, single phase and three phase transformers.
CO5	**Evaluate** the performance of DC machines.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1	2			1			2
CO2	3	3	3	1	1	2			1			2
CO3	3	3	3	2	1	2			1			2
CO4	3	3	3	2	1	2			1			2
CO5	3	3	3	2	1	2			1			2
Avg.	**3**	**3**	**3**	**1.6**	**1**	**2**			**1**			**2.0**

DETAILED SYLLABUS

Module I: Principle of Electromechanical Energy Conversion (4 Lectures)

Energy stored in electric and magnetic fields, energy conversion in single and multi excited systems and torque production, reluctance torque; Reluctance and hysteresis motors.

Module II: General Description of Electrical Machines (5 Lectures)

Constructional details of dc and ac machines, description of magnetic and electric circuits in cylindrical rotor and salient pole machines, mmf distribution of current carrying single and multiple coils; Armature winding as a current sheet, associated mmf and flux density waves.

Module III: DC Machines and Commutations (9 Lectures)

Simplex lap and wave windings, emf and torque equations, interaction of the fields produced by field and armature circuits.

Module IV: DC Generators (4 Lectures)

Methods of excitation, shunt, series and compound generators, characteristics, testing.

Module V: DC Motors **(4 Lectures)**

Methods of excitation, characteristics, starting and speed control methods; Losses and their estimation, efficiency.

Module VI: Single-phase Transformers **(9 Lectures)**

Principle of operation, equivalent circuit, voltage regulation and efficiency; Parallel operation. Principle of operation and comparison with two winding transformer.

Autotransformers: Principle of operation and comparison with two winding transformer

Module VII: Three Phase Transformers **(6 Lectures)**

Various connections and their comparative features, harmonics in emf and magnetizing current, effect of connections and construction on harmonics; Parallel operation of three-phase transformers, sharing of load, 3-phase to 2-phase conversion, 3-phase to 6-phase conversion.

Text/Reference Books:

[1]. Fitzgerald A. E., Kingsley C. and Kusko A., “Electric Machinery”, 6th Ed., McGraw-Hill International Book Company,2008.
[2]. Say M. G., “The Performance and Design of Alternating Current Machines”, CBS Publishers and Distributors,2005.
[3]. Say M. G. and Taylor E. O., “Direct Current Machines”, 3rd Ed.,ELBS and Pitman.1986
[4]. Nagrath I. J. and Kothari D. P., “Electrical Machines”, 3rd Ed., Tata McGraw-Hill Publishing Company Limited,2008.
[5]. Chapman S. J., “Electric Machinery Fundamentals”, 4th Ed.,McGraw-Hill International Book Company, 2005
[6]. Clayton A. E. and Hancock N., “The Performance and Design of DC Machines”, CBS Publishers and Distributors, 2003.
[7]. Langsdorf A. S., “Theory of AC Machines”, 2nd Ed., Tata McGraw-Hill Publishing Company Limited, 2008.

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Electrical & Electronics Engineering			
EEE534	**Power Plant Engineering**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course students will be able to:

CO's	CO Descriptions
CO1	**Describe** and **analyze** different types of sources and mathematical expressions related to thermodynamics and various terms and factors involved with power plant operation.
CO2	**Analyze** the working and layout of thermal power plants and the different systems comprising the plant and **discuss** about its economic and safety impacts
CO3	To **define** the working principle of diesel power plant, its layout, safety principles and compare it with plants of other types.
CO4	**Discuss** and **analyze** the mathematical and working principles of different electrical equipment involved in the generation of power and to **understand** co-generation.
CO5	Discuss and analyze the mathematical and working principles of different electrical equipment involved in the generation of power and to understand co-generation.

CO's-PO's Mappings Matrix:
Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	3	1		2					1
CO2	2	2	3	1	2		1					1
CO3	2		2	1		1	2					1
CO4	2		2	1		1	2					1
CO5	2	2	1	2	1	2	1					1
Avg.	**2**	**2.33**	**2**	**2.67**	**1.33**	**1.33**	**1.66**					**1**

DETAILED SYLLABUS

Module I: Introduction **(10 Lectures)**

Conventional & Non-Conventional Sources of Energy and their availability in India, Different Types of Power Plants, Layout of Steam , Hydel , Diesel , MHD, Nuclear and Gas turbine power plants, Combined Power cycles – comparison and selection , Load duration Curves, Steam boilers and cycles – High pressure and Super Critical Boilers – Fluidized Bed Boilers.

Module II: Thermal Power Plants **(10 Lectures)**

Basic thermodynamic cycles, various components of steam power plant-layout-pulverized coal burners-Fluidized bed combustion-coal handling systems-ash handling systems- Forced draft and induced draft fans- Boilers-feed pumps super heater- regenerator-condenser- de-aerators, cooling towers, electrostatic precipitators.

Module III: Hydel Power Plant **(8 Lectures)**

Principle of working, Classification, Site selection; Different components & their functions; Types of Dams;Types, Characteristics & Selection of Hydro-Turbines; Mini & Micro Hydro Power Plants, Pumped Storage Power Plants.

Module IV: Diesel And Gas Turbine Power Plant **(8 Lectures)**

Types of diesel plants, components, Selection of Engine type, applications. Gas turbine power plant- Fuels- Gas turbine material, open and closed cycles, reheating, Regeneration and inter cooling, combines cycle.

Module V: Co-Generation **(6 Lectures)**

Concept; Schemes; Brief Description; Benefits & Limitations; Applications. Non-Conventional Energy Sources, Types, Brief Description, Advantages & Limitations.

Text/Reference Books:

[1]. P.K.Nag, "Power Plant Engineering", Tata McGraw Hill Publications.2007

[2]. EI-Wakil M.M, "Power Plant Technology," Tata McGraw-Hill 1984

[3]. Power Plant Engineering, Gautam S, Vikas Publishing House. 2012

[4]. Power station Engineering and Economy by Bernhardt

[5]. G.A.Skrotzki and William A. Vopat- Tata McGraw Hill Publishing Company Ltd.2002

[6]. "Modern Power Station Practice", Volume B, British Electricity International Ltd., Central Electricity Generating Board,Pergamon Press, Oxford.1991

[7]. 'Power Plant Familiarization – Vol. II', NPTI Publication.

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Production Engineering			
PE501	**Manufacturing Process-II**	**L**	**T**
		3	**1**

S. No.	Contents	Contact Hours
1.	**Foundry:** Patterns, Pattern materials, types of patterns, Pattern allowances. Mould and core making, properties of molding and core sands, Sand testing, Machine Molding. Gating, Risering and solidification of casting.	08
2.	**Special casting processes:** Centrifugal casting, investment casting, Die casting, Continuous casting and shell molding. Working principle and operation of cupola. Cleaning of casting, inspection of casting, casting defects.	08
3.	**Welding and Allied Process:** Gas welding and Gas cutting processes. Electric Arc Welding: Carbon Arc welding, Shielded-Metal Arc Welding, Submerged Arc Welding, TIG (or GTAW) welding, MIG (or GMAW) welding, Electroslag welding, Plasma Arc welding.	08
4.	**Resistance welding :** Spot, Seam, Projections, Butt welding etc.	04
5.	**Advance Welding Methods:** Thermit welding, atomic hydrogen welding, Ultrasonic Welding, explosive welding, electron beam welding, Laser beam welding, Soldering, Brazing and Braze-welding.	10
6.	**Welding Design:** Design of welded joints. Weldability and weldability testing. Inspection (Destructive and non-destructive testing)	04
	Total	**42**

SuggestedBooks:

1. DeGarmo, E. P, Black, J. T., Kohser, R. A. " Materials and Processes in Manufacturing", Prentice Hall of India Pvt. Limited
2. Kalpakjian, S. and Schmid, S. R, "Manufacturing Engineering and Technology", Pearson Education
3. Groover, M. P., "Fundamentals of Modern Manufacturing", John Wiley and Sons Inc.
4. Lindberg, R. A., "Processes and Materials of Manufacture", Prentice Hall India Limited
5. Rao, P. N., "Manufacturing Technology (Vol. 1&2)", Tata McGraw Hill

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Production Engineering			
PE502	**Metrology & Measurement**	**L**	**T**
		3	**0**

S. No.	Contents	Contact Hours
1.	**Standard of Measurements:** Principles of measurements: Line standard: Imperial standard yard, standard meter, wave length standards, end bars, effect of environment on measuring accuracy. Constructional details of measuring instruments, Abbe principles, pivots and Bearings, sources of error, temperature variations, parallel, sine and cosine errors, elastic deformations etc.	06
2.	**Measuring accuracy:** Dimensional and geometrical accuracy. Tolerance and Limit Systems: System of tolerance and fits, ISA and BIS system of tolerances and fits, the economics of wide and close tolerance, principles of limit gauging of plain work, Design and manufacture of gauge.	08
3.	**Measuring Instruments:** Linear measurement: Direct measuring tools, comparators types, relative merit and limitations, optical instruments, projectors and microscopes, angular measurements: clinometer, taper gauges, sine bar, angle blocks and auto collimators, circular division testers, optical dividing head.	08
4.	**Geometrical form of surfaces:** Concepts and measurements of flatness, straightness, Parallelism, perpendicularity, roundness, cylindricity, Runout and concentricity, errors in positioning. Uses of interference methods, Measurements of surface texture.	06
5.	**Screw Thread Measurements:** Systems of screw threads. Principles of limit gauging of threaded work, measurements of screw threads, external and internal threads and measuring instruments. Spur Gear Measurements: Geometrical definitions of spur gears, basic parameters of spur gears, measurements of spur gear parameters, individual and accumulative error measurements.	08
6.	**Alignment and large scale measurements:** Machine tool alignments, instruments and methods for testing straightness, flatness & squarness, alignments charts, dynamic testing of machine tools. Concept of on-line inspection	06
	Total	**42**

Suggested Books:

1. Jain R K, “Engineering Metrology”, Khanna Publishers, New Delhi
2. Kumar D S, “Mechanical Measurements and Control Engineering” Metropolitan Book Company, New Delhi
3. Sawney R, “Instrumentation and Mechanical Measurements”, Dhanpat Rai and Sons, New Delhi
4. Holeman J P, “Experimental Methods for Engineers”, Tata Mc Graw Hill Publishing Company, Delhi
6. Beckwith T H, “Mechanical Measurements”, Addison Wesley, New York

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Electrical Engineering			
HU50I	**Professional Communication**	**L**	**T**
		1	**2**

Course Overview:

This course is designed to help one develop communication skills in English with a sense of language. It will be of help to improve clarity, precision and overall impact in both oral as well as written communication. It will also enable one to produce clear and effective scientific and technical documents required for professional communication. We will focus on basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations. One can learn how to gather, organize, and present information effectively according to audience and purpose. Moreover, emphasis will be on sustainable communication that will facilitate an understanding of one's role and help to align with the mission of the organization.

Objective:

To provide you with the communication skills one needs to advance in a field, keeping in mind that, in career, one may be involved with design, development, field service and support, management, sales, customer liaison, or all of the above.

Course Outcomes:

CO 1: Demonstrate effective oral and written communication with diverse audiences and produce variety in professional written documents to better support and communicate.
CO 2: Plan and deliver a formal presentation on a topic with confidence and poise.
CO 3: Appraise ethics and social responsibility as a professional.
CO 4: Apply analytical skills and critical thinking to solve problems and can express using sound logical arguments utilizing the best available resources for communication.
CO 5: Exhibit an understanding of multiculturalism and be able to work well in teams.

Lecture 1-10

<u>Introduction to Communication</u>

Communication and Self Concept
Role of Emotions
Basics of Communication
Purpose of communication- to inform, to express feelings, to imagine, to influence, to meet social expectations and others
Audience analysis- identifying audience to determine the content, language usage and listener expectations for ensuring effective communication
Cross Cultural Communication and Multi Cultural Communication
Effective Communication: Modes/ Models/Networks

LSRW Skills
Non-Verbal Communication

<u>Barriers to Communication</u>

Introduction
Intrapersonal and Interpersonal Barriers

Organizational Barriers

Information Gap Principle, Noise, Filters **<u>Effective Listening and Speaking</u>** Traits of a good listener Phonetics – Basic Sounds of English – Word Accent - Intonation Achieving confidence, clarity and fluency as a speaker, paralinguistic features, barriers to speaking, types of speaking, Persuasive Speaking, Public Speaking etc. **Additional exercises and activities based on developing Listening and Speaking skills**
Lecture 11-15 Planning, Outlining and Structuring Choosing the mode of delivery Guidelines for effective delivery, Body Language and Voice, Visual Aids etc. **Activities and practice on developing Presentation skills**
Lecture 16-20 Introduction, Objectives, Types, Samples and Examples Problem Solving, Networking in English Meetings and Conferences Minutes of Meeting, Agenda of Meeting **Activities and exercise based on developing GD and Business Networking skills in English**
Lecture 21-30 Introduction, Audience Recognition, Language, Grammar, Style, Techniques The Art of Condensation Note Making and Note Taking Guidelines and Samples **<u>Business/Official Communication</u>** Letters, Resumes, Memos, and e-mails Rules, formats, Style, Etiquette Sales and Credit letters Letter of Enquiry Letter of Quotation, Order, Claim and Adjustment Government Letters, Semi- Government Letters to Authorities etc. Characteristics, Categories, Formats, Structures, Types, Samples Job Application Curriculum vitae Resumes- Chronological, Combination, Functional etc. Reports and Proposals of different kinds **Exercise and activities based on developing Writing skills**
Lecture 31-35 Right Words and Phrases, Sentence Patterns Paragraph Comprehension Passage etc. **Activities and Strategies to engage in active thinking about word meanings, the relationships among words, and use of words in different situations**

Lecture 36-40 Types: Skimming, Scanning, Intensive, Extensive Value Based/Motivational Materials: Articles, Prose, Text Reading **Activities and exercise based on developing Reading skills**
Lecture 41-45 Types and Overview Emotional Intelligence Decision Making and Time Management **Activities and exercise based on developing Leadership and Management skills**

Recommended Texts:

1. Raman , Meenakshi and Sangeeta Sharma. *Technical Communication: Principles and Practice*. 2nd ed. OUP India, 2012.
2. Markel, Mike. *Technical Communication*. 7th ed. New York, NY: Bedford/St. Martin's, 2003. ISBN: 9780312403386.
3. Gamble, Teri Kwal and Michael Gamble. *Communication Works*. 9th Ed. New Delhi: Tata-McGraw-Hill, 2010.
4. Hacker, Diana. *A Pocket Style Manual*. 4th ed. New York, NY: Bedford/St. Martin's, 1999. ISBN: 9780312406844.
5. Perelman, Leslie C., James Paradis, and Edward Barrett. *The Mayfield Handbook of Technical and Scientific Writing*. New York, NY: McGraw-Hill, 1997. ISBN: 9781559346474.
6. **David F. Beer and** David McMurrey**, *Guide to Writing as an Engineer*, 2nd ed., Wiley, 2004,** ISBN: 0471430749.
7. Dale Jungk, *Applied Writing for Technicians*, McGraw-Hill, 2005, ISBN 0-07-828357-4.

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Production Engineering			
PE511	**Engineering Economy**	**L**	**T**
		3	**0**

S. No.	Contents	Contact Hours
1	Fundamental economic concepts and basic economic laws relating to market and prices. Selection in present terms economy. The time element is economy study, interest and interest formulas. Nominal and effective interest rates, calculation of equivalent involving interest. Present worth, properties, capitalized costs and capitalized values.	08
2	Comparison of alternatives, Selection and replacement of equipment from amongst multiple alternatives. Uncertainty in economy studies, decision making under known probabilities, decision trees in evaluation of alternatives.	06
3	Promotion of a company and its legal aspects. Raising of capital, equity capital and borrowed capital. General accounting and double entry, book keeping, journals and ledgers, income statement, balance sheet and their analysis.	06
4	Cost accounting, cost elements and cost structure, Methods of allocating factory overhead, various classification of cost and use of cost data in economy studies.	08
5	Depreciation and depreciation accounting, classification and types of depreciation and accounting for the recovery of cost of capital assets. Value time function, common methods of depreciation, accounting and their selection.	08
6	Economy of operation and minimum cost analysis for purchase, production order, maintenance tooling etc. Break even analysis, effect of price on profit. Income taxes, inflation.	08
	Total	**42**

Suggested Books:

1. Industrial Engg. And Mgt.. B.Kumar (Dhanpat Rai.)
2. Industrial Engg. & mgt. O.P.Khanna,(Khanna Pub)
3. Engineering Economy. Gerald J. Thuesen.(PHI)
4. Engineering Economy. E. Paul DeGarmo.(EEE)

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Production Engineering			
PE512	**Lean Manufacturing**	**L**	**T**
		3	**0**

S. No.	Contents	Contact Hours
1.	Objectives of lean manufacturing-key principles and implications of lean manufacturing- traditional Vs lean manufacturing.	03
2.	Value creation and waste elimination- main kinds of waste- pull production-different models of pull production-continuous flow-continuous improvement/Kaizen- worker involvement -cellular layout-administrative lean.	08
3.	Standard work -communication of standard work to employees -standard work and flexibility -visual controls-quality at the source- 5S principles -preventative maintenance-total quality management-total productive maintenance -changeover/setup time -batch size reduction -production leveling.	09
4.	Value Stream Mapping-The as-is diagram-the future state map-application to the factory simulation scenario-line balancing -Poke Yoke – overall equipment effectiveness. One Piece Flow-Process razing techniques – cells for assembly line – case studies	08
5.	Introduction - elements of JIT - uniform production rate - pull versus push method- Kanban system - small lot size - quick, inexpensive set-up - continuous improvement. Optimised production technology.	08
6.	Team establishment, transformation process, Project Management, Lean implementation, Reconciling lean with other systems- lean six sigma-lean and ERP-lean with ISO 9001:2000.	06
	Total	**42**

SuggestedBooks:

1. Askin R G and Goldberg J B, “Design and Analysis of Lean Production Systems”, John Wiley and Sons Inc., 2003.
2. Hobbs, D.P. “Lean Manufacturing implementation”, Narosa Publisher, 2004.
3. Micheal Wader, “Lean Tools: A Pocket Guide to Implementing Lean Practices”, Productivity and Quality Publishing Pvt Ltd, 2002.
4. Michael L George, David T Rowlands, Bill Kastle, “What is Lean Six Sigma”, McGraw Hill, New York, 2004.
5. Kenichi Sekine, “One-Piece Flow”, Productivity Press, Portland, Oregon, 1992.
6. Alan Robinson “Continuous Improvement in Operations”, Productivity Press, Portland, Oregon, 1991.
7. Poke - Yoke, "Improving Product Quality by Preventing Defects", Productivity Press, 1992.

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Production Engineering			
PE513	**Process Engineering**	**L**	**T**
		3	**0**

S. No.	**Contents**	**Contact Hours**
1.	Introduction to process planning, Design and manufacture cycle, Process planning - the design/manufacture interface, Process planning activities, Process planning verses production planning.	05
2.	Process planning methods, Manual process planning, Experience-based process planning, Part design/drawing interpretation, Basic process planning terminology, Equivalent parts -interchangeability and standardization, Concept of dimensional chain, Dimensional and Tolerance analysis	08
3.	Process selection, Process capability analysis, Process and operations sequencing, Calculation of process parameters, Process re-engineering, Preparation of process sheet,	07
4.	Expert systems and their use in developing process planning systems,	02
5.	Computer-aided process planning (CAPP), Variant process planning, Generative and dynamic CAPP, Forward and Backward planning, Logical design of process planning systems,	06
6.	Optimal selection of manufacturing processes, tools and fixtures, coolants and other consumables required for manufacturing,	08
7.	Cost analysis and cost control for different processes, Make-or-buy decisions, Methods of process cost estimation and its application in preparation of manufacturing budget.	06
	Total	**42**

Suggested Books:

1. Process Engineering for manufacturing by Donald F. Eary and Gerald E. Johnson
2. Process Planning by Peter Scallan, ELSEVIER
3. Process Engineering techniques Evaluation by W.F. Waller
4. Product Planning systems by L.N.Goslin

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Production Engineering			
PE521	**Value Engineering**	**L**	**T**
		3	**0**

S. No.	Contents	Contact Hours
1.	**Introduction & Value Orientation**: Reasons for unnecessary costs, VE-versatile technique, definition, beginning and the Spread. Value orientation, customer and cost, internal customers, value defined, Increasing value.	05
2.	**The Orientation Phase:** Training, Selection of projects, impact of VE application, ABC analysis, Problematic areas, production problems, maintenance problems, vendor development problems, design problems, old designs, specifications and standards. Selection of leader, team members, workshop.	08
3.	**The Information Phase**: Decision and costs, use of work book, human relations. **The FunctionPhase:** Importance of functions, types of functions, functions defined, levels of functions, Function-cost, concept of worth, value potential, function Analysis System Technique (FAST), scope lines.	07
4.	**The Creation Phase**: Brainstorming, split-brain theory, brainstorming process, Gordon technique, checklists, Morphological analysis technique, word association technique. **The Evaluation Phase**: Filters, ranking, feasibility rankings, weighted evaluation, factor comparison, Decision matrix.	08
5.	**The Recommendation Phase:** Conducting trails, assessing management's needs, preempting, making the presentation. **The Implementation Phase:** Action plan, record progress, report progress, organizing review meetings, problems in implementation, incorrect project selection, human factors.	06
6.	**The Audit Phase:** Technical audit, cost audit, case study, timing of audit, problems in audit, audit personnel, documentation, frequency of audit, benefits. **Managing the VE Program**: The need, management support, VE organization, VE group, VE manager, tasks, VE workshops, selection of projects, follow-up, Publicity, VE Budgets, action plan, Select a simple project, Management Presentation, Audit of savings.	08
	Total	**42**

SuggestedBooks:

1. Manufacturing Processes for Engineering Materials : S. Kalpakjian, 3rd edition Addison - Wesley,
2. Composite Materials: Science and Engineering: Krishan Kumar Chawla, Springer Science & Business Media
3. Callister's Materials Science and Engineering: R. Balasubramaniam, 2nd edition,Wiley

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Production Engineering			
PE522	**Work Study and Ergonomics**	**L**	**T**
		3	**0**

S. No.	**Contents**	**Contact Hours**
1.	Introduction: Purpose and scope of work study and its historical development. Work study as a tool for productivity enhancement.	05
2.	Method Study: Objectives and scopes; general procedure to tackle method study problems (steps; select, record, critical examination, develop, install and maintain improved method). Recording techniques and their applications (Operation process chart, flow process chart, two handed process chart, multiple activity chart, flow diagram, string diagram, photographic aids and models).	08
3.	Micro-motion Study: Preparation of motion films and analysis with the help of therbligs and SIMO charts, memomotion study, cycle graph and chronocylegraph, Principles of motion economy.	07
4.	Work Measurements: Concept, scope and objectives. Various work measurement techniques. Stop watch study, procedure in detail. Performance rating and determination of normal time. Allowances in time study and determination of Standard time Work Sampling : Concept and uses. Sampling study procedure and presentation of results. Establishing time standards by work sampling, practical applications.	08
5.	Pmts: Establishment and uses of elemental time data, predetermined motion time systems, major systems, uses and applications. Wage & Incentive: Principles and methods of job evaluation and merit rating. Principles of wage & incentive payment, comparative study of incentive schemes.	06
6.	Ergonomics: Concept, scope and objectives of human factors in engineering and Man-environment interaction. Causes and prevention of fatigue, Design of Man-environment systems and methodology.	08
	Total	**42**

Suggested Books:

1. Workstudy and Ergonomics by Lakhwinder Pal Singh Cambridge Publication
2. Workstudy and ergonomics by P.C Tewari CRC Press
3. Motion and Time Study Design and Measurement of Work by Ralph M. Barnes, Wiley Publication.

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Production Engineering			
PE523	**Eco-Friendly Manufacturing**	**L**	**T**
		3	**0**

S. No.	**Contents**	**Contact Hours**
1.	INTRODUCTION; Introduction to lean, sustainable, green manufacturing; concept of Eco-friendly manufacturing; the monozukuri principles.	04
2.	REGULATORY CONSIDERATIONS: Regulatory considerations and sustainability strategies, Imperative global warming perspectives, Carbon credits, green power and renewable energy credits;	07
3.	ENVIRONMENTAL PERFORMANCE INDICES; Effect of industrial activity on environment, measures and metrics; ranking of risks; Environmental Load Units (ELU); International green manufacturing standards and compliance; ISO 14000;	06
4.	MATERIAL FLOWS THROUGH THE ECONOMY AND THE ENVIRONMENT: Metals production, Metal recycling, Energy and other advantages of metal	06
5.	INDUSTRIAL WASTE: Type of wastes, causes of waste generation and its elimination in manufacturing industries, Hidden waste in industries, workplace organization.	07
6.	ANALYTICAL TOOLS: Lean vision and lean principles, value added and non-value-added activities Metrics for sustainable practices; life cycle assessment/impact tools; Product Stewardship in Industry	06
7.	ECO FRIENDLY MANUFACTURING SYSTEM: Green Design and Manufacturing in Consumer Products; Green rapid prototyping and rapid manufacturing; green packaging; Green collaboration processes via the Internet; Reverse supply chain, green supply chain.	6
	Total	**42**

Suggested Books:

1. Fast Track to Waste Free Manufacturing J.W. Davis, Productivity Press USA
2. Clean Production, K.B. Misra, Springer – Verlog – 1996
3. Environmentally Benign Manufacturing, WTEC Panel Report, 2001
4. Design for environment: A guide to sustainable product development: Eco- efficient product development, J, Fiksel. McGraw-Hill.- 2009
4. Green Manufacturing: Case Studies in Lean Manufacturing and Sustainability., AME, Association for Manufacturing Excellence (2007) Productivity Press, Inc.

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Production Engineering			
PE531	**Automobile Engineering**	**L**	**T**
		3	**0**

S. No.	Contents	Contact Hours
1.	Introduction to automobile: Importance, applications, job opportunities, classification, types of vehicles, basic structure, general layout, hybrid vehicles.	05
2.	Automotive electric and electronic systems: Electric and electronics principles, systems, and circuits, automotive batteries, construction, and operation, starting system, charging system, operation and service, ignition system, electronic ignition and fuel control, engine management, electric vehicles, electronic fuel injection system - monopoint and multipoint systems.	08
3.	Automotive drive trains: Clutch - types and construction, fluid flywheel, gear boxes, manual and automatic - overdrives - propeller clutches, drive shafts, universal joints, drive axles.	07
4.	Automotive chassis: Vehicle construction, chassis, frame and body, construction, operation, performance, steering system, wheel alignment, brakes, wheels and tyres.	07
5.	Maintenance and Trouble Shooting: Automobile performance, drivability, emissions and emission norms, noise and vibration, engine tuning, equipment for measuring various vehicle parameters such as BHP, A/F ratio, noise, vibration and emission, comfort and safety.	08
6.	Newer Fuels: Use of natural gas, LPG, hydrogen, bio- diesel in automobiles as fuels, electric and hybrid vehicles, fuel cells. Other recent advances in automobiles and automotive components.	07
	Total	**42**

Suggested Books:

1. Crouse – Anglin, “Automotive Mechanics”, McGraw Hill, 10th Edition, Singapore.
2. Pulkrabek Willard W., “Engineering Fundamental of the Internal Combustion Engine”, Prentice Hall of India, New Delhi, 2002.
3. Bosch, “Automotive Handbook”, SAE Publication.
4. Denton Tom, “Automobile Electrical and Electronics Systems”, Butterwoth, Heinemann, 2003.
5. Layne Ken, “Automotive Engine Performance: Tune up, Testing and Service”, Englewood Prentice Hall of India, 1996.

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Production Engineering			
PE532	**CAD/CAM**	**L**	**T**
		3	**0**

S. No.	Contents	Contact Hours
1.	**Introduction:** CAD/CAM Processes, Role of CAD/CAM/CAE in the Product Cycle, CAD tools to support the design process and manufacturing, Benefits of CAD/CAM/CAE in the industry.	08
2.	**Geometric Modeling:** Wire frame modeling – entities, curve representation methods, parametric representation of analytic and synthetic curves, Surface modeling – parametric representation of analytic and synthetic surfaces, Solid modeling – Boundary representation, constructive solid geometry	12
3.	**Geometrical transformation:** Two-dimensional transformation Three-dimensional transformation representation of matrix: translation, scaling, rotation, mirror, shearing, Solid modeling types: parametric, solid, surface.	05
4.	**Numerical Control (NC):** Introduction, numerical control – its growth and development, components of NC system, input devices, control systems – point to point, straight cut, and continuous path NC, open loop and closed loop NC systems, NC interpolations – linear, circular, helical, parabolic and cubic interpolation, applications of NC systems, merits and demerits.	05
5.	**Part Program Terminology:** G and M Codes, Types of interpolation, Methods of CNC part programming, Manual part programming, Computer Assisted part programming: APT language, CNC part programming using CAD/CAM Introduction to Computer Automated Part Programming.	08
6.	**Factors influencing selection of CNC Machines:** Cost of operation of CNC Machines-cost of Operation of CNC Machines-Practical aspects of introduction of CNC-Maintenance features of CNC Machines-Preventive Maintenance.	04
	Total	**42**

Suggested Books:

1. Zeid, I., “Mastering CAD/CAM”, Tata McGraw Hill.
2. Hsu, T. R. and Sinha, D. K., “Computer Aided Design: An Integrated Approach”, West Publishing Company.
3. Groover, M. P., “Automation, Production systems and Computer Integrated Manufacturing”, 3rd 2007 Ed., Prentice-Hall.
4. Singh, N., “Systems Approach to Computer Integrated Design and Manufacturing”, John Wiley & Sons
5. Besant, C. B. and Lui, C. W. K., “Computer Aided Design and Manufacture”, Ellis Horwood Ltd.
6. Rao, P. N., Tiwari, N. K. and Kundra, T.K., “Computer Aided Manufacturing”, Tata McGraw Hill.

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Production Engineering			
PE533	**Industrial Pollution**	**L**	**T**
		3	**0**

S. No.	**Contents**	**Contact Hours**
1.	Introduction: Environments and Human activities, Environments and Ecology, Consequences of population growth. Energy problem.	02
2.	Pollution of air, water and land, Fossil fuel related pollutants in the environment.	06
3.	Environmental Impacts of Hydro-electric, Nuclear energy and chemicals.	03
4.	Air pollution - Definitions and scales of concentration, classification and properties of air pollutants, Emission- sources and their classification. Air pollution laws and standards, Inversion Ambient air sampling, stack sampling, sampling system, analysis of air pollutants. Air pollution emission control, selection of a particulate: collector, control of gaseous emission, combustion	04
5.	Water pollution - Hydrologic cycle and water quality , origin of waste water and its composition, Type of water pollutants and their effects, water pollution laws: and standards, waste water sampling and analysis water quality standard, waste water treatment , Biological systems(Aerobic and Facultative ponds), Recovery of material from process effluents.	14
6.	Noise pollution- Different noise environments and their sources, measurement of noise and the equipments Noise pollution lows an, Vibration isolation and noise control in industries.	07
7.	Solid Waste Management Sources and classification, Public health aspect, effluent treatment processes and solid waste management: sources and classification. Public health aspect, effluent treatment process and solid waste management, “Solid-Solid separation technique for recovery and reuse	08
	Total	**42**

Suggested Books:

1. Bhatia S C, Managing Industrial Pollution, Macmillan India Pvt. Ltd.
2. Dix H M, Environmental Pollution, Institution of Environmental Sciences Series/ Wiley
3. Sawyer C N, Mccarty P L, Parkin G F, Chemistry for Environmental Engineering and Science, McGraw-Hill

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Chemical Engineering			
CL501	**Mass Transfer operation**	**L**	**T**
		3	**1**

COURSE OBJECTIVE:-The students will be able to understand the concepts of basic mass transfer operations involved in industrial processes as well as relate them to practical problems in everyday lives.

Syllabus:

MODULE 1: Diffusion Mass Transfer **Lectures 8**

1. Introduction to mass transfer and Fick's Law.
2. Diffusivity measurement and prediction, multi-component diffusion, molecular diffusion in solids.
3. Steady-state molecular diffusion in equimolar counter diffusion.

MODULE 2: Mass Transfer Coefficients **Lectures 8**

1. Concept of mass transfer coefficients, mass transfer under laminar and turbulent flow past solids.
2. Theories of mass transfer and their applications-Penetration theory, Surface Renewal Theory, Two film Theory, inter-phase mass transfer.
3. Equilibrium and diffusion between phases.
4. Study of individual and overall mass transfer coefficients mass transfer coefficients
5. Eddy diffusion, mixing length, wetted wall column.
6. Mass, heat and momentum transfer analogies, JD factor.

MODULE 3: Humidification **Lectures 8**

1. Phase relations and definitions, Humid heat, humid volume, adiabatic saturation temperature
2. Dew point, Lewis relation, Charles's Relation for humidification and dehumidification relations

MODULE 4: Drying **Lectures 8**

1. Equilibrium-insoluble solids, soluble solids.
2. Critical moisture, equilibrium moisture, bound and unbound moisture.
3. Drying operation- batch drying, direct dryers, indirect dryers and their types
4. Rate of batch drying, cross circulation drying and continuous dryers- Tray, Tunnel etc
5. Drying at high and low temperature.

MODULE 5: Evaporation **Lectures 8**

1. Evaporation in direct heating steam headed evaporators, natural circulation units
2. Horizontal tube and vertical tube coil evaporators, forced circulation and film type evaporators.
3. Single and multiple effect evaporators – Characteristics and applications
4. Economy and capacity of single and multiple effect evaporators and their calculations
5. Feed operations- Backward, Forward, Mixed and parallel.
6. Vapor recompression and integration of evaporators.

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Textbooks:

1. Treybal, R. E.: "Mass transfer Operations", 3rd ed., McGraw-Hill, New York, 1980.
2. Unit Operations of Chemical Engineering, McCabe W.L., and Smith J.C. & Harriot, McGraw Hill Book Co., New York 1980, 5th Edition.

Reference books:

1. Geankpolis, C.J., Transport Processes and Separation Process Principles (IncludesUnit Operations),Prentice Hall of India, New Delhi, 4th Edition, 2003.

2. Roman Zarzytci, AndrzaiChacuk, Absorption: Fundamentals and Application, Pergamon, Press, 1993.

Course Outcomes:

After completion of this course, the student will be able to:

CO1	Solve diffusion and diffusion related problems.
CO2	Estimate mass transfer coefficients for gas–liquid contacting systems.
CO3	Explain the humidification and dehumidification operations.
CO4	Estimate the rate of batch and continuous drying.
CO5	Apply design calculations of single and multiple effect evaporators.

Mapping of course outcomes with program specific outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	2	-	-	-	-	-	-	-
CO2	1	3	3	3	2	-	-	-	-	-	-	-
CO3	2	2	2	3	-	-	-	-	-	-	-	-
CO4	1	2	3	3	1	2	1	-	-	-	-	-
CO5	1	2	3	1	2	3	1	-	-	-	-	-

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Chemical Engineering			
CL502	**Chemical Reaction Engineering**	**L**	**T**
		3	**0**

Course objective

This course will provide students understand the kinetics of reaction engineering and provide basis for design of simple chemical reactors.

Module – I **Lectures 8**

Classification of reactions, Definition of reaction rate, Variable effecting the rate, Concept rate of reaction, order of reaction and its determination, theoretical study of reaction rate, collision and activated complex theory.

Module-II **Lectures 8**

Classification of reactors: Concept of ideality. Development of design Equation for batch reactor, CSTR, and PFR, application of ideal reactor.

Module-III **Lectures 8**

Design of isothermal and non-isothermal batch, CSTR, PFR reactors optimum temperature progression, thermal characteristics of reactors

Module-IV **Lectures 8**

Combination of reactors, reactors with recycles Yield and selectivity in multiple reactions.Multiple reactions in batch, continuous stirrer and plug flow reactors uniqueness of steady state in continuous stirred tank reactor.

Module- V **Lectures 8**

Non-ideal reaction, evaluation of RTD characteristics, modelling of real system.

Course Outcomes:

After completion of this course, the student will be able to

CO1	**Explain the basic concepts in reaction and reactor engineering.**
CO2	**Design performance equations of reactors.**
CO3	**Analyse Non-Isothermal operation in Ideal Reactors**
CO4	**Examine the Non-Ideal Behaviour of real reactor.**

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Mapping of course outcomes with program specific outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Textbook:

1. Chemical Reaction Kinetics By J.M. Smith (3rd Edition Mc Graw Hill)
2. Chemical Reaction Theory an Introduction By K.G. Denbigh & K.G. Turner (2nd Edition United Press & ELBS)
3. Chemical Kinetic and Reactor Engineering By G. Copper & GVJ jeffery`s (Prentice Hall 1972)
4. Chemical reaction engineering By O.Levenspiel (2nd Edition Willey Eastern, Singapore)
5. Chemical process Principal Part-III ByHoughenWatsn& Ragatz [Kinetics & catalysis (2nd Edition asian publication House Bombay)]
6. Element of Chemical Reaction Engineering By Fogler ,H.S. (2nd edition Prentice Hall of India Pvt. Ltd

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Chemical Engineering			
HU501	**Professional Communication**	**L**	**T**
		3	**0**

Course Overview:

This course is designed to help one develop communication skills in English with a sense of language. It will be of help to improve clarity, precision and overall impact in both oral as well as written communication. It will also enable one to produce clear and effective scientific and technical documents required for professional communication. We will focus on basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations. One can learn how to gather, organize, and present information effectively according to audience and purpose. Moreover, emphasis will be on sustainable communication that will facilitate an understanding of one's role and help to align with the mission of the organization.

Objective:

To provide you with the communication skills one needs to advance in a field, keeping in mind that, in career, one may be involved with design, development, field service and support, management, sales, customer liaison, or all of the above.

Course Outcomes:

CO 1: Demonstrate effective oral and written communication with diverse audiences and produce variety in professional written documents to better support and communicate.
CO 2: Plan and deliver a formal presentation on a topic with confidence and poise.
CO 3: Appraise ethics and social responsibility as a professional.
CO 4: Apply analytical skills and critical thinking to solve problems and can express using sound logical arguments utilizing the best available resources for communication.
CO 5: Exhibit an understanding of multiculturalism and be able to work well in teams.

Lecture 1-10

<u>Introduction to Communication</u>

Communication and Self Concept
Role of Emotions
Basics of Communication
Purpose of communication- to inform, to express feelings, to imagine, to influence, to meet social expectations and others
Audience analysis- identifying audience to determine the content, language usage and listener expectations for ensuring effective communication
Cross Cultural Communication and Multi Cultural Communication
Effective Communication: Modes/ Models/Networks

LSRW Skills
Non-Verbal Communication

<u>Barriers to Communication</u>

Introduction
Intrapersonal and Interpersonal Barriers

Organizational Barriers
Information Gap Principle, Noise, Filters

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<u>Effective Listening and Speaking</u>
Traits of a good listener
Phonetics – Basic Sounds of English – Word Accent - Intonation Achieving confidence, clarity and fluency as a speaker, paralinguistic features, barriers to speaking, types of speaking, Persuasive Speaking, Public Speaking etc.

Additional exercises and activities based on developing Listening and Speaking skills

Lecture 11-15
Planning, Outlining and Structuring
Choosing the mode of delivery
Guidelines for effective delivery,
Body Language and Voice, Visual Aids etc.
Activities and practice on developing Presentation skills

Lecture 16-20
Introduction, Objectives, Types, Samples and Examples
Problem Solving, Networking in English
Meetings and Conferences
Minutes of Meeting, Agenda of Meeting
Activities and exercise based on developing GD and Business Networking skills in English

Lecture 21-30
Introduction, Audience Recognition, Language, Grammar, Style, Techniques
The Art of Condensation
Note Making and Note Taking
Guidelines and Samples
<u>Business/Official Communication</u>
Letters, Resumes, Memos, and e-mails
Rules, formats, Style, Etiquette
Sales and Credit letters
Letter of Enquiry
Letter of Quotation, Order, Claim and Adjustment
Government Letters, Semi- Government Letters to Authorities etc.
Characteristics, Categories, Formats, Structures, Types, Samples
Job Application
Curriculum vitae
Resumes- Chronological, Combination, Functional etc.
Reports and Proposals of different kinds
Exercise and activities based on developing Writing skills

Lecture 31-35
Right Words and Phrases,
Sentence Patterns
Paragraph
Comprehension Passage etc.
Activities and Strategies to engage in active thinking about word meanings, the relationships among words, and use of words in different situations

Lecture 36-40 Types: Skimming, Scanning, Intensive, Extensive Value Based/Motivational Materials: Articles, Prose, Text Reading **Activities and exercise based on developing Reading skills**
Lecture 41-45 Types and Overview Emotional Intelligence Decision Making and Time Management **Activities and exercise based on developing Leadership and Management skills**

Recommended Texts:

1. Raman , Meenakshi and Sangeeta Sharma. *Technical Communication: Principles and Practice*. 2nd ed. OUP India, 2012.
2. Markel, Mike. *Technical Communication*. 7th ed. New York, NY: Bedford/St. Martin's, 2003. ISBN: 9780312403386.
3. Gamble, Teri Kwal and Michael Gamble. *Communication Works.* 9th Ed. New Delhi: Tata-McGraw-Hill, 2010.
4. Hacker, Diana. *A Pocket Style Manual*. 4th ed. New York, NY: Bedford/St. Martin's, 1999. ISBN: 9780312406844.
5. Perelman, Leslie C., James Paradis, and Edward Barrett. *The Mayfield Handbook of Technical and Scientific Writing*. New York, NY: McGraw-Hill, 1997. ISBN: 9781559346474.
6. **David F. Beer and** David McMurrey**, *Guide to Writing as an Engineer*, 2nd ed., Wiley, 2004,** ISBN: 0471430749.
7. Dale Jungk, *Applied Writing for Technicians*, McGraw-Hill, 2005, ISBN 0-07-828357-4.

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Chemical Engineering			
CL511	**Instrumentation and Process Control**	**L**	**T**
		3	**0**

Course objective: To provide detail knowledge about various techniques used for the measurement of primary industrial parameters(Flow, level, temperature and pressure) and application of different sensor/transducers , final control element for industrial and control system.

Syllabus:

MODULE I **Lectures 8**

Process variable, Elements of measuring instrument, Static and dynamic response of measuring device; Different types of thermometer and Thermocouples, Absolute pressure, Gauge Pressure, Differential Pressure, Measuring pressure for corrosive fluids, Head flow meters, open channel meters, area flow meters, Flow of dry material.

MODULE II **Lectures 10**

Transmitter, Transducers, Converter, Multiplexer, Pneumatic control valve, Stepper motor, Motorized valve; Data acquisition system and intelligent instruments, Process Instrumentation Diagrams: Representation and symbols, Instrumentation diagram for Distillation Column, Heat exchanger, Petroleum refinery.

MODULE III **Lectures 7**

Introductory Concepts: Need for control and automation, Control logic, manipulate variable, Control variable, set point and load; Blending Tank, Stirred Tank, Reactor, Interacting and Non-Interacting Process, Modeling considerations for control purposes.

MODULE IV **Lectures 9**

Linearization of Non-linear function across steady state- Deviation variable, Some Important aspects of Laplace transforms., Forcing functions (Step, Impulse, Ramp) and their Laplace transfer, Transfer functions and the input-output models; Dynamics and analysis of first, second and higher order systems, Transportation Lag, Dead Time.

MODULE V **Lectures 6**

Concept of feedback control, Closed loop and open loop transfer function, Implementation of block diagram, Different type of controllers, Control valve characteristics.

Routh stability criterion,Root locus plot and stability analysis,Bode stability criterion Nyquist stability criterion, Frequency response technique; Phase margin and gain margin;

Text/Reference books

1. Patranabis, D “Principles of Industrial Instrumentation” Tata Mc.Graw Hill Publishing Co.
2. Johnson, C,D,”Process Control Instrumentation Technology” Pearson Education, Inc
3. Coughnaowr, D.D. Process systems Analysis and Control, Mc.Graw –Hill,Inc.
4. SeborgD.E.Edgar, T, and Mellichamp,D.A. “Process Dynamics and Control” John Wiley and Sons, Inc.

5. Stephanopolous, G "Chemical Process Control" Prenticed –Hall.

Course outcome: At the end of the course, the student will be able to

CO1: Understandthe various measuring devices in chemical industry.

CO2: Able to explaininstrumentation diagram in process flow sheet.

CO3: Sketch the block diagram for various chemical processes.

CO4: Examine the stability concerns of a block diagram.

Course outcome mapping with Programme outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	2	1	-	-	-	-	-	-	3
CO2	2	2	3	2	1	-	-	-	-	-	-	2
CO3	2	3	3	3	1	-	-	-	-	-	-	2
CO4	3	3	3	2	2	-	-	-	-	-	-	3

Vinoba Bhave University , Hazaribagh

Chemical Engineering			
CL512	Process Dynamics and Control	L	T
		3	0

Course Objective: - The students will be able to understand the various types of control systems used in industrial equipment's along with the stability analysis of such systems.

Syllabus

MODULE I **Lectures 7**

Introductory Concepts: Need for control and automation, Control logic, Manipulate variable, Control variable, Set point and load; Development of mathematical models for different processes: Blending Tank, Stirred Tank, Reactor, Interacting and Non-Interacting Process, Modeling considerations for control purposes.

MODULE II **Lectures 10**

Linearization of Non-linear function across steady state- Deviation variable, Some Important aspects of Laplace transforms., Forcing functions (Step, Impulse, Ramp) and their Laplace transfer, Transfer functions and the input-output models; Dynamics and analysis of first, second and higher order systems, Transportation Lag, Dead Time

MODULE III **Lectures 8**

Concept of feedback control, Servo and regulatory problem, Closed loop and open loop transfer function, Implementation of block diagram, Different type of controllers, Control valve characteristics

MODULE IV **Lectures 9**

Routh stability criterion ,Root locus plot and stability analysis ,Bode stability criterion Nyquist stability criterion, Frequency response technique; Phase margin and gain margin;Ziegler Nichols method ,Cohen Coon method

MODULE V **Lectures 6**

State-space representation, Feed forward and ratio control.Cascade, IMC (Internal Model Control), MPC (Model Predictive Control).

Textbooks:

1. Coughnaower, D.D.Process systems Analysis and Control, Mc.Graw –Hill,Inc.
2. SeborgD.E.Edgar,T,andMellichamp,D.A. "Process Dynamics and Control" John Wiley and Sons, Inc.

reference books:-

1. Stephanopolous,G "Chemical Process Control" Prenticed –Hall.
2. Bequette,,B.W,"Process Control; Modeling Design and Simulation" Prentice Hall,Inc.

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COURSE OUTCOMES:-

Students will be able to:-

CO1: Analyze the role of Laplace transform in process control.

CO2: Develop dynamic modeling and system behavior studies.

CO3:Develop concept for designing of controllers and advance controllers.

CO4: Evaluate the role of stability characteristics in control system.

Course outcome mapping with Programme outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1	-	-	-	-	-	-	3
CO2	2	2	3	2	1	-	-	-	-	-	-	2
CO3	2	3	3	3	1	-	-	-	-	-	-	2
CO4	3	3	3	2	2	-	-	-	-	-	-	3

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Chemical Engineering			
CL513	**Computer Aided Process Control**	**L**	**T**
		3	**0**

Course Objectives:

1. To impart knowledge of tools being used to control the process in industry.

2. To get acquainted with DDC, DCS and others supervisory computer control.

3. To understand the digital and analog computer control process.

4. To understand open and close loop system for process control.

Course Outcomes: At the end of the course, the students will be able to:

1. Understand the computer aided process control, DDC and DCS.
2. Estimate Z-transform and inverse of Z-transform.
3. Write algorithm for PD, PI and PID control.
4. Apply model based control for feed forward and cascade control strategies.

MODULE I **Lectures 10**

Introduction to Computer-Aided Process Control

Computer control vs. analog control; Advantage and limitations Basic concepts of computer hardware and software; Theory and implementation; Introduction to A/D, D/A, multiplexing sample and hold and signal conditioning schematic and block diagram representation of computer-controlled system.

MODULE II **Lectures 3**

Z-transformation Z-transform Inverse Z- transform modified Z- transform Inverse of modified Z transformation and their properties Plus transfer function.

MODULE III **Lectures 7**

Digital control algorithm conversion of analog PI, PD, PID, into digital Direct synthesis method deadbeat control dahlia’s algorithm and kalian’s approach into digital controller design k-control algorithm for load changes Ringing problem and its elimination.

MODULE IV **Lectures 10**

Sampling theorem; Aliening selection of sampling period. Open and close loop response of sample data system stability analysis. Implementation of control algorithm and realization of discrete transfer; function.

MODULE V **Lectures 10**

Introduction to the implementation of various control strategies feed forward cascade adaptive and model-based control. Using digital computer.

Introduction to DDC, DCS, supervisory optimizing and hierarchical computer control

Text & Reference Books:

1. Computer aided process control by S.K. Singh, Prentice Hall of India Pvt. Ltd.
2. Process Control Engineering by P. Sai Krishna, I. K. International Pvt Ltd, 2010
3. Industrial Instrumentation & Control by S.K.Singh, Tata McGraw-Hill Education

Course outcome mapping with Programme outcomes:

	POs1	POs2	POs3	POs4	POs5	POs6	POs7	POs8	POs9	POs10	POs11	POs12
CO1	3	2	1	-	-	-	-	-	-	-	-	3
CO2	3	2	2	2	-	-	-	-	-	-	-	3
CO3	3	2	1	2	3	-	-	-	-	-	-	3
CO4	3	1	2	1	3	-	-	-	-	-	-	3

Vinoba Bhave University , Hazaribagh

Chemical Engineering			
CL521	**Numerical Methods inChemical Engineering**	**L**	**T**
		3	**0**

Course Objective: To study the numerical+ analysis methods and their applications in solving chemical engineering problems.

Syllabus

MODULE I **Lectures 6**

Introduction, Approximation and Concept of Error & Error Analysis. Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrix inversion, Gauss-Siedel method, Chemical engineering problems involving solution of linear algebraic equations.

MODULE II **Lectures 7**

Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, Chemical engineering problems involving solution of non-linear equations.

Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression.

MODULE III **Lectures 10**

Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments, quadrature methods, Chemical engineering problems involving numerical differentiation and integration.

MODULE IV **Lectures 7**

Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single, and a system of ODEs .

MODULE V **Lectures 5**

Introduction to Partial Differential Equations: Characterization of PDEs, Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method.

Course Outcomes:

After completion of this course, the student will be able to

CO1	**Solve linear and non linear equations using bisection and Newtons method.**
CO2	**Evaluate sets of linear equations.**
CO3	**Apply laplace equations to heat and mass transfer governing equations.**
CO4	**Understand linear and non linear regression techniques and to correlate with experimental data.**

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CO5	**Solve initial and boundary value problems of ordinary differential equations.**

Mapping of course outcomes with program specific outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**2**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**2**	**-**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**2**	**1**	**2**	**1**	**2**							

Text Books

1. Gupta, S. K., "Numerical Methods for Engineers, New Academic Science, 2012.

References Books

1.S.C. Chapra& R.P. Canale, "Numerical Methods for Engineers with Personal Computer Applications", McGraw Hill Book Company, 1985.

2. R.L. Burden & J. D. Faires, "Numerical Analysis", 7th Ed., Brooks Coles, 2000.

3. Atkinson, K. E., "An Introduction to Numerical Analysis", John Wiley & Sons, 1978.

4. Press, W. H. et al., "Numerical Recipes in C: The Art of Scientific Computing, 3rd Edition, Cambridge University Press, 2007.

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Chemical Engineering			
CL522	**Mathematical Methods Chemical Engineering**	**L**	**T**
		3	**0**

Course Objectives:

1. To impart the knowledge of partial differential equations.
2. To understand concept of probability and distributions.
3. To know the probable errors while using different techniques.
4. To understand model writing techniques.

Course Outcomes: At the end of the course, the students will be able to:

5. Understand the vectors and partial differential equations.
6. Understand probability and distributions
7. Estimate error analysis in different techniques.
8. Write model equations for numerical techniques for solution of ODE and PDEs.

MODULE 1 **Lectures 9**

Vector and tensor spaces; Metric,norm and inner products; orthonormalization; matrices, operators and transformations; eigen values and eigen vectors; Fredholm alternative, Rayleigh quotient and its application to chemical engineering systems; self adjoint and non self adjoint systems

MODULE 2 **Lectures 6**

Partial differential equations and their application in chemical engineering; Strum-louiville theory; Separation of variables and Fourier transformations.

MODULE 3 **Lectures 8**

Applications of Greens function for solution of ODE and PDEs in chemical engineering; Numericals techniques for solution of ODE and PDEs; Linear stability and limit cycles; Bifurcation theory; Secondary bifurcation and chaos.

MODULE 4 **Lectures 6**

Probability concepts and distributions, random variables, error analysis, point estimation and confidence intervals, hypothesis testing

MODULE 5 **Lectures 8**

Development of empirical chemical engineering models using regression techniques, design of experiments, process monitoring based on statistical quality control techniques, case studies

Text/Reference Books:

1. Pushpavnam, S., Mathematical Methods in Chemical engineering, Prentice Hall of India, New Delhi, IsBN-81-203-1262-7

Course outcome mapping with Programme outcomes:

	POs1	POs2	POs3	POs4	POs5	POs6	POs7	POs8	POs9	POs10	POs11	POs12
CO1	3	2	1	-	-	-	-	-	-	-	-	3
CO2	3	2	1	-	-	-	-	-	-	-	-	3
CO3	3	3	3	3	-	-	-	-	-	-	-	3
CO4	3	2	3	1	-	-	-	-	-	-	-	3

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Chemical Engineering			
CL523	**Optimization of Chemical Processes**	**L**	**T**
		3	**0**

Course Objectives:-

1. To understand the different optimization techniques
2. To impart knowledge of linear programming's
3. To apply optimization techniques for the design of different equipment
4. To apply optimization techniques for the optimization of process parameters

MODULE – I: **[4L]**

Nature and Organization of optimization problems, fitting models to data, formulation of objectivefunctions.

MODULE – III **[6L]**

Basic concepts of optimization, optimization of unconstrained function, one dimensional search.

MODULE – III: **[6L]**

Linear programming and applications.

MODULE – IV: **[10L]**

Optimization recovery of waste heat, shell and tube heat exchanger, evaporator design, liquid-liquidextraction process, optimal design of staged distillation column.

MODULE – V: **[10L]**

Optimal pipe diameter, optimal residence time for maximum yield in an ideal isothermal batch reactor,chemostat, optimization of a thermal cracker using linear programming.

Text Book:

1. Optimization of chemical process, T.F.Edgar and Himmelblau.D.M., McGraw Hill.

Reference Book:

1. Optimization: Theory and Applications, S.S.Rao, Wiley Eastran Ltd.

Course Outcomes: At the end of the course, the students will be able to:

1. Understand the basic concept of optimization.
2. Estimate the recovery of waste heat from shell and tube heat exchanger.
3. Write linear programing for various problems.
4. Design evaporator, liquid-liquid extraction process and stage distillation column.

Course outcome mapping with Programme outcomes:

	POs1	POs2	POs3	POs4	POs5	POs6	POs7	POs8	POs9	POs10	POs11	POs12
CO1	2	1	1	1	-	-	-	-	-	-	-	3
CO2	3	1	3	2	-	-	-	-	-	-	-	3
CO3	3	3	3	2	1	-	-	-	-	-	-	3

Vinoba Bhave University , Hazaribagh

CO4	3	3	3	3	1	-	-	-	-	-	-	3

Chemical Engineering			
CL524	**Fluidization Engineering**	**L**	**T**
		3	**0**

Course Objectives:

To study the fluidization phenomena, fluidized bed regimes and models.

Course Outcomes:

The students will be able to:

1. understand the fluidization phenomena and operational regimes.

2. design various types of gas distributors for fluidized beds and determine effectiveness of gas mixing at the bottom region.

3. analyze fluidized bed behavior with respect to the gas velocity.

4. develop and solve mathematical models of the fluidized bed.

MODULE I **Lectures 4**

Flow through packed beds-Ergun equation,

MODULE II **Lectures 12**

Phenomena of fluidization liquid like behavior of a fluidized bed, Types of fluidization-particulate and Aggregative fluidization Advantages and disadvantages of fluidization over packed beds and moving beds. Industrial applications. Minimum fluidization velocity, Terminal velocity and pressure drop in a fluidized bed.

MODULE III **Lectures 8**

Average particle size, sphericity, voidage, Expansion of liquid-solid fluidized bed, Richandson, Zaki equation, use of dimensional analysis

MODULE IV **Lectures 8**

Brief idea of the mechanism of gas-solid fluidization homogeneous & bubble phase, size of bubble, bubble velocity and its expansion.

MODULEV **Lectures 8**

Design of batch & continuous fluidizer for heat & mass Transfer, Entrainment & Elutriation-Entrainment at or above TDH, Entrainment below TDH, Semi fluidizations.

Text Books:

1. Fluidization Engineering, Kunii, Diazo and Octave Levenspiel (Chapters 1,2,3,4,7,9,10 and 12).

2. Fluidization, Max Leva (Chapters 2,3, and 7)

Reference Book:

1. Perry's Chemical Engineers Hand Book, Perry Rober H, 7th edition, McGraw Hill

Course outcome mapping with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	2	-	-	-	-	-	-	-	-
CO2	3	3	3	3	-	-	-	-	-	-	-	-
CO3	3	3	2	3	-		1	-	-	-	-	
CO4	3	3	3	3	-	3	-	-	-	-	-	-

Vinoba Bhave University , Hazaribagh

Chemical Engineering			
CL531	Environmental Engineering	L	T
		3	0

Objective: Objective of this course is to understand the different environmental issues and its consequence on the ecosystem. Further, it has been introduced the technical solution of numerous pollutions such as air, water, soil, and noise pollution. It also addresses the solid waste issue of urban area.

Course Outcome (CO): At the end of the course, student will be able to

CO1. Understand the different type of pollutions (air, water and noise) its consequence on eco-system.

CO2. Evaluate the plum size, plum rise, COD, BOD and noise label.

CO3. Identify the different control measures as well as treatment process of different pollutant.

CO4. Explain the different type of chemical and biological treatment process.

MODULE I (10 lectures)

Air Pollution: Types of air Pollutants, Classification of Industries based on Pollutants, sources of air Pollutant, line source, point source and fumigate source, Atmospheric dispersion, Dispersion model, plume size, types of calculation of plume rise, calculation of concentration, Atmospheric salability Meteorology,

MODULE II (5 lectures)

Gaseous pollutant control technology, ESP, cyclone separation, victory scrubber, bag filters, Air Act.

MODULE III (10 lectures)

Water Pollution: Sources, criteria and standards, physical and chemical characteristics, Pre Primary, Secondary and Tertiary treatments of wastewater, sludge digestion and disposal, Advanced treatment processes, Disinfections, Typical Industrial treatment processes, Municipal waste waters treatment, Water act.

MODULE IV **(05 lectures)**

Noise Pollution: Definition ,measurement, effects and control

MODULE V **(05 lectures)**

Solid Waste: Classification of solid waste, collection, chemical and biological treatment, disposal of solid waste

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BOOKS RECOMMENDED

Mahajan S.P., "Pollution Control in Process Industries", Tata McGraw Hill Inc., New Delhi, 2001.

Rao C.S., "Environmental Pollution Control Engineering", 2nd Edition, Revised, Wiley Eastern Limited, India, 2006.

Bhatia S.C., "Environmental Pollution & Control in Chemical Process Industries", Khanna Publications, Delhi, 2001.

Sawyer C.N., McCarty P.L. & Perkin G.F., "Chemistry for Environmental Engineering and Science", McGraw-Hill, 5th ed., 2002

Relationship of COs to POs for Environmental Engineering

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1.	3	2	1	-	-	2	1	-	-	1	-	-
CO2.	3	3	2	2	-	2	2	-	-	-	-	-
CO3.	2	2	3	2	-	2	2	-	-	-	-	-
CO4.	3	3	3	1	-	1	3	-	-	-	-	-

Vinoba Bhave University , Hazaribagh

Chemical Engineering			
CL532	**Industrial Pollution Control**	**L**	**T**
		3	**0**

Objectives

1. To understand the importance of industrial pollution and its abatement
2. To study the underlying principles of industrial pollution control
3. To acquaint the students with case studies
4. Student should be able to design complete treatment system

Course Outcomes: At the end of the course, the student will be able to:

1. Recognize the causes and effects of environmental pollution
2. Analyze the mechanism of proliferation of pollution
3. Develop methods for pollution abatement and waste minimization
4. Design treatment methods for gas, liquid and solid wastes

Module I **Lectures 8**
Industries & Environment

Industrial scenario in India - Industrial activity and Environment - Uses of Water by industry - Sources and types of industrial wastewater - Industrial wastewater and environmental impacts - Regulatory requirements for treatment of industrial wastewater - Industrial waste survey - Industrial wastewater generation rates, characterization and variables - Population equivalent - Toxicity of industrial effluents and Bioassay tests.

Module II **Lectures 8**
Air Pollutant Abatement

Air pollutants scales of concentration, lapse rate and stability, plume behavior, dispersion of air pollutants, atmospheric dispersion equation and its solutions, Gaussian plume models. Air pollution control methods, Source correction methods, Design concepts for pollution abatement systems for particulates and gases. Such as gravity chambers, cyclone separators, filters, electrostatic precipitators, condensation, adsorption and absorption, thermal oxidation and biological processes.

Module III **Lectures 8**
Waste water treatment processes

Design concepts for primary treatment, grid chambers and primary sedimentation basins, selection of treatment process flow diagram, elements of conceptual process design, design of thickner, biological treatment Bacterial population dynamics, kinetics of biological growth and its applications to biological treatment, process design relationships and analysis, determination of kinetic coefficients, activated sludge process. Design, trickling filter design considerations, advanced treatment processes, Study of environment pollution from process industries and their abatement: Fertilizer, paper and pulp, inorganic acids, petroleum and petrochemicals, recovery of materials from process effluents.

Module IV **Lectures 8**

Solid waste and Hazardous waste management

Sources and classification, properties, public health aspects, Sanitary land fill design, Hazardous waste classification and rules, management strategies, Nuclear waste disposal Treatment methods – component separation, chemical and biological treatment, incineration, solidification and stabilization, and disposal methods, Latest Trends in solid waste management.

Module V **Lectures 8**

Industrial Noise pollution Sources of noise pollution, characterization of noise pollution prevention& control of noise pollution, Factories Act 1948 for regulatory aspects of noise pollution.

Textbook

1. Rao C.S., “Environmental Pollution Control Engineering”, 2nd edition
2. Mahajan S.P., “Pollution Control in Process Industries”.
3. Nemerow N.L., “Liquid waste of industry- theories, Practices and Treatment”, Addison Wesley, New York, 1971
4. Weber W.J., “Physico-Chemical Processes for water quality control”, Wiley Interscience New York, 1969
5. Strauss W., “Industrial Gas Cleaning”, Pergamon, London, 1975
6. Stern A.C., “Air pollution”, Volumes I to VI, academic Press, New York, 1968
7. Peterson and Gross. E Jr., “Hand Book of Noise Measurement”, 7th Edn, 2003.
8. Antony Milne, “Noise Pollution: Impact and Counter Measures”, David & Charles PLC, 2009.

Mapping of course outcomes with program specific outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**1**	**1**	**2**		**1**		**2**	**1**		**-**	**-**	**1**
CO2	**1**	**1**	**2**				**2**	**1**		**-**	**-**	**1**
CO3	**1**	**1**	**2**			**1**	**2**	**1**		**-**	**-**	**1**
CO4	**1**	**1**	**2**			**1**	**2**	**1**		**-**	**-**	**1**
Co5	**1**	**1**	**2**			**1**	**2**	**1**				**1**

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE501	**Mechanics of Materials**	**L**	**T**
		3	**1**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Elements of Elasticity: - Concept of stress & strains, stress & strain tensor. Three dimensional stress & strain analysis, Transformation of Stress & strain, Stress & strain invariants, Equilibrium equation, Compatibility equation, Boundary condition. Two dimensional problem in Cartesian co-ordinate, Solution by polynomials, Cantilever with end load, simple beam with udl, Stress Function strain gauges principle of photo elasticity Strainconfigurations.	**12**
2.	Elastic Stability:- Energy method analysis of long column. Euler's theory of buckling for long column & its limitation. Rankine - Gardon formulae, laterally loaded struts. Unsymmetrical bending of beans, shear centre.	**12**
3	Theory of failure: various theory of failure	**8**
4	Elements of plastic theory:- Plastic hinge, shape factor, collapse load for beams & portal frame. Uniqueness, upper & lower bound theorem. Effect of axial force & shear in plastic moment ofsections.	**10**

Reference Books:

1. Timoshenko and Gere, Mechanics of Materials, CBS Publishers, New Delhi,1996
2. T. D. Gunneswra Rao and MudimbyAndal, Strength of Materials - Fundamentals and Applications, Cambridge University Press, 1st Edition,2018.
3. S. B. Junarkar, Mechanics of Structures, Charotar Publishers, Anand,1998.
4. Strength of Materials - Pytel& Singer, Harper & Row Publishers,2018

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE502	**Environmental Engineering**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Water demand: - Population- forecast, design period, factors affecting populations growth, water demand, factors affecting rate of demand, variations in rate of demand.	**8**
2.	Quality of water: - sources of impurities, common impurities in water and their effect, water analysis, physical, chemical and biological characteristics, water borne diseases, Indian andWHO drinking standard.	**8**
3.	Purification: Sedimentation, flocculation, coagulation, filtration, disinfection, water softening, aeration, miscellaneous treatment method.	**8**
4.	Distribution of water: - Introductions , Methods of distribution, pressure in distribution mains, system of water supply, storage and distribution reservoir, layout and design of distribution system and distribution reservoir.	**12**
5.	Waste water treatment: - Sewage characteristics. Sewerage system: - Type, design, construction and maintenance. Treatment :- Primary and secondary treatments, screens, grit chamber, sedimentation chamber, principle and design of activated sludge digestion, final disposal of sludge and effluents, Disposal of sewage by dilution, self-purification of streams, sewage disposal by irrigation, waste water reuse, solid waste collection, re-utilization/disposal, B.O.D, C.O.D.	**12**

Reference Books

1. G.B. Masters, Introduction to Environmental Engineering and Science, Pearson Education,2013.
2. Gerard Kiely, Environmental Engineering, McGraw Hill Education Pvt Ltd, Special Indian Edition, 2007.
3. W P Cunningham, M A Cunningham, Principles of Environmental Science, Inquiry and Applications, Tata McGraw Hill, Eighth Edition,2016.
4. M. Chandrasekhar, Environmental science, Hi Tech Publishers,2009

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Civil Engineering			
HU501	**Instrumentation and Process Control**	**L**	**T**
		3	**0**

Course Overview:

This course is designed to help one develop communication skills in English with a sense of language. It will be of help to improve clarity, precision and overall impact in both oral as well as written communication. It will also enable one to produce clear and effective scientific and technical documents required for professional communication. We will focus on basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations. One can learn how to gather, organize, and present information effectively according to audience and purpose. Moreover, emphasis will be on sustainable communication that will facilitate an understanding of one's role and help to align with the mission of the organization.

Objective:

To provide you with the communication skills one needs to advance in a field, keeping in mind that, in career, one may be involved with design, development, field service and support, management, sales, customer liaison, or all of the above.

Course Outcomes:

CO 1: Demonstrate effective oral and written communication with diverse audiences and produce variety in professional written documents to better support and communicate.

CO 2: Plan and deliver a formal presentation on a topic with confidence and poise.

CO 3: Appraise ethics and social responsibility as a professional.

CO 4: Apply analytical skills and critical thinking to solve problems and can express using sound logical arguments utilizing the best available resources for communication.

CO 5: Exhibit an understanding of multiculturalism and be able to work well in teams.

Lecture 1-10

Introduction to Communication

Communication and Self Concept
Role of Emotions
Basics of Communication
Purpose of communication- to inform, to express feelings, to imagine, to influence, to meet social expectations and others
Audience analysis- identifying audience to determine the content, language usage and listener expectations for ensuring effective communication
Cross Cultural Communication and Multi Cultural Communication
Effective Communication: Modes/ Models/Networks

LSRW Skills
Non-Verbal Communication

Barriers to Communication

Introduction
Intrapersonal and Interpersonal Barriers

Organizational Barriers
Information Gap Principle, Noise, Filters

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<u>Effective Listening and Speaking</u> Traits of a good listener Phonetics – Basic Sounds of English – Word Accent - Intonation Achieving confidence, clarity and fluency as a speaker, paralinguistic features, barriers to speaking, types of speaking, Persuasive Speaking, Public Speaking etc. **Additional exercises and activities based on developing Listening and Speaking skills**
Lecture 11-15 Planning, Outlining and Structuring Choosing the mode of delivery Guidelines for effective delivery, Body Language and Voice, Visual Aids etc. **Activities and practice on developing Presentation skills**
Lecture 16-20 Introduction, Objectives, Types, Samples and Examples Problem Solving, Networking in English Meetings and Conferences Minutes of Meeting, Agenda of Meeting **Activities and exercise based on developing GD and Business Networking skills in English**
Lecture 21-30 Introduction, Audience Recognition, Language, Grammar, Style, Techniques The Art of Condensation Note Making and Note Taking Guidelines and Samples **<u>Business/Official Communication</u>** Letters, Resumes, Memos, and e-mails Rules, formats, Style, Etiquette Sales and Credit letters Letter of Enquiry Letter of Quotation, Order, Claim and Adjustment Government Letters, Semi- Government Letters to Authorities etc. Characteristics, Categories, Formats, Structures, Types, Samples Job Application Curriculum vitae Resumes- Chronological, Combination, Functional etc. Reports and Proposals of different kinds **Exercise and activities based on developing Writing skills**
Lecture 31-35 Right Words and Phrases, Sentence Patterns Paragraph Comprehension Passage etc. **Activities and Strategies to engage in active thinking about word meanings, the relationships among words, and use of words in different situations**

Lecture 36-40 Types: Skimming, Scanning, Intensive, Extensive Value Based/Motivational Materials: Articles, Prose, Text Reading **Activities and exercise based on developing Reading skills**
Lecture 41-45 Types and Overview Emotional Intelligence Decision Making and Time Management **Activities and exercise based on developing Leadership and Management skills**

Recommended Texts:

8. Raman , Meenakshi and Sangeeta Sharma. *Technical Communication: Principles and Practice*. 2nd ed. OUP India, 2012.
9. Markel, Mike. *Technical Communication*. 7th ed. New York, NY: Bedford/St. Martin's, 2003. ISBN: 9780312403386.
10. Gamble, Teri Kwal and Michael Gamble. *Communication Works*. 9th Ed. New Delhi: Tata-McGraw-Hill, 2010.
11. Hacker, Diana. *A Pocket Style Manual*. 4th ed. New York, NY: Bedford/St. Martin's, 1999. ISBN: 9780312406844.
12. Perelman, Leslie C., James Paradis, and Edward Barrett. *The Mayfield Handbook of Technical and Scientific Writing*. New York, NY: McGraw-Hill, 1997. ISBN: 9781559346474.
13. **David F. Beer and** David McMurrey**, *Guide to Writing as an Engineer*, 2nd ed., Wiley, 2004,** ISBN: 0471430749.
14. Dale Jungk, *Applied Writing for Technicians*, McGraw-Hill, 2005, ISBN 0-07-828357-4.

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE511	**Water Resources Engineering-1**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	**Introduction -** Hydrologic cycle, water-budget equation, history of hydrology,worldwaterbudget,WaterbudgetofIndia,Organization preserving hydrological data,	**4**
2.	**Precipitation –** types and forms of precipitation, different characteristics of rainfall and their representation, measurement of rainfall , rain gauge network, mean precipitation over an area, depth area-duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India	**8**
3.	**Abstractions from precipitation -** evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration,evapotranspiration equations, potential evapotranspiration, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, infiltration capacity curve, classification of infiltrationcapacities, infiltration indices	**10**
4.	**Runoff –**components ofrunoff Estimation of run off, SCS-CN method of estimating runoff, flow duration curve, flow-mass curve, Different types ofindices.	**4**
5.	**Hydrograph:** Elements of storm hydrograph, simple and complex storm hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph, Derivation of unit hydrograph from S- Curve technique, SUH and IUH.	**10**
6.	**Floods estimation and Flood Routing:** Estimation of peak discharge, rational method, SCS method and unit hydrograph method, Design flood, return period, flood frequency analysis, concepts of flow routing, Different methods of routing,PMF,SPF	**8**

Suggested books:

1. KSubramanya, Engineering Hydrology, Mc-GrawHill.
2. K N Muthreja, Applied Hydrology, Tata Mc-GrawHill.
3. K Subramanya, Water Resources Engineering through Objective Questions, TataMc-GrawHill.

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE512	**Solid waste management**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	**Solid Waste Management** – Municipal Solid Waste Management different Sources; composition; generation rates; collection of waste; separation, transfer and transport of waste; treatment and disposal options, Hazardous Waste Management – Fundamentals Characterization of waste.	**14**
2.	**Biological Treatment :** Biological Treatment of Solid and Hazardous Waste Composting; bio-reactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation	**12**
3.	**Landfill design**: Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration.	**6**
4.	**Relevant Regulations Municipal solid waste rules**; hazardous waste (management and handling) rules; biomedical waste handling rules; fly ash rules; recycled plastics usage rules; batteries (management and handling) rules, Construction & demolition rules.	**12**

Suggested books:

1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group2005.
2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York,1994.
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York,1997.

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Civil Engineering			
CE513	**Hydropower engineering**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Introduction: Sources of energy, advantages of hydropower, Hydropower development in India and the world. Future of Hydro-Power requirements: Load studies, nature of load; load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power, secondary power, prediction of load, power potential of a stream, storage and pondage studies.	**10**
2.	Types of Hydropower Plants and Principal Components: Classification of hydel power plants, Runoff-river plants, storage plants, pumped storage plants, High head, medium head, low head developments, Base load, peak load developments. Components: reservoir, fore bays, intakes, penstocks, valves, surge tanks, tailrace etc.	**10**
3.	Water Conveyance: Classification of penstocks, design criteria for penstocks, economical diameter of penstocks, number of penstocks and equivalent penstock diameter, pressure conduits in rocks or concrete. Turbines: Main types of turbines, selection, constructionalfeaturesofturbines,settingandgoverningof turbines, cavitation, Thoma's coefficient, draft tubes and types	**10**
4.	Power House Planning: Underground power house: location, types, components, types of layout, limitations Surface power house: power house structure, dimensions, lighting and ventilation, Variations in the design of power house. Tidal power: Basic principle, location of tidal power plant, difficulties in tidal power generation, components of Tidal power plant; modes of generation, estimation of energy and power,regulation of power output.	**10**
5	Introduction to Integrated Power Development: Steam power versus hydropower, combined operation of hydropower and thermal power plants, economic feasibility. Solar power development, large reservoirs/canal.	**6**

Suggested books:

1. M.M. Dandekar and K.N. Sharma, "Water Power Engineering", Vikas Publishing House, NewDelhi.
2. M. M. Deshmukh, "Water Power Engineering", DhanpatRai and Sons, NewDelhi.

3. P. S. Nigam, “Handbook of Hydro Electric Engineering”, Nem Chand & Bros.,Roorkee

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE514	**Advance surveying**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	**Field Astronomy**: Introduction, purposes, astronomical terms, Astronomical coordinate system, astronomical triangle, determination of azimuth, declination & hour angle, different types of time, LMT, ST & GMT and interdependencies. Equation of time,	**12**
2.	**Aerial photogrammetry**: Introduction, Principle, Uses, Aerial & terrestrial photographs, Scale of vertical and tilted photograph, photographic mapping- mapping using paper prints, mapping using stereoplotting instruments, mosaics,map substitutes.	**10**
3.	**Remote Sensing And Geographical Information System**: Introduction, Electromagnetic spectrum, Principles of energy interaction in atmosphere and earth surface, Image interpretation techniques, digital satellite data; Global Positioning system: Definition of GIS, Key Components of GIS, Functions of GIS, Spatial data, spatial information system, Geospatial analysis, Integration of Remote sensing & GIS and Applications in Civil Engineering	**12**
4.	**Hydrographic surveying**: Introduction, shoreline survey, sounding method of locating sounding, Three pointproblem.	**10**

Suggested books:

1. Surveying Vol. II and III by Dr. B.C. Punamia, Laxmi Publishers. NewDelhi
2. Surveying Vol. II and III by Dr. K.R. Arora, Standard Book House. NewDelhi
3. Advanced Surveying by R. Agor, Khanna Publishers, NewDelhi
4. Remote Sensing and GIS by B Bhatia, Oxford University Press, NewDelhi.
5. Remote sensing and Image interpretation by T.M Lillesand,. R.W Kiefer,. and J.W Chipman, 5th edition, John Wiley and SonsIndia

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Civil Engineering			
CE515	**Water resources system**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	**Introduction and Basic Concepts**: Introduction, System Components, Planning and management, Concept of a system, Advantages and limitations of systems approach, Modeling of Water Resources Systems, Simulation andoptimization, Economics in water resources, Challenges in water sector	**6**
2.	**Linear Programming and Applications**: General form of LP, Standard and Canonical forms of LP, Elementary transformations, Graphical method, Feasible and infeasible solutions, Simplex method, Dual and sensitivity analysis, LP problem formulation, Reservoir sizing and Reservoir operation using LP	**8**
3.	**Simulation:** Introduction, River basin simulation, Reservoir operation simulation, Performance evaluation - Reliability, Resiliency and Vulnerability, Some simulation models	**4**
4.	**Water Resources Systems Modeling:** River basin planning and management, Water distribution systems, Groundwater systems, Water quality modeling, Floodplain management, Urban storm water management	**8**

Suggested books:

1. Loucks D.P, Stedinger J.R and Haith D.A, ‘Water Resources Systems Planning and Analysis’, Prentice Hall,
USA, 1981.

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Civil Engineering			
CE521	**Steel Structures-I**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction to steel structures and IS 800-2007- Material specifications - Rolled sections – Section classifications - Design approach; design philosophy, i.e. loading load combination, factor of safety, permissible and working stress elastic method, limit state of design, plastic design	**6**
2.	Connections: riveted, bolted and welded connections, strength and efficiency	**8**
3.	Tension member: rolled sections and built-up sections,	**8**
4	Compression members - Slenderness ratio – Design - Simple and built- up sections - lacings and battens - Tension members.	**10**
5.	Flexural members – Rolled sections - built-up beams - Design for strength and serviceability, web crippling, webyielding, bearing stiffeners	**8**
6.	BEAM column: stability consideration, interaction formulae and Column bases: stability of base, gusseted base and grillage footing	**8**

Suggested books:

1. Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi2008.

2. Dayaratnam P, Design of Steel Structures, S. Chand & Co., New Delhi,2003.

3. Arya, A.S and Ajmani, A.L., Design of Steel Structures, Nemchand and brothers, Roorkee, 1992..

4. Punmia, B.C., Ashok Kumar Jain and Arun Kumar Jain. Comprehensive Design of Steel Structures, Laxmi Publications Pvt. Ltd., New Delhi2000.

5. IS 800-2007, Code of practice for general construction in steel, Bureau of Indian Standards, NewDelhi.

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Civil Engineering			
CE522	**Advance Geotechnical**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Dewatering: Methods. selection, analysis and design of dewatering system.	**6**
2.	Grouting Types of grouts and their properties; Methods of grouting; Grout selection and control.	**8**
3.	Compaction Diffused double layer theory of compaction; 'Methods of compaction; Engineering properties of compact soil; Field compaction and itscontrol.	**8**
4	S oil Stabilization: Stabilization using chemical additives and othermethod	**8**
5.	R e i n f o r c e d E a r t h Concept, materials, application and design of reinforced earth wall.	**8**

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Civil Engineering			
CE523	**Industrial Structures**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Industrial steel building frames: Types of frames, bracing, crane girders and columns, workshop sheds, trussed bents	**6**
2.	Transmission and Communication towers: Types and configuration, Analysis and design; Chimneys; Loads and stresses in chimney shaft, Earthquake and wind effect, Stresses due to temperature difference, combined effect of loads and temperature	**10**
3.	Silos and Bunkers; Jassen's theory, Airy's theory, Shallow and deep bins, Rectangular bunkers with slopping bottom, Rectangular bunkers with high side walls, Steel stacks; introduction, force acting on a steel stack, design consideration, design example of stacks	**12**
4	Concrete Shell Structures: Folded plate and cylindrical shell structures; Introduction, structural behaviour of long and short shells, beam and arch action, analysis and design of cylindrical shell structures	**10**
5.	Machine foundations; introduction, machine vibration, structural design of foundation to rotary machines, impact machines, vibration characteristics, design consideration of foundation to impact machine, grillage, pile and raft foundation.	**10**

Suggested books:

1. 1.Design of Steel Structures, Arya and Azmani, Nem Chand Brothers, Roorkee,2004
2. Punmia B.C, Ashok Kr. Jain, Arun Kr. Jain, RCC Designs (Reinforced Concrete Design), 10th Edition, Lakshmi Publishers,2006.
3. Ramachandra, Design of Steel Structures, 12th Edition, Standard Publishers,2009.

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Civil Engineering			
CE524	**Design of Structural Systems**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Classification of structural systems, Loads, assumptions and Idealizations	**10**
2.	The whole structural design process including definition of functional requirements, selection of structural scheme	**18**
3.	Formulation of design criteria, preliminary and computer- aided proportioning, and analysis of response, cost, and value.	**18**

Suggested books:

1. Structural Stability - Theory and Implementation by W.F.Chen and E.M.Lui byElsevier.
2. Reeve,D., Chadwick, A. and Fleming, C. Coastal Engineering-Processes, theory and design practice, Spon Press, Taylor & Francis Group, London &Paris,2004.

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Civil Engineering			
CE525	**Geotechnical Design**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Subsurface site evaluation; Use of geophysical methods in sub-soil exploration, seismic survey method, Use of active and passive MASW methods in geotechnical survey	**12**
2.	Integrated design of retaining walls, Design of sheet pile wall, Design of anchored bulkheads	**12**
3.	Foundations, pavements, and materials for airports, highways, dams, or other facilities. Various factors affecting the design criteria,	**8**
4.	Requirements of compaction and compressibility for designof sensitive structures	**6**

Reference Books

1. Analysis and Design of Substructures: Limit State Design by Swami Saran

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE526	**Environmental Geo-technology**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	A consideration of technical and scientific aspects of key geo-societal issues.	**8**
2.	Case studies and analysis of current and historic databases will be used to illustrate topics including impact of climate change, energy resources, water and soil pollution, and health risks posed by heavy metals and emerging pollutants.	**16**
3.	Influence of disposal of industrial and construction waste on the Geo-environment	**12**
4.	Effect and impact of effluent from chemical and mining industries on ground water, Design of clay liners	**8**

Reference Books:

1. Introduction to Environmental Geotechnology by Hsai – YangFang
2. CDEEP, IITB video lectures on course CE 488 and CE 641 by Prof. D. N.Singh

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Civil Engineering			
CE531	**Air Pollution & its Control Measures**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Air pollutants, Sources, classification, Combustion Processes and pollutant emission, Effects on Health, vegetation, materials and atmosphere	**8**
2.	Reactions of pollutants in the atmosphere and their effects-Smoke, smog and ozone layer Disturbance, Greenhouse effect.	**8**
3.	Air sampling and pollution measurement methods, principles and instruments, Ambient air quality and emission standards, Air pollution indices,	**8**
4.	Meteorology: wind profiles, topographical effects, inversion & plume behavior, plume rise –stable and unstable condition, Gaussian model for plume dispersion	**8**
5.	Air Act, legislation and regulations, control principles,	**4**
6.	Removal of gaseous pollutants by adsorption, absorption, reaction and other methods, Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation etc. Biological air pollution control technologies, Indoor air quality.	**12**

Reference Books:

1. Colls, J., Air Pollution: Measurement, Modeling and Mitigation, CRC Press,2009.
2. Noel, D. N., Air Pollution Control Engineering, Tata McGraw Hill Publishers,1999.
3. Stern, A.C., Fundamentals of Air Pollution, Academic Press,1984.

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Civil Engineering			
CE532	**Advance Engineering System**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Equations of motion for simple physical system. mechanical, electrical and eectromechanical systems	**10**
2.	Equations of motion for simple heat, conduction and fluid system. Analogies. Equations of motion for mechanical system in two and three dimension. Dynamic response of first orderand second order systems	**12**
3.	Forced oscillations of elementary systems. Dynamic stability of compound system. Total response of compound system. Fundamentals of compound systemanalysis.	**12**

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE533	**Global Positioning System**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Overview of GPS – Development of Global Surveying Techniques, History of GPS, New Satellite Navigations constellations, Basic concept of GPS, Space, Control and User segments.	**8**
2.	GPS Observables – Structure of GPS Signal, Frequency, P Code, C/A code and data format, Generation of C/A code, Navigation data bits Pseudo range measurements, Phase measurements, system accuracy characteristics, DOP, Data format.	**8**
3.	Surveying with GPS–Planning a GPS Survey, Positioning methods – point positioning, relative positioning, Static, Fast static, RTK, Differential Positioning, Post processing, real-time processing,	**8**
4	Accuracy measures, software modules, Network adjustments, Dilution of Precision.	**8**
5	Applications of GPS – General Uses of GPS, Attitude determination, Interoperability of GPS. Future of GPS – Modernization plans of navigational satellites, Hardware and software improvements.	**8**

Reference Books:

1. Bradford W. Parkinson, James Spilker, Global Positioning System: Theory and Applications, Vol. I, 1996.
2. Gunter Seeber, Satellite Geodesy Foundations, Methods and Applications, Walter de Gruyter Pub., 2003.
3. Hofmann W.B, Lichtenegger, H, Collins, J Global Positioning System – Theory and Practice, Springer-VerlagWein, 2001.

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE534	**Disaster Management**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Understanding Disaster:Concept of Disaster – Different approaches- Concept of Risk – Levels of Disasters – Disaster Phenomena and Events (Global, national and regional) Hazards and Vulnerabilities: Natural and man-made hazards; response time, frequency and forewarning levels of different hazards – Characteristics and damage potential or natural hazards; hazard assessment – Dimensions of vulnerability factors; vulnerability assessment – Vulnerability and disaster risk – Vulnerabilities to flood and earthquake hazards	**8**
2.	Disaster Management Mechanism:Concepts of risk management and crisis managements – Disaster Management Cycle – Response and Recovery – Development, Prevention, Mitigation and Preparedness – Planning for Relief	**8**
3.	Capacity Building:Capacity Building: Concept – Structural and Nonstructural Measures Capacity Assessment; Strengthening Capacity for Reducing Risk – Counter-Disaster Resources and their utility in Disaster Management – Legislative Support at the state and national levels	**8**
4	Coping with Disaster:Coping Strategies; alternative adjustment processes – Changing Concepts of disaster management – Industrial Safety Plan; Safety norms and survival kits Mass media and disaster management	**8**
5	Planning for disaster management:Strategies for disaster management planning – Steps for formulating a disaster risk reduction plan – Disaster management Act and Policy in India – Organizational structure for disaster management in India – Preparation of state and district disaster management plans	**8**

TEXT BOOKS:

1. Manual on Disaster Management, National Disaster Management, Agency Govt of India.
2. Disaster Management by Mrinalini Pandey Wiley 2014.
3. Disaster Science and Management by T. Bhattacharya, McGraw Hill Education (India) Pvt Ltd Wiley 2015

Vinoba Bhave University , Hazaribagh

Civil Engineering			
CE535	**Environmental Management System**	**L**	**T**
		3	**0**

Detail Syllabus:

MODULE	CONTENTS	Hrs
1.	Environmental Management System in Industry : Quality of environment. ISO 14000 Environment standards, EMS model. Policy planning process, implementation and operation in industry.	**8**
2.	Environmental Pollution & Control Techniques: Definition of pollution, pollutant and significance of pollution of pollution control. Types of environment pollution: air, water and land pollution and control.	**8**
3.	Hazardous waste management system : landfill as incineration, environment problems and solution Concept of Restoration Ecology and Reclamation of degraded land.	**8**
4	Environment Impact Assessment and Audits : Basic concept of EIA, Needs for EIA and Methods. Introduction and Significance of Environment Audit. Audit regulations, standards and protocols. Setting up EIA and Audit Division in Industry.	**8**
5	Disasters and their management: Introduction of disasters, Classification and sub types of disasters. Industrial disasters and related case studies. Precautions of SHE in disaster management. Role of SHE in disaster management	**8**

Vinoba Bhave University , Hazaribagh

Electronics & Communication Engineering			
EC501	**Microprocessor& Interfacing**	**L**	**T**
		3	**1**

Course Outcomes: After the completion of the course the student will be able to:

CO1	**Understand the evolution of 8085 microprocessor and its architecture.**
CO2	**Understand the evolution and architectures of 8086 microprocessor.**
CO3	**Analyze and understand the instruction set and programming of 8085 microprocessor.**
CO4	**Understand the Interfacing of 8085 Microprocessor with Different I/O peripherals.**
CO5	**Understand the exception, interrupts and interrupt handling schemes.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	3	-	-	-	-	-	-	-	2
CO2	-	3	-	3	-	-	-	1	-	-	-	2
CO3	-	3	-	-	-	-	-	1	-	-	-	2
CO4	-	3	-	3	-	-	-	1	-	-	-	2
CO5	2	3	-	3	-	-	-	1	-	-	-	2

Detailed Syllabus:

Module	Course Content	No. of Lecture
1	Introduction to Microprocessor, Components of a Microprocessor: Registers, ALU and control & timing, System bus (data, address and control bus), Microprocessor systems with bus organization. Microprocessor Architecture and Operations, Memory, I/O devices, Memory and I/O operations.	**8**
2	8085 Microprocessor Architecture, Address, Data and Control Buses, 8085 Pin Functions, Demultiplexing of Buses, Generation of Control Signals, Instruction Cycle, Machine Cycles, T-States, Memory Interfacing.	**9**

3	Assembly Language Programming Basics, Classification of Instructions, Addressing Modes, 8085 Instruction Set, Instruction and Data Formats, Writing, Assembling & Executing a Program, Debugging the Programs. Writing 8085 assembly language programs with decision, making and looping using data transfer, arithmetic, logical and branch instructions. Stack & Subroutines, Developing Counters and Time Delay Routines, Code Conversion, BCD Arithmetic and 16-Bit Data operations	**9**
4	Interfacing Concepts, Ports, Interfacing Of I/O Devices, Interrupts In 8085, Programmable Interrupt Controller 8259A, Programmable Peripheral Interface 8255A.	**9**
5	Advanced Microprocessors: 8086 logical block diagram and segments, 80286: Architecture, Registers (Real/Protected mode), Privilege levels, descriptor cache, Memory access in GDT and LDT, multitasking, addressing modes, flag register.	**9**

Text Books:

1. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh S. Gaonkar Pub: Penram International.
2. Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevanathan, S. K. Shah, Oxford
3. Advanced Microprocessors, Daniel Tabak, McGrawHill
4. Microprocessor & Interfacing - Douglas Hall, TMH
5. 8086 Programming and Advance Processor Architecture, Savaliya M. T., WileyIndia
6. The 8088 and 8086 Microprocessors, Triebel & Singh, Pearson Education.

Vinoba Bhave University , Hazaribagh

Electronics & Communication Engineering			
EC502	**Digital Communication System**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Evaluate the performance of PCM, DPCM and DM in a digital communication system
CO2	Perform various multiplexing Techniques
CO3	Design encoder and decoder schemes for error control
CO4	Obtain the power spectra of digital modulated signals.
CO5	Understand noise as a random process and its effect on communication receivers

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	2	-	1	-	-	-	-	-
CO2	2	3	-	-	1	2	1	-	-	-	-	-
CO3	2	1	-	-	1	-	1	-	-	-	-	-
CO4	2	3	1	-	-	1	-	-	-	-	-	-
CO5	1	2	-	-	-	-	1	-	-	-	-	-

Detailed Syllabus:

Module	**Course Content**	**No. of Lecture**
1	**Introduction:** A historical perspective in the development of digital communication, Elements of digital communication system. **Source encoding:** Pulse code modulation, quantization noise, linear and non-linear quantization, companding. Differential pulse code modulation, delta modulation, adaptive delta modulation, Delta sigma modulation, linear predictive coders.	**8**
2	**Multiplexing:** Introduction to different type of multiplexing, Frequency Division & Time Division Multiplexing, Multiplexing hierarchy, synchronous and asynchronous multiplexing, pulse staffing and word staffing. **Baseband transmission:** Baseband signal receiver, integrate and dump type filter probability of error calculations, optimum filters, coherent reception, matched filter and its transfer function. Probability of error of matched filter. Regenerative repeater, Bit synchronization, In-phase and	**8**

	mid-phase synchronizer. Early late gate synchronizer. Frame synchronization.	
3	**Different type of line coding:** UPNRZ, UPRZ, PNRZ, PRZ, Manchester, differential encoding and their spectral characteristic, self synchronization properties of some of the encoded signal. **Equalization:** Inter symbol interference (ISI), Purpose of equalization, Eye pattern, Nyquist criterion for zero ISI, fixed equalizer. Design of equalizer, Adaptive equalizer, Decision directed equalizer, Adaptive decision directed equalizer, Partial response signaling.	**10**
4	**Digital modulation techniques:** BPSK, DPSK. BFSK, MARY-PSK & -FSK, QPSK, MSK principles, QASK, Error calculation. **Spread-spectrum modulation:** Pseudo-Noise Sequence, A notion of Spread Spectrum, Direct-Sequence Spread- Spectrum with Coherent Binary Phase-Shift Keying, Processing Gain, Probability of Error, Frequency-hop Spread Spectrum, Code-Division Multiple Access.	**8**
5	**Information theory and coding:** Concept and measure of information, Entropy, Discrete and continuous messages, Message source, zero memory sources, extension of zero memory source, Markov source and their entropy, Channel with and without memory, Channel capacity, Hartlay and Shannon's law. **Properties of code:** Uniquely decodable codes, Instantaneous codes, Kraft inequality and Macmillion inequality, Construction of instantaneous codes, Hoffman and Shannon-Fano coding, Error Coding.	**6**

Text Books:

1. S.Haykin, Digital Communications, John Wiley & Sons, 2009.
2. B.Sklar, Digital Communications, 2 nd Edition, Pearson Education, New Delhi, 2009.
3. John G.Proakis, Digital Communications, 3 rd edition, McGraw Hill, 1995.

Vinoba Bhave University , Hazaribagh

Electronics & Communication Engineering			
HU501	**Professional Communication**	**L**	**T**
		3	**0**

Course Overview:

This course is designed to help one develop communication skills in English with a sense of language. It will be of help to improve clarity, precision and overall impact in both oral as well as written communication. It will also enable one to produce clear and effective scientific and technical documents required for professional communication. We will focus on basic principles of good writing-which scientific and technical writing shares with other forms of writing-and on types of documents common in scientific and technical fields and organizations. One can learn how to gather, organize, and present information effectively according to audience and purpose. Moreover, emphasis will be on sustainable communication that will facilitate an understanding of one's role and help to align with the mission of the organization.

Objective:

To provide you with the communication skills one needs to advance in a field, keeping in mind that, in career, one may be involved with design, development, field service and support, management, sales, customer liaison, or all of the above.

Course Outcomes:

CO 1: Demonstrate effective oral and written communication with diverse audiences and produce variety in professional written documents to better support and communicate.
CO 2: Plan and deliver a formal presentation on a topic with confidence and poise.
CO 3: Appraise ethics and social responsibility as a professional.
CO 4: Apply analytical skills and critical thinking to solve problems and can express using sound logical arguments utilizing the best available resources for communication.
CO 5: Exhibit an understanding of multiculturalism and be able to work well in teams.

Lecture 1-10

Introduction to Communication

Communication and Self Concept
Role of Emotions
Basics of Communication
Purpose of communication- to inform, to express feelings, to imagine, to influence, to meet social expectations and others
Audience analysis- identifying audience to determine the content, language usage and listener expectations for ensuring effective communication
Cross Cultural Communication and Multi Cultural Communication
Effective Communication: Modes/ Models/Networks

LSRW Skills
Non-Verbal Communication

Barriers to Communication

Introduction
Intrapersonal and Interpersonal Barriers

Organizational Barriers
Information Gap Principle, Noise, Filters

<u>Effective Listening and Speaking</u>
Traits of a good listener
Phonetics – Basic Sounds of English – Word Accent - Intonation Achieving confidence, clarity and fluency as a speaker, paralinguistic features, barriers to speaking, types of speaking, Persuasive Speaking, Public Speaking etc.

Additional exercises and activities based on developing Listening and Speaking skills

Lecture 11-15
Planning, Outlining and Structuring
Choosing the mode of delivery
Guidelines for effective delivery,
Body Language and Voice, Visual Aids etc.
Activities and practice on developing Presentation skills

Lecture 16-20
Introduction, Objectives, Types, Samples and Examples
Problem Solving, Networking in English
Meetings and Conferences
Minutes of Meeting, Agenda of Meeting
Activities and exercise based on developing GD and Business Networking skills in English

Lecture 21-30
Introduction, Audience Recognition, Language, Grammar, Style, Techniques
The Art of Condensation
Note Making and Note Taking
Guidelines and Samples
<u>Business/Official Communication</u>
Letters, Resumes, Memos, and e-mails
Rules, formats, Style, Etiquette
Sales and Credit letters
Letter of Enquiry
Letter of Quotation, Order, Claim and Adjustment
Government Letters, Semi- Government Letters to Authorities etc.
Characteristics, Categories, Formats, Structures, Types, Samples
Job Application
Curriculum vitae
Resumes- Chronological, Combination, Functional etc.
Reports and Proposals of different kinds
Exercise and activities based on developing Writing skills

Lecture 31-35
Right Words and Phrases,
Sentence Patterns
Paragraph
Comprehension Passage etc.

Activities and Strategies to engage in active thinking about word meanings, the relationships among words, and use of words in different situations
Lecture 36-40 Types: Skimming, Scanning, Intensive, Extensive Value Based/Motivational Materials: Articles, Prose, Text Reading **Activities and exercise based on developing Reading skills**
Lecture 41-45 Types and Overview Emotional Intelligence Decision Making and Time Management **Activities and exercise based on developing Leadership and Management skills**

Recommended Texts:

1. Raman , Meenakshi and Sangeeta Sharma. *Technical Communication: Principles and Practice.* 2nd ed. OUP India, 2012.
2. Markel, Mike. *Technical Communication*. 7th ed. New York, NY: Bedford/St. Martin's, 2003. ISBN: 9780312403386.
3. Gamble, Teri Kwal and Michael Gamble. *Communication Works.* 9th Ed. New Delhi: Tata- McGraw-Hill, 2010.
4. Hacker, Diana. *A Pocket Style Manual*. 4th ed. New York, NY: Bedford/St. Martin's, 1999. ISBN: 9780312406844.
5. Perelman, Leslie C., James Paradis, and Edward Barrett. *The Mayfield Handbook of Technical and Scientific Writing*. New York, NY: McGraw-Hill, 1997. ISBN: 9781559346474.
6. **David F. Beer and** David McMurrey**, *Guide to Writing as an Engineer*, 2nd ed., Wiley, 2004,** ISBN: 0471430749.
7. Dale Jungk, *Applied Writing for Technicians*, McGraw-Hill, 2005, ISBN 0-07-828357-4.

Vinoba Bhave University , Hazaribagh

Electronics & Communication Engineering			
EC511	**Linear Control System**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	**Analyze electromechanical systems using mathematical modeling**.
CO2	**Determine Transient and Steady State behavior of systems using standard test signals**.
CO3	**Analyze linear and non-linear systems for steady state errors, absolute stability and relative stability.**
CO4	**Design a stable control system satisfying requirements of stability and reduced steady state error.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	2	3	2	-	-	-	-	-	-	-	-	1

Detailed Syllabus:

Module	**Course Content**	**No. of Lecture**
1	**INTRODUCTION:** Concepts of Control Systems- Open Loop and closed loop control systems and their differences, Different examples of control systems- Classification of control systems, Feed-Back Characteristics, Effects of feedback, Mathematical models, Differential equations, Impulse Response and transfer functions.	**7**
2	**TRANSFER FUNCTION REPRESENTATION:** Block diagram representation of systems considering electrical systems as examples - Block diagram algebra – Representation by Signal flow graph-Reduction using mason's gain formula.	**6**
3	**TIME RESPONSE ANALYSIS:** Standard test signals - Time response of first order systems –Characteristic Equation of Feedback control systems, Transient response of second order systems- Time domain specifications– Steady state response-Steady state errors and error constants–Effects of	**10**

	proportional derivative, proportional integral systems. **STABILITY ANALYSIS IN S-DOMAIN:** The concept of stability– Routh's stability criterion – qualitative stability and conditional stability – limitations of Routh's stability.	
4	**ROOT LOCUS TECHNIQUE:** The root locus concept - construction of root loci-effects of adding poles and zeros to G(s) H(s) on the root loci. **FREQUENCY RESPONSE ANALYSIS:** Introduction, Frequency domain specifications-Bode diagrams Determination of Frequency domain specifications and Phase margin and Gain margin Stability Analysis from Bode Plots. Polar Plots, Nyquist Plots Stability Analysis. Compensation techniques – Lag, Lead, and Lead-Lag Controllers design in frequency Domain, PID Controllers.	**10**
5	**State Space Analysis of Continuous Systems:** Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.	**6**

Text Books:

1. Control Systems Theory and Applications - S. K. Bhattacharya, Pearson.
2. B.C. Kuo, Automatic Control Systems, 7th Edition, Prentice Hall of India, 2009.
3. I.J. Nagarath and M. Gopal: Control Systems Engineering, 2nd Edition, New Age Pub. Co. 2008.
4. Modern Control System with Advanced topics- S. K. Bharadwaj and S. K. Nagar, New Age Publication.
5. Control Systems - N. C. Jagan, BS Publications.
6. Control Systems - A. Ananad Kumar, PHI.
7. Control Systems - N. K. Sinha, New Age International (P) Limited Publishers.

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Electronics & Communication Engineering			
EC512	**Radar Engineering**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	**Understand the basic operation of pulse and CW radar systems.**
CO2	**Evaluate the radar performance based on pulse width, peak power and beam width.**
CO3	**Choose suitable tracking radar for a given problem.**
CO4	**Select appropriate criterion for detecting a target.**
CO5	**Understand the working of phased array radars and navigational aids**.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	1	-	-	-	2	-
CO2	-	3	-	-	-	-	1	-	-	-	2	-
CO3	2	2	-	-	1	-	1	-	-	-	2	-
CO4	2	-	-	-	-	-	-	-	-	-	2	2
CO5	2	2	-	-	-	-	1	-	-	2	2	2

Detailed Syllabus:

Module	**Course Content**	**No. of Lecture**
1	**Radar and Radar Equation:** Introduction, Radar block diagram and operation, frequencies, applications, types of displays, derivation of radar equation, minimum detectable signal, probability of false alarm and threshold detection, radar cross-section, system losses.	**8**
2	**CW Radar:** Doppler Effect, CW Radar, applications, FM-CW radar, altimeter, Multiple Frequency Radar. Pulse Radar- MTI, Delay Line Canceller, Multiple Frequencies, Range-gated Doppler Filters, Non-coherent MTI, Pulse Doppler Radar.	**8**
3	**Tracking Radar:** Sequential lobing, conical scanning, mono pulse, phase comparison mono pulse, tracking in range, Comparison of trackers.	**8**
4	**Detection:** Introduction, Matched Filter, Detection Criteria, Detector characteristics.	**6**

5	**Phased Arrays**: Basic concepts, feeds, phase shifters, frequency scan arrays, multiple beams, applications, advantages and limitations. Navigational Aids: Direction Finder, VOR, ILS and Loran.	**10**

Text Books:

1. M.I. Skolnik, Introduction Radar Systems, Second Edition, Mc Graw Hill Book Co., 1981.
2. F.E. Terman, Radio Engineering, Mc Graw Hill Book Co. (for Chapter 7 only), Fourth Edition 1955.
3. Simon Kingsley & Shaun Quegan, Understanding RADAR Systems, McGraw Hill Book Co., 1993.

Electronics & Communication Engineering			
EC513	**Linear Integrated Circuit**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Design op-amp circuits to perform arithmetic operations
CO2	Analyze and design linear and non-linear applications using op-amps
CO3	Analyze and design oscillators
CO4	Analyze and design filters
CO5	Understanding of PLL and Timers.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	-	-	-	-	-	-	-	-	-
CO2	1	2	2	-	-	-	-	-	-	-	-	-
CO3	1	3	2	3	-	-	-	-	-	-	-	-
CO4	1	2	2	2	-	-	-	-	-	-	-	-
CO5	1	1		-	-	-	-	-	-	-	-	-

Details Syllabus:

Module	Course Content	No. of Lecture

1	Op-Amp equivalent circuits, ideal Op-Amp, Op-Amp DC characteristics, AC characteristics, non-ideal Op-Amp characteristics. DC and AC amplifiers, summing, scaling, and averaging amplifiers, instrumentation amplifiers, I/V, V/I converter, integrator, differentiator, differential amplifiers. Op-amp with negative feedback, voltage series, voltage shunt feedback amplifier.	**8**
2	Logarithmic Amplifiers, Rectifiers, Peak detection and voltage regulation.	**5**
3	Comparator and its applications, Schmitt trigger, free-running, one-shot multivibrators, Barkhausen Criterion, sine wave generators, phase-shift, wein-bridge oscillators, square/Triangular/saw tooth wave function generator.	**10**
4	Filter Classifications, Frequency and Impedance Scaling, First and second order Low Pass and High Pass Designs, Band-Pass Filter, Notch filter.	**8**
5	PLL and Timers, Voltage controlled Oscillator, Closed loop analysis of PLL, Astable and Monostable Multivibrators using 555 Timer, Voltage regulators-linear and switched mode types.	**8**

Text Books:

1) OP-Amps and Linear Integrated Circuits: - Ramakant Gayakwad (Pearson Education)
2) Linear Integrated Circuits: - D Roy Choudhury, Shail Bala Jain (New Age International Publishers
3) Design with Operational amplifiers and Analog integrated circuits: - Sergio Franco (TATA McGraw-Hill 3rd Edition)

Electronics & Communication Engineering			
EC521	**Signal and System**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	**Classify the signals as Continuous time and Discrete time.**
CO2	**Analyze the spectral characteristics of signals using Fourier analysis.**
CO3	**Classify systems based on their properties and determine the response of LTI system using convolution.**
CO4	**Identify system properties based on impulse response and Fourier analysis.**
CO5	**Apply transform techniques to analyze continuous-time and discrete-time signals and systems** also **Comprehensive understanding of control systems, order of systems & stability analysis.**

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	1	-	-	1
CO2	3	-	-	-	-	2	-	-	-	-	-	1

CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	-	-	3	-	-	-	-	-	1
CO5	2	2	-	-	-	3	-	-	-	-	-	1

Detailed Syllabus:

Module	Course Content	No. of Lecture
1	**SIGNALS AND SYSTEMS:** Continuous Time and Discrete Time signals, Exponential and Sinusoidal Signals, Unit Impulse and Unit Step Functions, Continuous and Discrete Time Systems, basic System Properties. **LINEAR TIME INVARIANT SYSTEMS:** Discrete Time LTI Systems, Continuous Time LTI Systems, properties of LTI Systems, causal LTI Systems Described by Difference equations.	6
2	**FOURIER SERIES REPRESENTATION OF PERIODIC SIGNALS:** Response of LTI systems to Complex Exponentials, Fourier series Representation of CT periodic Signals, properties of CT Fourier Series, Fourier Series representation of DT periodic Signals, properties of DFS, Fourier series and LTI Systems, Filtering, Examples of CT filters, Examples of DT filters. CONTINUOUS TIME FOURIER TRANSFORM: Representation of a periodic Signals by continuous FT, FT of periodic signals, convolution and multiplication property of continuous FT, systems characterized by Linear Constant Coefficient Differential Equations.	9
3	**TIME AND FREQUENCY CHARACTERIZATION OF SIGNALS AND SYSTEMS**: Magnitude and phase representation of FT, Magnitude and phase response of LTI systems, Time domain and Frequency domain aspects of ideal and non-ideal filters. **DISCRETE TIME FOURIER TRANSFORM (DTFT) and DISCRETE FOURIER TRANSFORM (DFT):** Properties of DTFT and DFT, convolution property, multiplication property, Duality, Systems characterized by Linear Constant Coefficient Difference Equations.	9
4	**SAMPLING:** Sampling theorem, Impulse sampling, sampling with zero order Hold, Reconstruction of signal from its samples using interpolation, Effect of under sampling **Z-TRANSFORM:** Z-transform, Region of convergence and its properties, Inverse Z transform, properties of ZT, Analysis and characterization of LTI systems using ZT, LTI Systems, System function algebra and block diagram representations.	9

5	**SIGNAL FLOWGRAPHS:** Impulse Response and Transfer function of linear Systems, Block diagrams, Signal flow graphs, Basic properties of SFG, SFG Terms, SFG Algebra, Gain formula, Application of gain formula to block diagrams.	**7**

Text Books:

1. Alan V. Oppenheim, Alan S. Willsky, S. Hamid Nawab, Signals and Systems Prentice Hall India, 2nd Edition, 2009.
2. John G. Proakis, Dimitris G. Manolakis, Digital Signal Processing, Principles, Algorithms, and Applications, 4th Edition, PHI, 2007.
3. Robert A. Gable, Richard A. Roberts, Signals & Linear Systems, 3rd Edition, John Wiley,1995.

Vinoba Bhave University , Hazaribagh

Electronics & Communication Engineering			
EC522	**Digital Switching and Multiplexing**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the characteristics of telephone systems.
CO2	Design and test telecom switching systems.
CO3	Model and estimate the telecom traffic.
CO4	Understand the network synchronization and management.
CO5	Evaluate fiber based wide area networks.

Mapping of Course Outcomes with Program Outcomes:

Course Outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	2	-	-	-	-	2	-
CO2	2	3	-	-	1	-	-	-	-	-	2	2
CO3	2	3	-	-	-	-	-	-	-	-	2	2
CO4	2	2	-	-	-	-	-	-	-	-	2	2
CO5	1	2	-	-	2	2	-	-	-	-	2	2

Detailed Syllabus:

Module	Course Content	No. of Lecture
1	**Introduction:** Evolution of Telecommunication, Basics of switching system, step-by-step switching, Design considerations. Principles of Crossbar switching, electronic space division switching, stored program control, software architecture, switching functions.	**8**
2	**Digital transmission:** Frequency Division multiplexing, Time Division multiplexing, Statistical Division Multiplexing, switching hierarchy, Synchronous digital hierarchy both USA and European standards. **Message switching:** circuit switching & packet switching, space division switching, Time division switching. Two dimensional switching, grade of service, non-blocking, digital cross connect, concentrators, expanders and distributors, two stage networks, three stage networks, n-stage networks.	**10**
3	**Time Division Switching:** Time Division space switching, Time division time switching, and time multiplexed space switching. Time multiplexed time switching, space – time combination switching, three stage combination switching, N-stage combination switching, signaling techniques.	**6**
4	**Telecommunication Traffic:** Units of Traffic, Network traffic load and parameters, Grade of service and Blocking Probability, traffic measurement, Mathematical model, Incoming traffic and service time characteristics, Blocking models and loss estimates, delay systems.	**8**

	Digital Subscriber access – ISDN, High data rate digital subscriber loops, Digital Loop carrier systems, fiber in the loop, voice band modems, digital satellite services, Broadband switching systems.	
5	**Network synchronization:** Control and management, timing, timing inaccuracies, network synchronization, network control and management. **SONET/SDH:** SONET multiplexing overview, frame formats, operation, administration and maintenance, frequency justification and payload framing, virtual tributes, DS3 payload mapping, E4 payload mapping, SONET optical standards, SONET rings & networks.	**8**

Text Books:

1. Digital Telephony,John C Bellamy,3/e,Wiley-India,1999
2. Telecommunication Switching Systems and Networks,T Viswanathan,PHI,1997
3. “Performance Modeling, Loss Networks, and Statistical Multiplexing (Synthesis Lectures on Communication Networks)” by Ravi Mazumdar and Jean Walrand.
4. “Broadband Communications: Convergence of Network Technologies (IFIP Advances in Information and Communication Technology)” by Danny H K Tsang and Paul J Kühn.
5. “Basics of Computer Networking (SpringerBriefs in Electrical and Computer Engineering)” by Thomas Robertazzi.

Vinoba Bhave University , Hazaribagh

Electronics & Communication Engineering			
EC523	**Biosensors**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	**Understand bio sensing and transducing techniques.**
CO2	**Understand principles of linking cell components and biological pathways with energy transduction, sensing and detection.**
CO3	**Demonstrate appreciation for the technical limits of performance of biosensor.**
CO4	**Apply principles of engineering to develop bio analytical devices and design of biosensors.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Module	Course Content	No. of Lecture
1	**General principles:** A historical perspective, Signal transduction, Physico-chemical and biological transducers, Sensor types and technologies, Definitions and Concepts Terminology and working vocabulary, Main technical definitions, calibration, selectivity, sensitivity, reproducibility, detection limits, response time.	**8**
2	**Physico-chemical transducers:** Electrochemical transducers (amperometric, potentiometric, conductimetric), optical transducers (absorption, fluorescence, SPR), Thermal transducers, piezoelectric transducers.	**5**
3	**Bio recognition systems: Enzymes:** Oligonucleotides and Nucleic Acids, Lipids (Langmuir-Blodgett bilayers, Phospholipids, Liposomes), Membrane receptors and transporters, Tissue and organelles (animal and plant tissue), Cell culture, Immuno receptors, Chemoreceptors, Limitations & problems, Immobilization of biomolecules.	**10**

4	**Biosensor Engineering:** Methods for biosensors fabrication, self-assembled monolayers, screen printing, photolithography, micro-contact printing, MEMS, Engineering concepts for mass production.	**8**
5	**Application of modern sensor technologies:** Clinical chemistry, Test-strips for glucose monitoring, Urea determination; Implantable sensors for long-term monitoring, Environmental monitoring, Technological process control, Food quality control, Forensic science benefits, Problems & limitations.	**8**

Text Books:

1. Donald G. Buerk, Biosensors: Theory and Applications, First Edition, CRC Press, 2009.
2. Alice Cunningham, Introduction to Bioanalytical Sensors, John Wiley& Sons, 1998.
3. Brian R. Eggins, Chemical Sensors and Biosensors, John Wiley& Sons, 2003.

Electronics & Communication Engineering			
EC531	**Electronics Instrumentation**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Apply knowledge of instruments for effective use
CO2	Select suitable instruments for typical measurements
CO3	Identify various transducers to measure strain, temperature and displacement
CO4	Understand data acquisition system and general purpose interfacing bus

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	2	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	3	-	2	-	-	-	-	-

Detailed Syllabus:

Module	**Course Content**	**No. of Lecture**
1	**Measurement And Error:** Sensitivity, Resolution, Accuracy and Precision, Absolute and Relative types of errors, Statistical analysis, Probability of Limiting errors, Linearity.	**8**
2	**Instruments:** Current and Resistance in instruments, Analog and Digital Multimeters, Measurement of time and frequency, Digital Frequency Meter and applications.	**7**

3	**Impedance Measurement:** Kelvin Bridge, Megger, Maxwell, Hay and Shering Bridges. Q-meter, Noise and Interference reduction techniques in Measurement Systems, Wave Analyzer, Spectrum Analyzer, FFT Analyzer, Oscilloscopes, Pulse Measurements, Delayed Time Base, Analog Storage, Sampling and Digital Storage Oscilloscopes.	**10**
4	**Transducers:** Classification and selection of Transducers, Introduction to Strain, Load, Force, Displacement, Velocity, Acceleration, Pressure and Temperature Measurements, Introduction to Smart sensors and MEMS.	**7**
5	**Introduction to Data Acquisition Systems (DAS):** Block Diagram, Specifications and various components of DAS, applications of DAS in various fields. General purpose **Instrumentation Bus (GP-IB):** Protocol, SCPI Commands and Applications to DSO and DMM.	**8**

Text Books:

1. Helfrick& Cooper-Modern Electronic Measurement & Instrumentation.
2. Golding, E.W.- Electrical Measurement and Measuring Instruments.
3. H.S Kalsi- Electronic Instrumentation.

Electronics & Communication Engineering			
EC532	**Digital System Design***	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	**Design of combinational and sequential logic circuits and develop Verilog models**.
CO2	**Understand characteristics of the TTL/CMOS logic families and realize Boolean equation using CMOS logic**.
CO3	**understand fault detection techniques for digital logic circuits**
CO4	**understand SRAM/DRAM organization and periphery circuitry, operation of SRAM cell, DRAM cell, DDR2/DDR4 and SD card**.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	-	2	-	1	-	-	-	-	-
CO2	2	3	-	-	1	2	1	-	-	-	-	-
CO3	-	2	-	-	1	-	1	-	-	-	-	-
CO4	2	2	1	-	-	1	-	-	2	-	-	-

Detailed Syllabus:

Vinoba Bhave University , Hazaribagh

Module	Course Content	No. of Lecture
1	**INTRODUCTION:** Introduction to Number Systems and Boolean Algebra Digital and Analog Basic Concepts, Number Base Conversion - Complement Codes, Binary Arithmetic , Binary codes: BCD, Weighted codes -2421, 8421, gray code - Binary Logic functions, Boolean Algebra, Theorems and Properties of Boolean Algebra. **MINIMIZATION OF BOOLEAN FUNCTION:** Minimization techniques in digital Logic Canonical forms, Generation of Switching Equations from Truth Table - K-map(Karnaugh map) 2 ,3 and 4 variables, K map with Don't care terms - Quine Mc-Cluskey minimization technique, Quine Mc-Cluskey using Don't Care Terms - Mixed logic Combinational circuits.	**8**
2	**COMBINATIONAL CIRCUIT DESIGN:** Design with basic logic gates, comparators, data selectors, priority encoders, decoders, full adder, serial binary adder, parallel binary adders-ripple-carry adder, carrylook ahead adder; Parallel prefix adders- Carry select Adder, Conditional sum adder, Kogge-stone Adder, Brent-kung adder, Verilog models.	**8**
3	**SEQUENTIAL CIRCUIT DESIGN:** Memory elements and their excitation functions SR, JK, T, and D latches and flip-flops, master slave JK flip-flop, edge-triggered flip-flop, synchronous and asynchronous counters, finite-state machine, sequence detector, minimization and transformation of sequential machines, Registers, Verilog models.	**10**
4	**TESTING OF COMBINATIONAL CIRCUITS:** Fault models, structural testing: path sensitization Logic families: TTL and CMOS Logic circuits, Transfer characteristics, fan-in, fan-out, noise margin, rise time and fall time analysis, realization of Boolean equations using CMOS logic.	**8**
5	**MEMORY:** Types of memories, MOS SRAM cells, DRAM, SDRAM, DDR SDRAM, DDR2 SDRAM, DDR4 SDRAM, organization of a SRAM, Organization of SDRAM, Periphery circuitry of Memory, Flash memory, SD card.	**6**

Text Books:

1. William J. Dally and John W. Poulton, Digital Systems Engineering, Cambridge University Press, 2008.
2. Schilling, Herbert Taub and Donald, Digital Integrated Electronics, Tata McGraw-Hill, 2008.
3. Jayaram Bhasker, Verilog Primer, 3rd edition, Prentice-Hall India, 1998.
4. Sameer Palnitkar, Verilog HDL: A guide to digital Design and Synthesis, 2nd edition, Pearson, 2003.

5. John F Wakerly, Digital Design Principles and Practices, 3rd Edition, Prentice Hall India, 2001.

Franklin P. Processor, David E. Winkel, The Art of Digital Design: An Introduction to Top Down Design, 2nd Edition, PTR Prentice Hall, 1987.

Vinoba Bhave University , Hazaribagh

Electronics & Communication Engineering			
EC533	**Materials for Engineering Applications**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	**Correlate processing, microstructure and properties of materials**.
CO2	**Understand behaviour of materials under various conditions**.
CO3	**Characterize modes of failure of engineering materials and design new materials with better properties and cost effective processes.**
CO4	**Identify suitable materials for engineering applications.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	-	-	-	-	-	-	-	-	-	2	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2

Detailed Syllabus:

Module	**Content**	**No. of Lectures**
1	**Structure of solids**: Classification of engineering materials, Structure-property relationship in engineering materials, Crystalline and non-crystalline materials, Miller Indices, Crystal planes and directions, Determination of crystal structure using X-rays, Inorganic solids, Silicate structures and their applications. Defects; Point, line and surface defects.	**6**
2	**Mechanical properties of materials**: Elastic, Anelastic and Viscoelastic behaviour, Engineering stress and engineering strain relationship, True stress, true strain relationship, review of mechanical properties, Plastic deformation by twinning and slip, Movement of dislocations, Critical shear stress, Strengthening mechanism, and Creep.	**10**
3	**Equilibrium diagram**: Solids solutions and alloys, Gibbs phase rule, Unary and binary eutectic phase diagram, Examples and applications of phase diagrams like Iron - Iron carbide phase diagram.	**10**

4	**Electrical and magnetic materials**: Conducting and resistor materials, and their engineering application; Semiconducting materials, their properties and applications, Magnetic materials, Soft and hard magnetic materials and applications, Superconductors, Dielectric materials, their properties and applications. Smart materials: Sensors and actuators, piezoelectric, magnetostrictive and electrostrictive materials.	**8**
5	**Corrosion process**: Corrosion, Cause of corrosion, Types of corrosion, Protection against corrosion. **Materials selection**: Overview of properties of engineering materials, Selection of materials for different engineering applications.	**6**

Text Books:

1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, B H, 2005.
3. ASM Publication Vol. 20, Materials Selection and Design, ASM, 1997
4. Pat L. Mangonon: The Principles of Materials Selection and Design, PHI, 1999.

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN501	**Underground Coal Mining**	**L**	**T**
		3	**1**

Course Objectives:

After getting exposed to basics of mining engineering, students should get a dig into different types of mines. When it comes to coal mines, especially underground coal mines where there is relatively high risk compare to other mines, students should be well familiar with risks and challenges associated with them, thus requiring some case studies essentially. Underground coal mining-II covers many working methods which are applicable within different and rare circumstances. Students, after going through this subject, will be benefitted with deep knowledge of underground coal mining, as they have some basics in earlier.

- This course is designed to address the following:
- To expose the students with the knowledge of special working methods carried out for abnormal cases.
- To expose the students with modern methods being carried out across the globe.
- To encourage the students for some innovative works by the exposure of some case studies.

Syllabus:

Modules:

Module-1: Thick Seam Mining: Concept of thick seam, problems of the mining thick seams, past experience of working thick seams by Bord & Pillar method in multi sections.

Module-2: Modern multi- slicing method:i ncline slicing, horizontal slicing, cross slicing inascending and descending order. Equipments for thick seam mining. Case Study.

Module-3: Advanced Underground Winning Methods: Sublevel Caving, Integral Caving, Blasting Gallery Method, Descending Shield Method,

Module-4: Hydraulic Mining: Bhaska and Tipong Method. Case Study.
Module-5: Steep Seam Mining: Mining technology of inclined and steep seams

Module-6: Thin Seam Mining: Problems in thin seam mining, equipments and methods forthin seam extraction. Case Study.

Module-7: Underground Coal Gasification (UCG):Basic concepts, applications and limitations ofthe methods with case studies. Coal Bed Methane: Basic concepts, applications and limitations of the methods with casestudies.

Text/Reference Books:

1. Principles and Practices & Modern Coal Mining, R.D. Singh, New Age International Publication.
2. Underground Mining & Coal, Singh, T.N. Singh – Oxford Publication.
3. Modern Coal Mining Technology, Das S.K. – Lovely Prakasan publication.
4. Longwall mining, Peng S.S., Chiang H/S. – John Willey Publication.
5. Mine Planning for Coal, Mathur S.P. – M.J Consultant Publications.
6. Winning and Working Coal in India Vol.II- R.T. Deshmukh and D.J. Deshmukh, Dhanbad Publishers
7. Underground Coal Mining Methods – J.G. Singh, Braj-Kalpa Publishers.

Course outcomes

After completion of the course, students will be able to:

1. Understand mine planning, opening of deposits, pillar development, pillar extraction, Layout required for out puts, long well mining, mechanized extraction of long wall panel.
2. Understand the concept of gasification, Technology involved in it, Non-mining methods of UCG, Gasification at great depth, merits and demerits, Future scope and Development.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2	3	2	3		2	3	2	3
CO3	2	2		2	3			3			2	3
CO4			2			2	2		3	2	2	
Avg.	2	2.5	2	2	3	2	2.5	3	2.5	2.5	2	3

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN502	**Mine Ventilation Engineering**	**L**	**T**
		3	**0**

Course objective

The purpose of this course is to present a modern and comprehensive treatment of mine ventilation system from the viewpoint of the total mine atmosphere environment and its control. Hence, the subject is treated in terms of the theory and practices in the three broad areas of air conditioning-quantity control, quantity control(ventilation), temperature –humidity control.

From the basic physics of gases, the theory is to developed to cover air measurements, the flow of air through ducts, through opening, and through circuits, the design of networks and the design of temperature-humidity control systems. The solution of examples problems and the many references to the technical literature will further assist the reader in grasping this theory.

Syllabus:

Modules:

Module-1: Introduction and course overview: composition of mine air, its variation, origin,occurrence, physical, chemical and physiological properties of mine gases.

Module-2: Classification of various types of damps: Sampling and analysis of mine air. Methanecontent and pressure, methane drainage and methane layering. Monitoring of gases.

Module-3: Heat and humidity: Sources of heat in mines, effect of heat and humidity, psychometric,kata thermometer, Methods of improving: of cooling power of mine air. Air conditioning–basic vapourcycle, representative layout.

Module-4: Air flow through mine openings: Laws of air flow, resistance of airways, equivalentorifice, distribution of air, flow control devices

Module-5: Natural Ventilation: Calculation of NVP from air density, thermodynamic treatment etc. artificial aids to natural ventilation.

Module-6: Mechanical Ventilation: principal types of mine fan and their suitability, merits, limitation, efficiency and characteristics .Selection of mine fan: fan testing, output control in fans, series and parallel operation ofmine fans.

Module-7: Ventilation of advancing: heading-auxiliary fan, duct, matching of fan to the duct system.Reversal of air current: Fan drift, evasee, diffuser, booster fans.

Text/Reference Books:

1. Banerjee S.P. (2003); "Mine Ventilation"; Lovely Prakashan, Dhanbad, India.
2. Panigrahi D.C: Mine Ventilation, CRC Press
3. Deshmukh, D. J. (2008); "Elements of Mining Technology. II"; Denett& Co., Nagpur, India.
4. Hartman, H. L., Mutmansky, J. M. & Wang, Y. J. (1982); "Mine Ventilation and Air Conditioning"; John Wiley & Sons, New York.
5. Karmakar, N. C. (2001); "Handbook of gas testing"; Lovely Prakashan, Dhanbad, India.
6. Le Roux, W. L. (1972); Mine Ventilation Notes for Beginners"; The Mine Ventilation Society of South Africa.

7. McPherson, M. J. (1993); Subsurface Ventilation and Environmental Engineering"; Chapman & Hall, London.
8. Misra G.B. (1986); "Mine Environment and Ventilation"; Oxford University Press, Calcutta, India.
9. Ramlu, M. A. (1991); "Element of Mine Ventilation"; Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
10. Vutukuri, V. S. & Lama, R. D. (1986); "Environmental Engineering in Mines"; Cambridge University Press, Cambridge.
11. Kejriwal, B.K," A Survey of Accidents, Their Causes &Prevention''.
12. Kaku L.C, "Fire in Coal Mine", Lovely Prakashan, Dhanbad, India.
13. Ghatak S., "Mine Ventilation. 1 & Vol. 2, Lovely Prakashan, Dhanbad, India.
14. Banerjee S.P., "Prevention combating Mine Fires", Lovely Prakashan, Dhanbad, India.

Course outcomes

Upon successful completion of this course, the student will be able to:

Knowledge based

- Explain the meaning of mine ventilation system.
- Recognise the different types of damps and their causes and prevention techniques.
- Describe the various techniques of fan selection for a particular mine;
- Explain the laws of air flows, resistance of airways, equivalent orifice, distribution of air;
- Have complete understanding of the significant role of different flow control devices.

Skills

Use mine ventilation system to:

- Apply the techniques used in fan selection to solve real life problem in mining industry
- Develop skills sets for calculating natural ventilation pressure from air density etc.
- Formulate air quantity required to solve real life problem.
- Deal with fire dams in mine.
- Recognising the physiological properties of dust.
- Develop the prevention and suppression techniques of dust, dust formation sources.
- Develop methods of improving the cooling power of mine air.
- Determine the characteristics of mine airways.
- Maintain and monitor the mine fans.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							3				
CO2		2	2	2	3	2	3		3	2	3	2
CO3	3			2	3			1			2	2
CO4		3	2			3	3		3	2		
Avg.	3	2.5	2	2	3	2.5	3	2	3	2	2.5	2

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN511	**Mining Machinery**	**L**	**T**
		3	**0**

Course Objectives:
This course introduces prime movers used for moving of mining machinery, Rails, Joints, Crossings, Plates for track laying, Locomotives used in mines, drills used for drilling in mines, mine winders, winding drums, man riding systems, cutter loaders, pumps, opencast machinery for mining to improve its output.
Syllabus:

Modules:
Module 1: Prime Mover for Mining Machinery: O.C. engine, hydraulic power, pneumaticpower, elements of mechanical power transmission – gear, belt, chain, coupling, clutch and brake.
Module 2: Rope haulage: Construction of the wire ropes, rope haulages–gravity, direct,balanced direct, main & tail, endless, reversible endless. Suitability of these haulages and their limitations. Dimension of ropes, drums and pulleys, care and maintenance of ropes, changing
of haulage ropes, rope splicing, safety appliances in haulage road, signaling, Statutory requirements of haulages.
Module 3: Track Laying: Rail, joints, crossings, plates, turn tables a curve, track extension,
Aerial Ropeways: Types, construction, Application and operation.
Module 4: Mine Locomotives: Types, constructional features of compressed air, diesel, batteryand electric trolley-wire locomotives, comparison of various locomotive haulages. Comparison of rope and locomotive haulages. Conveyors: Principle types and their operations, installation, shifting, maintenance and applicability, shuttle cars, stage loaders, bridge conveyors, capacity.**Module 5:** Drills for Coal and Stone: Various types, their construction and maintenance, Jumbodrills.
Module 6: Mine Winders: Koepe and Drum winders and their applications, head gear, headgear pulley, shaft fitting – Keps, rope guides, shaft sinking and bells, capping and recapping, cage and suspension gear.
Module 7: Winding Drum-types and construction, Safety devices in winders-over speed andover wind preventers, slow breaking, depth indicator, Methods of counter balancing rope. Duty cycle. Mechanical and electrical braking. Winding from different levels in shaft.
Module 8: Man riding system in underground mines. Face Machinery: SDL & LHD–theirapplications, capacity, operation, fitting, control and maintenance. Cutter loaders – Shearers, Coal plough and Continuous Miners – their constructional features, applications, capacity and maintenance.
Module 9: Layout of faces with Power loader working under varied condition, Shuttle cars.Pumps: Types, Construction, operation, characteristics and application, Calculation of size, efficiencies and capacities. Layout of drainage system.
Module 10: Opencast Machinery: Blast Hole Drill, Ripper, Shovel, Dragline, Dumper, BucketWheel Excavator, Continuous Miners – their basic construction, applications and operation.

Text/Reference Books:

1. Elements of Mining Technology Vol. III, D.J. Deshmukh, Denett& Company,
2. Coal Mining Series Vol. 1 & II, Ernest Mason, Virtue

3. Mine Transport – N.T. Karelin, Orient Longmans
4. Mining and Transport – S. C. Walker, Elsevier
5. Introduction to Mining Engineers – Hartman. H.L, John Wiley & Sons.
6. Pumps Focus Compressors Walkar wending & Transport, Cherkasky B.M.
7. Mine Mechanisation and Automation, Alemgren G, U. Kumar.

Course Outcomes:

Students can understand mechanism involved in heavy machinery, locomotives used in mines, track laying with different techniques. Different types of drills used in mines, winders applications, winding drum construction, face machinery, open cast machinery like blast hole drill, ripper, dumper, bucket wheel excavator, which will enhance the output of mines.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				3			3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			3			2	3
CO4			2			2	2		3	3	2	
Avg.	2	3	2	2	3	2	2.5	3	2.5	3	2	3

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN512	**Drilling & Blasting**	**L**	**T**
		3	**0**

Course objective:

The course provides the knowledge for drilling and blasting technology under rock excavation in detailed manner. The course contains mainly the drilling and blasting techniques used from development phase till production phase in such a way that rock/ore/coal breaking attains in maximum technical and economic values. The course covers the basics of rock geology related to drilling applications, the fundamentals of drilling and blasting procedures adopted during excavation in surface and sub-surface excavation and also understand its socio-economic and environmental impacts.

Syllabus :

Module-1: Production Drilling: Definition, components of drilling systems, rockdrilling classification, drilling accessories -types and size of drill bits and their suitability. Theory of rock breakage by rotary and percussive action. Drilling machinery-face machinery, surface and sub surface operations, motive power to rock drilling.

Module 2: Explosives: definition and classification of conventional and non-conventionalexplosives, constituents of explosives, commercial explosives and their properties, bulk explosive systems, permitted explosives, magazines, selection of explosives, transportation and handling of explosives and their related regulations.

Module 3: Initiation System & Blasting Accessories: Detonators of severaltypes, detonating cord, Safety fuse, relays, non-electricinitiation, exploders and Blasting fittings.

Module 4: Surface Blast Design: Factors affecting blast design, Selection of variousblast parameters Burden, Spacing, stemming distance, Sub-grade drilling, Depth of hole, Bench height, hole diameter, Safecharge calculation, powder factor calculations, Deck Charging, Drillingpatterns, controlled deep hole blasting, Inclined hole drilling, Secondary blasting, misfires problem and remediation in surface blast operations.

Module 5: Underground Blast Design: Various cut patterns, U/G blast design, Series&Parallel connection of detonators, inverse and direct initiation. Precautions during blasting, blasting practices in shaft sinking and in metalliferous mines.

Module 6: Rock Breakage Mechanism: Breakage mechanism, rock fragmentation,Factors affecting rock fragmentation, Back break, over break, charge loading parameters. Fly rock, Ground Vibration, Noise, Control Blasting Techniques.

Module7: Blasting Efficiency: Techniques to assess the blasting performance,efficiency and cost of drilling and blasting, cost effective blast design.

Course Outcomes:

After completion of the subject the students will be able to:

1.Identifying and relating various drilling procedures to various rock characteristics.

2.Outline and define various blasting practices, accessories, explosives & their suitability in Indian mines both underground and opencast.

3.Analyze and optimize blast performance and productivity improvements.

4.Formulate and list the documentation for safe blasting practices.

5.To understand and appreciate environmental and social implications of rock/coal blasting.

References/Text Books:

1.Rock blasting effects and operations, Lovely Prakashan: P. Pal Roy.

2.Drilling and Blasting: chapters in SME Mining Engineers Handbook: P Darling.

3.Drilling and blasting of rock, CRC publications:Jimino.

4.Surface and Underground Excavations: Ratan RajTatiya.

5.Blasting principles for open pit mining, SME vol. □ &□: W Hustrulid.

6.Blasting Practices in Surface Mines: S K Das.

7.Explosives and Blasting Technology: G.K. Pradhan.

8.Surface Blast Design: C.J. Konya.

9.Rock Blasting: Sushil Bhandari.

10. Indian Explosive Act 1884.

11. Legislation in Indian Mines – A Critical Appraisal: Rakesh and Prasad.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2		2	3		2	2	2	3
CO3	2			2	3			3			3	3
CO4			2			2	2		3	2		
Avg.	2	3	2	2	3	2	2.5	3	2.5	2	2.5	3

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN513	**Small Scale Mining**	**L**	**T**
		3	**0**

Course objective:

The course provides the knowledge of managing small scale mines, technical operation and understand Problems of small-scale mining: Geo-mining, conservational and financial implications, environmental impacts and mitigation measures, legislation related to small scale mining.
Aqueous extraction of placer deposits: Scope and applicability, alluvial mining.
Beach sand mining: Ground sluicing, Hydraulicing, Dredging, Machinery for placer mining.
Small Scale Mining methods: Manual, semi-mechanized and mechanized mining methods, conventional and novel techniques occurrence of granite and minor minerals geological aspects of small-scale mining, processing and finishing.

Syllabus:

Module-1: Introduction to small scale mining**,** Concept and definitions, scenario and Indian policy on small scale mining.

Module-1: Problems of small-scale mining: Geo-mining, conservational and financial implications, environmental impacts**,** Mitigation measures and legislation related to small scale mining.
Module-3: Aqueous extraction of placer deposits: Scope and applicability, alluvial mining.
Beach sand mining: Ground sluicing, Hydraulicking, Dredging, Machinery for placer mining.
Module-4: Small Scale Mining methods: Manual, semi-mechanized and mechanized mining methods, conventional and novel techniques occurrence of granite and minor minerals
Module-5: Geological aspects of small-scale mining, processing and finishing.

Text/Reference Books:

1. Artisanal and Small-scale Mining: Challenges and Opportunities
2. Mining on a small and Medium Scale: A global perspective
3. Ghose AjoyK., Prelims - Mining on a Small and Medium Scale
4. Bhatia R.L. AH S.V. ChakravortyS.L,Legislative Framework in Indian Mineral Sector and Scope for Its Improvement vis-a-vis Small Scale Mining; Cluster-Mining: A Tested Concept for Small Mines.
5. Equipment Selection for Small to Medium Scale Mines, Prabir Paul, G.C. MishraD.K.Panda, pp. 129–140.
6. Marble Mining in Small Scale Sectors in India — Problems, Prospects and Suggestions,A. BhatnagarS.K. Mukhopadhyay

Course Outcomes:

This course qualifies participants to apply an advanced body of knowledge in the area of small-scale mining and equips them with highly developed skills for research and enquiry. Students enrolled in this course will be able to apply the body of knowledge to a range of contexts within the mining industry enabling them to undertake professional or highly skilled work within the mining industry and allow them to undertake further study.

1. Review, analyse, consolidate and synthesizes knowledge to identify and provide solutions to complex small-scale mining problems
2. Assess and evaluate complex ideas in small scale mining and selection of the number required and the size of appropriate equipment
3. Apply specialized technical and creative skills using appropriate tools to solve problems in small scale mining.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				3			3				
CO2		3	2	3		2	2		2	3		3
CO3	2			2	3			3			2	2
CO4		3	2			3	2		3	2	2	
Avg.	2	3	2	2.5	3	2.5	2	3	2.5	2.5	2	2.5

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN514	**Heavy Earth Moving Machinery (HEMM)**	**L**	**T**
		3	**0**

Course objective:
This subject provides knowledge about the various machineries included basically in large surface mining projects, the role of various equipment their working, construction, and productivity in different stages of mining

Syllabus:
Module-1: Classification of surface mining systems vis-à-vis machinery deployment.

Module-2: Functional units of dragline, shovel,and their design aspects, power requirements for the above machinery, various capacities available.

Module-3: Functional units of dozer, Front-End-loader, scraper and their design aspects, power requirements for the above machinery, various capacities available.Dumpers of various capacities, their functional units, operation and maintenance.

Module-4: High capacity conveyors, high angle conveyors, their functional units, various capacities available.

Module-5: Functional units of Bucket Wheel Excavator and Bucket chain excavator, their design aspects, operation and maintenance.Rippers, Continuous Miners, their design aspects, operation and maintenance.

Module-6: Various types of opencast drilling machines, pneumatic and hydraulic rock breakers.

Text/Reference Books:

1. S.K. Das, Surface Mining Operations
2. Misra, G.B., Surface Mining
3. D. Biswas, Modern concepts of Surface Mining
4. N. Banerjee, Opencast Mining
5. AMIE Publication, Surface Mine Blast Evaluation
6. T.N. Singh, Surface Mining Technology
7. B.A. Kennedy, Surface Mining.
8. W. Hustrulid, M. Kuchta and R. Martin, Open pit Mine Planning and Design.
9. Eugeniusz Rusinski, Jerzy Czmochowski, PrzemyslawMoczko, Damian Pietrusiak, Surface Mining Machines: Problems of Maintenance and Modernization.
10. LVA Sendlein, Surface mining: Environmental Monitoring and Reclamation Handbook.

Goals and Outcomes:
This course qualifies participants to apply an advanced body of knowledge in the area of heavyearth moving machines and equips them with highly developed skills for research and enquiry.Students enrolled in this course will be able to apply the body of knowledge to a range of

contexts within the mining industry enabling them to undertake professional or highly skilled work within the mining industry and allow them to undertake further study.

Knowledge:

1. Analyse the operation and heavy earth moving machines used in surface operations
2. Analyse the development of surface mines
3. Analyse application of the heavy earth moving machines used in surface mining and advanced appreciation of the systems engineering involved with interacting machines.

Skills:

1. Review, analyse, consolidate and synthesizes knowledge to identify and providesolutions to complex surface mining problems
2. Assess and evaluate complex ideas in surface mining and selection of the number required and the size of appropriate equipment
3. Apply specialized technical and creative skills using appropriate tools to solve problems in surface mining.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				1			3				
CO2		3	3	2		2	3		2	3	2	3
CO3	3	3		2	3			2			2	2
CO4			2			2	3		3	2	2	
Avg.	2.5	3	2.5	2	2	2	3	2.5	2.5	2.5	2	2.5

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN521	**Metalliferous Mining Methods**	**L**	**T**
		3	**0**

Course objective:
Objective of metal mining course is to give refresher's information of metal mining methods with respect to development and extraction.
Provides methodology for section of metal mining methods, methods of driving underground openings.
To appraise special mining techniques and problems.

Syllabus
Module-1: Introduction to Metal Mining: Peculiarities of Metalliferous deposit. Scope andlimitations of underground mining, Opening up of underground deposits, choice of entry shaft and combination and their applicability, limitations.

Module-2: Mine Developments: Methods of developments, Factors effecting choice of level interval,Cross cuts, Drive, shape and size of drive, winzes, Raises, block size, shaft station, ore bin, ore pass and their position in relation to ore body and general scheme of its development. Division of mining area into working units and level pattern, dimensions of panels and blocks.

Module-3: Stopping: Classification of stopping methods, applicability, limitations, merits and demerits,Factors affecting choice of stopping methods like depth, dip, Width grade / value of deposit, physio mechanical characteristics of the ore and wall rocks. Stope design and production planning in various methods of stopping. Production and cycle time estimates. Stope and development support, mining cycles, shift times, estimating equipment's requirements.

Module-4: Stopping Methods: Stopping without supports: Open stopping, overhand, underhand, breaststopping. Stopping with Supports: shrinkage stopping cut and fill stopping, square set stopping. Caving methods: Top Slicing, sublevel caving and block caving.

Module-5: Special Stopping methods: Sublevel stopping, long-hole stopping, blast hole stopping, raisestopping, V.C.R Stopping, in-situ leaching, bio-mineral engineering, hydraulic mining, blast hole stopping, underground bench blasting, Extraction of remnant pillars, shaft pillars and contiguous reefs, their supporting system and special precautions during extraction.

Module-6: Deep mining: concept of deep mining, special problems of deep mining, salt potash andSulphur mining and their special problems, stopping practices in rock burst prone mines. Under sea mining, novel mining methods, application of tunnel and shaft boring machines and their applications.

Goals and Outcomes:

On completion of the subject, students will be able to:

1. Explain various terminology and development of underground metal mines.
2. Compare between coal and metal mining.
3. Explain various raising methods in stope development.
4. Explain various stopping methods used in metal mines.
5. Describe about face mechanism.
6. Explain about deep mining.
7. Explain design and planning of various stopping methods for effective production.

Suggested Text books:

1. Introductory Mining Engg: Harman, John Wiley and sons;
2. EMT-D. J Deshmukh

Reference Books:

1. Deep Mining-jack Spalding, mining publications;
2. P. Darling:” SME Mining engineers hand book” Vol. I &II
3. U/G Mining Method-Hustrulid, society for mining, metallurgy & Exploration
4. Shevyalov:” Mining and mineral deposits”. MIR Publishers
5. Popov:” Working of mineral deposits”. MIR Publishers

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3	3	2	2	2	2		2	3	2	3
CO3	3	3		2	3			3			2	2
CO4			2			2	2		3	2	2	
Avg.	2.5	3	2.5	2	2.5	2	2	3	2.5	2.5	2	2.5

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Mining Engineering			
MN522	**In -situ Exploitation Methods**	**L**	**T**
		3	**0**

Course Objectives:

This course introduces how to reduce hazards for the employees from accidents, dust, andradiation, low cost of production of valuable minerals, how to minimize large mill tailing deposits. Basic concept of underground coal gasification, deep-seated low-grade mineral deposits, cola bed methane production and how to read the presence of fractures in coal beds.

Syllabus:

Module 1: Introduction:In-situ exploitation methods, types of in-situ exploitation methods, itsscopes, limitations etc.

Module 2: Underground Coal Gasification:Basic concept of underground coal gasification,methods of gasification, layout of gasification method, applications and limitations of U.C.G., Case Study.

Module 3: Solution Mining:In-situ leaching, chemical, bio-chemical and thermal leaching, itsbasic concepts, its applications and limitations, Case Study.

Module 4: Coal Bed Methane Production:Methane generation and storage in coal, geologicalcontrol in Coal Bed Methane (CBM) exploration, methane adsorption & desorption in coal.

Module 5: Coal as CBM Reservoir:In-place methane estimation, transport of methane in coal-bed. Hydraulic fracturing in coal beds, Compression and transport, liquefaction and utilization.

Module 6: Nuclear Device Mining Systems:Scope of application for mining of deep-seated low-grade mineral deposits.

Text/Reference Books:

1) Principle and practices in modern coal mining by R D Singh
2) Coal Gasification: existing processes and new developments by Schilling H D
3) Coal Combustion and gasification by L. Douglas Smoot and Philip J Smith
4) Advanced Reservoir and Production Engineering for Coal Bed Methane by Pramod Thakur
5) Progressive Technologies of Coal, Coalbed Methane, and Ores Mining by Volodymyr Bondarenko, Iryna Kovalevs'ka, KostiantynGanushevych
6) Fundamental of coal bed methane by John Seidle.
7) Mineral Resources: From Exploration to Sustainability Assessment by Manuel Bustillo Revuelta
8) Mining of mineral deposits by GenadiyPivnyak, Volodymyr Bondarenko, Iryna Kovalevs'ka, MykhayloIlliashov
9) Mineral Exploitation, Environmental Sustainability and Sustainable Development in EAC, SADC and ECOWAS Regions by D.K. Twerefou
10) Acid in Situ Leach Uranium Mining: 1 - USA and Australia. Research Report.
11) An Environmental Critique of In Situ Leach Uranium Mining. Research Report, Melbourne, VIC, Australia.
12) Guidebook on environmental impact assessment for in situ leach mining process. IAEA in Austria.
13) Mineralogy and Genesis of the Polymetallic and Poly phased Low Grade Fe-Mn-Cu Ore of JbelRhals Deposit (Eastern High Atlas, Morocco) by Michele Verhaert et al.
14) Introduction to ore-forming processes by Laurence Robb

Course Outcomes:

At the end of the course, students will be able to understand how to minimize the capex and opex of a mine, how to reduce the water consumption, how to reduce the work force for getting more OMS and how to minimize the lead time for mine development ,how to deal with coal bed methane production and gasification and how to mine the low grade deep seated minerals in a economic way.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			2			2	2
CO4			2			2	3		3	2	2	
Avg.	2	3	2	2	3	2	3	2.5	2.5	2.5	2	2.5

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Mining Engineering			
MN523	**Waste Management in Mines**	**L**	**T**
		3	**0**

Course Objectives:

The course is designed to provide a better understanding to support waste minimization through a avoid, reduce, reuse and recycle approach. Provide for continual improvement in waste management practices and processes. Minimize impact to future rehabilitation of the mine site as well as prevention of land and water contamination (both on-site and off-site).

Syllabus :

Module 1. Chemical aspects of environmental pollution by mine wastes and their impact

Module 2. Production and characterization of solid wastes in different types of mines

Module 3. Generation and characterization of mine effluents and leachate

Module 4: Tailings–characterization, technical issues, sampling and analysis, siteselection anddesign of tailing impoundment, tailings dam failure

Module 5: Management of different types of mine wastes**.**

Text/Reference Books:

1. Guidelines for Mine Waste Dump and Stockpile Design by P. Mark Hawley (Editor), John Cunning (Editor)
2. Environmental Management of Solid Waste: Dredged Material and Mine Tailings by Wim Salomons (Editor), Ulrich Forstner (Editor)
3. Mine Wastes: Characterization, Treatment and Environmental Impacts by Bernd Lottermoser (Author)

Course Outcome:

After completion of the course, students will be able to:

1. Understand about the different type of mine waste generated during the entire mining process right from the mineral extracting to the beneficiation process which provides a complete view of the mine waste generated by the different mining methods like surface mining, underground mining etc used in the extraction process of minerals from the earth's crust.
2. Understand about the impacts of this mine waste on the environment and how it is a threat to the human lives.
3. Understand the most efficient methods to deal with this global problem faced by people all over the world as it is the concern of our extinction in this beautiful earth

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CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				3			3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			3			2	2
CO4		2	2			2	2		3	2		
Avg.	2	2.5	2	2	3	2	2.5	3	2.5	2.5	2	2.5

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN524	**Marine Exploration & Mining**	**L**	**T**
		3	**0**

Course objectives:

Apart from land mineral resources, the oceans also contain valuable mineralswealth such as petroleum, natural gas, manganese and other sulphide minerals. Knowledge of mining of shallow and deep-sea mineral resources required good understanding of the nature of continental shelf, slope ad sea floor, ad mining conditions. The mining of minerals from sea, is totally a different technology and required special excavation and extraction equipment. the production of oil and

Modules:

Module-1: Introduction to Marine environment. Characteristics of the ocean floor.Profile of the sea. Shelf, slope and rise Nature of the deposits of environments.

Module-2: Exploration and characterization of inland water. Mineralogical studies of marine sediments and continental slope. Continental shelf and deep-sea bed mineral resources. Exploration systems of dissolved and un dissolved mineral deposits;

Module-3: Off shore exploration of oil and gas and sub-sea systems.

Module-4: Deep sea bed Mining. Wells and algae for extraction of minerals,Economic & Technologies.

Module-5: Environmental impact of ocean mining. Law of the sea, legal considerations in ocean mining.natural gas from off-shore areas need more sophisticated technologies for exploration and oil field development

Course outcome:
The new technologies for the extraction of oil and gas production,developments in marine technologies for the extraction of deep-seated minerals and future.

Suggested Text books:

1. Hartman HL “Introductory Mining Engg” Willey Eastern.
2. Issues of “MARINE MINING” Manjula R. Shyam “Metals from sea bed Prospects of mining poly metallic nodules of India “Oxford& IBH”.
3. Marine mineral exploration, H. Kunzendorf Elsevier
4. Deep-Sea Mining Resource Potential, Technical and Environmental Considerations Editors: Sharma, Rahul

CO-PO Mapping:

Vinoba Bhave University , Hazaribagh

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2			2	2			3				
CO2		3	2	2		2	3		2	3	2	2
CO3	2	2		2	3			3			2	2
CO4			2			2	2		3	2	2	
Avg.	2	2.5	2	2	2.5	2	2.5	3	2.5	2.5	2	2

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN531	**Mineral Process Engineering**	**L**	**T**
		3	**0**

Course Objectives:

This course introduces objectiveof mineral processing, characteristics of minerals and coal, crushing methods, separation methods, methods of concentration, fields of application and limitations. Upon completion of the course, students will possess the knowledge needed to design a mineral processing operation that ensures maximum profitability for a mining company while achieving the required product quality specifications. Students will understand the methodology used to select the appropriate unit operations, determine the optimum operating conditions and select the required size of the unit. A knowledge of product quality assurance programs that includes the monitoring of plant efficiency will be demonstrated.

Modules:

Module 1: Introduction: Scope, objectiveand limitations of mineral processing, liberationand beneficiation.

Module 2: Comminution:Theory and practices of crushing and grinding; different types ofcrushing and grinding equipment's – their applications and limitations.

Module 3: Size Separation:Laboratory size analysis and interpretation; settling of solids influids; industrial screens, mechanical classifiers and hydro cyclones.

Module 4: Gravity Concentration Methods:Jigging, Heavy media separation, flowing filmconcentrators–theory, applications and limitations.

Module 5: Froth Floatation:Physico-chemical principles, reagents, Machines, floatation ofsulphides, oxides and coal.

Module 6: Electrical and magnetic methods of concentrating technique:Magnetic methodsof concentration Principles, Applications and limitations of magnetic concentration, Electric methods of concentration Principles, High tension and low-tension electric concentration, Ore sorters,

Module 7: Dewatering:Thickeners, filters, thermal drying.

Module 8: Flow Sheets:Simplified flow sheets for coal, copper, lead and zinc, gold,uranium,iron, manganese and lime stone ores, Laboratory sampling.

Text/Reference Books:

1. Introduction to Mineral Processing – V. Malleswar Rao, Indian Academy of Geoscience
2. Mineral Processing – Barry A Wills, Elsevier.
3.Mineral Processing – S.K. Jain, CBS Publishers & Distributors
4. Mineral beneficiation a concise basic course by D.V. Subbarao
5. J. W. Leonard and B. C. Hardinge, Coal Preparation, Society for Mining, Metallurgy and Exploration, Inc., Littleton, CO, ISBN 0-87335-104-5, 1991.
6. N. L. Weiss, SME Mineral Processing Handbook, Volumes 1 and 2, Society for Mining, Metallurgy and Exploration, Inc., Littleton, CO, ISBN 0-89520-433-6, 1985.

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Course goals and outcomes:

At the end of the course, students will be able to learn the following points which are given below:

1. Understand Scope, objectiveand limitations of mineral processing and theory of Comminution
2. Understand basic concepts of Size Separation
3. Understand basic concepts Froth Floatation
4. Understand Applications and Limitations of Concentrating techniques
5. Understand various Flow Sheets
6. Develop processing flow sheets for the production of aggregates and mineral concentrates from raw ore material
7. Obtain the knowledge for the typical process circuits used to treat aggregates and ores containing one or more valuable minerals.
8. Conduct mass and water balances throughout the process flow sheet.
9. Predict solid-solid and solid-liquid separation performances based on known physical properties of the raw material and process unit models.
10. Determine the process unit, size and number needed to effectively achieve solid-solid separations and solid liquid separations.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2		2	3		2	3	2	2
CO3	2			2	3			3			2	2
CO4		2	2			2	2	3	3	2	2	
Avg.	2	2.5	2	2	3	2	2.5	3	2.5	2.5	2	2

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN532	**Bulk Material Handling**	**L**	**T**
		3	**0**

Course Objectives:

When the students enter the college to pursue a degree in Mining Engineering and as well pursue a career in Mining Engineering after graduation, they need to understand the breadth and depth available in this field for different bulk material handling system. When many alternative disciplines of engineering appear to offer apparently more glamorous avenues for advancement, the Mining Engineering student should realize the solid foundations available in this mother of all engineering disciplines. The students should understand the enormous possibilities available for creative and innovative works in this all-pervasive field of engineering. This course introduces material handling and transportation concept, Operation and maintenance of different conveying system, Design of transportation system and different storage systems etc.

This course is designed to address the following:

- To give an understanding to the students of the vast breadth and numerous areas of engagement available in the overall field of Mining Engineering
- To motivate the student to pursue a career in one of the many areas of Mining Engineering with deep interest and keenness.
- To expose the students to the various avenues available for doing creative and innovative work in this field by showcasing the many monuments and inspiring projects of public utility.

Modules:

Module 1: Introduction to Bulk Material Handling:Properties of the bulk material vis-à-visdifferent bulk handling operations

Module 2: Classification of Bulk Material transportation System:Road transport system,Rail transport system, pipe line transport system, conveyor transport system.

Module 3: Design, Operation and Maintenance of different types of Conveyor:Beltconveyors. High angle conveyors, Cable belt conveyors, Booster belt conveyors -their selection and application in the mining industry.

Module 4: Design, Operation and Maintenance of slurry transport system:Design andoperation of slurry transport of minerals and mining wastes.

Module 5: Operation and Maintenance of material handling machines:Operation andmaintenance of Stacker, Reclaimer and Spreader

Module 6: Hydraulic and pneumatic conveying system:Hydraulic and pneumaticconveying, stacking and blending, reclaiming of bulk materials.

Module 7: Automation and online monitoring:Automation and online monitoring of bulkmaterial handling system,

Module 8: Storage System:Storage systems: Silos, bins and bunkers. Rapid loading system,Merry-go-round system.

Text/Reference Books:

1. Design and Selection of Bulk Material Handling Equipment and Systems Vol II, Jayanta Bhattacharya
2. Design and Selection of Bulk Material Handling Equipment and Systems: Mining Mineral

Processing Port Plant and Excavation Engineering: Vol. I, Jayanta Bhattacharya
3. Hand Book of Bulk Materials Handling, Fruchtbaum, Jacob
4. Material Handling – Principles and Practices by Allegri (Sr.), T.H CBS Publishers and Distributors, Delhi, 1987.
5. Kennedy, B.A., Surface Mining – 2nd Edition, SME, New York, 1990.
6. Peng, S.S., and Chiang, H.S., Longwall Mining, John Wiley and Sons, New York, 1984.
7. Hartman, H.L., (Ed.), SME Mining Engg. Handbook Vol. I and II,
8. Society for Mining, Metallurgy, and Exploration, Inc., Colorado, 1992.

Course outcomes

1. Introduction to what constitutes Bulk material handling system.
2. Highlighting the depth of engagement possible within each of these areas.
3. Exploration of the various possibilities of a career in this field.
4. Understanding the vast interfaces this field has with the society at large.
5. Providing inspiration for doing creative and innovative work in bulk material handling system.
6. Highlighting possibilities for taking up entrepreneurial activities in this field.
7. Providing a foundation for the student to launch off upon an inspired academic pursuit into this subject of engineering.
8. Know about material handling system, different material handling methods.
9. Student gets knowledge about design, operation and maintenance of different conveying system i.e. hydraulic, pneumatic, slurry transportation system etc.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				3			3				
CO2		3	2	2		2	3		2	3	2	3
CO3	2			2	3			3			2	2
CO4		2	2			2	2		3	2	2	
Avg.	2	2.5	2	2	3	2	2.5	3	2.5	2.5	2	2.5

Vinoba Bhave University , Hazaribagh

Mining Engineering			
MN533	**Clean Coal Technology**	**L**	**T**
		3	**0**

Course objectives:

The course outlines the current changes and developments in the coal combustion-related processes. The course objectifies with the aim of utilizing the energy from coal and its by-products efficiently, such that minimal amount of waste generation and disposal takes place. The course aims at stating the physical and chemical process working under the carbon capture, and sequestrations. Clean coal technology works around the foundation to create minimal impact on the environment.

Modules:

Module 1: Introduction to CCT: Definition and objectives. Classification of CCT's. Carbonsequestration and storage of CO2, coal bed methane recovery and its utilization, underground coal gasification (in-situ and surface gasification),
Module 2: Coal characterization and utilization: Coal production and utilization trends., Lifecycle of coal, Status of coal utilization technology and related operating and environmental problems. coal characterization and qualities and their effect on selection of efficient methods for eco-friendly utilization of coal. classification system of coal, rank and grade of coal.
Module 3: Pre-combustion techniques: Necessity, scope and limitations of pre-combustion coalcleaning technology. Wash ability characteristics and preparation problems related to coal quality. Principles, operations and selection of processes for coal preparation. Plant performance evaluation and forecasting of cleaning results. Environmental problems and related mitigating measures.
Module 4: Combustion techniques: Fluidized bed combustion techniques, integrated gasificationcombined cycle (IGCC) and their co – generation options.
Module 5: Post combustion techniques: Necessity, scope and limitations of combustion andpost-combustion clean coal technologies. Developments, basic principles, operating features of clean coal technologies. Selection, performance and related environmental problems and their control.
Module 6: Waste management and Pollutants: Characterization, impacts, control, treatment andsafe disposal of wastes and pollutants released from various stages of clean coal technologies. Utilization of wastes and pollutants.
Module 7: Industrial lectures: Case studies of coal preparation plant projects by industryprofessionals, covering comprehensive planning to commission the same.
Module 8: Basics of Professionalism: Professional Ethics, Entrepreneurial possibilities in CleanCoal Technology, Possibilities for creative & innovative working in this field to extend a practicable solution to coal industries.

Reference/text books:

1. Clean Coal Technologies for Power Generation by P Jayrama Reddy.
2. Clean Coal Engineering Technology by Bruce Granville Miller.
3. Clean Coal Technology and Sustainable Development from Proceedings of the 8th International Symposium on Coal Combustion. -Yue, Guangxi, Li,Shuiqing, (2016).
4. Clean Coal Engineering Technology: Bruce G Miller, Elsevier Publications.
5. Fuels and Combustion: Samir Sarkar, University Press (India) Pvt Limited, India.
6. The Chemistry and Technology of Coal: James G Speight, Marcel Dekker.

Course outcomes:

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1. After successful completion of the course the learner will be able to:
2. List the new technologies for coal-fired power generation.
3. Identify policy considerations and outline future aspects for coal use.
4. Examine new technologies for clean coal and analyze commercial viability of new technologies.
5. Assess technologies in clean coal to technologies in energy alternatives.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3	2	2		2	3		3	3	2	3
CO3	2			2	3			3			2	1
CO4	2	2	2			2	2		3	2	2	
Avg.	2	2.5	2	2	3	2	2.5	3	3	2.5	2	2

5th Semester Syllabus

Metallurgical Engineering			
ML501	**Material Characterization**	**L**	**T**
		3	**0**

Course objectives -

The Material Characterization course is to prepare students for careers in metallurgy engineering where knowledge of characterization techniques leading to the advancement of research and technology. Knowledge of characteristic features and their identification such as thermal properties, metallography, surface morphology, chemical properties, crystal structure etc. of the materials is must for a metallurgist to select a candidate material for a given engineering application as well as to provide solution of a given metallurgical task. This course will help students in their project work during graduation, to solve different metallurgical problems upon graduation while at the same time, provide a firm foundation for the pursuit of graduate studies in metallurgy engineering.

Course Outcomes: After completing this course the student will be able to:

CO1	Determine crystal structures of materials
CO2	Analyse microstructure of materials at different length scales
CO3	Analyse defects and fracture surfaces of the tested materials
CO4	Indicate instrumentation associated with and operating principles of varioustechniques

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	3	2	-	-	1	-	-	-	-	-	-	-
CO2	3	2	2	1	-	1	1	1	-	-	-	-
CO3	1	3	2	1	2	-	-	-	-	-	-	-
CO4	3	1	1	1	3	-	1	-	1	-	1	1

Course Detail -

Module 1 - Thermal characterization techniques: - Theory, Instrumentation and Application of Thermo gravimetric Analysis (TGA), Differential thermal analysis (DTA), Differential scanning Calorimetry (DSC). (8 hours)

Module 2 - Diffraction method: Principle of X-ray diffraction methods, Brags Law, determination of crystal structure, lattice parameter, crystallite size. (6 hours)

Module 3 - Optical microscopy techniques: Metallurgical Microscopes, Image formation, resolving power, numerical aperture, empty magnification, depth of focus, components of microscopes, important lens defects and their correction. (12 hours)

Module 4 - Electron microscopy: Interaction of electrons with matter, Construction and Working of TEM, SEM with their merits, limitations and applications, modes of operation, Electron beam. (8 hours)

Module 5 - Advance Microscopic technique:- Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy. (6 hours)

Books -

1. Elton N Kaufmann, **Characterization of Materials,** Willey Publishers, 2003.
2. Ruth E. Whan, ***Material Characterization, Metals Handbook***, Vol 10, ASM, 1986.
3. B.D. Cullity, ***Elements of X-ray diffraction***, Pearson Education, 2014.
4. Douglas B. Murphy and Michael Davidson, ***Fundamentals of Light Microscopy and Electronic Imaging***, Wiley-Blackwell, 2012.

Metallurgical Engineering			
ML503	**Degradation of Materials**	**L**	**T**
		3	**0**

Objectives of the course

To familiarize the student with the extent and importance of material degradation. To study various aspects of corrosion and its control.

Course Outcomes

After completing this course, the student will be able to:

CO1	Explain the importance of studying corrosion
CO2	Describe the thermodynamic aspects of corrosion
CO3	Describe the kinetic aspects of corrosion
CO4	Indicate the various forms of corrosion

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	3	-	-	-	-	2	-	-	-	1	-	-
CO2	3	2	1	1	-	-	-	-	-	-	-	2
CO3	2	3	3	1	1	1		3	2	-	-	3
CO4	-	-	-	-	-	3	-	-	-	-	-	-

Detailed Syllabus:

Module 1: Introduction, Definition, Forms of environmental degradation, Classification of corrosion Importance of corrosion studies and cost of corrosion. (4 Hours)

Module 2: Corrosion principles: Electrochemical aspects, Thermodynamic aspects of corrosion – Gibbs energy and electrochemical potential (4 Hours)

Module 3: Metal-Electrolyte Interface, EMF series, Nernst relationship and Pourbaix Diagram (6 Hours)

Module 4. Kinetic aspects of corrosion: Corrosion rate, Current density, Exchange current density, Mixed potential theory, Polarization and Passivation. (6 Hours)

Module 5: Forms of corrosion: Uniform Corrosion, Localized Corrosion; Pitting; Crevice Corrosion, Galvanic Corrosion and Protection; Concentration Cells, Intergranular Corrosion; De-alloying, environmentally assisted failures (SCC, Hydrogen embrittlement; corrosion fatigue), Erosion; Fretting. Experimental methods to identify corrosion susceptibility (9 Hours)

Module 6: Corrosion Measurements and Corrosion Control: Exposure studies, Electrochemical work bench, DC and AC methods of testing, Polarization measurements-Corrosion rate assessment by Tafel's extrapolation method, Linear polarization resistance (LPR). Coatings, Inhibitors, Cathodic and Anodic protection. (9 Hours)

Suggested books

1) Corrosion Engineering, Mars. G. Fontana, McGraw Hill Education, 2017

2) Electrochemical Techniques in Corrosion Science and Engineering. R.G. Kelly, J.R. Scully, D.W. Shoesmith, R.G. Buchheit, CRC Press., 2002

Suggested reference books

1) Corrosion: Metal / Environment Reactions, Volume 1, L.L. Shreir, R.A. Jarman, G.T. Burstein, Butterworth-Heinemann, 1994.

2) Principles and Prevention of Corrosion, Denny A. Jones, Pearson, 1995.

Metallurgical Engineering			
ML505	**Heat Treatment of Metallic Materials**	**L**	**T**
		3	**0**

Course objective: To become familiar with the types, and their designations, the heat treatment, and properties of different types of metals and alloys.

Course Outcomes:

At the end of the course students will be able to:

CO1	understand the fundamentals of, and optimise the heat treatment processes used in the steel industry
CO2	solve process/product problems where heat treatment is involved in the manufacturing steel industry
CO3	design and implement correct heat treatment process

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	3	-	-	-	-	2	-	-	-	1	-	3
CO2	3	2	1	1	-	-	-	-	-	-	-	2
CO3	2	3	3	1	1							3

Detailed Syllabus:

Module1: Objective and variables of heat treatments, Limitation of Fe-Fe3C Phase Diagram, Formation of Austenite, TTT and CCT Diagram, Types of TTT Diagram. Application of TTT Diagrams (Martempering, Austempering and Patenting). (7 hours)

Module2: Annealing (Full, Homogenising, Spheroidisation and Stress-relieving annealing), Normalising, Comparison of Annealing and Normalising, Hardening and Tempering of plain and alloy steels, Hardening (Objective, Austenitizing temperature and Internal stresses), Quenching Mediums and Methods, Retained austenite and Defects in hardening. (9 hours)

Module3: Tempering of steels, Aims and stages of tempering, Effects of Carbon and alloying elements, Tempering of alloy steels and Multiple tempering, Embrittlement during tempering, Hardenability and its determination, Factors affecting hardenability. (7 hours)

Module 4: Case and Surface hardening: Carburising, Nitriding and Carbonitriding, Induction and Laser Hardening. Heat treatments of general engineering steels: Spring, Bearing steels, Tool steels, HSLA steel and Maraging steels, Dual phase steels and Stainless steels (8 hours)

Module 5: Heat Treatments of Al-alloys, Cu-alloys and Ti-alloys. Age-Hardening: Types and sequence of precipitates, Mechanism and kinetics of precipitation. Heat-treatment defects and their rectification. (8 hours)

Essential Reading:

1. B. Zakharov, Heat Treatment of Metals, CBS Publishers.
2. Principles of Heat Treatment of Steels, ASM.

Supplementary Reading:

1. C R Brooks, Principles of the Heat Treatment of Plain Carbon and Low Alloy Steels, ASM International.
2. R Kumar, Physical Metallurgy of Iron and steels, Asia Publishing House.
3. G. Krauss, Steels: Processing, Structure and Performance, ASM International.
4. K E Thelning, Steel and Its Heat Treatment, Butterworth.
5. W C Leslie, The Physical Metallurgy of Steels, MeGraw-Hill International.

Metallurgical Engineering			
ML507	**DEFORMATION THEORY OF METALS**	**L**	**T**
		3	**0**

Objectives of the course

To obtain knowledge of stress response of materials, load bearing ability, elastic and plastic deformation. To obtain insight about different mechanical properties of materials under engineering applications.

Course Outcomes:

After completing this course, students will have:

CO1	Knowledge on the load bearing ability of different materials and their response to stress under engineering applications
CO2	Knowledge of deformation and failure mechanism of materials under different typesof loading and environment

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	3	-	-	-	-	1	-	-	-	2	-	2
CO2	1	2	1	1	-	-	-	-	-	-	-	1

Detailed Syllabus:

Module 1: Elastic Behaviour: Concept of elasticity in three dimensions, Generalised Hook's Law, Plane stress and plane strain state, Strain energy, Stress intensity factor, Concept of finite element method. (8 hours)

Module 2: Theory of Plasticity: Flow curve; Yield criteria, Plastic stress strain relationship. Dislocation Theory: Line defects, Deformation by slip, Theoretical shear strength, Critical resolved shear stress (7 hours)

Module 3: Burger's vector and dislocation loop, Edge, Screw, Mixed and Partial dislocations, Dislocation reactions, Dislocations in ***fcc***and ***bcc*** crystals, Cross slip and climb of dislocations, Interaction of dislocations, Energy of dislocations, Forces on dislocations, Dislocation sources and multiplication of dislocations. (10 hours)

Module 4: Dislocation pile-ups and Bauschinger's effect, Strain hardening in single crystals and polycrystals, Yield point phenomenon, Strain aging, Dynamic strain aging, Strengthening mechanisms. (9 hours)

Module 5: Deformation Twinning: Classification, Slip vs. twinning, Stress for twinning. (6 hours)

Essential Reading:

1. G. E. Dieter, Mechanical Metallurgy, McGraw Hill Publication, 1988.
2. D. Hull and DC Bacon, Introduction to Dislocation, Elsevier Butterworth – Heinemann, Pub., 4th Ed. (2001).

Supplementary Reading:

1. Wole Soboyejo, Mechanical Properties of Engineering Materials, Marcel Dekker Publication, 2003.
2. R. W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, John Wiley & Sons Publication, 1995.
3. R. E. Reed–Hill, Physical Metallurgy Principals, Litton Education Publication, 2004

Metallurgical Engineering			
ML509	**UNIT PROCESS OF EXTRACTION**	**L**	**T**
		3	**0**

Course objective:
To impart the knowledge of ores and minerals, its beneficiation and concentration.

Course Outcomes:

At the end of the course the student will be able to:

CO1	Discuss the principles of fire refining, liquation, distillation refining and zone refining.
CO2	Recognize the importance of Ellingham diagrams and criteria required for reduction of metals.

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	2	-	-	-	-	2	-	-	-	2	-	2
CO2	1	3	1	1	-	-	-	-	-	-	-	1

Detailed Syllabus:

Module 1: Grinding, Sizing of comminuted particles, Drying, Calcination, Roasting, Sintering; Role of Ellingham diagrams in Extraction of metals; (6 hours)

Module 2: Pyrometallurgical Processes: Reduction and smelting using Blast furnace and Electric arc furnace, Flash smelting, Converting, Principles of metallothermic reduction, Refining processes such as Fire refining, Liquation, Zone Refining, Distillation and Vacuum Refining; (8 hours)

Module 3: Hydrometallurgical Processes: Leaching, Various types of Leaching such as Pressure leaching and Bacterial leaching, leaching methods such as In-situ, Heap, and Percolation leaching, Mechanical and Pneumatic vats, Solution purification methods such as Chemical, Ion exchange and Solvent extraction, Cementation; (10 hours)

Module 4:Electrometallurgical Processes: Faraday's laws, Review of properties of aqueous electrolytes, Ionic mobilities, Transport number and Conductivity in electrolytes, Debye-Huckle limiting law. Mean activity coefficient of ions in electrolytes, Electrode potential, Polarization, Gas and Metal over voltage, E. M. F. of cells, Elementary theory of Electro deposition (10 hours)

Module 5: Electro winning and Electro refining; Brief idea of metal extraction processes in the Indian context; Calculations of material and heat balances pertaining to some important metal extraction processes. (6 hours)

Essential Reading:

1. C. Bodsworth, Extraction and Refining of Metals, CRC Press, 1994.
2. A. Ghose and H. S. Ray, Principles of Extractive Metallurgy, Wiley Eastern, 1991.
3. H. S. Ray, R. Sridhar, K. P. Abraham, Extraction of Non-ferrous Metals, Affiliated East-West Press Pvt. Ltd., New Delhi-1985.
4. T. Rosenquist, Principles of Extractive Metallurgy, McGraw hill, 1974.
5. R. D. Pehike, Unit Processes of Extractive Metallurgy, American Elsevier, N. Y., 1968.

Metallurgical Engineering			
ML511	**NON-FERROUS EXTRACTIVE METALLURGY**	**L**	**T**
		3	**0**

Objectives of the course

The various methods will be considered for beneficiation, extraction and refining of nonferrous metals. The course will highlight the energy and environmental aspects of extraction processes. Modern developments in technology will also be discussed.

Course Outcomes:

At the end of the course, the student should be able to:

CO1	Analyse different extraction processes
CO2	Solve numerical problems involving thermodynamic and kinetic concepts of relevance to extractive metallurgy
CO3	Describe the effect of a change in process parameters of different extraction processes

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	2	-	-	-	-	3	-	-	-	2	-	2
CO2	2	2	1	1	-	-	-	2	-	-	-	1
CO3		3				2			2			

Detailed syllabus :

Module 1:COPPER: Principal ore minerals, traditional bath smelting processes viz., Blast furnace, Reverberatory furnace, Electric furnace. Autogenous smelting – Outokumpu flash smelting, INCO flash smelting. Converting. Continuous smelting and converting- Noranda process and Mitsubishi process, other processes. Hydro-metallurgical extraction - principles, leaching processes. Recovery of copper from leach solutions- cementation and electro-winning. Refining - fire refining, electrolytic refining. (8 hours)

Module 2:ZINC: General principles, roasting. Retort processes- horizontal and vertical retort processes. Electro-thermal production. Production in shaft furnace- Imperial Smelting Process. Hydro-metallurgical zinc production - leaching practice, solution purification; Electrolytic production. New developments in zinc production. Refining of crude zinc- liquation and fractional distillation. (8 hours)

Module 3:LEAD: Ore concentration. Smelting- sintering reduction process, reduction in the blast furnace. Roast reaction processes. Direct smelting reduction processes- air flash smelting, oxygen flash smelting, oxygen - slag bath smelting, QSL Process. Refining of lead bullion – pyro-metallurgical and electrolytic refining. (8hours)

Module 4:ALUMINUM: Raw materials, Production of pure alumina- Bayer process; Deville-Pechiney process; Hall-Heroult cell- electrolyte, electrode reactions, current efficiency, cell voltage, anode effect. Refining of aluminum. Alternate processes for the production of aluminum. Simplified flow sheets for the extraction of Nickel, Magnesium, Uranium and Titanium. Non-ferrous metal industry in India. (8 hours)

Module 5:NUCLEAR REACTOR TECHNOLOGY: Brief review of fundamental concepts of nuclear reactor engineering. Fuels for nuclear reactors. Basic components of a reactor, characteristics and requirements. Types of reactors. Nuclear power reactors in India. (8 hours)

References:

1. Extraction of Non-ferrous Metals, Affiliated East- West Press, 2001– H. S. Ray, K. P. Abraham and R. Sridhar .
2. Nuclear Reactor Engineering, CBS Publishers and Distributors, Delhi, 1986 – S. Glasstone and A. Sesonke .
3.Rare Metals Hand book, Robert E. Krieger Publishing Company, 1971 – C.A. Hampel.
4. Hand Book of Extractive Metallurgy, Vols. II and III, Wiley- VCH, 1997– Ed. FathiHabashi

Metallurgical Engineering			
ML513	**PHASE TRANSFORMATION**	**L**	**T**
		3	**0**

Objectives of the course

To introduce the student to key concepts in Phase transformations and enable an understanding of the steps involved in several important phase transformations.

Course Outcomes

After completing this course, the student should be able to:

CO1	Classify phase transformations
CO2	Indicate important steps in different types of phase transformations
CO3	Explain phase transformations from the perspective of thermodynamics and kinetics
CO4	Describe a few well known and studied phase transformations

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	3	-	-	-	-	2	-	-	-	1	-	3
CO2	3	2	1	1	-	-	-	-	3	-	-	2
CO3	2	3	3	1	1		-	-	-	-	2	3
CO4	3	2	2	1	1	3	-	-	-	2	1	1

Detailed Syllabus:

Module 1: Definition and types of Phase transformations. Diffusion: Fick's laws of diffusion, solution of Fick's second law and its applications, atomic model of diffusion and role of crystal defects, temperature dependence of diffusion coefficient. (9 hours)

Module 2: Kirkendall effect. Diffusional transformation in solids and diffusionless transformation in solids. Nucleation and growth - energy considerations; homogeneous nucleation, heterogeneous nucleation, growth kinetics, overall transformation rates.
(10 hours)

Module 3: Crystal interfaces and microstructure. Microstructure evolution including recrystallization and grain growth. Precipitation from solid solution: Homogeneous and hetrogeneous nucleation of precipitates, the aging curve, mechanisms of age hardening, examples from Al-Cu and other alloy systems (9 Hours)

Module 4: Martensitic Transformations: General characteristics of martensitic reactions, similarity to deformation twinning, bain distortion, crystallography and kinetics of martensitic transformations, examples from ferrous and non-ferrous alloy systems. (6 hours)

Module 5: Order-disorder Transformation Examples of ordered structures, long and short range order, detection of super lattices, influence of ordering on properties. **:**Spinodal decomposition (6 hours)

Suggested books

1. Solid State Phase Transformations, V. Raghavan, Prentice Hall India Learning Private Limited, 1987.
2. Phase Transformations in Metals and Alloys, David A. Porter and Kenneth E. Easterling, Third Edition, CRC Press, 2017

Suggested reference books

1. Physical Metallurgy Principles, Reza Abbaschian, Lara Abbaschian, and Robert E. Reed-Hill, Cengage, 2013
2. Mechanisms of Diffusional Phase Transformations in Metals and Alloys, Hubert I. Aaronson, Masato Enomoto, and Jong K. Lee, CRC Press, 2016.

Metallurgical Engineering			
ML515	**PHYSICS OF MATERIALS**	**L**	**T**
		3	**0**

Objectives of the course:
To understand the science behind the properties exhibited by materials. To recognize the size scale from which the property originates and hence the impact of various material constituents on the properties of the materials.

Course Outcomes
After completing this course, the student should be able to:

CO1	Explain the origin of the various properties of materials
CO2	Indicate the phenomena that impact specific properties
CO3	Utilize reciprocal space
CO4	Explain the similarities and differences between classical particles, Fermions, and Bosons

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	2	-	-	-	-	2	-	-	-	1	-	2

CO2	1	2	-	1	-	-	-	-	2	-	-	2
CO3	2	3	2	-	1		-	-	-	-	2	-
CO4	3	2	2	1	1	2	-	-	-	2	1	1

Detailed Syllabus:

Module 1: Overview of properties of materials (2 Hours)
Module 2: Thermal expansion (1 Hour)
Module 3: Electrical Conductivity, Measuring electrical conductivity (1 Hour)
Module 4: Free electron gas, ideal gas (2 Hours)
Module 5: Free electron theory of metals, Wiedemann-Franz law, Drude model, Successes and Limitations of Drude model, Source of limitations of Drude model (4 Hours)
Module 6: Large systems and Statistical Mechanics, Maxwell Boltzmann statistics (2 Hours)
Module 7: Classical Particles, Quantum particles, History of quantum mechanics, Drude-Sommerfeld model (4 Hours)
Module 8: Fermi-Dirac Statistics, Features of Fermi-Dirac Distributions, comparison with Maxwell-Boltzmann statistics (4 Hours)
Module 9: Anisotropy and Periodic potential, Confinement and Quantization, Density of states (4 Hours)
Module 10: Fermi Energy, Fermi Surface, Fermi Temperature, Electronic contribution to Specific Heat at Constant Volume (2 Hours)
Module 11: Reciprocal space (3 Hours)
Module 12: Wigner Seitz Cells, Brillouin Zones, Allowed Energy Levels, and the Origin of Bands (3 Hours)
Module 13: Calculating allowed and forbidden energy levels, Free electron approximation, tight binding approximation (2 Hours)
Module 14: Electron compounds, Semiconductors, Optoelectronic properties, magnetic properties, phonons (3 Hours)
Module 15: Superconductivity, Bose-Einstein statistics, Meissner effect, BCS theory, Physics of nanoscale materials. (3 Hours)

Suggested books
1. Physics of Materials, Essential concepts of Solid State Physics. PrathapHaridoss, Wiley 2015.

Suggested reference books
1.Solid State Physics, Ashcroft and Mermin, Cengage 2003

Metallurgical Engineering			
ML517	**CASTING AND SOLIDIFICATION OF MATERIALS**	**L**	**T**
		3	**0**

Course objective: This course is mainly intended to introduce and explain various moulding-casting techniques and equipment used. Principle of solidification and defects in castings and their remedies are also dealt in details.

Course outcomes:

At the end of the course students will be able to:

CO1	describe how heat flow in simple geometries influences the solidification process.
CO2	understand for nucleation and growth of crystals rom the melt, both for planar, cellular and dendrittic growth front
CO3	understanding of polyphase reactions during solidification - eutectic and peritectic solidification.
CO4	describe how flow of heat and mass influence the microstructure and casting defects

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	2	-	-	-	-	3	-	-	-	1	-	2

CO2	1	2	-	1	-	-	-	-	1	-	-	2
CO3	2	-	3	-	1		-	-	-	-	2	-
CO4	3	2	2	1	1	2	-	-	-	2	1	1

Detailed Syllabus:

Module1: Introduction**:** Casting as a process of Manufacturing. Moulding Processes, Equipments and Mechanization**:** Different types of Moulds, Moulding Materials and Moulding processes, Pattern and other mould making equipments, forces acting on moulds, Mould factors in metal flow, Moulding factors in casting design.

Module 2: Different types of binders and their uses in mould and core-makings. Melting of Metals and Alloys for casting: Brief mention of various melting units, melting and post melting treatments, melting practices as adopted for a few metals and alloys such as CI, Al, Cu, steels, cast irons.

Module 3: Solidification of Metals and Alloys: Nucleation, Growth, Role of alloy constitution, Thermal conditions and inherent nucleation and growth conditions in the liquid melt, Significance and practical control of cast structure.

Module 4: Principles of Gating and Risering: Feeding characteristics of alloys, Types of Gates and Risers, Time of solidification and Chowrinov rule, Wlodawer system for feeder head calculations, gating ratio, concept of directionality in solidification, Yield of casting and prescription for its augmentation.

Module 5: Special casting Methods: Investment casting, Die casting,
Centrifugal casting, Full mould casting, Vacuum sealed casting. Casting Defects: A detailed analysis of casting defects. Their causes and prescription of remedial measures.

Essential Reading:

1. P. R. Beeley, Foundry Technology, Newnes-Buttterworths, 2001.
2. P. D. Webster, Fundamentals of Foundry Technology, Portwillis press, Red hill, 1980.

Supplementary Reading:

1. P. C. Mukherjee, Fundamentals of Metal casting Technology, Oxford IBH, 1980.
2. R. W. Hein, C. R. Loper and P. C. Rosenthal, Principles of Metal casting, Mc Graw Hill, 1976.

Metallurgical Engineering			
ML519	**MECHANICAL WORKING OF MATERIALS**	**L**	**T**
		3	**0**

Course objective:

Objective of metal working processes are to provide the desired shape and size, under the action of externally applied forces in metals.

Course outcomes:

At the end of the course students will be able to:

CO1	Understand the stress-strain relationship.
CO2	Describe deformation behaviour, yield criteria and metal working.
CO3	Differentiate metal forming processes of forging, rolling, extrusion, and drawing.

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	2	-	-	-	-	2	-	-	-	1	-	3
CO2	1	2	-	1	-	-	-	-	1	-	-	1

CO3	-	-	2	-	2	-	-	-	-	1	-	-

Detailed syllabus :

Module 1: Forming processes, effect of metallurgical structure & strain-rate, cold working, recovery, recrystalisation and grain growth, hot working, Stress, Strain fields, strain energy & line tension of a dislocation, Forces on and between dislocations, Dislocation reactions in FCC, BCC and HCP crystals. (8 hours)

Module 2: Dislocation intersections, Origin, multiplication and observation of dislocations, plasticity of single crystal of FCC, BCC and HCP structures, Twinning, deformation mechanisms of poly-crystalline metals, effect of grain boundary, solute atoms and second phase particles. (9 hours)

Module 3: Yield point phenomena and strain ageing, Forging processes, forging equipment, Forging in plane strain, Open and closed die forging, Forging defects, Rolling processes, Rolling mills. (7 hours)

Module 4: Rolling of bars and shapes, Forces and geometrical relationships in rolling, Simplified analysis of rolling load, rolling variables, problems and defects in rolled products, Theories of cold and hot rolling, torque and horsepower. (8 hours)

Module 5: Extrusion processes, extrusion equipment, Deformation and defects in extrusion, analysis of the extrusion process, Extrusion of tubing and production of seamless pipes and tubes, Rod, wire and tube drawing, Deep drawing and redrawing, Common defects in sheet metal formed products. (8 hours)

References:

1. G. E. Dieter: Mechanical Metallurgy, McGraw Hill Book Company, 1988.
2. C. J. Richardson, et.al: Worked Examples in Metal Working, Institute of Metals, London, 1985.
3. ASM Hand Book, Vol. 14: Forming and Forging, ASM, 1988.

Metallurgical Engineering			
ML521	**ALTERNATE ROUTE FOR IRON PRODUCTION**	**L**	**T**
		3	**0**

Course objective:

To impart the knowledge of production of iron by the processes other than blast furnace.

Course outcomes:

After completing this course, the student should be able to:

CO1	Enumerate modern trends in iron making
CO2	Explain brief principles of alternative methods and their advantages and limitations

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	2	-	-	-	-	2	-	-	-	1	-	3
CO2	1	2	-	1	-	-	-	-	1	-	-	1

Detailed syllabus :

Module 1:Blast furnace Iron making, Alternate routes of Iron making, Kinetics of Iron Oxides Reduction, Coal based DR processes, Gas based DR processes using Retorts, Fluidized bed shaft furnaces (12 hours)

Module 2: Futureout look of DR processes, Smelting Reduction processes, classification, Corex, Kawasaki smelting, INRED, ELRED, Plasma smelt etc., processes.(11hours)

References:

1. Amit chatterjee, Beyond Blast furnaces, CRC Press, 1994.
2. FathiHabashi, Hand Book of Extractive Metallurgy, Vols. I, Wiley- VCH, 1997.

Metallurgical Engineering			
ML523	**ELECRONIC, OPTICAL AND MAGNETIC MATERIALS**	**L**	**T**
		3	**0**

Course Objective:

The primary aim of this course is to introduce students to the fundamentals underpinning electronic properties of materials. This spans everything from the basics of electron behavior in solids to the design of magnet and optoelectronic devices.

Course Outcomes:

CO1	describe how electrons interact with each other, electromagnetic radiation and the crystal lattice to give the material its inherent electrical, optical and magnetic properties.

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	2	-	-	-	-	2	-	-	-	1	-	3

Detailed Syllabus:

Module 1:Review of free electron and band theories of solids, Electrical conduction in metals and semiconductors, Hall effect, Temperature dependence of electrical conductivity.(6 hours)

Module 2: Thermoelectric properties of metals and semicondutors, Semicondutors, Direct and indirect band gap semiconductors, Electron transport in amorphous solids, Principles of semiconductor devices. Ionic conductivity, Super conductivity, Piezo- electricity and Ferro-electricity. (10 hours)

Module 3:Optical Properties: Introduction, Refraction, Absorption, Absorption in Dielectrics, Photographic images, Luminescence, Lasers. (6 hours)

Module 4: Magnetic Properties: Introduction, Dia, Para and Ferromagnetism, Weiss Field and Magnetic Domains, Anti ferromagnetism and Ferri magnetism. Ferromagnetic anisotropy and magnetostriction. (10 hours)

Module 5: Magnetic energy and Domain structure, Hysteresis loop. Soft and Hard magnetic Materials. (6 hours)

Reference Books:

1. Hummel, R.E., Electronic properties of Materials, Springer
2. Raghavan, V., Materials Science and Engineering, Prentice Hall
3. Azaroff, L.I, Magnetic Materials;
4. Lovell, M.C., Avery, A.J, and Vernon, M.W, Physical properties of materials.

Metallurgical Engineering			
ML525	**POWDER METALLURGY**	**L**	**T**
		3	**0**

Objectives of the course:
This course introduces the particulate technology to create components from powder route.

Course Outcomes:
At the end of this course, the student will be able to:

CO1	List different stages of manufacturing using the powder metallurgy route
CO2	Describe characteristics of a P/M component
CO3	Describe the consolidation process during P/M route and identify the defects that arise
CO4	Analyze the material and design needs of a P/M component

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2

CO1	1	-	-	-	-	2	-	-	-	1	-	2
CO2	3	2	-	1	-	-	-	-	1	-	-	2
CO3	2	-	1	-	1		-	-	-	-	2	-
CO4	3	2	2	1	1	2	-	-	-	2	1	1

Detailed Syllabus:

Module 1: Powder production: Mechanical, Chemical and Electrochemical methods, Atomization and other emerging processes, High energy ball milling, mechanical alloying and applications, self-propagating high temperature synthesis. Performance Evaluation of different Processes, Design and Selection of Process. (10 hours)

Module 2: Powder characterization: Particle Size, Shape, Distribution and morphology, Tap density, green density, Inter-particle Friction, flowability and surface Area, Particle porosity. Compressibility. (6 hours)

Module 3:Blending and mixing of powders-equipment, Lubricants & Binders, Particle Packing Modifications. Powder compaction: Powder Compaction: die compaction, process variables, density distribution during compaction, Isostatic Pressing, Cold and hot isostatic pressing, Injection Molding, Powder Extrusion, Slip Casting, Tape Casting. (10 hours)

Module 4: Sintering: Theory of Sintering, Sintering mechanisms, Sintering Variables, Sintering furnaces and atmospheres, Pressure less sintering, Liquid Phase Sintering, and Sintering of Single & Mixed Phase Powders. Modern Sintering Techniques: spark plasma sintering, microwave sintering. (8 hours)

Module 5: Defects in P/M route and their control, treatment of powder metallurgy Components. Testing and quality control, metallic and ceramic P/M components, application of P/M products. Applications of Powder Metallurgy: Filters, Tungsten Filaments, Self-Lubricating Bearings, Porous Materials, ODS Alloys, Biomaterials and Case Studies.

(6 hours)

Suggested books

1. Powder metallurgy: science, technology and materials – Anish Upadhyaya, G.S. Upadhyaya, Universities Press (2011)

2. Power metallurgy: science, technology and materials – P.C. Angelo, R. Subramanian, Prentice Hall India Learning Pvt. Ltd., (2008)

Metallurgical Engineering			
ML527	**NUCLEAR MATERIALS**	**L**	**T**
		3	**0**

Course Objectives:
The course will assume students have at least a basic understanding of a reactor system. The aim is then to develop an appreciation of materials issues associated with nuclear reactor technology and how this information is used when designing reactor systems. A mechanistic description of materials selection for intense radiation fields and the associated degradation mechanisms will be covered for different classes of material with a focus on the specific advantages and disadvantages. The course will then cover specific cases where materials issues have been crucial to systems performance and a variety of degradation and failure mechanisms as well as the radiation damage processes that brought about these failures.

Course Outcomes:

After completion of the course the students will able to:

CO1	Analyze radiation types, radioactive decay and dose units.
CO2	Discuss the mechanisms of radiation damage of nuclear materials, the units used to measure damage and the models behind them.
CO3	Use the Kinchin-Pease Model to predict damage accumulation and its part in general chemical rate theory of radiation damage
CO4	Analyze the types of fuel and components for the Nuclear Fuel Assembly.

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	1	-	-	-	-	-	-	-	-	1	-	3
CO2	3	3	-	-	-	-	-	-	1	-	-	2
CO3	2	-	1	-	1	-	-	-	-	-	2	-
CO4	2	2	2	1	1	2	-	-	-	2	1	1

Detailed syllabus:

Module 1: Nuclear radiation, microscopic flux and microscopic cross-section, attenuation of radiation fission, elastic collision slowing down infinite multiplication constant (8 hours)

Module 2: Fuel and breeder materials manufacture and properties, Structural materials, Radiation damage in fuel elements, Structural coolant and control rod materials (8 hours)

Module 3: Nuclear power, present and future states. (2 hours)

Reading:

1. Bodansky, Nuclear Energy: Principles, Practices and Projects, Springer, 2004.
2. C.A. Hampel, Rare Metals Handbook, Robert E. Krieger Publishing Company, 1971.
3. S. Glasstone and A. Sesonke, Nuclear Reactor Engineering, CBS Publishers and Distributors, Delhi, 2003.

Metallurgical Engineering			
ML529	**CERAMIC AND POLYMER MATERIALS**	**L**	**T**
		3	**0**

Course objective:

Develop an awareness of careers related to various areas in ceramics. Also to provide the basic building blocks of polymer science by imparting fundamental knowledge of molecular weight, polymerization mechanism, polymer reactions and environmental awareness & polymer science.

Course outcomes:

At the end of the course students will be able to:

CO1	understand the properties and applications of ceramics materials
CO2	analyse the basic knowledge of processing of ceramic and glassy materials and their comparison with other materials.
CO3	understand the relationships between polymer molecular weight, molecular weight distribution, and the properties of polymeric materials
CO4	demonstrate an ability to distinguish different polymerization reactions and their mechanisms/kinetics.

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	-	-	-	-	-	-	-	-	-	1	-	3
CO2	2	3	-	-	-	-	-	-	2	-	-	2
CO3	2	-	1	-	2	-	-	-	-	-	1	-
CO4	2	2	-	1	1	2	-	-	-	2	1	1

Detailed Syllabus:

Module 1: Introduction of ceramics, Common ceramics crystal structures: silicates, clay, minerals, graphite and carbides.Classification and applications of ceramics materials. Raw materials preparation, Different structural ceramics: their properties and applications.

Module 2: Mechanical behaviour of different structural ceramics-brittleness of ceramics, Conceptof fracture toughness and different toughness measurement techniques, Elastic modulus, Strength measurement,Weibull theory.

Module 3: Basic concepts in polymer science, various polymerization mechanisms, polymerization techniques and molecular weight. Free radical polymerization: initiators, chain transfer, inhibition and retardation; Cationic and anionic polymerization: initiators; Kinetics of free radical, cationic and anionic polymerization reactions, an overview of solid phase and gas phase polymerization.

Module 4: Polycondensation, polyaddition and ring-opening polymerization, need for stoichiometric control, gelation, crosslinking, Carother‟s equation, kinetics of step polymerization, an overview of interfacial and melt polymerization technique.

Module 5: Step copolymerization: introduction, types, methods of synthesis; Chain copolymerization: introduction, types, copolymerization equation, monomer reactivity ratio, applicability of copolymerization equation, types of copolymerization behavior, sequence length distribution, Q-e scheme; Commercial applications of copolymerization.

Essential Reading:

1. W. D. Kingery, H. K. Bowen, D. R. Uhlmann, ***Introduction to Ceramics,*** Wiley Publishers, 1986.

2. Randall German, John Wiley & Sons, ***Powder Metallurgy,*** 2006.

Supplementary Reading:

1. M. N. Rahaman, Marcel Dekker, ***Ceramic processing & Sintering***, 1995.

Metallurgical Engineering			
ML531	**POLLUTION IN METALLURGICAL INDUSTRIE AND ITS CONTROL**	**L**	**T**
		3	**0**

Course objective:

Pollution control of the ecosystem and to impart knowledge to maintain the measures needed for pollution made by integrated steel plants.

Course outcomes:

After completion of the course students will be able to:

CO1	Analyse the cause of pollution due to steel industries
CO2	Create the rules and regulation to have minimum or zero pollution

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	-	-	-	-	-	-	-	-	-	1	-	3
CO2	1	-	-	-	-	-	2	-	-	-	-	2

Detailed Syllabus:

Module 1: Review of various types of pollutions; air pollution, water pollution, solid waste pollution and noise pollution; Environmental impact assessment in metallurgical industries; Emissions from integrated iron and steel plants and suggestion of equipments for their control.

Module 2: Environmental aspects of sponge iron plants and their effective control; Pollutant emissions from other alternative iron and steelmaking processes and their control. Management of wastes from iron and steelmaking operations

Module 3: Environmental pollutant emissions from Al, Zn Cu and lead industries; Preventive measures to reduce the atmospheric pollutions from these non-ferrous industries. Environmental legislations related to metallurgical industries.

Essential Reading:

1. C. S. Rao, Environmental Pollution Control Engineering, Willey Eastern Ltd., 1991.
2. G. N. Pandey & G. C. Carney, Environmental Engineering, Tata McGraw Hill Publishing Company, 1989.

Supplementary Reading:

1. Proceedings of International Conference on Environmental Management in Metallurgical Industries EMMI-2000, Allied
Publisher, Calcutta.
2. Proceeds of International Workshop on Environmental and Waste Management in Iron and Steel Industries, Dec 2 – 3, 1999,
NML Jamshedpur.

Metallurgical Engineering			
ML533	**MATERIALS TECHNOLOGY**	**L**	**T**
		3	**0**

Course objective:

Use the fundamental science and engineering principles relevant to materials that include the relationships between nano/microstructure, characterization, properties, processing, performance and design of materials.Use their knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.Use the technical and communication skills developed in the program as a foundation for careers in engineering, research and development, the pursuit of advanced education and other professional careers.Use lifelong learning skills to develop knowledge and skills, to pursue new areas of expertise and careers, and to take advantage of professional development opportunities.Become leaders in their fields who will contribute to bettering society**.**

Course outcomes:

At the end of the course student will:

CO1	apply general math, science and engineering skills to the solution of engineering problems.
CO2	apply core concepts in Materials Science to solve engineering problems.
CO3	knowledgeable of contemporary issues relevant to Materials Science and Engineering.
CO4	select materials for design and construction

Mapping of course outcomes with program outcomes:

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO1	2	-	-	-	-	-	-	-	-	1	-	1
CO2	2	2	-	-	-	-	-	-	2	-	-	2
CO3	-	-	1	-	-	-	-	-	-	-	2	-
CO4	2	2	2	1	1	2	-	-	-	2	1	-

Detailed syllabus:

Module 1: Metallic Materials: Concept of phase diagram crystallography and microstructure, Steels, Different types of Steel, Iron-Iron Carbide phase diagram, TTT and CCT diagrams. Heat-Treatment of steels: Annealing, Normalizing, Hardening and Tempering of steels, Plain carbon steels and their applications. Alloy steels: High speed steels, stainless steels, HSLA. (8 hours)

Module 2: Non Ferrous alloys: Al alloys, Cu alloys, applications of these alloys, Magnesium alloys, Titanium alloys and Zirconium alloys. (4 hours)

Module 3: Electrical and Magnetic properties of materials: Band Structure, Conductors, Insulators, semiconductors, superconductors, p-n junction and application of these properties. (4 hours)

Module 4: Engineering polymers and composites: Thermoplastics, Thermosetting polymers, processing of composites, Hybrid composites. Ceramics: Different ceramics available, Properties of ceramics, Crystal structure, Overview of Ceramic Applications, Processing of ceramics, Densification and sintering, Mechanical properties and characterization. Mechanical Characterization: Tension test, Fatigue test, Creep test, Hardness, Impact Tests, Fracture of materials, Modes of fracture. (12 hours)

Module 5: Non Destructive Testing: Ultrasonic Radiography, X-ray diffraction, Crystal Structure, Bragg's law, Liquid penetrant testing, Ultrasonic testing, Electromagnetic testing, Acoustic emission testing, Magnetic resonance imaging and NMR spectroscopy. (10 hours)

Essential Reading:

1. Van Vlack L H, Elements of Material Science and Engineering, ISBN: 8131706001 ISBN-13: 9788131706008, Addison Wesley,
6th edition, 1967.

2. W. F. Smith, Principles of Materials Science and Engineering (McGraw Hill Series in Materials Science and Engineering),
McGraw-Hill College; 3rd edition (1995) ISBN-10: 0070592411. ISBN-13: 978-0070592414
3. William D. Jr. Callister, Wiley, Materials Science and Engineering: An Introduction, 7th edition (2006) ISBN-10: 0471736961.
Supplementary Reading:
1. Vernon John, Introduction to Engineering Materials, ISBN-10: 0333124650 ISBN-13: 9780333124659, Macmillan, 1972-06
2. James P. Schaffer, Ashok Saxena, Thomas H. Sanders, Jr. Stephen D. Antolovich, Steven B. Warner, McGraw, Science and Design
of Engineering Materials, -Hill Publishing Co.; 2nd edition (2000) ISBN-10: 0071131485 ISBN-13: 978-0071131483

Computer Science & Engineering and Information Technology					
Code: CS501	**Operating System**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

Course Outcome:

1. Apply optimization techniques for the improvement of system performance.
2. Ability to design and solve synchronization problems.
3. Learn about minimization of turnaround time, waiting time and response time and also maximization of throughput by keeping CPU as busy as possible.
4. Ability to change access controls to protect files.
5. Ability to compare the different operating systems.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CS5103.1	2	2	2	2	-	-	-	-	1	-	3	1
CS5103.2	2	-	3	-	-	-	-	-	2	-	1	2
CS5103.3	1	2	3	2	2	-	-	-	3	-	1	2
CS5103.4	-	-	-	-	-	-	-	-	1	-	1	-
CS5103.5	-	1	-	-	2	-	-	-	-	-	1	-
Average	1	1	1.4	0.8	0.8	0	0	0	1.4	0	1.4	1

MODULE 1: FUNDAMENTALS

Overview: Role and purpose of operating systems; history of operating system development; functionality of a typical operating system; design issues (efficiency, robustness, flexibility, portability, security, compatibility).
Basic principles: Structuring methods; abstractions, processes, and resources; design of application programming interfaces (APIs); device organization; interrupts; user/system state transitions.

MODULE 2: PROCESS MANAGEMENT

Scheduling: Preemptive and non- preemptive scheduling; scheduling policies; processes and threads; real –time issues;
Concurrency: The idea of concurrent execution; states and state diagrams; implementation structures (ready lists, process control blocks, and so forth); dispatching and context switching; interrupt handling in a concurrent environment;
Mutual exclusion: Definition of the “mutual exclusion” problem; deadlock detection and prevention; solution strategies; models and mechanisms (semaphores, monitors, condition variables, rendezvous); producer-consumer problems; synchronization; multiprocessor issues

MODULE 3: MEMORY MANAGEMENT

Review of physical memory and memory management hardware; overlays, swapping, and partitions; paging and segmentation; page placement and replacement policies; working sets and thrashing;

caching.

MODULE 4: SECONDARY STORAGE MANAGEMENT

Device management: Characteristics of serial and parallel devices; abstracting device differences; buffering strategies; direct memory access; recovery from failures.
File systems: Fundamental concepts (data, metadata, operations, organization, buffering, sequential vs non-sequential files); content and structure of directories; file system techniques (partitioning, mounting and un-mounting, virtual file systems); memory-mapped files; special-purpose file systems; naming, searching, and access; backup strategies.

MODULE 5 SECURITY AND PROTECTION

Overview of system security; policy/mechanism separation; security methods and devices; protection, access, and authentication; models of protection; memory protection; encryption; recovery management.

Text / Reference Books

1. Silberschatz, P.B. Galvin & G. Gagne, Operating .system concepts, John Wiley,9th Edition,2012
2. W. Stallings, Operating systems, Prentice-Hall, 2012

Computer Science & Engineering and Information Technology					
Code: CS502	**Database Management System**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

1. Realize the difference between file system and database system and appreciate the features of the database management system.
2. Must be able to model application requirements using the tools like ER modelling and database schemas.
3. Should be familiar with the basic operations of SQL and their constraints and their utility at the application level.
4. Must be aware of the normalization techniques and their applications for database design.
5. Should have an idea about the issues involved during processing of transactions, their solutions and data preservation.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO.1	3	-	-	-	2	-	-	-	-	-	-	2
CO.2	-	2	2	1	-	2	2	-	-	-	1	-
CO.3	-	1	-	-	3	-	-	-	-	-	1	-
CO.4	-	1	2	1	-	-	-	-	-	-	-	-
CO.5	2	2	3	-	-	-	2	-	-	-	-	-

MODULE 1: INTRODUCTION

File & Data Base Concept, Overview of DBMS, Data Models, Schema and Instances, Data Independence

MODULE 2: ENTITY-RELATIONSHIP MODEL

Basic concepts, Keys, Entity-Relationship Diagram, Cardinality ratios, Strong & Weak Entity Sets, Specialization, Generalization, Aggregation.

Relational Model

Procedural & Non Procedural Languages, Relational Algebra, Extended Relational Algebra Operations, Views, Modifications Of the Database, Relational Calculus.

MODULE 3: SQL

Basic Concepts, Set operations, Aggregate Functions, Null Values, assertions, views, Nested Sub-queries, Cursors, Stored procedures and triggers.

Integrity Constraints & Introduction to RDBMS

Domain Constraints, Referential Integrity Constraints, Codd's rule.

MODULE 4: FUNCTIONAL DEPENDENCIES AND NORMALIZATION

Functional Dependency, Armstrong's axioms, Canonical Cover, Closure, Full and Partial Functional dependencies, Prime & Non Prime attribute, 1NF, 2NF, 3NF, BCNF, Multi valued Dependency , 4NF, 5NF, DKNF.

MODULE 5: TRANSACTION & CONCURRENCY CONTROL

Transaction concept, ACID properties, Conflict & View serializabilty, Test for Conflict serializability, Concurrency Control, Lock base protocols, Two phase locking.

MODULE 6: STORAGE STRATEGIES

Single-Level Index (primary, secondary, clustering), Multi-level Indexes, Dynamic Multi-level Indexes, Hashing Techniques, B tree and B+ tree.

Query Optimization

Full Table scan, Indexed-based scan, Merge join, Nested loop join, Equivalence rules , Heuristic Optimization , Cost Based Optimization.

MODULE 7: BACKUP & RECOVERY

Physical & Logical Backup, Transaction logs, Causes of failures, Recovery techniques.

Distributed Databases

Basic Concepts, Data Fragmentation, Replication and Allocation Techniques, Types of Distributed Database Systems, Query Processing, Overview of Client-Server Architecture and Its relationship to Distributed Databases.

TEXT BOOKS:

1. Data base System Concepts, Silberschatz, Korth, McGraw Hill

2. Fundamentals of Database Systems, Elmasri Navathe Pearson Education

REFERENCES:

1. Data base Systems design, Implementation, and Management, Peter Rob & Carlos Coronel 7th Edition.

2. Introduction to Database Systems, C.J. Date Pearson Education

<table>
<tr><td colspan="5">Computer Science & Engineering and Information Technology</td></tr>
<tr><td>Code: CSE511</td><td>Compiler Design</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2"></td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

COURSE OUTCOMES

1. *Identify* the issue that arises in the design and construction of translator for programming language.
2. *Analyze* RE and CFG to specify the lexical and syntactic structure of programming language.
3. *Design* different parsers from given specification.
4. *Assess* the various program transformations.
5. *Design* a compiler for a programming language.

MODULE 1: INTRODUCTION TO COMPILER

Compilers, Analysis of source programs, Tokens, patterns, lexemes, Phases of compilers, Parsing, Parse trees, Ambiguity, Associativity and precedence of operators, Top-down parsing, Bottom-up parsing, Left recursion, Syntax directed translation.

MODULE 2: FINITE AUTOMATA

Classification of grammars, NFA, DFA, Conversion of NFA to DFA, RE to NFA (Thompson's Construction), Optimization of NFA/DFA using FIRSTPOS, LASTPOS, FOLLOWPOS.

MODULE 3: CONTEXT FREE GRAMMAR

RE vs. CFG, Eliminating ambiguity and left recursion, Left factoring.

MODULE 4: COMPILER PARSER

Top down parsing-LL parser, LL grammars. Bottom up parsing- LR parser, SLR parser, CLR parser, LALR parser. Polishing expressions Operator precedence grammar. LR grammars. Comparison of parsing methods. Error handling.

MODULE 5: RUN TIME ENVIRONMENTS

Symbol tables, Language facilities for dynamic storage allocation, Dynamic storage allocation technique, Organization for non-block and block structured languages.

MODULE 6: INTERMEDIATE CODE GENERATION

Intermediate languages, graphical representations, Synthesized and inherited attributes, Dependency graph, Syntax directed translation, S and L- attributed definitions, Polish notation, Three address, quadruples, triples, indirect triples Flow of control statement.

MODULE 7: CODE OPTIMIZATION AND CODE GENERATION

Basic blocks and flow graphs, Optimization of basic blocks, Code optimization techniques, Issues in design of code generator, Target machine code and simple code generator.

TEXT BOOKS

- Alfred V. Aho, Ravi Sethi, Jeffrey D. Ullman, Monica S. Lam, *Compilers: Principles, Techniques, and Tools*. Addison-Wesley, 2006 (optional).
- Thomas W. Parsons, *Introduction to Compiler Construction*. Computer Science Press,**1992.**

REFERENCE BOOKS

- Compiler design in C, A.C. Holub, PHI.
- Compiler construction (Theory and Practice), A.Barret William and R.M. Bates, Galgotia Publication.
- Compiler Design, Kakde.

Computer Science & Engineering and Information Technology					
Code: IT511	**Internetworking**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

CO 1: Students will be able to classify the routing protocols and analyse how to assign the IP addresses for the given network.
CO 2: Students will be able to understand the architecture of different internet servers.
CO 3: Students will be able to configure the firewall in the network.

MODULE 1:- AN OVERVIEW ON INTERNET

The need for an Internet, The TCP/IP Internet, Internet services, Internet protocols and standardization, Review of Network technologies.

MODULE 2: - INTERNETWORKING CONCEPTS

Architectural model introduction, Application level interconnection, Network level interconnection, Properties of the Internet, Internet Architecture, Interconnection through IP Gateways or routers, Internet and Intranet.

MODULE 3: - INTERNET ADDRESS

Introduction, Universal identifiers, Three primary classes of IP addresses, Classless IP address, Network and Broadcast addresses, Mapping internet addresses to physical addresses (ARP), ARP protocol format, Transport Gateways and subnet addressing, Multicast addressing.

MODULE 4: - INTERNET PROTOCOL

Internet Architecture and Philosophy, The concept of unreliable delivery, Connectionless delivery system, The Internet Datagram, Routing direct and indirect delivery, Table driven IP routing, Protocol layering, Reliable stream transport, TCP performance, Bootstrap protocol (BOOTP).

MODULE 5: - ROUTING

The origin of Gateway routing tables, Original Internet Architecture and Cores, Core Gateways, Automatic route propagation, Vector distance (Bellman-Ford), routing, Gateway to Gateway Protocol (GGP), Autonomous system concept, Exterior Gateway Protocol (EGP), Interior Gateway Protocol (RIP, OSPF, HELLO), Routing Information Protocol (RIP), Combining RIP, HELLO, and EGP, Routing with partial information.

MODULE 6: - ENTERPRISE NETWORKING AND INTERNET SERVERS

Corporate networking, Broadband at the Metropolitan area level, High speed dedicated WAN services and switched WAN services, ISDN, BISDN and ATM services, Frame relay technology and services, Virtual private network concepts PPTP protocol. DNS, DHCP Servers, FTP, TELNET, E-Mail.

MODULE 7: - FIREWALL & NETWORKING

Introduction, Implementation of Firewall, Activities of Firewall, Configuration of firewall, Firewalls & SSL, SSL implementation, Bit implementation of SSL, Use of SSL.

REFERENCE BOOKS

1. Computer Networks and Internets - Douglas E. Comer; PE.
2. Communication Networks - Leon-Garcia-Widjaja; TMH.
3. Internetworking with TCP / IP - Douglas E .Comer; PE.
4. TCP/IP protocol suite - Forouzan Behrouz A; TMH.
5. Computer Networks – Andrew S. Tanenbaum; PHI.
6. Data and Computer Communication - William Stallings; PHI.
7. The Complete reference of Networking - Craig Zacker; TMH.

Computer Science & Engineering and Information Technology					
Code: CS512	**System Analysis and Design**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOME

1. To provide a solid foundation of systems principles
2. An understanding of how business function, while heightening students to the issues analysts face daily.

COURSE CONTENTS:

MODULE 1: INTRODUCTION

System definition and concepts: Characteristics and types of system, Manual and automated systems
Real-life Business sub-systems: Production, Marketing, Personal, Material, Finance
Systems models types of models: Systems environment and boundaries, Real-time and distributed systems, Basic principles of successful systems

MODULE 2: SYSTEMS ANALYST

Role and need of systems analyst, Qualifications and responsibilities, Systems Analyst as and agent of change,
Introduction to systems development life cycle (SDLC):
Various phases of development: Analysis, Design, Development, Implementation, Maintenance
Systems documentation considerations: Principles of systems documentation, Types of documentation and their importance, enforcing documentation discipline in an organization.
System Planning
Data and fact gathering techniques: Interviews, Group communication, Presentations, Site visits.
Feasibility study and its importance, Types of feasibility reports System Selection plan and proposal Prototyping
Cost-Benefit and analysis: Tools and techniques

MODULE 3: SYSTEMS DESIGN AND MODELING

Process modeling, Logical and physical design, Design representation, Systems flowcharts and structured charts, Data flow diagrams, Common diagramming conventions and guidelines using DFD and ERD diagrams. Data Modeling and systems analysis, designing the internals: Program and Process design, Designing Distributed Systems.
Input and Output Classification of forms: Input/output forms design, User-interface design, Graphical interfaces

MODULE 4: MODULAR AND STRUCTURED DESIGN

Module specifications, Module coupling and cohesion, Top-down and bottom-up design
.**System Implementation and Maintenance**
Planning considerations, Conversion methods, producers and controls, System acceptance Criteria, System evaluation and performance, Testing and validation, Systems qualify Control and assurance, Maintenance activities and issues.

MODULE 5: SYSTEM AUDIT AND SECURITY

Computer system as an expensive resource: Data and Strong media Procedures and norms for utilization of computer equipment, Audit of computer system usage,Audit trails,
Types of threats to computer system and control measures: Threat to computer system and control measures, Disaster recovery and contingency planning
Object Oriented Analysis and design
Introduction to Object Oriented Analysis and design life cycle, object modeling: Class Diagrams, Dynamic modeling: state diagram, Dynamic modeling: sequence diagramming.

TEXT BOOKS/ REFERENCES: -

1. System Analysis and Design Methods, Whitten, Bentaly and Barlow, Galgotia Publication.
2. System Analysis and Design Elias M. Award, Galgotia Publication
3. Modern System Analysis and Design, Jeffrey A. Hofer Joey F. George Joseph S. Valacich Addison Weseley.

Computer Science & Engineering and Information Technology					
Code: EC524	**Analog and Digital Communication**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOME:

After completing this course, the students will be able to:

1) Understand analog and digital communication techniques.
2) Learn data and pulse communication techniques.
3) Be familiarized with source and Error control coding.
4) Gain knowledge on multi-user radio communication.

SYLLABUS:

Module 1: ANALOG COMMUNICATION**:** Noise: Source of Noise – External Noise- Internal Noise- Noise Calculation. Introduction to Communication Systems: Modulation – Types – Need for Modulation. Theory of Amplitude Modulation – Evolution and Description of SSB Techniques – Theory of Frequency and Phase Modulation – Comparison of various Analog Communication System (AM – FM – PM).

Module 2: DIGITAL COMMUNICATION : Amplitude Shift Keying (ASK) – Frequency Shift Keying (FSK) Minimum Shift Keying (MSK) –Phase Shift Keying (PSK) – BPSK – QPSK – 8 PSK – 16 PSK – Quadrature Amplitude Modulation (QAM) – 8 QAM – 16 QAM – Bandwidth Efficiency– Comparison of various Digital Communication System (ASK – FSK – PSK – QAM).

Module 3: DATA AND PULSE COMMUNICATION : Data Communication: History of Data Communication – Standards Organizations for Data Communication- Data Communication Circuits – Data Communication Codes – Error Detection and Correction Techniques – Data communication Hardware – serial and parallel interfaces. Pulse Communication: Pulse Amplitude Modulation (PAM) – Pulse Time Modulation (PTM) – Pulse code Modulation (PCM) – Comparison of various Pulse Communication System (PAM – PTM – PCM).

Module 4: SOURCE AND ERROR CONTROL CODING: Entropy, Source encoding theorem, Shannon fano coding, Huffman coding, mutual information, channel capacity, channel coding theorem, Error Control Coding, linear block codes, cyclic codes, convolution codes, viterbi decoding algorithm.

Module 5: MULTI-USER RADIO COMMUNICATION: Advanced Mobile Phone System (AMPS) – Global System for Mobile Communications (GSM) – Code division multiple access (CDMA) – Cellular Concept and Frequency Reuse – Channel Assignment and Hand – Overview of Multiple Access Schemes – Satellite Communication – Bluetooth.

TEXT BOOK:

1. Wayne Tomasi, “Advanced Electronic Communication Systems”, 6th Edition, Pearson Education, 2009.

REFERENCES:

1. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley & Sons, 2004
2. Rappaport T.S, “Wireless Communications: Principles and Practice”, 2nd Edition, Pearson Education, 2007
3. H.Taub, D L Schilling and G Saha, “Principles of Communication”, 3rd Edition, Pearson Education, 2007.
4. B. P.Lathi, “Modern Analog and Digital Communication Systems”, 3rd Edition, Oxford University Press, 2007.

Computer Science & Engineering and Information Technology					
Code: IT521	**Principles of Programming Languages**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

1. To introduce the major programming paradigms, and the principles and techniques involved in design and implementation of modern programming languages.
2. To introduce frameworks for specifying and reasoning about programming languages.
3. Students will be able to summarize different hidden surface elimination algorithms and shading techniques used in computer graphics and digital media production.
4. Students will be able to explain about the technology necessary for creating multimedia content for the web, video, DVD, 2D and 3D graphics, sound and programming.
5. Students can apply the knowledge, techniques, skills and modern tools to become successful professionals in communication and Media industries.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO 1	-	-	2	-	-	-	-	-	-	-	-	-
CO 2	2	2	-	-	-	-	-	-	-	-	-	-
CO 3	2	-	1	-	3	-	-	-	-	-	-	-
CO 4	2	2	-	2	-	1	-	-	-	-	-	-
CO 5	1	2	-	-	-	-	-	-	-	-	-	-

**3: high, 2: moderate, 1 low*

MODULE 1:

Concepts of structural program development; concept of data types; precedence and associativity of operators; conditional transfer; deterministic and in-deterministic loops

MODULE 2:

Recursions; functions and procedures - call by value, call by reference and their differences; programming for numerical methods; records.

MODULE 3:

Data-type handling and various constructs (conditional, loop, functions etc); pointers: concept of pointers and passing parameters using pointers, non-numeric processing, concept of arrays of pointers and pointers to pointers;

MODULE 4:

Structures and unions – advantage of using structures, concept of information hiding, pointers to structures; files - basic concept of various types of file access methods: sequential, indexed sequential, random, various statements for file handling

MODULE 5:

Advanced Programming Languages like C++, ADA, LISP, PROLOG, and PASCAL. Comparison of various languages

TEXTBOOK / REFERENCE BOOKS:

1. Programming Language Pragmatics. Michael Scott, Morgan Kaufmann, 2000.

2. Essentials of Programming Languages. Friedman, Wand and Haynes, Prentice-Hall International (PHI), 1998.

3. Principles of Programming Languages. Tennant. PHI, 1981.

Computer Science & Engineering and Information Technology					
Code: IT522	**Semantic Web**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES:

1. Understand and explain the overall architecture of semantic web and to illustrate the overview of design principles and technologies in semantic web.
2. Design and implement a small ontology that is semantically descriptive of your chosen problem domain, implement applications that can access, use and manipulate the ontology, represent data from a chosen problem in XML with appropriate semantic tags obtained or derived from the ontology.
3. Describe the semantic relationships among these data elements using Resource Description Framework (RDF).
4. Design and implement a web services application that ―discovers‖ the data and/or other web services via the semantic web (which includes the RDF, data elements in properly tagged XML, and the ontology), discover the capabilities and limitations of semantic web technology for different applications.

MODULE I: INTRODUCTION

Introduction to the Syntactic Web and Semantic Web – Evolution of the Web – the Visual and Syntactic Web – Levels of Semantics – Metadata for Web Information – the Semantic Web Architecture and Technologies –Contrasting Semantic with Conventional Technologies– Semantic Modeling -Potential of Semantic Web Solutions and Challenges of Adoption Design Principles.

MODULE 2: KNOWLEDGE REPRESENTATION AND ONTOLOGIES

Knowledge Representation and Reasoning - Ontologies- Taxonomies –Topic Maps – Classifying Ontologies - Terminological Aspects: Concepts, Terms, Relations Between Them – Complex Objects - Subclasses and Sub-properties definitions –Upper Ontologies – Quality – Uses - Types of Terminological Resources for Ontology Building – Methods and Methodologies for Building Ontologies – Multilingual Ontologies -Ontology Development Process and Life Cycle – Methods for Ontology Learning – Ontology Evolution – Versioning Ontologies in Semantic Web.

MODULE 3: STRUCTURING AND DESCRIBING WEB RESOURCES

Structured Web Documents - XML – Structuring – Namespaces – Addressing – Querying – Processing - RDF – RDF Data Model – Serialization Formats- RDF Vocabulary –Inferencing RDFS – basic Idea – Classes – Properties- Utility Properties – RDFS Modelling for Combinations and Patterns- Transitivity.

MODULE 4: WEB ONTOLOGY LANGUAGE

OWL – Sub-Languages – Basic Notions -Classes- Defining and Using Properties – Domain and Range – Describing Properties - Data Types – Counting and Sets- Negative Property Assertions – Advanced Class Description – Equivalence – OWL Logic.

MODULE 5: SEMANTIC WEB TOOLS AND APPLICATIONS

State - of- the- Art in Semantic Web Community-Development Tools for Semantic Web – Jena Framework – SPARL –Querying Semantic Web- Semantic Desktop – Semantic Wikis - Semantic Web Services – Application in Science – Business

TEXTBOOKS:

1. LiyangYu,‖A Developer‘s Guide to the Semantic Web‖, Springer, First Edition, 2011.

2. John Hebeler, Matthew Fisher, Ryan Blace and Andrew Perez-opez, ―Semantic Web Programming‖, First Edition, Wiley, 2009.

3. Grigoris Antoniou, Frank van Harmelen, ―A Semantic Web Primer‖, Second Edition, MIT Press, 2008.
4. Robert M.Colomb,‖Ontology and the Semantic Web‖, Frontiers in Artificial Intelligence and Applications, IOS Press, 2007.

5. Dean Allemang andJames Hendler,‖Semantic Web for the Working Ontologist: Effective Modeling in RDFS and OWL‖, Second Edition, Morgan Kaufmann, 2011.

6. Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph, ―Foundations of Semantic Web Technologies, CRC Press, 2009.

REFERENCES:

1. Michael C. Daconta, Leo J.Obrst and Kevin T. Smith, ―The Semantic Web: A Guide to the Future of XML, Web Services, and Knowledge Management‖, First Edition, Wiley, 2003

2. Karin Breitman, MarcoAntonio Casanova and Walt Truszkowski, ―Semantic Web: Concepts, Technologies and Applications (NASAMonographs in Systems and Software Engineering) Springer, 2010.

3. Vipul Kashyap,Christoph Bussler and Matthew Moran, The Semantic Web: Semantics for Data and Services on the Web (Data-Centric Systems and Applications),Springer,2008.

Computer Science & Engineering and Information Technology					
Code: CS531	**Web Technology**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

After Successful completion of course, the students will be able to

1. **Describe** various web technology and application development issues and trends.
2. **Design** static and dynamic web pages using HTML, CSS and Java Script
3. **Design** and implement web services from the server and client side.
4. **Build** interactive web applications using JSP and Servlet.
5. **Identify** the engineering structural design of XML and parse construction tree model.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO 1	-	3	-	-	-	-	-	-	-	2	-	-
CO 2	3	2	3	2	3	1	-	-	-	-	-	-
CO 3	-	-	3	-	2		-	-	2	-	-	-
CO 4	2	2	3	-	2	1	-	-	-	-	-	-
CO 5	2	2	-	-	-	-	-	-	-	-	-	-
Avg	2.33	2.25	3	2	2.33	1			2	2		

Note- *3: high, 2: moderate, 1 low*

MODULE- 1: INTRODUCTION TO HTML AND WEB PAGES

Introduction to html: Fundamentals of HTML elements, Document body, Different tags, sections, text, hyperlink, lists, tables, color and images, frames, frameset, form.

Web Pages: types and issues, tiers; comparisons of Microsoft and java technologies; WWW: Basic concept, web client and web server, HTTP protocol (frame format), universal resource locator (URL).

MODULE- 2: DYNAMIC AND ACTIVE WEB PAGES

Dynamic web pages: The need of dynamic web pages; an overview of DHTML, Cascading Style Sheets (CSS), comparative studies of different technologies of dynamic page creation.
Active web pages: Need of active web pages; java applet life cycle.

MODULE- 3: JAVASCRIPT AND JAVA SERVLET

JavaScript: Data types, variables, operators, conditional statements, array object, date object, string object. Java Servlet: Servlet environment and role, HTML support, Servlet API, the Servlet Life cycle, cookies and sessions.

MODULE- 4: JSP

JSP: JSP architecture, JSP servers, JSP tags, understanding the layout in JSP, Declaring Variables, methods in JSP, inserting java expressions in JSP, processing request from user and generating dynamic response for the user, inserting applets and java beans into JSP, using include and forward action, comparing JSP and CGI program, comparing JSP and ASP program; Creating ODBC data source name, introduction to JDBC, prepare statement and callable statement.

MODULE- 5: J2EE AND XML

J2EE: An overview of J2EE web services, basics of Enterprise Java Beans, EJB vs. Java Beans, basic of RMI, JNI. XML: Basics XML, elements and attributes, document type definition, xml parsers, sequential and tree approach

TEXT BOOKS:

- Chris Bates, "Web Programming: Building Internet Applications", Wiley Dream Tech, 2nd Edition,2002.
- Jeffrey C K Jackson, Web Technologies", Pearson Education, 1st Edition,2006.
- Jason Hunter, William Crawford ―Java Servlet Programming‖ O'Reilly Publications, 2nd Edition, 2001.

REFERENCE BOOKS:

- W Hans Bergsten, "Java Server Pages", O"Reilly, 3rd Edition, 2003.
- D. Flanagan, "Java Script", O"Reilly, 6th Edition, 2011.
- Jon Duckett, "Beginning Web Programming", WROX, 2nd Edition, 2008.
- Herbert Schildt, "Java the Complete Reference", Hill - Osborne, 8th Edition, 2011.

LIST OF OPEN SOURCE SOFTWARE/LEARNING WEBSITE:

- Browsers like IE, Mozilla, Firefox etc.
- Server software XAMPP/WAMP/LAMP.
- www.apachefriends.org
- www.w3.org
- www.w3schools.com
- www.php.net
- www.mysql.com
- www.phpmyadmin.net
- www.javatpoint.com

Computer Science & Engineering and Information Technology					
Code: CS532	**Computer Architecture***	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

*This course open to all branch except CSE/IT.

Course Outcomes:

1. Ability to describe the organization of computer and machine instructions and programs
2. Ability to analyze Input / Output Organization
3. Analyze the working of the memory system and basic processing unit.
4. Ability to solve problems of multicores, multiprocessors and clusters.
5. Choose optical storage media suitable for multimedia applications.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	-	3	-	2	2	-	-	-	-	-	-	1
CO2	2	2	2	2	2	-	-	-	-	-	-	2
CO3	2	2	2	2	3	-	-	-	-	-	-	2
CO4	3	3	3	2	2	-	-	-	-	-	-	2
Average												

**3: high, 2: moderate, 1 low*

MODULE 1:
Basics of Digital Electronics: Multiplexers and De multiplexers, Decoder and Encoder, Codes, Logic gates, Flip flops, Registers.
Register Transfer and Micro Operations: Bus and Memory Transfer, Logic Micro Operations, Shift Micro Operations, Register transfer and register transfer language, Design of arithmetic logic unit.

MODULE 2:
Basic Computer Organization: Instruction codes, Computer instructions, Timing and Control, Instruction cycle, Memory reference Instruction, Complete computer description, Design of basic computer, Input output and interrupt.

MODULE 3:
Control Unit: Hardwired controls, Micro programmed controls.
Central Processing Unit : Program control, Reduced instruction set computer, Complex instruction set computer, Data Transfer, Manipulation, General register and stack organization, Addressing mode.

MODULE 4:
Computer Arithmetic: Addition and subtraction algorithm, Multiplication algorithm, Division algorithms.

MODULE 5:

Input-Output Organization: Priority interrupt, Peripheral devices, Input output interface, Data transfer schemes, Program control and interrupts, Direct memory access transfer, Input/output processor.
Memory Unit: High speed memories, Memory hierarchy, Processor Vs Memory speed, Cache memory, Associative memory, Inter leave, Virtual memory, Memory management.

MODULE 6:
Introduction to Parallel Processing: Pipelining, Characteristics of multiprocessors, Interconnection structures, Inter processor arbitration, Inter processor communication, Synchronization.

Text Books:

1. Computer System Architecture by Morris Mano, Prentice hall, 3rd Edition, (2007)

References:

1. Computer Organization by Carl Hamacher, Zvonko Vranesic, Safwat Zaky, Tata Mcgraw Hill, 5th Edition, (2011)

2. Computer Architecture : A Quantitative Approach by Hennessy, J. L, David A Patterson, and Goldberg, Pearson Education, 4th Edition, (2006)

Computer Science & Engineering and Information Technology					
Code: CS533	**Data Structures and Algorithms***	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

***This course is open to all branches except CSE/IT.**

COURSE OUTCOMES:

After Completion of this course, the students will be able to:

1. Understand various types of fundamental data structures (standard and user defined).
2. Determine and analyze about algorithm for the run time complexities and the space requirements.
3. Acquire knowledge of data structures and algorithms for implementing various computing system

MODULE 1

Linear Data Structures - Sequential representations - Arrays and Lists, Stacks, Queues and Dequeues, strings, Application, Linear Data Structures, Link Representation - Linear linked lists, Circularly linked lists. Doubly linked lists, application.

MODULE 2

Non-linear Data Structure: Trees - Binary Trees, Traversals and Threads, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced and weight-balanced trees, B-trees, B+ -trees, Application of trees; Recursion - Design of recursive algorithms, Tail Recursion, When not to use recursion, Removal of recursion.

MODULE 3

Graphs - Representations of graphs (adjacency list, adjacency matrix, Sparse Matrix); Breadth-first and Depth-first Search. Hashing: Hash tables, including collision-avoidance strategies;

MODULE 4

Asymptotic analysis of upper and average complexity bounds; Identifying differences among best, average, and worst case behaviors; Big O, little o, omega, and theta notation; Time and space tradeoffs in algorithms;

MODULE 5

Sorting and Searching Algorithms- Sequential and binary search algorithms; Bubble sort, Selection Sort, Insertion Sort, Quick Sort, Merge Sort, Heap sort and Radix Sort. Brute-force algorithms; Greedy algorithms; Divide-and-conquer; Backtracking; Shortest path algorithms (Single source shortest path; Dijkstra’s and Floyd’s algorithms); Minimum spanning tree (Prim’s and Kruskal’s algorithms);

TEXT / REFERENCE BOOKS

1. S. Sahni, Data structures, algorithms, & applications in Java, McGraw-Hill, 2005
2. J. P. Trembly et al, An introduction to data structures with applications, McGraw- Hill, 2007
3. D. E. Knuth, Art of computer programming, Volume 1: Fundamental algorithms, Addison-Wesley.2011 4. Thomas H. Cormen , Charles E. Leiserson , Ronald L. Rivest , Clifford Stein, Introduction to Algorithms, 3rd Edition, PHI, 2009

Computer Science & Engineering and Information Technology					
Code: CS551	**Operating System Lab**	**L**	**T**	**P**	**C**
		0	**0**	**3**	**1**

COURSE OUTCOMES:

After completion of this course, students will be able to:

1. Appreciate the advantages of Unix OS.
2. Develop and debug, C programs created on UNIX platforms.
3. Use and if necessary install standard libraries.

LIST OF EXPERIMENTS:

1. Study of Basic commands of Linux.

2. Write a Shell script to print given numbers sum of all digits

3. Write a shell script to validate the entered date. (eg. Date format is: dd-mm-yyyy)

4. Write a shell script to check entered string is palindrome or not.

5. Write a Shell script to say Good morning/Afternoon/Evening as you log in to system.

6. Write a C program to create a child process

7. Finding out biggest number from given three numbers supplied as command line arguments

8. Printing the patterns using for loop.

9. Shell script to determine whether given file exist or not.

10. Write a program for process creation using C. (Use of gcc compiler).

11. Implementation of FCFS Algorithm.

12. Implementation of Round Robin Algorithm.

13. Implementation of Banker’s Algorithm.

<table>
<tr><td colspan="5">Computer Science & Engineering and Information Technology</td></tr>
<tr><td>Code: CS552</td><td>Database Management System Lab</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td></td><td></td><td>0</td><td>0</td><td>3</td><td>1</td></tr>
</table>

H/W Requirement:

- At least Dual Core or Core-I3 Pro Computing System, 2GB RAM, 80GB HDD

Software

- All systems are configured in DUAL BOOT mode i.e., Students can boot from Windows 7/8 or Linux as per their lab requirement.
- MySQL/PgSQL/Oracle May be used as Database Management System
- Systems are provided for students in the 1:1 ratio.

COURSE OUTCOMES

1. Design and implement a database schema for a given problem-domain
2. Create and maintain tables using PL/SQL
3. Populate and query a database Course
4. Application development using PL/SQL & front end tools

LIST OF EXPERIMENTS

1 Database Schema for a customer-sale scenario
Customer(Cust id : integer, cust_name: string)
Item(item_id: integer, item_name: string,
price: integer)
Sale(bill_no: integer, bill_data: date, cust_id: integer, item_id: integer,
qty_sold: integer) For the above schema, perform the following—

a) Create the tables with the appropriate integrity constraints
b) Insert around 10 records in each of the tables
c) List all the bills for the current date with the customer names and item numbers

d) List the total Bill details with the quantity sold, price of the item and the final amount
e) List the details of the customer who have bought a product which has a price>200
f) Give a count of how many products have been bought by each customer
g) Give a list of products bought by a customer having cust_id as 5

h) List the item details which are sold as of today
i) Create a view which lists out the bill_no, bill_date, cust_id, item_id, price, qty_sold, amount
j) Create a view which lists the daily sales date wise for the last one week

2 Database Schema for a Student Library scenario
Student(Stud_no : integer, Stud_name: string)
Membership(Mem_no: integer, Stud_no:
integer) Book(book_no: integer,
book_name:string, author: string)

Iss_rec(iss_no:integer, iss_date: date, Mem_no: integer,
book_no: integer) For the above schema, perform the
following—

a) Create the tables with the appropriate integrity constraints
b) Insert around 10 records in each of the tables
c) List all the student names with their membership numbers

d) List all the issues for the current date with student and Book names
e) List the details of students who borrowed book whose author is CJDATE
f) Give a count of how many books have been bought by each student
g) Give a list of books taken by student with stud_no as 5

h) List the book details which are issued as of today
i) Create a view which lists out the iss_no, iss _date, stud_name, book name
j) Create a view which lists the daily issues-date wise for the last one week

3 Database Schema for a Employee-pay
scenario employee(emp_id : integer,
emp_name: string) department(dept_id:
integer,dept_name:string)
paydetails(emp_id : integer, dept_id: integer, basic: integer, deductions: integer, additions: integer, DOJ: date)
payroll(emp_id : integer, pay_date: date)

For the above schema, perform the following—
a) Create the tables with the appropriate integrity constraints
b) Insert around 10 records in each of the tables
c) List the employee details department wise

d) List all the employee names who joined after particular date
e) List the details of employees whose basic salary is between 10,000 and 20,000
f) Give a count of how many employees are working in each department
g) Give a names of the employees whose netsalary>10,000

h) List the details for an employee_id=5
i) Create a view which lists out the emp_name, department, basic, dedeuctions, netsalary
j) Create a view which lists the emp_name and his netsalary

4 Database Schema for a Video Library scenario
Customer(cust_no: integer,cust_name: string)
Membership(Mem_no: integer, cust_no: integer)
Cassette(cass_no:integer, cass_name:string,
Language: String)

Iss_rec(iss_no: integer, iss_date: date, mem_no: integer, cass_no: integer)

For the above schema, perform the following—

a) Create the tables with the appropriate integrity constraints
b) Insert around 10 records in each of the tables

c) List all the customer names with their membership numbers
d) List all the issues for the current date with the customer names and cassette names
e) List the details of the customer who has borrowed the cassette whose title is “ The Legend”
f) Give a count of how many cassettes have been borrowed by each customer

g) Give a list of book which has been taken by the student with mem_no as 5
h) List the cassettes issues for today
i) Create a view which lists outs the iss_no, iss_date, cust_name, cass_name
j) Create a view which lists issues-date wise for the last one week

5 Database Schema for a student-Lab scenario
Student(stud_no: integer, stud_name: string, class: string)

Class(class: string,descrip: string)
Lab(mach_no: integer, Lab_no: integer, description: String)
Allotment(Stud_no: Integer, mach_no: integer, dayof
week: string) For the above schema, perform the
following—

a) Create the tables with the appropriate integrity constraints
b) Insert around 10 records in each of the tables
c) List all the machine allotments with the student names, lab and machine numbers
d) List the total number of lab allotments day wise

e) Give a count of how many machines have been allocated to the ‘CSIT’ class
f) Give a machine allotment details of the stud_no 5 with his personal and class details
g) Count for how many machines have been allocated in Lab_no 1 for the day of the week as “Monday”
h) How many students class wise have allocated machines in the labs

i) Create a view which lists out the stud_no, stud_name, mach_no, lab_no, dayofweek
j) Create a view which lists the machine allotment details for “Thursday”.

6 a) Write and execute subprogram to find largest number from the given three numbers.
b) Write and execute subprogram using loop, while and for iterative control statement.

7. a) Write and execute subprogram to check whether the given number is Armstrong or not b) Write and execute subprogram to generate all prime numbers below 100.

a)Write and execute subprogram to demonstrate the GOTO statement. 8 b) Write a subprogram to demonstrate %type and %rowtype attributes

9 a) Write and execute subprogram to demonstrate predefined exceptions
b) Write and execute subprogram to demonstrate user defined exceptions

10 a) Create a cursor, which displays all employee numbers and names from the EMP table.
b) Create a cursor, which update the salaries of all employees as per the given data.

11 a) Create a cursor, which displays names of employees having salary > 50000.
b) Create a procedure to find reverse of a given number

12 a) Create a procedure to update the salaries of all employees as per the given data
b) Create a procedure to demonstrate IN, OUT and INOUT parameters

13 a) Create a function to check whether given string is palindrome or not.
b) Create a function to find sum of salaries of all employees working in depart number 10.

14 a) Create a trigger before/after update on employee table for each row/statement.
b) Create a trigger before/after delete on employee table for each row/statement.
c) Create a trigger before/after insert on employee table for each row/statement.

16 a) Create a Form to display employee details using SQL

b) Create a Report to generate all employee annual salaries….

Additional Programs

1 Create a form using Forms 6i to display Employee table data.

2 Create a Master/details relationship form which perform Add New, Search, Delete, Save and Update on the records

3 Generate a report to calculate employee's salaries department wise from employee table.

4 Create a Report to generate the details of employee table including sum and average salaries department wise. Course Outcome:Upon successful completion of this Lab the student will be able to:

- **Creating , Modify database Tables and manipulate data in the Tables**
- **Performing database operations in a procedural manner using pl/sql**
- **Performing database operations (create, update, modify, retrieve, etc.,) using front-end tools like D2K/Gambas/PhP/Servlet/JSP.**
- **Design and Develop applications like banking, reservation system, etc.**
- **Design and implement a small database project using RDBMS to understand the concept of a database transaction and related database facilities.**

Mechanical Engineering			
ME601	**Solid Mechanics**	**L**	**T**
		3	**1**

Objectives:
The objective is to present the mathematical and physical principles in understanding the linear continuum behavior of solids.

Course Contents
Module-I
Introduction to Cartesian tensors, Strains: Concept of strain, derivation of small strain tensor and compatibility. (9)
Module-II
Derivation of Cauchy relations and equilibrium and symmetry equations, principal stresses and directions. (6)
Module-III
Constitutive equations: Generalized Hooke's law, Linear elasticity, Material symmetry; Boundary value problems: concepts of uniqueness and superposition. (6)
Module-IV
Plane stress and plane strain problems. (3)
Module-V
Introduction to governing equations in cylindrical and spherical coordinates, axisymmetric problems. (8)
Module-VI
Application to thick cylinders, rotating discs, torsion of non-circular cross-sections, stress concentration problems, thermo-elasticity, 2-d contact problems. (5)
Module-VII
Solutions using potentials energy methods, Introduction to plasticity. (3)

Course Outcomes:
Upon completion of this course, students will be able understand the deformation behavior of solids under different types of loading and obtain mathematical solutions for simple geometries.

Text Books:
[1] G. T. Mase, R. E. Smelser and G. E. Mase, Continuum Mechanics for Engineers, ThirdEdition, CRC Press, 2004.
[2] Y. C. Fung, Foundations of Solid Mechanics, Prentice Hall International, 1965.
[3] Lawrence. E. Malvern, Introduction to Mechanics of a Continuous Medium, Prentice Hallinternational, 1969.

Mechanical Engineering			
ME611	**Manufacturing Technology**	**L**	**T**
		3	**0**

Objectives:

(i) To provide knowledge on machines and related tools for manufacturing various components.
(ii) To understand the relationship between process and system in manufacturing domain.
(iii) To identify the techniques for the quality assurance of the products and the optimality ofthe process in terms of resources and time management.

Course Contents:

Module-I

Tooling for conventional and non-conventional machining processes: Mould and die design, Press tools, Cutting tools; Holding tool. (6)

Module-II

Jigs and fixtures, principles, applications and design; press tools – configuration, design of die and punch; principles of forging die design. (4)

Module-III

Metrology: Dimensions, forms and surface measurements, Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; Metrology in toolwear and part quality including surface integrity, alignment and testing methods; tolerance analysis in manufacturing and assembly. (8)

Module-IV

Process metrology for emerging machining processes such as micro-scale machining, Inspection and workpiece quality. (4)

Module-V

Assembly practices: Manufacturing and assembly, process planning, selective assembly, Material handling and devices. (6)

Module-VI

Linear programming, objective function and constraints, graphical method, Simplex andduplex algorithms, transportation assignment, Traveling Salesman problem; Network models: shortest route, minimal spanning tree,
maximum flow model- Project networks: CPM andPERT, critical path scheduling; Production planning &control: Forecasting models, aggregate production planning, materials requirement planning. (8)

Module-VII

Inventory Models: Economic Order Quantity, quantity discount models, stochastic inventory models, practical inventory controlmodels, JIT. Simple queuing theory models. (4)

Course Outcomes:

Upon completion of this course, students will be able to the tooling needed for manufacturing, the dimensional accuracy and tolerances of products, assembly of different components and the application of optimization methods in manufacturing.

Text Books:

(i) Kalpakjian and Schmid, Manufacturing processes for engineering materials (5th Edition) Pearson India, 2014.

(ii) Taha H. A., Operations Research, 6thEdition, Prentice Hall of India, 2003.

(iii) ShenoyG.V. and Shrivastava U.K., Operations Research for Management, WileyEastern, 1994.

Mechanical Engineering			
ME612	**Mechatronics Systems**	**L**	**T**
		3	**0**

Objectives:
(i) To understand the structure of microprocessors and their applications in mechanical devices
(ii) To understand the principle of automatic control and real time motion control systems, with the help of electrical drives and actuators
(iii) To understand the use of micro-sensors and their applications in various fields

Course Contents:

Module-I
Introduction: Definition of Mechanical Systems, Philosophy and approach; Systems and Design: Mechatronic approach, Integrated Product Design, Modeling, Analysis and Simulation, Man-Machine Interface. (8)

Module-II
Sensors and transducers: classification, Development in Transducer technology, Optoelectronics-Shaft encoders, CD Sensors, Vision System, etc.; (8)

Module-III
Drives and Actuators: Hydraulic and Pneumatic drives, Electrical Actuators such as servo motor and Stepper motor, Drive circuits, open and closed loop control. (5)

Module-I
Embedded Systems:Hardware Structure, Software Design and Communication, Programmable Logic Devices,Automatic Control and Real Time Control Systems. (6)

Module-IV
Smart materials: Shape Memory Alloy, Piezoelectric and Magnetostrictive Actuators: Materials, Static and dynamic characteristics, illustrative examples for positioning, vibration isolation, etc (4)

Module-V
Micromechatronic systems: Microsensors, Microactuators; Micro-fabrication techniques LIGA Process: Lithography, etching, Micro-joining etc. Application examples; (5)

Module-VI
Case studies Examples of Mechatronic Systems from Robotics Manufacturing, Machine Diagnostics, Road vehicles and Medical Technology. (4)

Course Outcomes:
Upon completion of this course, students will get an overview of mechatronics applications and the use of micro-sensors and microprocessors.

Text Books:

(i) Mechatronics System Design, Devdas Shetty & Richard A. Kolk, PWS Publishing Company (Thomson Learning Inc.)

(ii) Mechatronics: A Multidisciplinary Approach, William Bolton, Pearson Education

(iii) A Textbook of Mechatronics ,R.K.Rajput, S. Chand & Company Private Limited

(iv) Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering, William Bolton, Prentice Hall.

Mechanical Engineering			
ME613	**Microprocessor in Automation**	**L**	**T**
		3	**0**

Objectives:
To introduce the basic concepts of Digital circuits, Microprocessor system and digital controller

Course Contents:

Module-I
Number Systems, codes, digital electronics: Logic Gates, combinational circuits design, Flip-flops, Sequential logic circuits design: Counters, Shift registers. (6)

Module-II
Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus systems, Timing and control signals. (4)

Module-III
Machine cycles, instruction cycle and timing states, instruction timing diagrams, Memory interfacing. (3)

Module-IV
Assembly Language Programming: Addressing modes, Instruction set, simple programs in 8085; Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interruptrequests and their handling, Programmable interrupt controller; Interfacing peripherals: Programmable peripheral interface (8255). (10)

Module-V
Interfacing Analog to Digital Converter & Digital to Analog converter, Multiplexed seven segments LED display systems, Stepper Motor Control. (5)

Module-VI
Data Communication: Serial Data communication (8251), Programmable Timers (8253); 8086/8088 Microprocessor and its advanced features. (5)

Module-VII
Introduction to Digital Control: Sampling theorem, Signal conversion and Processing, Z-Transform, Digital Filters, Implementation of Digital Algorithm. (7)

Course Outcomes:
Students who have done this course will have a good idea of the use of microprocessors for automation.

Text Books:

(i) Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited
(ii) Digital Computer Electronics: An Introduction to Microcomputers, Albert Paul Malvino, Tata McGraw-Hill Publishing Company Ltd.
(iii) Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
(iv) Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
(v) Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall

Mechanical Engineering			
ME621	**Design of Transmission System**	**L**	**T**
		3	**0**

Objectives:
To learn about the design procedures for mechanical power transmission components

Contents:

Module-I
Flexible transmission elements- design of flat belts & pulleys, selection of V-belts and pulleys, selection of hoisting wire ropes and pulleys, design of chains and sprockets. (6)

Module-II
Gear transmission- speed ratios and number of teeth, force analysis, tooth stresses, dynamic effects, fatigue strength, factor safety, gear materials; Design of straight tooth spur gear and parallel axis helical gears based on strength and wear considerations, pressure angle in the normal and transverse plane; equivalent number of teeth and forces for helical gears. (6)

Module-III
Straight bevel gear- tooth terminology, tooth forces and stresses, equivalent number of teeth. Estimating the dimensions of a pair of straight bevel gears. (4)

Module-IV
Worm gear, merits & demerits, terminology, thermal capacity, materials, forces & stresses, efficiency, estimating the size of worm gear pair. Cross helical gears, terminology, helix angles, sizing of a pair of helical gears. (4)

Module-V
Gear box- geometric progression, standard step ratio; Ray diagram, kinematics layout; Design of sliding mesh gear box- Design of multi-seed gear box for machine too applications; constant mesh gear box, speed reducer unit; Variable speed gear box; Fluid couplings, Torque converters for automotive applications. (10)

Module-VI
Cam design, types: pressure angle and undercutting base circle determination, forces and surface stresses; Design of plate clutches, axial clutches, cone clutches, internal expandingrim clutches; Electromagnetic clutches; Band and Block brakes. (6)

Module-VII
External shoe brakes, internal expanding shoe brake. (4)

Course Outcomes:

Upon completing this course the students will be able to design transmission systems for engines and machines.

Text Books:

(i) Shigley J., Mischke C., Budynas R. and Nisbett K., Mechanical Engineering Design, 8^{th}ed., Tata McGraw Hill, 2010.
(ii) Jindal U.C., Machine Design: Design of Transmission System, Dorling Kindersley, 2010.
(iii) Maitra G. and Prasad L., Handbook of Mechanical Design, 2nd ed., Tata McGraw Hill,2001.

Mechanical Engineering			
ME622	**Computational Fluid Dynamics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Develop mathematical models for flow phenomena.
2. Analyze mathematical and computational methods for fluid flow and heat transfer simulations.
3. Solve computational problems related to fluid flows and heat transfer.
4. Evaluate the grid sensitivity and analyze the accuracy of a numerical solution.
5. Evaluate flow parameters in internal and external flows.
6. Develop flow simulation code for fluid flow and heat transfer problems.

Contents:

Module-I
Introduction: History and Philosophy of computational fluid dynamics, CFD as a design and research tool, Applications of CFD in engineering, Programming fundamentals, MATLAB programming, Numerical Methods (5)

Module-II
Governing Equations of Fluid Dynamics: Models of the flow, The substantial derivative, Physical meaning of the divergence of velocity, The continuity equation, The momentum equation, The energy equation, Navier-Stokes equations for viscous flow, Euler equations for inviscid flow, Physical boundary conditions, Forms of the governing equations suited for CFD, Conservation form of the equations, shock fitting and shock capturing, Time marching and space marching. (5)

Module-III
Mathematical Behavior of Partial Differential Equations: Classification of quasi-linear partial differential equations, Methods of determining the classification, General behavior of Hyperbolic, Parabolic and Elliptic equations. Basic Aspects of Discretization: Introduction to finite differences, Finite difference equations using Taylor series expansion and polynomials, Explicit and implicit approaches, Uniform and unequally spaced grid points. (6)

Module-IV

Grids With Appropriate Transformation: General transformation of the equations, Metrics and Jacobians, The transformed governing equations of the CFD, Boundary fitted coordinate systems, Algebraic and elliptic grid generation techniques, Adaptive grids. Parabolic Partial Differential Equations: Finite difference formulations, Explicit methods – FTCS, Richardson and DuFort-Frankel methods, Implicit methods – Laasonen, Crank-Nicolson and Beta formulation methods, Approximate factorization, Fractional step methods, Consistency analysis, Linearization. (8)

Module-V

Stability Analysis: Discrete Perturbation Stability analysis, von Neumann Stability analysis, Error analysis, Modified equations, Artificial dissipation and dispersion. Elliptic Equations: Finite difference formulation, solution algorithms: Jacobi-iteration method, Gauss-Siedel iteration method, point- and line-successive over-relaxation methods, alternative direction implicit methods. Hyperbolic Equations: Explicit and implicit finite difference formulations, splitting methods, multi-step methods, applications to linear and nonlinear problems, linear damping, flux corrected transport, monotone and total variation diminishing schemes, tvd formulations, entropy condition, first-order and second-order tvd schemes. (7)

Module-VI

Scalar Representation of Navier-Stokes Equations: Equations of fluid motion, numerical algorithms: ftcs explicit, ftbcs explicit, Dufort-Frankel explicit, Maccormack explicit and implicit, btcs and btbcs implicit algorithms, applications. Grid Generation: Algebraic Grid Generation, Elliptic Grid Generation, Hyperbolic Grid Generation, Parabolic Grid Generation.(4)

Module-VII

Finite Volume Method For Unstructured Grids: Advantages, Cell Centered and Nodal point Approaches, Solution of Generic Equation with tetra hedral Elements, 2-D Heat conduction with Triangular Elements. Numerical Solution of Quasi One Dimensionl Nozzle Flow: Subsonic-Supersonic isentropic flow, Governing equations for Quasi 1-D flow, Non-dimensionalizing the equations, MacCormack technique of discretization, Stability condition, Boundary conditions, Solution for shock flows. (5)

Text Books:

(i) Anderson, J.D.(Jr), Computational Fluid Dynamics, McGraw-Hill Book Company, 1995.

(ii) Hoffman, K.A., and Chiang, S.T., Computational Fluid Dynamics, Vol. I, II and III, Engineering Education System, Kansas, USA, 2000.

(iii) Chung, T.J., Computational Fluid Dynamics, Cambridge University Press, 2003.

(iv) Anderson, D.A., Tannehill, J.C., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, McGraw Hill Book Company, 2002.

Mechanical Engineering			
ME623	**Machine Tool Design**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand basic motions involved in a machine tool.
2. Design machine tool structures.
3. Design and analyze systems for specified speeds and feeds.
4. Select subsystems for achieving high accuracy in machining.
5. Understand control strategies for machine tool operations.
6. Apply appropriate quality tests for quality assurance.

Contents:

Module-I
Introduction to Machine Tool Drives and Mechanisms: Introduction to the course, Working and Auxiliary Motions in Machine Tools, Kinematics of Machine Tools, Motion Transmission (6)

Module-II
Regulation of Speeds and Feeds: Aim of Speed and Feed Regulation, Stepped Regulation of Speeds, Multiple Speed Motors, Ray Diagrams and Design Considerations, Design of Speed Gear Boxes, Feed Drives, Feed Box Design (10)

Module-III
Design of Machine Tool Structures: Functions of Machine Tool Structures and their Requirements, Design for Strength, Design for Rigidity, Materials for Machine Tool Structures, Machine Tool Constructional Features, Beds and Housings, Columns and Tables, Saddles and Carriages (10)

Module-IV
Design of Guideways, Power Screws and Spindles: Functions and Types of Guideways, Design of Guideways, Design of Aerostatic Slideways, Design of Anti-Friction Guideways, Combination Guideways, Design of Power Screws. (6)

Module-V
Design of Spindles and Spindle Supports: Functions of Spindles and Requirements, Effect of Machine Tool Compliance on Machining Accuracy, Design of Spindles, Antifriction Bearings(4)

Module-VI
Dynamics of Machine Tools: Machine Tool Elastic System, Static and Dynamic Stiffness (3)

Module-VII
Acceptance Tests (1)

Text Books:

(i) N.K. Mehta, Machine Tool Design and Numerical Control, TMH, New Delhi, 2010

(ii) G.C. Sen and A. Bhattacharya, Principles of Machine Tools, New Central Book Agency, 2009.

(iii) D. K Pal, S. K. Basu, “Design of Machine Tools”, 5th Edition. Oxford IBH, 2008

(iv) N. S. Acherkhan, “Machine Tool Design”, Vol. I, II, III and IV, MIR publications, 1968.

Mechanical Engineering			
ME631	**Industrial Robotics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the basic components of robots.
2. Differentiate types of robots and robot grippers.
3. Model forward and inverse kinematics of robot manipulators.
4. Analyze forces in links and joints of a robot.
5. Programme a robot to perform tasks in industrial applications.
6. Design intelligent robots using sensors.

Contents:

Module-I

Robotics-classification, Sensors-Position sensors, Velocity sensors, Proximity sensors, Touch and Slip Sensors, Force and Torque sensors. (6)

Module-II

Grippers and Manipulators-Gripper joints, Gripper force, Serial manipulator, Parallel Manipulator, selection of Robot-Selection based on the Application (8)

Module-III

Kinematics-Manipulators Kinematics, Rotation Matrix, Homogenous Transformation Matrix, Direct and Inverse Kinematics for industrial robots for Position and orientation. (8)

Module-IV

Differential Kinematics and static- Dynamics-Lagrangian Formulation, Newton-Euler Formulation for RR & RP Manipulators. (6)

Module-V

Trajectory planning-Motion Control- Interaction control, Rigid Body mechanics, Control architecture- position, path velocity and force control systems, computed torque control, adaptive control, and Servo system for robot control. (6)

Module-VI

Programming of Robots and Vision System- overview of various programming languages. (4)

Module-VII

Application of Robots in production systems- Application of robot in welding, machine tools, material handling, and assembly operations parts sorting and parts inspection. (2)

Text Books:

(i) Fu, K.S., Gonzalez, R.C., and Lee, C.S.G., Robotics control, Sensing, Vision and Intelligence, McGraw-Hill Publishing company, New Delhi, 2003.

(ii) Klafter, R.D., Chmielewski, T.A., and Negin. M, Robot Engineering-An Integrated Approach, Prentice Hall of India, New Delhi, 2002.

(iii) Craig, J.J., Introduction to Robotics Mechanics and Control, Addison Wesley, 1999.

Mechanical Engineering			
ME632	**Computer Aided Design**	**L**	**T**
		3	**0**

Objectives:

To provide an overview of how computers can be utilized in mechanical component design

Contents:

Module-I

Fundamentals of Computer Graphics- Product cycle, sequential and concurrent engineering, Computer Aided Design, CAD system architecture, computer graphics, Coordinate systems, 2D and 3D transformations, viewing transformation. (12)

Module-II

Geometric Modeling- representation of curves, Hermite curves, Bezier curves, B-spline curves, rational curves, Techniques of surface modelling, surface patch, Coons and bicubic patches, Bezier and B-spline surfaces, Solid modelling techniques, CSG and B-rep, Octra, Loxel, Mix representation. (8)

Module-III

Visual realism- hidden line-surface-solid removal algorithms, shading, colouring, computer animation Assembly of parts- assembly modelling, interferences of positions and orientation, tolerance analysis, mass property calculations. (4)

Module-IV

Mechanism simulation and interefence checking CAD standards- Graphical Kernel System (GKS), standards for vexchange images, Open Graphics Library (OpenGL), Data exchange standards- IGES, STEP, CALS etc. (10)

Module-V

Communication standards (6)

Course Outcomes:

Upon completion of this course, the students can use computer and CAD software for modelling mechanical components

Text Books:

(i) Ibrahim Zeid, Mastering CAD CAM, Tata McGraw Hill Publishing Co. 2007.
(ii) C. McMohan and J. Browne, CAD/CAM Principles, II edition, Pearson Education, 1999.
(iii) W. M. Neumann and R.F. Sproul, Principles of Computer Graphics, McGraw Hill, 1989.
(iv) D. Hearn and M.P. Baker, Computer Graphics, Prentice Hall Inc., 1992.

Mechanical Engineering			
ME633	**Production Planning and Control**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand production systems and their characteristics.
2. Evaluate MRP and JIT systems against traditional inventory control systems.
3. Understand basics of variability and its role in the performance of a production system.
4. Analyze aggregate planning strategies.
5. Apply forecasting and scheduling techniques to production systems.
6. Understand theory of constraints for effective management of production systems.

Contents:

Module-I
Introduction to Production Systems: Production Systems: Classification & Characterization, Overview of Production Planning and Control issues, Review of EOQ& inventory control systems. (8)

Module-II
Material Requirement Planning: Dependent Demand & Material Requirement Planning, Structure of MRP system, MRP Calculations, Planning Issues, Implementation Issues. (5)

Module-III
Just in Time Production Systems: Just-in-Time System: Evolution, Characteristics of JIT Systems, Continuous Improvement, The Kanban System, Strategic Implications of JIT System. Factory Physics: Basic factory dynamics, Variability basics, Push and pull production systems

(7)

Module-IV
Aggregate Planning: Aggregate Planning: Purpose & Methods, Reactive and Aggressive Alternatives, Planning Strategies, LP Formulation, Master Production Scheduling. (5)

Module-V
Scheduling: Scheduling in Manufacturing, Sequencing Operations for One Machine, Sequencing Operations for a two-station Flow Shop, Job Shop Dispatching. (5)

Module-VI
Forecasting Methods: Demand Forecasting: Principles and Methods, Judgment methods, Causal methods, Time-series methods. (5)

Module-VII
Issues in PPC: Special features in Planning & Control of Product-focused Systems and Process-focused Systems, Theory of Constraints. (5)

Text Books:

(i) KrajewskiL.J. and Ritzmen L.P., Operations Management: Strategy and Analysis, 9th Edition, Pearson Education, 2010.

(ii) Chase, R.B., Jacobs, F.R. and Aquilano, N.J., Operations Management for Competitive Advantage, 11th Edition, Tata McGraw Hill Book Company, New Delhi, 2010.

(iii) Hopp, WJ and Spearman, ML, Factory Physics: Foundations of Manufacturing Management, McGraw Hill International Edition, Third Edition, 2008.

Mechanical Engineering			
ME634	**Innovative Design**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the conceptual development techniques to find solution for a critical design issue.
2. Apply embodiment principles to translate the conceptual ideas to engineering design.
3. Apply environmental, ethical and social issues during innovative design process.
4. Design and develop innovative engineering products for industrial needs using robust design philosophy.

Contents:

Module-I

Introduction: Innovations in Design, Engineering Design Process, Prescriptive and integrative models of design, Design Review and societal considerations. (8)

Module-II

Identification of Customer Need: Evaluating Customer requirements and survey on customer needs, Conversion of customer needs into technical Specifications, Information sources. (8)

Module-III

Concept Generation and Evaluation: Creativity and Problem solving, Brainstorming, Theory of Inventive Problem solving (TRIZ), Functional Decomposition of the problem for innovative concept development, Morphological design, Introduction to Axiomatic Design, Concept evaluation and decision making. (10)

Module-IV

Embodiment Design: Introduction, Product Architecture, Configuration and Parametric design Concepts, Industrial Design, Taguchi Methods. (7)

Module-V

Design for X: Design for Manufacturing, Design for Assembly, Design for Environment, Design for Reliability and Robustness, Introduction to FMEA and FMECA. (7)

Text Books:

(i) Nigel Cross, Engineering Design Methods, John Wiley, 2009.

(ii) George E. Dieter, Engineering Design, McGraw-Hill, 2009.

(iii) GenrichAltshuller, The Innovation Algorithm, Technical Innovation Centre, 2011.

Mechanical Engineering			
ME635	**Supply Chain Management**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the decision phases and apply competitive & supply chain strategies.
2. Understand drivers of supply chain performance.
3. Analyze factors influencing network design.
4. Analyze the influence of forecasting in a supply chain.
5. Understand the role of aggregate planning, inventory, IT and coordination in a supply chain.

Contents:

Module-I

Strategic Framework: Introduction to Supply Chain Management, Decision phases in a supply chain, Process views of a supply chain: push/pull and cycle views, Achieving Strategic fit, Expanding strategic scope. (6)

Module-II

Supply Chain Drivers and Metrics: Drivers of supply chain performance, Framework for structuring Drivers, Obstacles to achieving strategic fit. (5)

Module-III

Designing Supply Chain Network: Factors influencing Distribution Network Design, Design options for a Distribution network, E-Business and Distribution network, Framework for Network Design Decisions, Models for Facility Location and Capacity Allocation. (10)

Module-IV

Forecasting in SC: Role of forecasting in a supply chain, Components of a forecast and forecasting methods, Risk management in forecasting. (5)

Module-V

Aggregate Planning and Inventories in SC: Aggregate planning problem in SC, Aggregate Planning Strategies, Planning Supply and Demand in a SC, Managing uncertainty in a SC: Safety Inventory. (8)

Module-VI
Coordination in SC: Modes of Transportation and their performance characteristics, Supply Chain IT framework, Coordination in a SC and Bullwhip Effect. (4)

Module-VII
Green Supply Chain Management: Introduction and Concept. (2)

Text Books:
(i) Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 4th Edition, Pearson Education Asia, 2010.
(ii) David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, Designing and Managing the Supply Chain - Concepts Strategies and Case Studies, 2nd Edition, Tata-McGraw Hill, 2000.

Mechanical Engineering			
ME641	**Automobile Engineering**	**L**	**T**
		3	**0**

Objectives:
To understand the construction and working principle of various parts of an automobile

Contents:

Module-I
Types of automobiles, vehicle construction and layouts, chassis, frame and body, vehicle aerodynamics, IC engines- components, function and materials, variable valve timing (VVT). (5)

Module-II
Engine auxiliary systems, electronic injection for SI and CI engines, unit injector system, rotary distributor type and common rail direct injection system, transistor based coil ignition& capacitive discharge ignition systems, turbo chargers (WGT, VGT), engine emission control by 3-way catalytic converter system, Emission norms (Euro & BS). (10)

Module-III
Transmission systems, clutch types & construction, gear boxes- manual and automatic gearshift mechanisms, over drive, transfer box, flywheel, torque converter, propeller shaft, slip joints, universal joints, differential and rear axle, Hotchkiss drive and Torque tube drive. (5)

Module-IV
Steering geometry and types of steering gear box, power steering, types of front axle, types of suspension systems. (5)

Module-V
Pneumatic and hydraulic braking systems, antilock braking system (ABS), electronic brake force distribution (EBD) and traction control. (5)

Module-VI
Alternative energy sources, natural gas, LPG, biodiesel, bio-ethanol, gasohol and hydrogen fuels in automobiles, modifications needed, performance, combustion & emission characteristics of alternative fuels in SI and CI engines. (7)

Module-VII
Electric and Hybrid vehicles, application of Fuel Cells. (3)

Course Outcomes:
Upon completion of this course, students will understand the function of each automobile component and also have a clear idea about the overall vehicle performance.

Text books:
(i) Kirpal Singh, Automobile Engineering, 7thed., Standard Publishers, New Delhi, 1997.
(ii) Jain K.K. and Asthana R.B., Automobile Engineering, Tata McGraw Hill, New Delhi,2002.
(iii) Heitner J., Automotive Mechanics, 2nd ed., East-West Press, 1999.
(iv) Heisler H., Advanced Engine Technology, SAE International Publ., USA, 1998.

Mechanical Engineering			
ME642	**Engineering Economics and Accountancy**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Prepare accounting records and summarize and interpret the accounting data for managerial decisions.
2. Understand the macro-economic environment of the business and its impact on enterprise.
3. Understand cost elements of the product and its effect on decision making.
4. Understand the concepts of financial management and smart investment.

Contents:

Module-I
Engineering Economics: Introduction to Engineering Economics – Fundamental concepts – Time value of money – Cash flow and Time Diagrams – Choosing between alternative investment proposals – Methods of Economic analysis. (8)

Module-II
The effect of borrowing on investment- Various concepts of National Income – Significance of National Income estimation and its limitations, Inflation –Definition – Process and Theories of Inflation and measures to control. (8)

Module-III
New Economic Policy 1991 – Impact on industry. (4)

Module-IV
Accountancy: Accounting Principles, Procedure – Double entry system – Journal – Ledger, Trail Balance – Cash Book – Preparation of Trading, Profit and Loss Account – Balance sheet. (10)

Module-V
Cost Accounting – Introduction – Classification of costs – Methods of costing – Techniques of costing – Cost sheet and preparation of cost sheet- Breakeven Analysis – Meaning and its application, Limitations. (10)

Text Books:

(i) Henry Malcom Stenar-Engineering Economic Principles, McGraw Hill Pub.

(ii) Dewett K.K., “Modern Economic Theory”, Siltan Chand & Co.

(iii) Agrawal AN,”Indian Economy” Wiley Eastern Ltd, New Delhi

(iv) Jain and Narang “Accounting Part-I’, Kalyani Publishers

(v) Arora, M.N. “Cost Accounting”, Vikas Publications.

Mechanical Engineering			
ME643	**Reliability Engineering**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the concepts of reliability, availability and maintainability
2. Develop hazard-rate models to know the behavior of components
3. Build system reliability models for different configurations
4. Asses reliability of components and systems using field and test data
5. Implement strategies for improving reliability of repairable and non-repairable systems

Contents:

Module-I

Introduction: Probabilistic reliability, failures and failure modes, repairable and non-repairable items, pattern of failures with time, reliability economics. (6)

Module-II

Component Reliability Models: Basics of probability & statistics, hazard rate & failure rate, constant hazard rate model, increasing hazard rate models, decreasing hazard rate model, time-dependent & stress-dependent hazard models, bath-tub curve. (10)

Module-III

System Reliability Models: Systems with components in series, systems with parallel components, combined series-parallel systems, k-out-of-m systems, standby models, load-sharing models, stress-strength models, reliability block diagram. (10)

Module-IV

Life Testing & Reliability Assessment: Censored and uncensored field data, burn-in testing, acceptance testing, accelerated testing, identifying failure distributions & estimation of parameters, reliability assessment of components and systems. (8)

Module-V

Reliability Analysis & Allocation: Reliability specification and allocation, failure modes and effects and criticality analysis (FMECA), fault tree analysis, cut sets & tie sets approaches; Maintainability Analysis: Repair time distribution, MTTF / MTBF, MTTR, availability, maintainability, preventive maintenance. (6)

Text Books:

(i) Ebeling CE, An Introduction to Reliability and Maintainability Engineering, TMH, New Delhi, 2004.

(ii) O'Connor P and Kleymer A, Practical Reliability Engineering, Wiley, 2012.

Mechanical Engineering			
ME644	**Theory of Constraints**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the philosophy of TOC.
2. Assess the system performance using throughput accounting.
3. Apply DBR and OPT methodologies for manufacturing scheduling.
4. Implement critical chain methodology for project scheduling
5. Understand TOC thinking process tools including CRT, EC, FRT and PRT

Contents:

Module-I

Introduction: Basic philosophy, local and global optima, five focusing steps of TOC, comparison with TQM & JIT philosophies. (8)

Module-II

Throughput Accounting: Financial and operating measures, local and global performance measures, throughput, inventory, operating expenses, linking concepts of throughput accounting with financial accounting. (10)

Module-III

Manufacturing Scheduling: Line and job shop processes, make-to-stock and make-to-order environments, scheduling rules, DBR methodology for scheduling line processes, OPT methodology for scheduling job shops, buffering and types of buffers, buffer management. (10)

Module-IV

Project Scheduling: Critical chain methodology, developing single-project critical chain plan, developing multi-project critical chain plan, buffer and threshold sizing, project risk management. (5)

Module-V

TOC Thinking Process: Current reality tree, evaporating clouds, future reality tree, prerequisite tree, transition tree. (7)

Text Books:

(i) Dettmer H. W., Goldratt's Theory of Constraints: A Systems Approach to Continuous Improvement. ASQ Quality Press, Wiscousin, 1997.

(ii) Leach, L.P, Critical Chain Project Management, 2nd Edition, Artech House Inc, London, 2005.

Mechanical Engineering			
ME645	**Environmental Impact Assessment**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Identify the environmental attributes to be considered for the EIA study.
2. Formulate objectives of the EIA studies
3. Identify the suitable methodology and prepare Rapid EIA.
4. Prepare EIA reports and environmental management plans.
5. Plan the methodology to monitor and review the relief and rehabilitation works.

Contents:

Module-I

Introduction: The Need for EIA, Indian Policies Requiring EIA , The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements. (10)

Module-II

Identifying the Key Issues: Key Elements of an Initial Project Description and Scoping, Project Location(s), Land Use Impacts, Consideration of Alternatives, Process selection: Construction Phase, Input Requirements, Wastes and Emissions, Air Emissions, Liquid Effluents, Solid Wastes, Risks to Environment and Human, Health, Socio-Economic Impacts, Ecological Impacts, Global Environmental Issues.

(8)

Module-III

EIA Methodologies: Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods. (4)

Module- IV

Environmental index using factor analysis, Cost/benefit analysis, Predictive or Simulation methods. Rapid assessment of Pollution sources method, predictive models for impact assessment, Applications for RS and GIS. (3)

Module-V

Reviewing the EIA Report: Scope, Baseline Conditions, Site and Process alternatives, Public hearing. Construction Stage Impacts, Project Resource Requirements and Related Impacts, Prediction of Environmental Media Quality, Socio-economic Impacts, Ecological Impacts, Occupational Health Impact, Major Hazard/ Risk Assessment, Impact on Transport System, Integrated Impact Assessment. (6)

Module-VI

Review of EMP and Monitoring: Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, What should be monitored? Monitoring Methods, Who should monitor? Pre-Appraisal and Appraisal. (6)

Module-VII

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Tannery industry. (7)

Text Books:

1. Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.
2. Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers, 2002
3. Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.
4. Anjaneyulu.Y., and Manickam. V., Environmental Imapact Assessment Methodologies, B.S. Publications, Hyderabad, 2007.
5. Wathern.P., Environmental Impact Assessment- Theory and Practice, Routledge Publishers, London, 2004.

Mechanical Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

[1]. Hisrich & Peters, "Entrepreneurship", Tata McGraw Hill

[2]. Roy, Rajeev, "Entrepreneurship", Oxford University Press

[3]. Norman M. Scarborough, "Essentials of Entrepreneurship & Small Business Management", 6^{th} ed., Prentice Hal

[4]. Dutta, Bholanath, "Entrepreneurship management" ,Excel Books.

Electrical Engineering			
EE601	**Power Electronics**	**L**	**T**
		3	**1**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their switching characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation, switching techniques and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and various configurations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices (7 Lectures)

Diode, Thyristor, MOSFET, IGBT, GTO: constructional features, I-V Characteristics; Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a thyristor.

Module II: AC-DC Converters (6 Lectures)

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter **(10 Lectures)**
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module IV: Single-Phase Voltage Source Inverter **(8 Lectures)**
Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage.

Module V: Three-Phase Voltage Source Inverter **(7 Lectures)**
Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation

Module VI: AC Voltage Controllers **(4 Lectures)**
Introduction, principle of on-off control, principle of phase control and integral cycle control, configuration of three phase controllers, cycloconverter.

Text/References Books:

[1]. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
[2]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
[3]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.
[4]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Electrical Engineering			
EE611	**Power Systems-II**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Illustrate** power system components using single line diagram and usage of per unit system.
CO2	**Calculate** symmetrical components and **Examine** different types of faults (both symmetrical and unsymmetrical).
CO3	**Formulate** nodal admittance (Y-bus) matrix, and **develop** load flow equations and **find** its solution.
CO4	**Illustrate** the concept of stability, power angle curve, and swing equation and **diagnose** steady-state and transient stability of the power system.
CO5	**Apply** different types of active, reactive and voltage control techniques.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	2	1	3	2							
CO3	3	2	1	3	2							2
CO4	3	3	1	2	2							2
CO5	3	3	1	2	2							2
Avg.	**3**	**2.4**	**1**	**2.5**	**2**							**2**

DETAILED SYLLABUS

Module I: Per Unit System and Faults **(10 Lectures)**

Per Unit meaning and its calculation. Need and advantages of per unit system, Selection of base quantities, per unit impedance for 1-φ and 3 – φ system. Change of base value. Faults causes and consequences. Classification of faults and statistics of occurrence.

Fortescue theorem, Method of symmetrical components (positive, negative and zero sequences). Symmetrical component transformation. Sequence networks for generators, lines and transformers. Sequence network for power system. Balanced and Unbalanced faults, computation of fault currents.

Module II: Load Flow Analysis **(10 Lectures)**

Review of the structure of power system and its components, Bus classification, formulation of Y_{bus} matrix, power flow equations. Gauss – Seidel method, algorithm, derivation of iterarative equation, modification for PV bus, Advantages and disadvantages, acceleration factor. Newton – Raphson method, algorithm, power mismatch vector, size of Jacobian matrix and its elements. Advantages and disadvantages.

Module III: Power system Stability **(11 Lectures)**

Concept of power system stability and it's classification. Dynamic equation of synchronous machine. Swing equation and power angle curve. Single machine infinite bus system. Large signal stability, Equal area criteria, derivation. Critical clearing angle and effect of clearing time on stability. Methods for improvement of transient stability. Introduction to Multi – machine transient stability.

Module IV: Economic Operation of Power Systems **(5 Lectures)**

Input-output characteristics of thermal and hydro plants, Optimum generator allocations without and with transmission losses, calculation of penalty factors, incremental transmission loss, transmission loss coefficients and their calculations.

Module V: Load Frequency Control: **(6 Lectures)**

Concept of load frequency control, load frequency control of single area system, effect of governor droop and load damping, block diagram representation of single area system, steady state frequency error, dynamic response.

Text Books

[1]. J Grainger and W.D. Stevenson , " Power System Analysis '' , McGraw Hill Education , 1994.

[2]. A.J. Wood and B.F. Wollenberg, "Power Generation, Operation and Control", John Wiley and Sons,2011.

[3]. D.P. Kothari and I.J. Nagrath, " Modern Power System Analysis '' ,McGraw Hill Education 2003

[4]. O.L. Elgerd , " Electric energy systems theory '' , McGraw Hill Education , 1995.

Reference Books

[1]. Soni Gupta & Bhatnagar , " A course in Electric Power '' , Dhanpat Rai & Sons.

[2]. A R Bergen and V Vittal , " Power system analysis '' , Pearson Education Inc, 1999.

Electrical Engineering			
EE612	**Power System Restructuring**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students will be able to:

CO1	**Understand** the developments of restructuring worldwide.
CO2	**Identify** the roles and responsibilities of different entities in power market.
CO3	**Identify** issues like congestion management Ancillary Services Management.
CO4	**Evaluate** the transmission pricing schemes
CO5	**Explain** the Ancillary Services Management and the reforms in Indian power sector

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1	2	1	1								2
CO2	1	2	1	2		1						2
CO3	2	2	1	2		1			2			2
CO4	1	1	1	2					1			2
CO5	2	2	1	1								2
Avg.	**1.4**	**1.75**	**1.0**	**1.6**		**1**			**1.5**			**2**

DETAILED SYLLABUS

Module I: Introduction to Restructuring of Power Industry (8 Lectures)
Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models.

Module II: Electricity Market Model (8 Lectures)
Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading.

Module III: Transmission Congestion Management **(8 Lectures)**
Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion Management

Module IV: Locational Marginal Prices and Financial Transmission Rights **(5 Lectures)**
Mathematical preliminaries: - Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights.

Module – V: Transmission Pricing Schemes **(7 Lectures)**
Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Rolled-in transmission pricing paradigm, Marginal transmission pricing paradigm, Composite pricing paradigm, Merits and de-merits of different paradigms, Classification of loss allocation methods, Pro-rata methods, Incremental methods, Power flow tracing based allocation

Module – VI: Ancillary Service Management **(4 Lectures)**
Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service.

Module-VII: Reforms In Indian Power Sector **(2 Lectures)**
Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

Text Books

[1]. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured electrical power systems: operation, trading and volatility" Pub., 2001.
[2]. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.
[3]. Leo Lei Lai, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology" Wiley Pub. November 2001.
[4]. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley & Sons, 2002.

Text/Reference Books:

[1]. Making competition work in electricity Sally Hunt, John Wiley & Sons, Inc., 2002.
[2]. Marija llic, Francisco Galiana and Lestor Fink , Power System Restructuring Engineering & Economics , Kulwer Academic Publisher, USA-2000.

Electrical Engineering			
EE613	**Electrical Estimation and Costing**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the purpose of estimation and costing.
CO2	**Understand** distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses..
CO3	**Analyze** design of lighting points and its number, total load, sub-circuits, size of conductor.
CO4	**Understand** types of service mains and estimation of service mains and power circuits.
CO5	**Estimate** overhead transmission and distribution systems and its components.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1						2
CO2	3	3	3	2	1	1						2
CO3	3	3	3	2	1	1						2
CO4	3	3	3	2	1	1						2
CO5	3	3	3	2	1	1						2
Avg.	**3**	**3**	**3**	**2**	**1**	**1**						**2**

DETAILED SYLLABUS

Module I: Principles of Estimation (5 Lectures)
Introduction to estimation & costing, Electrical Schedule, Catalogues, Market Survey and source selection, Recording of estimates, Determination of required quantity of material, Labor conditions, Determination of cost material and labour,Contingencies, Overhead charges, Profit, Purchase system, Purchase enquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills, Tender form, General idea about IE rule, Indian Electricity Act and major applicable I.E rules.

Module II: Residential Building Electrification (7 Lectures)
Introduction to electrical symbols, their advantages and requirement. Concept of wiring diagram, schematic diagrams and their types. General Rules guidelines for wiring of residential installation and positioning of equipments**,** Principles of circuit design in lighting and power circuits Procedures for designing the circuits and deciding the number of circuits, Method of

drawing single line diagram. Selection of type of wiring and rating of wires and cables Load calculations and selection of size of conductor, Selection of rating of main switch Distribution board, protective switchgear ELCB and MCB and wiring accessories, Earthing of residential Installation, sequence to be followed for preparing estimate, Preparation of detailed estimates and costing of residential installation.

Module III: Electrification of Commercial Installation (7 Lectures)

Concept of commercial installation, Differentiate between electrification of residential and commercial installation, Fundamental considerations for planning of an electrical installation system for commercial building, Design considerations of electrical installation system for commercial building, Load calculation and selection of size of service connection and nature of supply, Deciding the size of the cables, busbar and bus bar chambers, Mounting arrangements and positioning of switchboards, distribution boards main switch etc, Earthing of the electrical installation, Selection of type wire, wiring system and layout, Sequence to be followed to prepare estimate, Preparation of detailed estimate and costing of commercial installation.

Module IV: Service Connection, Inspection and Testing of Installation (7 Lectures)

Concept of service connection, Types of service connection and their features, Method of installation of service connection, Estimates of underground and overhead service connections, Inspection of internal wiring installations, Inspection of new installations, testing of installations, testing of wiring installations, Reason for excess recording of energy consumption by energy meter.

Electrical Installation For Power Circuits: Introduction, Important considerations regarding motor installation wiring, Determination of input power, Determination of input current to motors Determination of rating of cables

Determination of rating of fuse, Determination of size of Condit, distribution Board main switch and starter.

Module V: Design and Estimation of Overhead Transmission & Distribution Lines (10 Lectures)

Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports, Factors governing height of pole, Conductor materials, Determination of size of conductor for overhead transmission line, Cross arms, Pole brackets and clamps,Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Overhead line insulators, Insulator materials, Types of insulators, Lightning Arrestors, Phase plates, Danger plates, Anti climbing devices, Bird guards, Beads of jumpers, Muffs, Points to be considered at the time of erection of overhead lines, Erection of supports, Setting of stays, Fixing of cross arms, Fixing of insulators, Conductor erection, Repairing and jointing of conductor , Dead end clamps, Positioning of conductors and attachment to insulators, Jumpers, Tee-offs, Earthing of transmission lines, Guarding of overhead lines, Clearances of conductor from ground, Spacing between conductors, Testing and commissioning of overhead distribution lines, Some important specifications.

Module VI: Design and Estimation of Substations (6 Lectures)

Introduction, Classification of substation, Indoor substations, Outdoor substations, Selection and location of site for substation, Main Electrical Connections, Graphical symbols for various types of apparatus and circuit elements on substation main connection diagram, Key diagram of typical substations, Equipment for substation and switchgear installations, Substation auxiliaries supply, Substation Earthing.

Text/Reference Books:

[1]. Raina K.B. and Bhattacharya S.K., “Electrical Design, Estimating and Costing”, New Age International, New Delhi, 2010

[2]. N. Alagappan & S. Ekambaram, “Electrical Estimating & Costing”, TMH,2006

[3]. Dr.S.L.Uppal, “Electrical Wiring, Estimating and Costing”, 5th Edition, Khanna Publishers,2003.

[4]. M.V. Deshpande, “Elements of Electrical Power Station Design”, PHI 2009.

[5]. J. B. Gupta, “A Course in Electrical Installation Estimating and Costing”, S. K. Kataria and Sons, India,2013.

[6]. ISI, National Electric Code, Bureau of Indian Standard Publications, New Delhi, 2011.

Electrical Engineering			
EE614	**Electrical Energy Conservation and Auditing**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Explain** about various energy sources, energy sector reforms and restructuring.
C02	**Explain** about energy management and auditing
C03	**Outline** various power factor improvement methods and energy saving methods
C04	**Illustrate** various energy efficient technologies and their energy saving potential

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	1								
CO2	3	2	2	1		1	1					
CO3	3	2	2	1		2	2					
CO4	3	2	2	1		2	2					
Average	**3**	**2**	**2**	**1**		**1.66**	**1.66**					

DETAILED SYLLABUS

Module I: Energy Scenario **(6 Lectures)**

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Module II: Basics of Energy and its various forms **(7 Lectures)**

Energy Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Module III: Energy Management & Audit **(6 Lectures)**

Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.

Module IV: Energy Efficiency in Electrical Systems **(7 Lectures)**

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors.

Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module V: Energy Efficiency in Industrial Systems **(8 Lectures)**

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Module VI: Energy Efficient Technologies **(8 Lectures)**

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver. Variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text/Reference Books:

[1]. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)

[2]. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)

[3]. S. C. Tripathy, “Utilization of Electrical Energy and Conservation”, McGraw Hill, 1991.

Electrical Engineering			
EE621	**High Voltage Engineering**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Read** the terms and numerical methods used in High Voltage engineering.
CO2	**Discuss** the different breakdown mechanisms in dielectrics and liquids.
CO3	**Analyze** the concept of Generation of High Voltages, High Currents, Impulse voltages and currents.
CO4	**Outline** the techniques employed in High Voltage Measurements.
CO5	**Generalize** with non-distractive test techniques in High Voltage Engineering.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/PO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2	2	2		1								
CO3		2	3		2							
CO4	1		3		2							
CO5	2	2	2		2							
Avg.	**2**	**2**	**2.7**	**1**	**2**							

DETAILED SYLLABUS

Module I: Introduction **(2 Lectures)**

Introduction to High voltage Engineering, its scope, Latest Trends, HVDC Transmission.

Module II: Electrical Discharges **(6 Lectures)**

Introduction, breakdown in gases, Townsend's criterion for breakdown, numerical. Streamers theory, Paschen's law, time lag for break down, breaks down under ac voltage, impulse voltage. Break down in electro negative gases, vacuum break down.

Module III: Generation of high voltage in Lab **(10 Lectures)**

Generation of HVAC: Different methods for generation of HVAC in lab, comparison between power and testing transformer, Cascaded transformer method, Resonant transformers, numericals. Generation of HVDC: Rectifier circuits, electrostatic generator, Cockroft Walton voltage multiplier circuit, numericals. Generation of Impulse voltage: Impulse wave and its characteristics, different forms of impulse wave, Different types of impulse generator circuits and their analysis. Multi stage impulse generator, its construction, layout, triggering and synchronization, numericals.

Module IV: High Voltage Measurement **(6 Lectures)**
Purpose of HV testing in lab, sphere gap its construction, working. Use of sphere gaps in HV measurement, factors affecting measurement by sphere gap. CRO- their types, principle and working, recurrent surge oscillograph, measurement using CRO.

Module V: Over Voltages **(12 Lectures)**
Origin and characteristics of over voltages on transmission lines, wave propagation, use of modal theory in wave propagation. Reflection and refraction of voltage and current waves over the line, Lattice diagram, Ferro resonance, numerical. External over voltages- Lightning over voltages, theories about lightning, development of lightning stroke, direct and indirect stroke, line model for lightning. Protection against over voltages, use of ground wire, tower footing resistance, lightning arrestors, etc. Insulation co ordination.

Module VI: Testing of Insulators **(6 Lectures)**
Definitions of various terms used in testing, testing of insulators, power transformers, cables. Non destructive Testing- Use of Schering Bridge, Partial discharge technique for testing of insulation.

Text/Reference Books:

[1]. Khalifa **, "**High Voltage Engineering**",** Marcel Dekker; 1st Printing edition,1990.
[2]. Kuffel, **"**High Voltage Engineering**",** Newnes,2000.
[3]. R.D. Begamudre, "EHV AC Transmission Engineering", New Age International,2011
[4]. Kamraju and Naidu, **"**High Voltage Engineering**",** Tata McGraw-Hill Education,2004.
[5]. C.L.Wadhwa, **"**High Voltage Engineering**",** New Age International,2007.

Electrical Engineering			
EE622	**Industrial Electrical Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the electrical wiring systems for residential, commercial and industrial consumers, representing the systems with standard symbols and single line drawings.
CO2	**Understand** various components of industrial electrical systems.
CO3	**Analyze and select** the proper size of various electrical system components.

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3									1
CO2	3	3	3									1
CO3	3	3	3		2							1
Avg.	**3**	**3**	**3**		**2**							**1**

DETAILED SYLLABUS

Module 1: Electrical System Components (8 Lectures)

LT system wiring components, selection of cables, wires, switches, distribution box, metering system, Tariff structure, protection components- Fuse, MCB, MCCB, ELCB, inverse current characteristics, symbols, single line diagram (SLD) of a wiring system, Contactor, Isolator, Relays, MPCB, Electric shock and Electrical safety practices.

Module 2: Residential and Commercial Electrical Systems (8 Lectures)

Types of residential and commercial wiring systems, general rules and guidelines for installation, load calculation and sizing of wire, rating of main switch, distribution board and protection devices, earthing system calculations, requirements of commercial installation, deciding lighting scheme and number of lamps, earthing of commercial installation, selection and sizing of components.

Module 3: Illumination Systems (6 Lectures)

Understanding various terms regarding light, lumen, intensity, candle power, lamp efficiency, specific consumption, glare, space to height ratio, waste light factor, depreciation factor, various illumination schemes, Incandescent lamps and modern luminaries like CFL, LED and their operation, energy saving in illumination systems, design of a lighting scheme for a residential and commercial premises, flood lighting.

Module 4: Industrial Electrical Systems I **(8 Lectures)**
HT connection, industrial substation, Transformer selection, Industrial loads, motors, starting of motors, SLD, Cable and Switchgear selection, Lightning Protection, Earthing design, Power factor correction – kVAR calculations, type of compensation, Introduction to PCC, MCC panels. Specifications of LT Breakers, MCB and other LT panel components.

Module 5: Industrial Electrical Systems II **(6 Lectures)**
DG Systems, UPS System, Electrical Systems for the elevators, Battery banks, Sizing the DG, UPS and Battery Banks, Selection of UPS and Battery Banks.

Module 6: Industrial Electrical System Automation **(6 Lectures)**
Study of basic PLC, Role of in automation, advantages of process automation, PLC based control system design, Panel Metering and Introduction to SCADA system for distribution automation.

Text/Reference Books:

[1]. S. L. Uppal and G. C. Garg, "Electrical Wiring, Estimating & Costing", Khanna publishers, 2008.
[2]. K. B. Raina, "Electrical Design, Estimating & Costing", New age International, 2007.
[3]. S. Singh and R. D. Singh, "Electrical estimating and costing", Dhanpat Rai and Co., 1997.
[4]. H. Joshi, "Residential Commercial and Industrial Systems", McGraw Hill Education, 2008.

Electrical Engineering			
EE623	**Special Electrical Machines**	**L**	**T**
		3	**0**

Course Outcomes:
After Successful completion of course, the students will be able to:

COs	**Description**
CO 1	**Identify** and differentiate various electrical machines.
CO2	**Analyze** the torque speed characteristics and transfer function of Permanent Magnet Synchronous Motors(PMSM).
CO3	**Explain** the construction, working principle and performance of Stepper Motor
CO4	**Compare** and **contrast** the open loop and closed loop systems for servo motors.
CO5	**Classify** the different types of tachogenerators and its characteristics.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2			2	1						2
CO2	3	2			2	1						
CO3	3	1		2	2	1						

CO4	2	1	2			1						
CO5	2	1	1		3	1						
Avg.	**2.6**	**1.3**	**1.5**	**2**	**2.25**	**1**						**2**

DETAILED SYLLABUS

Module I: FHP Universal Commutator motors **(6 Lectures)**

Principle of operation and performance characteristics of universal commutator motor without and with compensating windings, phasor diagrams and expressions for power and torque, speed-torque characteristics with DC and AC excitations.

Module II: FHP Synchronous Motors **(12 Lectures)**

Permanent magnet synchronous motors, hysteresis motors, synchronous reluctance motors, switched reluctance motors, brushless dc motors.

Module III: Stepper motors **(12 Lectures)**

Introduction, Multi-stack variable-reluctance stepping motors, Principles of operation , Aspects of design ,Single stack variable-reluctance stepping motors, Hybrid stepping motors, comparison of motor types, design of drive circuits, torque/rotor position characteristics.

Module IV: Servomotors **(6 Lectures)**

DC and AC servomotors, transfer function analysis, Synchros.

Module V: Tacho generators **(6 Lectures)**

DC tachogenerators, Induction and synchronous AC tachgenerators, characteristics and applications.

Text/Reference Books:

[1]. P.C. Sen, “Principles of Electric Machines and Power Electronics”, 2nd Edition, Wiley India Ltd. 2007
[2]. E. Openshaw Taylor, “The Performance and Design of AC Commutator Motors”, Wheeler Publishing, 1997
[3]. R. Krishnan, “Switched Reluctance Motor Drives”, 1st Edition, CRC Press. 2001
[4]. T.J.E. Miller and J.R. Hendershot, “Switched Reluctance Motors & Their Control”, Magna Physics Publishing, 1st Edition 1993
[5]. T.J.E. Miller, “Electronic Control of Switched Reluctance Machines”,1st Edition, Newnes. 2001
[6]. K.Venkataratnam, “Special Electrical Machines”, Universities Press 2008
[7]. E.V. Armensky and G.B. Falk, “Fractional Horsepower Electrical Machines”, Mir Publishers 1978
[8]. John Chiasson “Modeling and High-Performance Control of Electric Machines” John Wiley & Sons, Inc., Publication 2005
[9]. P. P. Acarnley “Stepping Motors : a guide to theory and practice” IET Control Engineering series 2002.

Electrical Engineering			
EE624	**Power System Transient**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Explain** the causes and characteristics for switching, lightning and temporary over voltages.
CO2	**Apply** and carry out simple analytical calculations of transient over voltages and currents in power systems
CO3	**Explain** critical switching and lightning voltages situations
CO4	**Illustrate** the travelling wave's phenomenon on transmission lines, use of Bewley's lattice to study travelling waves
CO5	**Illustrate** switching surges on integrated power system and application of EMTP for transient computations

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)
2.

COs/POs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	1	2		2								2
CO2	3	3	2	3			1					2
CO3	2	2	2				1					2
CO4	3	3	2	2			2					2
CO5	3	3	2	2			2					2
Avg.	**2.4**	**2.6**	**2.0**	**2.25**			1.5					2.0

DETAILED SYLLABUS

Module I: Introduction and Survey **(9 Lectures)**

Review and importance of the study of transients - causes for transients. RL circuit transient with sine wave excitation - double frequency transients - basic transforms of the RLC circuit transients. Different types of power system transients - effect of transients on power systems role of the study of transients in system planning.

Module II : Switching Transients **(9 Lectures)**

Over voltages due to switching transients - resistance switching and the equivalent circuit for interrupting the resistor current - load switching and equivalent circuit - waveforms for transient voltage across the load and the switch - normal and abnormal switching transients. Current suppression - current chopping - effective equivalent circuit. Capacitance switching - effect of source regulation - capacitance switching with a restrike, with multiple restrikes. Illustration for multiple restriking transients – ferro-resonance.

Module III: Lighting Transients (8 Lectures)

Review of the theories in the formation of clouds and charge formation - rate of charging of thunder clouds – mechanism of lightning discharges and characteristics of lightning strokes – model for lightning stroke - factors contributing to good line design - protection using ground wires – tower footing resistance-Interaction between lightning and power system.

Module IV: Raveling Waves On Transmission Line Computation of Transients (8 Lectures)

Computation of transients - transient response of systems with series and shunt lumped parameters and distributed lines. Traveling wave concept - step response - Bewely's lattice diagram – standing waves and natural frequencies - reflection and refraction of travelling waves.

Module V: Transient in Integrated Power System (8 Lectures)

The short line and kilometric fault - distribution of voltages in a power system - Line dropping and load rejection - voltage transients on closing and reclosing lines - over voltage induced by faults - switching surges on integrated system Qualitative application of EMTP for transient computation.

Text Books:

[1]. Allan Greenwood, 'Electrical Transients in Power Systems', Wiley Interscience, New York, 2nd edition 1991.

[2]. R.D.Begamudre, 'Extra High Voltage AC Transmission Engineering', Wiley Eastern limited, 1986.

References Books:

[1]. M.S.Naidu and V.Kamaraju, 'High Voltage Engineering', Tata McGraw Hill, 2nd edition, 2000.

Electrical Engineering			
EE631	**Power Electronics***	**L**	**T**
		3	**0**

(This course is not offered to Electrical Engg. Students)

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their switching characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation, switching techniques and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and various configurations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices (7 Lectures)

Diode, Thyristor, MOSFET, IGBT, GTO: constructional features, I-V Characteristics; Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a thyristor.

Module II: AC-DC Converters (6 Lectures)

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter **(10 Lectures)**
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module IV: Single-Phase Voltage Source Inverter **(8 Lectures)**
Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage**.**

Module V: Three-Phase Voltage Source Inverter **(7 Lectures)**
Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation

Module VI: AC Voltage Controllers **(4 Lectures)**
Introduction, principle of on-off control, principle of phase control and integral cycle control, configuration of three phase controllers, cycloconverter.

Text/References Books:

[5]. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education India, 2009.
[6]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
[7]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2007.
[8]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Electrical Engineering			
EE632	**Green Energy Technology**	**L**	**T**
		3	**0**

Course Outcome:

After successful completion of the course students will be able to:

CO1	**Identify** different non-conventional energy system and **explain** the principle of thermo-electrical and thermionic conversions
CO2	**Analyze** the performance and limitations of the solar and wind energy conversion system
CO3	**Illustrate** the concept of geothermal energy.
CO4	**Outline** the basics of fuel cells.
CO5	**Understand** the principles behind the bio-mass, ocean thermal and wave energy conversions.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1	1		1					1
CO2	3	2	2	2	1		1					1
CO3	1	1		1	1		1					1
CO4	2	1	1	1	1		1					1
CO5	2	1	1	1	1		1					1
Avg.	**2.2**	**1.2**	**1.33**	**1.2**	**1**		**1**					**1**

DETAILED SYLLABUS

Module I: Introduction (6 Lectures)

Basics of energy, conventional energy sources, fossil fuels limitations, renewable energy sources, advantages and limitations, global energy scenario, energy scenario of India, new technologies (hydrogen energy, fuel cells, bio fuels).

Module II: Solar Energy (12 Lectures)

Theory of solar cells, solar cell materials, I-V characteristics of solar cell, PV module, PV array, MPPT, PV systems, Stand alone and grid connected PV systems, storage, PV based water pumping, solar radiation and its measurement, flat plate collectors and their materials, applications and performance, solar thermal power plants, limitations.

Module III: Wind Energy (10 Lectures)

Wind power and its sources, site selection, power in the wind, impact of tower height, classification of wind turbine and rotors, wind energy extraction, betz'z limit, wind characteristics, performance and limitations of wind energy conversion systems.

Module IV: Biomass and Geothermal energy **(8 Lectures)**

Availability of biomass and its conversion theory, types of biomass, gasification, biogas plant, biomass cogeneration, resources of geothermal energy, thermodynamics of geo-thermal energy conversion, geothermal power generation, environmental considerations.

Module V: Emerging technologies for power generation **(6 Lectures)**

Introduction to tidal energy, tidal characteristics, tidal power plant, tidal power development in India, introduction to wave energy, factors affecting wave energy, principles of wave energy plant, OTEC, applications of OTEC, principle of working of various types of fuel cells and their working, performance and limitations, future potential of fuel cells, Emergence of hydrogen, cost analysis of hydrogen production, hydrogen storage.

Text/Reference Books:

[1]. Duffie and Beckmen, Solar Engineering of Thermal Processes, Wiley Publications, 1991.
[2]. S. P. Sukhatme, Solar Energy, TMH, India. 2008.
[3]. John Twiden and Tony Weir, Renewable Energy Resources, BSP Publications, 2006.
[4]. D. P. Kothari, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, India,2011.
[5]. Non Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd., 2006.

Electrical Engineering			
EE633	**Mine Electrical Engineering***	**L**	**T**
		3	**0**

(This course is not offered to Electrical Engg. students)

Pre-requisite: Basic Electrical Engineering and Basic Electronics Engineering.

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** different types of power supply systems and protection schemes used underground coal mines.
CO2	**Understand** different types of circuit breakers used in Mines.
CO3	**Analyze** illumination, Intrinsically Safe circuit methods of attaining intrinsic safety, Zener safety barriers and their applications in mines.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1		1						2
CO2	3	3	2	1		1						2
CO3	3	3	2	1		1						2
CO4	3	3	2	1		1						2
CO5	3	3	12	1		1						2
Avg.	**3**	**3**	**2**	**1**		**1**						**2**

DETAILED SYLLABUS

Module I:

Types of electrical power supply systems for underground coal mines–solidly earthed, restricted neutral and insulated – neutral systems of electrical power supply; their comparisons. Earth fault protection techniques for above mine power supply systems, sensitive and fail-safe earth fault relays. On-line insulation monitoring for insulated-neutral electrical distribution system.

Module II:

Mining type circuit breakers–Air circuit breaker, vacuum and Hexa Sulfa Flouride(SF6) circuit breakers, Field switch, Tran switch unit, Gate End Box, Drill Panel.

Module III:

Electrical power planning for mechanized longwall faces–general scheme of electrical power distribution, voltage drop problems and remedial measures; in bye substation capacity selection.

General scheme of electrical power distribution in opencast projects, Quarry substation capacity selection. Choice of restricted-neutral and insulated-neutral systems in open cast mines.

Module IV:
Illumination planning for mines–underground roadway lighting system; intrinsically-safe lighting system for longwall faces, opencast mine lighting. Earthing practice in mines – earth pits, earthing of mobile electrical equipment in mines. Mining cables – types, constructional details; layout of cables through shaft and other locations.

Module V:
Principles of flame proof enclosures. Intrinsically safe circuit methods of attaining intrinsic safety, Zener safety barriers and their applications. Indian electricity rules as applied to mines.

Text/Reference Books:

[1]. A Text Book on Power Systems Engineering – Soni Gupta, Bhatnagar, Chakarbarti, Dhanpat Rai & Sons.
[2]. Electrical Equipment in mines- Harry Cotton, George Newness
[3]. Switchgear and Protection- S.S. Rao, Khanna Publications.
[4]. Indian Electricity Rules.
[5]. Principles of Mine Planning J. Bhattacharya, Allied Publications.
[6]. Universal Mining School Series (UK)
[7]. Coal Mining Practice- J.C. F Statham Vol III, Heart Series.
[8]. Electrical Power Systems – C.L. Wadhwa, New Age International Publishers.

Electrical Engineering			
EE641	**Special Electrical Machines***	**L**	**T**
		3	**0**

(This course is not offered to Electrical Engg. Students)

Course Outcomes:

After Successful completion of course, the students will be able to:

COs	Description
CO 1	**Identify** and differentiate various electrical machines.
CO2	**Analyze** the torque speed characteristics and transfer function of Permanent Magnet Synchronous Motors(PMSM).
CO3	**Explain** the construction, working principle and performance of Stepper Motor
CO4	**Compare** and **contrast** the open loop and closed loop systems for servo motors.
CO5	**Classify** the different types of tachogenerators and its characteristics.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			2	1						2
CO2	3	2			2	1						
CO3	3	1		2	2	1						
CO4	2	1	2			1						
CO5	2	1	1		3	1						
Avg.	**2.6**	**1.3**	**1.5**	**2**	**2.25**	**1**						**2**

DETAILED SYLLABUS

Module I: FHP Universal Commutator motors (6 Lectures)

Principle of operation and performance characteristics of universal commutator motor without and with compensating windings, phasor diagrams and expressions for power and torque, speed-torque characteristics with DC and AC excitations.

Module II: FHP Synchronous Motors (12 Lectures)

Permanent magnet synchronous motors, hysteresis motors, synchronous reluctance motors, switched reluctance motors, brushless dc motors.

Module III: Stepper motors (12 Lectures)

Introduction, Multi-stack variable-reluctance stepping motors, Principles of operation , Aspects of design ,Single stack variable-reluctance stepping motors, Hybrid stepping motors, comparison of motor types, design of drive circuits, torque/rotor position characteristics.

Module IV: Servomotors **(6 Lectures)**
DC and AC servomotors, transfer function analysis, Synchros.

Module V: Tacho generators **(6 Lectures)**
DC tachogenerators, Induction and synchronous AC tachgenerators, characteristics and applications.

Text/Reference Books:

[1]. P.C. Sen, "Principles of Electric Machines and Power Electronics", 2^{nd} Edition, Wiley India Ltd. 2007

[2]. E. Openshaw Taylor, "The Performance and Design of AC Commutator Motors", Wheeler Publishing, 1997

[3]. R. Krishnan, "Switched Reluctance Motor Drives", 1st Edition, CRC Press, 2001.

[4]. T.J.E. Miller and J.R. Hendershot, "Switched Reluctance Motors & Their Control", Magna Physics Publishing, 1st Edition 1993

[5]. T.J.E. Miller, "Electronic Control of Switched Reluctance Machines",1^{st} Edition, Newnes,2001

[6]. K.Venkataratnam, "Special Electrical Machines", Universities Press 2008

[7]. E.V. Armensky and G.B. Falk, "Fractional Horsepower Electrical Machines", Mir Publishers 1978

[8]. John Chiasson "Modeling and High-Performance Control of Electric Machines" John Wiley & Sons, Inc., Publication 2005

[9]. P. P. Acarnley "Stepping Motors : a guide to theory and practice" IET Control Engineering series ,2002.

Electrical Engineering			
EE642	**Soft Computing Techniques**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO1	**Distinguish** the concept between the hard and soft computing techniques.
CO2	**Understand** the basic concept of the Artificial Neural Network (ANN).
CO3	**Understand** the basic concept of the fuzzy logic system
CO4	**Explain** the concept of Genetic Algorithm (GA) and its limitation.
CO5	**Choose** the different kind of evolutionary programming for multi objective optimization problem based on their application.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2							2
CO2	3	3	3	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	3	2							2
CO5	3	3	3	2	2							2
Avg.	**3**	**3**	**3**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Fundamentals of Soft Computing Techniques (4 Lectures)

Conventional and Modern Control System, Intelligence, Soft and Hard Computing, Artificial Intelligence.

Module-II: Artificial Neural Network (10 Lectures)

Introduction to Artificial neural networks-biological neurons, Basic models of artificial neural networks- Connections, Learning, Activation Functions, McCulloch and Pitts Neuron.

Learning rule- Hebbian Learning, Perceptron Learning, Delta Learning- Training and Testing algorithm, Adaptive Linear Neuron, Back Propagation Network – Architecture, Training algorithm.

Module-III: Fuzzy Logic System-I (8 Lectures)

Fuzzy Logic- Fuzzy sets- Properties- Operation on fuzzy sets, fuzzy relations- operations on fuzzy relations.

Fuzzy membership functions, fuzzification, Methods of membership value assignments- intuition- inference- rank ordering, Lambda- cuts for fuzzy sets, Defuzzification methods.

Module –IV: Fuzzy Logic System-II **(7 Lectures)**

Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules – Decomposition of rules- Aggregation of rules, Fuzzy Inference Systems- Mamdani and Sugeno types, Neuro-fuzzy hybrid systems – characteristics- classification

Module-V: **(8 Lectures)**

Introduction to genetic algorithm, operators in genetic algorithm – coding – selection – cross over – mutation, Stopping condition for genetic algorithm flow, Generational Cycle, Applications.

Module-VI: **(5 Lectures)**

Evolutionary Programming, Multi-objective Optimization Problem Solving and its applications, Genetic- neuro hybrid systems, Genetic-Fuzzy rule based system.

Text Books:

[1]. N.P Padhy, Artificial Intelligence and Intelligent Systems- Oxford University Press.
[2]. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing- Wiley India.
[3]. Timothy J. Ross, Fuzzy Logic with engineering applications – Wiley India.
[4]. M.E. E1- Hawary , Artificial Intelligence application in Power Systems, IEEE Press,2009
[5]. Jan Jantzen, Foundations of Fuzzy Control, A practical approach, Wiley,2013
[6]. M Gopal, Digital Control and State Variable Methods, conventional and neural-fuzzy control system, Published by Tata McGraw Hill Education Private Ltd,2012
[7]. David E Goldberg, Genetic Algorithms, published by Pearson 2008

Reference Books:

[1]. Satish Kumar, Neural Networks- Prentice Hall of India.

Electrical Engineering			
EE643	**Energy Storage Systems**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of this course, students will be able to:

CO's	CO Descriptions
CO1	analyze the characteristics of energy from various sources and need for storage
CO2	classify various types of energy storage and various devices used for the purpose
CO3	Identify various real time applications

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1							2
CO2	3	3	3	2	1							2
CO3	3	3	3	2	1							2
CO4	3	3	3	3	1							2
CO5	3	3	3	2	1							2
Avg.	**3**	**3**	**3**	**2**	**1**							**2**

DETAILED SYLLABUS

Module I: Electrical Energy Storage Technologies (8 Lectures)
Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

Module II: Needs for Electrical Energy Storage (8 Lectures)
Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

Module III: Features of Energy Storage Systems (8 Lectures)
Classification of EES systems , Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES),Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2),Synthetic natural gas (SNG).

Module IV: Types of Electrical Energy Storage systems (6 Lectures)
Electrical storage systems, Double-layer capacitors (DLC) ,Superconducting magnetic energy storage (SMES),Thermal storage systems ,Standards for EES, Technical comparison of EES technologies.

Module V: Applications **(10 Lectures)**

Present status of applications, Utility use (conventional power generation, grid operation & service) , Consumer use (uninterruptable power supply for large consumers),New trends in applications ,Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems ,Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA–aggregation of many dispersed batteries.

Text Books:

[1]. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

[2]. The Electrical Energy Storage by IEC Market Strategy Board.

Reference Book:

[1]. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

Electrical Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

[1].Hisrich & Peters, "Entrepreneurship", Tata McGraw Hill

[2].Roy, Rajeev, "Entrepreneurship", Oxford University Press

[3]. Norman M. Scarborough, "Essentials of Entrepreneurship & Small Business Management", 6th ed., Prentice Hal

[4]. Dutta, Bholanath, "Entrepreneurship management" ,Excel Books

Electrical & Electronics Engineering			
EEE601	**Power Electronics**	**L**	**T**
		3	**1**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their switching characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation, switching techniques and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and various configurations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices **(7 Lectures)**

Diode, Thyristor, MOSFET, IGBT, GTO: constructional features, I-V Characteristics; Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a thyristor.

Module II: AC-DC Converters **(6 Lectures)**

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter (10 Lectures)

Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module IV: Single-Phase Voltage Source Inverter (8 Lectures)

Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage**.**

Module V: Three-Phase Voltage Source Inverter (7 Lectures)

Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation

Module VI: AC Voltage Controllers (4 Lectures)

Introduction, principle of on-off control, principle of phase control and integral cycle control, configuration of three phase controllers, cycloconverter.

Text/References Books:

[1]. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.

[2]. N. Mohan and T. M. Undeland, “Power Electronics: Converters, Applications and Design”, John Wiley & Sons, 2007.

[3]. R. W. Erickson and D. Maksimovic, “Fundamentals of Power Electronics”, Springer Science & Business Media, 2007.

[4]. L. Umanand, “Power Electronics: Essentials and Applications”, Wiley India, 2009.

Electrical & Electronics Engineering			
EEE611	**Power Systems-II**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Illustrate** power system components using single line diagram and usage of per unit system.
CO2	**Calculate** symmetrical components and **Examine** different types of faults (both symmetrical and unsymmetrical).
CO3	**Formulate** nodal admittance (Y-bus) matrix, and **develop** load flow equations and **find** its solution.
CO4	**Illustrate** the concept of stability, power angle curve, and swing equation and **diagnose** steady-state and transient stability of the power system.
CO5	**Apply** different types of active, reactive and voltage control techniques.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	1									
CO2	3	2	1	3	2							
CO3	3	2	1	3	2							2
CO4	3	3	1	2	2							2
CO5	3	3	1	2	2							2
Avg.	**3**	**2.4**	**1**	**2.5**	**2**							**2**

DETAILED SYLLABUS

Module I: Per Unit System and Faults **(10 Lectures)**

Per Unit meaning and its calculation. Need and advantages of per unit system, Selection of base quantities, per unit impedance for 1-φ and 3 – φ system. Change of base value. Faults causes and consequences. Classification of faults and statistics of occurrence.

Fortescue theorem, Method of symmetrical components (positive, negative and zero sequences). Symmetrical component transformation. Sequence networks for generators, lines and transformers. Sequence network for power system. Balanced and Unbalanced faults, computation of fault currents.

Module II: Load Flow Analysis **(10 Lectures)**

Review of the structure of power system and its components, Bus classification, formulation of Y_{bus} matrix, power flow equations. Gauss – Seidel method, algorithm, derivation of iterarative equation, modification for PV bus, Advantages and disadvantages, acceleration factor. Newton – Raphson method, algorithm, power mismatch vector, size of Jacobian matrix and its elements. Advantages and disadvantages.

Module III: Power system Stability (11 Lectures)

Concept of power system stability and it's classification. Dynamic equation of synchronous machine. Swing equation and power angle curve. Single machine infinite bus system. Large signal stability, Equal area criteria, derivation. Critical clearing angle and effect of clearing time on stability. Methods for improvement of transient stability. Introduction to Multi – machine transient stability.

Module IV: Economic Operation of Power Systems (5 Lectures)

Input-output characteristics of thermal and hydro plants, Optimum generator allocations without and with transmission losses, calculation of penalty factors, incremental transmission loss, transmission loss coefficients and their calculations.

Module V: Load Frequency Control: (6 Lectures)

Concept of load frequency control, load frequency control of single area system, effect of governor droop and load damping, block diagram representation of single area system, steady state frequency error, dynamic response.

Text Books

[1]. J Grainger and W.D. Stevenson , " Power System Analysis '' , McGraw Hill Education , 1994.
[2]. A.J. Wood and B.F. Wollenberg, "Power Generation, Operation and Control", John Wiley and Sons,2011.
[3]. D.P. Kothari and I.J. Nagrath, " Modern Power System Analysis '' ,McGraw Hill Education 2003
[4]. O.L. Elgerd , " Electric energy systems theory '' , McGraw Hill Education , 1995.

Reference Books

[1]. Soni Gupta & Bhatnagar , " A course in Electric Power '' , Dhanpat Rai & Sons.
[2]. A R Bergen and V Vittal , " Power system analysis '' , Pearson Education Inc, 1999.

Electrical & Electronics Engineering			
EEE612	**Power System Restructuring**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students will be able to:

CO1	**Understand** the developments of restructuring worldwide.
CO2	**Identify** the roles and responsibilities of different entities in power market.
CO3	**Identify** issues like congestion management Ancillary Services Management.
CO4	**Evaluate** the transmission pricing schemes
CO5	**Explain** the Ancillary Services Management and the reforms in Indian power sector

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	1	2	1	1								2
CO2	1	2	1	2		1						2
CO3	2	2	1	2		1			2			2
CO4	1	1	1	2					1			2
CO5	2	2	1	1								2
Avg.	**1.4**	**1.75**	**1.0**	**1.6**		**1**			**1.5**			**2**

DETAILED SYLLABUS

Module I: Introduction to Restructuring of Power Industry (8 Lectures)
Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models.

Module II: Electricity Market Model (8 Lectures)
Separation of ownership and operation, Deregulated models, pool model, pool and bilateral trades model, multilateral trade model. Competitive electricity market: Independent System Operator activities in pool market, Wholesale electricity market characteristics, central auction, single auction power pool, double auction power pool, market clearing and pricing, Market Power and its Mitigation Techniques, Bilateral trading.

Module III: Transmission Congestion Management **(8 Lectures)**
Introduction: Definition of Congestion, reasons for transfer capability limitation, Importance of congestion management, Features of congestion management – Classification of congestion management methods – Calculation of ATC - Non – market methods – Market methods – Nodal pricing – Inter zonal and Intra zonal congestion management – Price area congestion Management

Module IV: Locational Marginal Prices and Financial Transmission Rights **(5 Lectures)**
Mathematical preliminaries: - Locational marginal pricing– Lossless DCOPF model for LMP calculation – Loss compensated DCOPF model for LMP calculation – ACOPF model for LMP calculation – Financial Transmission rights.

Module – V: Transmission Pricing Schemes **(7 Lectures)**
Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Rolled-in transmission pricing paradigm, Marginal transmission pricing paradigm, Composite pricing paradigm, Merits and de-merits of different paradigms, Classification of loss allocation methods, Pro-rata methods, Incremental methods, Power flow tracing based allocation

Module – VI: Ancillary Service Management **(4 Lectures)**
Introduction of ancillary services – Types of Ancillary services – Classification of Ancillary services – Load generation balancing related services – Voltage control and reactive power support devices – Black start capability service.

Module-VII: Reforms In Indian Power Sector **(2 Lectures)**
Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

Text Books

[1]. Mohammad Shahidehpour, Muwaffaq Alomoush, Marcel Dekker, "Restructured electrical power systems: operation, trading and volatility" Pub., 2001.

[2]. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, "Operation of restructured power systems", Kluwer Academic Pub., 2001.

[3]. Leo Lei Lai, "Power System Restructuring and Deregulation: Trading, Performance and Information Technology" Wiley Pub. November 2001.

[4]. Steven Stoft, "Power system economics: designing markets for electricity", John Wiley & Sons, 2002.

Text/Reference Books:

[1]. Making competition work in electricity Sally Hunt, John Wiley & Sons, Inc., 2002.

[2]. Marija llic, Francisco Galiana and Lestor Fink , Power System Restructuring Engineering & Economics , Kulwer Academic Publisher, USA-2000.

Electrical & Electronics Engineering			
EEE613	**Electrical Estimation and Costing**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** the purpose of estimation and costing.
CO2	**Understand** distribution of energy in a building, wiring and methods of wiring, cables used in internal wiring, wiring accessories and fittings, fuses and types of fuses..
CO3	**Analyze** design of lighting points and its number, total load, sub-circuits, size of conductor.
CO4	**Understand** types of service mains and estimation of service mains and power circuits.
CO5	**Estimate** overhead transmission and distribution systems and its components.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	1	1						2
CO2	3	3	3	2	1	1						2
CO3	3	3	3	2	1	1						2
CO4	3	3	3	2	1	1						2
CO5	3	3	3	2	1	1						2
Avg.	**3**	**3**	**3**	**2**	**1**	**1**						**2**

DETAILED SYLLABUS

Module I: Principles of Estimation (5 Lectures)
Introduction to estimation & costing, Electrical Schedule, Catalogues, Market Survey and source selection, Recording of estimates, Determination of required quantity of material, Labor conditions, Determination of cost material and labour,Contingencies, Overhead charges, Profit, Purchase system, Purchase enquiry and selection of appropriate purchase mode, Comparative statement, Purchase orders, Payment of bills, Tender form, General idea about IE rule, Indian Electricity Act and major applicable I.E rules.

Module II: Residential Building Electrification (7 Lectures)
Introduction to electrical symbols, their advantages and requirement. Concept of wiring diagram, schematic diagrams and their types. General Rules guidelines for wiring of residential installation and positioning of equipments**,** Principles of circuit design in lighting and power circuits Procedures for designing the circuits and deciding the number of circuits, Method of

drawing single line diagram. Selection of type of wiring and rating of wires and cables Load calculations and selection of size of conductor, Selection of rating of main switch Distribution board, protective switchgear ELCB and MCB and wiring accessories, Earthing of residential Installation, sequence to be followed for preparing estimate, Preparation of detailed estimates and costing of residential installation.

Module III: Electrification of Commercial Installation (7 Lectures)
Concept of commercial installation, Differentiate between electrification of residential and commercial installation, Fundamental considerations for planning of an electrical installation system for commercial building, Design considerations of electrical installation system for commercial building, Load calculation and selection of size of service connection and nature of supply, Deciding the size of the cables, busbar and bus bar chambers, Mounting arrangements and positioning of switchboards, distribution boards main switch etc, Earthing of the electrical installation, Selection of type wire, wiring system and layout, Sequence to be followed to prepare estimate, Preparation of detailed estimate and costing of commercial installation.

Module IV: Service Connection, Inspection and Testing of Installation (7 Lectures)
Concept of service connection, Types of service connection and their features, Method of installation of service connection, Estimates of underground and overhead service connections, Inspection of internal wiring installations, Inspection of new installations, testing of installations, testing of wiring installations, Reason for excess recording of energy consumption by energy meter.
Electrical Installation For Power Circuits: Introduction, Important considerations regarding motor installation wiring, Determination of input power, Determination of input current to motors Determination of rating of cables
Determination of rating of fuse, Determination of size of Condit, distribution Board main switch and starter.

Module V: Design and Estimation of Overhead Transmission & Distribution Lines (10 Lectures)
Introduction, Typical AC electrical power system, Main components of overhead lines, Line supports, Factors governing height of pole, Conductor materials, Determination of size of conductor for overhead transmission line, Cross arms, Pole brackets and clamps,Guys and Stays, Conductors configuration spacing and clearances, Span lengths, Overhead line insulators, Insulator materials, Types of insulators, Lightning Arrestors, Phase plates, Danger plates, Anti climbing devices, Bird guards, Beads of jumpers, Muffs, Points to be considered at the time of erection of overhead lines, Erection of supports, Setting of stays, Fixing of cross arms, Fixing of insulators, Conductor erection, Repairing and jointing of conductor , Dead end clamps, Positioning of conductors and attachment to insulators, Jumpers, Tee-offs, Earthing of transmission lines, Guarding of overhead lines, Clearances of conductor from ground, Spacing between conductors, Testing and commissioning of overhead distribution lines, Some important specifications.

Module VI: Design and Estimation of Substations (6 Lectures)
Introduction, Classification of substation, Indoor substations, Outdoor substations, Selection and location of site for substation, Main Electrical Connections, Graphical symbols for various types

of apparatus and circuit elements on substation main connection diagram, Key diagram of typical substations, Equipment for substation and switchgear installations, Substation auxiliaries supply, Substation Earthing.

Text/Reference Books:

[1]. Raina K.B. and Bhattacharya S.K., "Electrical Design, Estimating and Costing", New Age International, New Delhi, 2010

[2]. N. Alagappan & S. Ekambaram, "Electrical Estimating & Costing", TMH,2006

[3]. Dr.S.L.Uppal, "Electrical Wiring, Estimating and Costing", 5th Edition, Khanna Publishers,2003.

[4]. M.V. Deshpande, "Elements of Electrical Power Station Design", PHI 2009.

[5]. J. B. Gupta, "A Course in Electrical Installation Estimating and Costing", S. K. Kataria and Sons, India,2013.

[6]. ISI, National Electric Code, Bureau of Indian Standard Publications, New Delhi, 2011.

Electrical & Electronics Engineering			
EEE614	**Electrical Energy Conservation and Auditing**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	**CO Description**
CO1	**Explain** about various energy sources, energy sector reforms and restructuring.
C02	**Explain** about energy management and auditing
C03	**Outline** various power factor improvement methods and energy saving methods
C04	**Illustrate** various energy efficient technologies and their energy saving potential

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	2	1								
CO2	3	2	2	1		1	1					
CO3	3	2	2	1		2	2					
CO4	3	2	2	1		2	2					
Average	**3**	**2**	**2**	**1**		**1.66**	**1.66**					

DETAILED SYLLABUS

Module I: Energy Scenario **(6 Lectures)**

Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

Module II: Basics of Energy and its various forms **(7 Lectures)**

Energy Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

Module III: Energy Management & Audit **(6 Lectures)**

Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments.

Module IV: Energy Efficiency in Electrical Systems **(7 Lectures)**

Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors.

Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

Module V: Energy Efficiency in Industrial Systems **(8 Lectures)**

Compressed Air System: Types of air compressors, compressor efficiency, efficient compressor operation, Compressed air system components, capacity assessment, leakage test, factors affecting the performance and savings opportunities in HVAC, Fans and blowers: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities. Pumps and Pumping System: Types, performance evaluation, efficient system operation, flow control strategies and energy conservation opportunities.

Cooling Tower: Types and performance evaluation, efficient system operation, flow control strategies and energy saving opportunities, assessment of cooling towers.

Module VI: Energy Efficient Technologies **(8 Lectures)**

Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver. Variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

Text/Reference Books:

[1]. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online)
[2]. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online)
[3]. S. C. Tripathy, "Utilization of Electrical Energy and Conservation", McGraw Hill, 1991.

Electrical & Electronics Engineering			
EEE621	**Analog and Digital Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	**Understand** the basic principles and fundamentals of analog & digital communication.
CO2	**Analyze** different types of modulation techniques and their performance in presence of noise.
CO3	**Apply** analytical skills for error detection and correction in communication.
CO4	**Understand** the concept of noise as a random process and its effect on communication receivers, ISI, Eye Pattern.
CO5	**Understand** the concept of information theory and source encoding.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	1	-	-	-	-	-	2	3	1
CO2	3	3	2	3	3	2	-	-	-	-	-	-
CO3	2	-	2	3	3	-	-	-	-	3	-	-
CO4	3	2	-	-	-	-	-	-	-	-	3	-
CO5	3	-	-	2	3	-	-	-	-	3	2	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	Signals and Signal Analysis: Periodic and nonperiodic signals, Composite signals, Signal analysis, Time and frequency domain representation. Introduction to Data and signal fundamentals, Analog and digital signals.	**8**
2	Analog Transmission: Concepts of carrier signal, noise, modulating signal and modulated signal; Amplitude modulation – double sideband suppressed carrier, double sideband transmitted carrier, single sideband; Frequency modulation –	**8**

	Narrowband FM and wideband FM; Digital to analog conversion – Amplitude shift keying, Frequency shift keying, Phase shift keying, Quadrature amplitude modulation, Performance.	
3	Digital Transmission: Problems with digital transmission, Different line coding schemes, Block coding schemes, Scrambling techniques; Analog to digital conversion – Sampling techniques, Sampling theorem, Pulse amplitude modulation, Pulse code modulation, Differential pulse code modulation, Delta modulation (along with advantages and disadvantages of each technique), Transmission modes (serial and parallel).	**10**
4	Multiplexing and Spreading: Concept of multiplexing, Frequency division multiplexing, Time division multiplexing – Synchronous and Statistical time division multiplexing.	**10**
5	Error Detection and Correction: Types of errors, Basic concepts of error detection and correction, Redundancy, Hamming distance, Error detection – Simple parity check codes, Two-dimensional parity check, Cyclic redundancy check, Polynomials and cyclic code analysis, Checksum, Error correction – Hamming code.	**8**

Text Books:

[1]. S. Haykin, Digital Communications, John Wiley & Sons, 2009.
[2]. B. Sklar, Digital Communications, 2nd Edition, Pearson Education, New Delhi, 2009.
[3]. John G. Proakis, Digital Communications, 3rd edition, McGraw Hill, 1995.
[4]. BP Lathi Communication System BS Publication
[5]. Singh & Sapre, Analog Communication, TMH.

Electrical & Electronics Engineering			
EEE622	**Digital Signal Processing**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	**Find** DFT of a given signal through Fast Fourier Transform Techniques.
CO2	**Design** FIR and IIR type digital filters.
CO3	**Identify** various filter structures and evaluate the finite word length and the coefficient quantization effects.
CO4	**Understand** the concepts of sample rate conversion techniques and its applications.
CO5	**Compare** the key architectural features of DSP Processors.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2		3	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-
CO5	-	2	-	-	-	-	-	-	-	-	-	1

DETAILED SYLLABUS

Module	Content	No. of Lectures
1	**Signals and systems:** Basic elements of DSP, concepts of frequency in Analog and Digital Signals, sampling theorem, Discrete time signals, systems analysis of discrete time LTI systems, Z transform, Convolution, Correlation.	**6**
2	**Frequency transformations:** Introduction to DFT, Properties of DFT, Circular Convolution, Filtering methods based on DFT, FFT Algorithms, Decimation in time Algorithms, Decimation in frequency Algorithms, Use of FFT in Linear Filtering, DCT, Use and Application of DCT.	**10**
3	**IIR filter design:** Structures of IIR, Analog filter design, Discrete time IIR filter from analog filter, IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives (LPF, HPF, BPF, BRF) filter design using frequency translation.	**10**
4	**FIR filter design:** Structures of FIR, Linear phase FIR filter, Fourier Series, Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques.	**8**

5	**Finite word length effects in digital filters:** Binary fixed point and floating point number representations, Comparison, Quantization noise, truncation and rounding, quantization noise power, input quantization error, coefficient quantization error, limit cycle oscillations-dead band, Overflow error-signal scaling.	**8**

Text Books:

[1]. J.G.PROAKIS & D.G.MANOLAKIS, Digital Signal Processing - Principles, algorithms & Applications, PHI, 2000.

[2]. .B.Venkataramani, M.Bhaskar, "Digital Signal Processors, Architecture, Programming and Application", Tata McGraw Hill, New Delhi, 2003

[3]. A.V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, 2nd Edition, PHI, 2000.

[4]. S.K.MITRA, Digital Signal Processing – A computer Based Approach, 2nd Edition, MGH, 2001.

[5]. Multi Rate Systems and Filter Banks – P.P.Vaidyanathan – Pearson Education.

[6]. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007.

Electrical & Electronics Engineering			
EEE623	**Digital Image Processing**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	**Understand** the need for image transforms and their properties.
CO2	**Choose** appropriate technique for image enhancement both in spatial and frequency domains.
CO3	**Identify** causes for image degradation and apply restoration techniques.
CO4	**Compare** the image compression techniques in spatial and frequency domains.
CO5	**Select** feature extraction techniques for image analysis and recognition.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	2	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-	2

DETAILED SYLLABUS

Module	Content	No. of Lectures
1	**Introduction**: Digital Image Representation, Fundamental Steps in Image Processing, Elements of Digital Image Processing Systems. **Digital image fundamentals**: Elements of Visual Perception, A Simple image model, Sampling and Quantization, Neighborhood of Pixels, Pixel Connectivity, Labeling of Connected Components, Distance Measures, Arithmetic and Logic Operations, Image Transformations, Perspective Transformations, Stereo Imaging.	**10**
2	**Image enhancement**: Spatial Domain Methods, Frequency Domain Methods, Point processing, Intensity Transformations, Histogram Processing, Spatial filtering, Smoothing Filters, Sharpening Filters, Enhancement in the Frequency Domain, Low Pass Filtering, High Pass Filtering, Homomorphic filtering.	**8**
3	**Wavelets and multi resolution processing**: Sub band Coding, Haar Transform, Multi resolution Series Expansions, Wavelet Transforms in One Dimension, Discrete Wavelet Transform, Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets. **Image compression**: Fundamentals of Compression, Image Compression Model, Error free Compression, Lossy Predictive Coding, and Transform Coding.	**10**

4	**Image segmentation**: Detection of Discontinuities, Line Detection, Edge Detection, Edge Linking and Boundary Detection, Thresholding, Threshold Selection on Boundary Characteristics, Region Growing, Region Splitting and Merging, Use of motion in Segmentation. **Image representation and description:** Chain Codes, Polygonal Approximations, Signatures, Skeleton, Boundary Descriptions, Shape Numbers, Fourier descriptors, Moments, Topological Descriptors.	**10**
5	**Image recognition and interpretation**: Elements of Image Analysis, Pattern and Pattern Classes, Minimum Distance Classifier, Matching by Correlation, Baye's Classifier, Neural Network Training Algorithm, Structural methods.	**6**

Text Books:

[1]. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, Pearson Education Asia, New Delhi, 2000.

[2]. B. Chanda, D. Dutta Majumder, Digital Image Processing and Analysis, PHI, New Delhi, 2000.

[3]. A.K. Jain, Fundamentals of Digital Image Processing, PHI, New Delhi, 2001.

Electrical & Electronics Engineering			
EEE631	**Power Electronics***	**L**	**T**
		3	**0**

(This course is not offered to Electrical & Electronics Students)

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	To **understand** different power semiconductor devices and their switching characteristics.
CO2	To **understand** the operation, characteristics and performance parameters of AC to DC Converters.
CO3	To **study** the operation, switching techniques and basic topologies of DC-DC Converters
CO4	To learn the different modulation techniques of PWM inverters and to **understand** commutation techniques.
CO5	To **study** the operation of AC voltage controller and various configurations.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	1		1					1
CO2	2	2	3	3	2		1					1
CO3	2	2	3	2	1	1	1					1
CO4	2	3	2	2	2	1	1					1
CO5	2	3	3	2	1	1	1					1
Avg.	**2.2**	**2.4**	**2.6**	**2.2**	**1.4**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Power Semiconductor Devices **(7 Lectures)**

Diode, Thyristor, MOSFET, IGBT, GTO: constructional features, I-V Characteristics; Firing circuit for thyristor; protection of thyristor and gate drive circuit, Turn on techniques, Voltage and current commutation of a thyristor.

Module II: AC-DC Converters **(6 Lectures)**

Single-phase half-wave and full-wave rectifiers, Single-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; effect of source inductance, Three-phase full-bridge thyristor rectifier with R, R-L and R-L-E load; freewheeling effect, power factor improvement.

Module III: DC-DC Buck and Boost Converter **(10 Lectures)**
Elementary chopper with an active switch and diode, concepts of duty ratio and average voltage, power circuit of a buck converter, analysis and waveforms at steady state, duty ratio control of output voltage.

Power circuit of a boost converter, analysis and waveforms at steady state, relation between duty ratio and average output voltage.

Module IV: Single-Phase Voltage Source Inverter **(8 Lectures)**
Power circuit of single-phase voltage source inverter, switch states and instantaneous output voltage, square wave operation of the inverter, concept of average voltage over a switching cycle, sinusoidal pulse width modulation, modulation index and output voltage**.**

Module V: Three-Phase Voltage Source Inverter **(7 Lectures)**
Power circuit of a three-phase voltage source inverter, switch states, instantaneous output voltages, average output voltages over a sub-cycle, 120- degree conduction, 180-degree conduction, three-phase sinusoidal pulse width modulation

Module VI: AC Voltage Controllers **(4 Lectures)**
Introduction, principle of on-off control, principle of phase control and integral cycle control, configuration of three phase controllers, cycloconverter.

Text/References Books:

[1]. M. H. Rashid, "Power electronics: circuits, devices, and applications", Pearson Education
[2]. India, 2009.
[3]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design",
[4]. John Wiley & Sons, 2007.
[5]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science
[6]. &Business Media, 2007.
[7]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

Electrical & Electronics Engineering			
EEE632	**Green Energy Technology**	**L**	**T**
		3	**0**

Course Outcome:

After successful completion of the course students will be able to:

CO1	**Identify** different non-conventional energy system and **explain** the principle of thermo-electrical and thermionic conversions
CO2	**Analyze** the performance and limitations of the solar and wind energy conversion system
CO3	**Illustrate** the concept of geothermal energy.
CO4	**Outline** the basics of fuel cells.
CO5	**Understand** the principles behind the bio-mass, ocean thermal and wave energy conversions.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1		1	1		1					1
CO2	3	2	2	2	1		1					1
CO3	1	1		1	1		1					1
CO4	2	1	1	1	1		1					1
CO5	2	1	1	1	1		1					1
Avg.	**2.2**	**1.2**	**1.33**	**1.2**	**1**		**1**					**1**

DETAILED SYLLABUS

Module I: Introduction **(6 Lectures)**

Basics of energy, conventional energy sources, fossil fuels limitations, renewable energy sources, advantages and limitations, global energy scenario, energy scenario of India, new technologies (hydrogen energy, fuel cells, bio fuels).

Module II: Solar Energy **(12 Lectures)**

Theory of solar cells, solar cell materials, I-V characteristics of solar cell, PV module, PV array, MPPT, PV systems, Stand alone and grid connected PV systems, storage, PV based water pumping, solar radiation and its measurement, flat plate collectors and their materials, applications and performance, solar thermal power plants, limitations.

Module III: Wind Energy **(10 Lectures)**

Wind power and its sources, site selection, power in the wind, impact of tower height, classification of wind turbine and rotors, wind energy extraction, betz'z limit, wind characteristics, performance and limitations of wind energy conversion systems.

Module IV: Biomass and Geothermal energy **(8 Lectures)**
Availability of biomass and its conversion theory, types of biomass, gasification, biogas plant, biomass cogeneration, resources of geothermal energy, thermodynamics of geo-thermal energy conversion, geothermal power generation, environmental considerations.

Module V: Emerging technologies for power generation **(6 Lectures)**
Introduction to tidal energy, tidal characteristics, tidal power plant, tidal power development in India, introduction to wave energy, factors affecting wave energy, principles of wave energy plant, OTEC, applications of OTEC, principle of working of various types of fuel cells and their working, performance and limitations, future potential of fuel cells, Emergence of hydrogen, cost analysis of hydrogen production, hydrogen storage.

Text/Reference Books:

[1]. Duffie and Beckmen, Solar Engineering of Thermal Processes, Wiley Publications, 1991.
[2]. S. P. Sukhatme, Solar Energy, TMH, India. 2008.
[3]. John Twiden and Tony Weir, Renewable Energy Resources, BSP Publications, 2006.
[4]. D. P. Kothari, Rakesh Ranjan, Renewable Energy Sources and Emerging Technologies, PHI, India,2011.
[5]. Non Conventional Energy Resources, D.S. Chauhan, New Age International Pvt Ltd., 2006.

Electrical & Electronics Engineering			
EEE633	**Mine Electrical Engineering***	**L**	**T**
		3	**0**

(This course is not offered to Electrical & Electronics students)

Pre-requisite: Basic Electrical Engineering and Basic Electronics Engineering.

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** different types of power supply systems and protection schemes used underground coal mines.
CO2	**Understand** different types of circuit breakers used in Mines.
CO3	**Analyze** illumination, Intrinsically Safe circuit methods of attaining intrinsic safety, Zener safety barriers and their applications in mines.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1		1						2
CO2	3	3	2	1		1						2
CO3	3	3	2	1		1						2
CO4	3	3	2	1		1						2
CO5	3	3	12	1		1						2
Avg.	**3**	**3**	**2**	**1**		**1**						**2**

DETAILED SYLLABUS

Module I:

Types of electrical power supply systems for underground coal mines–solidly earthed, restricted neutral and insulated – neutral systems of electrical power supply; their comparisons. Earth fault protection techniques for above mine power supply systems, sensitive and fail-safe earth fault relays. On-line insulation monitoring for insulated-neutral electrical distribution system.

Module II:

Mining type circuit breakers–Air circuit breaker, vacuum and Hexa Sulfa Flouride(SF6) circuit breakers, Field switch, Tran switch unit, Gate End Box, Drill Panel.

Module III:

Electrical power planning for mechanized longwall faces–general scheme of electrical power distribution, voltage drop problems and remedial measures; in bye substation capacity selection.

General scheme of electrical power distribution in opencast projects, Quarry substation capacity selection. Choice of restricted-neutral and insulated-neutral systems in open cast mines.

Module IV:
Illumination planning for mines–underground roadway lighting system; intrinsically-safe lighting system for longwall faces, opencast mine lighting. Earthing practice in mines – earth pits, earthing of mobile electrical equipment in mines. Mining cables – types, constructional details; layout of cables through shaft and other locations.

Module V:
Principles of flame proof enclosures. Intrinsically safe circuit methods of attaining intrinsic safety, Zener safety barriers and their applications. Indian electricity rules as applied to mines.

Text/Reference Books:

[1]. A Text Book on Power Systems Engineering – Soni Gupta, Bhatnagar, Chakarbarti, Dhanpat Rai & Sons.
[2]. Electrical Equipment in mines- Harry Cotton, George Newness
[3]. Switchgear and Protection- S.S. Rao, Khanna Publications.
[4]. Indian Electricity Rules.
[5]. Principles of Mine Planning J. Bhattacharya, Allied Publications.
[6]. Universal Mining School Series (UK)
[7]. Coal Mining Practice- J.C. F Statham Vol III, Heart Series.
[8]. Electrical Power Systems – C.L. Wadhwa, New Age International Publishers

Electrical & Electronics Engineering			
EEE641	**Special Electrical Machines***	**L**	**T**
		3	**0**

(This course is not offered to Electrical & Electronics Engg. Students)

Course Outcomes:

After Successful completion of course, the students will be able to:

COs	Description
CO 1	**Identify** and differentiate various electrical machines.
CO2	**Analyze** the torque speed characteristics and transfer function of Permanent Magnet Synchronous Motors(PMSM).
CO3	**Explain** the construction, working principle and performance of Stepper Motor
CO4	**Compare** and **contrast** the open loop and closed loop systems for servo motors.
CO5	**Classify** the different types of tachogenerators and its characteristics.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			2	1						2
CO2	3	2			2	1						
CO3	3	1		2	2	1						
CO4	2	1	2			1						
CO5	2	1	1		3	1						
Avg.	**2.6**	**1.3**	**1.5**	**2**	**2.25**	**1**						**2**

DETAILED SYLLABUS

Module I: FHP Universal Commutator motors (6 Lectures)

Principle of operation and performance characteristics of universal commutator motor without and with compensating windings, phasor diagrams and expressions for power and torque, speed-torque characteristics with DC and AC excitations.

Module II: FHP Synchronous Motors (12 Lectures)

Permanent magnet synchronous motors, hysteresis motors, synchronous reluctance motors, switched reluctance motors, brushless dc motors.

Module III: Stepper motors (12 Lectures)

Introduction, Multi-stack variable-reluctance stepping motors, Principles of operation , Aspects of design ,Single stack variable-reluctance stepping motors, Hybrid stepping motors, comparison of motor types, design of drive circuits, torque/rotor position characteristics.

Module IV: Servomotors **(6 Lectures)**
DC and AC servomotors, transfer function analysis, Synchros.

Module V: Tacho generators **(6 Lectures)**
DC tachogenerators, Induction and synchronous AC tachgenerators, characteristics and applications.

Text/Reference Books:

[1]. P.C. Sen, "Principles of Electric Machines and Power Electronics", 2nd Edition, Wiley
[2]. India Ltd. 2007
[3]. E. Openshaw Taylor, "The Performance and Design of AC Commutator Motors", Wheeler Publishing, 1997
[4]. R. Krishnan, "Switched Reluctance Motor Drives", 1st Edition, CRC Press, 2001.
[5]. T.J.E. Miller and J.R. Hendershot, "Switched Reluctance Motors & Their Control", Magna Physics Publishing, 1st Edition 1993
[6]. T.J.E. Miller, "Electronic Control of Switched Reluctance Machines",1st Edition,
[7]. Newnes,2001
[8]. K.Venkataratnam, "Special Electrical Machines", Universities Press 2008
[9]. E.V. Armensky and G.B. Falk, "Fractional Horsepower Electrical Machines", Mir Publishers, 1978
[10]. John Chiasson "Modeling and High-Performance Control of Electric Machines" John Wiley & Sons, Inc., Publication 2005
[11]. P. P. Acarnley "Stepping Motors : a guide to theory and practice" IET Control Engineering , series ,2002.

Electrical & Electronics Engineering			
EEE642	**Soft Computing Techniques**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO1	**Distinguish** the concept between the hard and soft computing techniques.
CO2	**Understand** the basic concept of the Artificial Neural Network (ANN).
CO3	**Understand** the basic concept of the fuzzy logic system
CO4	**Explain** the concept of Genetic Algorithm (GA) and its limitation.
CO5	**Choose** the different kind of evolutionary programming for multi objective optimization problem based on their application.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	2							2
CO2	3	3	3	2	2							2
CO3	3	3	3	2	2							2
CO4	3	3	3	3	2							2
CO5	3	3	3	2	2							2
Avg.	**3**	**3**	**3**	**2**	**2**							**2**

DETAILED SYLLABUS

Module I: Fundamentals of Soft Computing Techniques (4 Lectures)

Conventional and Modern Control System, Intelligence, Soft and Hard Computing, Artificial Intelligence.

Module-II: Artificial Neural Network (10 Lectures)

Introduction to Artificial neural networks-biological neurons, Basic models of artificial neural networks- Connections, Learning, Activation Functions, McCulloch and Pitts Neuron.

Learning rule- Hebbian Learning, Perceptron Learning, Delta Learning- Training and Testing algorithm, Adaptive Linear Neuron, Back Propagation Network – Architecture, Training algorithm.

Module-III: Fuzzy Logic System-I (8 Lectures)

Fuzzy Logic- Fuzzy sets- Properties- Operation on fuzzy sets, fuzzy relations- operations on fuzzy relations.

Fuzzy membership functions, fuzzification, Methods of membership value assignments- intuition- inference- rank ordering, Lambda- cuts for fuzzy sets, Defuzzification methods.

Module –IV: Fuzzy Logic System-II **(7 Lectures)**

Truth values and Tables in Fuzzy Logic, Fuzzy propositions, Formation of fuzzy rules – Decomposition of rules- Aggregation of rules, Fuzzy Inference Systems- Mamdani and Sugeno types, Neuro-fuzzy hybrid systems – characteristics- classification

Module-V: **(8 Lectures)**

Introduction to genetic algorithm, operators in genetic algorithm – coding – selection – cross over – mutation, Stopping condition for genetic algorithm flow, Generational Cycle, Applications.

Module-VI: **(5 Lectures)**

Evolutionary Programming, Multi-objective Optimization Problem Solving and its applications, Genetic- neuro hybrid systems, Genetic-Fuzzy rule based system.

Text Books:

[1]. N.P Padhy, Artificial Intelligence and Intelligent Systems- Oxford University Press.
[2]. S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing- Wiley India.
[3]. Timothy J. Ross, Fuzzy Logic with engineering applications – Wiley India.
[4]. M.E. E1- Hawary , Artificial Intelligence application in Power Systems, IEEE Press,2009
[5]. Jan Jantzen, Foundations of Fuzzy Control, A practical approach, Wiley,2013
[6]. M Gopal, Digital Control and State Variable Methods, conventional and neural-fuzzy control system, Published by Tata McGraw Hill Education Private Ltd,2012
[7]. David E Goldberg, Genetic Algorithms, published by Pearson 2008.

Reference Books:

[1]. Satish Kumar, Neural Networks- Prentice Hall of India.

Electrical & Electronics Engineering			
EEE643	**Energy Storage Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of this course, students will be able to:

CO's	CO Descriptions
CO1	analyze the characteristics of energy from various sources and need for storage
CO2	classify various types of energy storage and various devices used for the purpose
CO3	Identify various real time applications

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	1	1							2
CO2	3	3	3	2	1							2
CO3	3	3	3	2	1							2
CO4	3	3	3	3	1							2
CO5	3	3	3	2	1							2
Avg.	**3**	**3**	**3**	**2**	**1**							**2**

DETAILED SYLLABUS

Module I: Electrical Energy Storage Technologies (8 Lectures)

Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

Module II: Needs for Electrical Energy Storage (8 Lectures)

Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

Module III: Features of Energy Storage Systems (8 Lectures)

Classification of EES systems , Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES),Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2),Synthetic natural gas (SNG).

Module IV: Types of Electrical Energy Storage systems (6 Lectures)

Electrical storage systems, Double-layer capacitors (DLC) ,Superconducting magnetic energy storage (SMES),Thermal storage systems ,Standards for EES, Technical comparison of EES technologies.

Module V: Applications (10 Lectures)

Present status of applications, Utility use (conventional power generation, grid operation & service) , Consumer use (uninterruptable power supply for large consumers),New trends in applications ,Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems ,Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA–aggregation of many dispersed batteries.

Text Books:

[1]. "James M. Eyer, Joseph J. Iannucci and Garth P. Corey ", "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

[2]. The Electrical Energy Storage by IEC Market Strategy Board.

Reference Book:

[1]. "Jim Eyer, Garth Corey", Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

Electrical & Electronics Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance, Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

1. Hisrich & Peters, “Entrepreneurship”, Tata McGraw Hill
2. Roy, Rajeev, “Entrepreneurship”, Oxford University Press
3. Norman M. Scarborough, “Essentials of Entrepreneurship & Small Business Management”, 6th ed., Prentice Hal
4. Dutta, Bholanath, “Entrepreneurship management” ,Excel Books.

Production Engineering			
PE601	**Machine Tool Design**	**L**	**T**
		3	**1**

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** Classification of machine tools, basic motion and general requirements of machine tool design	06
2.	**Kinematics of Machine Tools**: Types of drives, selection and design requirements, stepped and stepless regulation	06
3.	**Design of Machine Tool Structures**: Layout of spindle speeds, preferred numbers, structure diagram, ray diagram, design of gear box for speed and feed. Compliance, stiffness and rigidity, design criterion, materials and basic design procedures for beds, tables and columns	10
4.	**Machine Tool Slides, Guideways and Spindle**: Function, requirements, constructional features, design criterion and tribological aspects of machine tool guideways and spindles, antifriction and roller slides	08
5.	**Machine Tool Vibrations:** Sources, effects and elimination of vibration, chatter	06
6.	**Control Systems in Machine Tools:** Control systems for changing speeds and feeds, ergonomic considerations applied to the design of control members	06
	Total	**42**

Suggested Books:

1. Fundamentals of Tool Engineering design, S.K. Basu, S.N. Mukherjee, R. Mishra, Oxford & IBH Publishing co.
2. Technology of Machine Tools, Krar, Gill, Smid, Tata Mc Graw Hill
3. Jigs & Fixture Design, Edwrd G Hoffman, Cengae Learning
4. A Textbook of Production Engineering, P.C. Sharma, S. Chand & Co
5. Machine Tool Design and Numerical Control, N.K.Mehta, Tata Mc Graw Hill
6. Tool Design , Donaldson,Lecain,Goold,Ghosh Tata Mc Graw Hill

Production Engineering			
PE611	**Manufacturing Process-III (TMCF + PM)**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1	**Principles of Metal Machining:** Metal Machining, Elements of machining, Classical metal machining process; Tool Signature, Mechanism of chip formation; types of chips. Geometry of chip formation, Forces on chips, Velocity relationships; stress and strain in chips; Mechanics of Multi-Point Cutting Tools: Milling cutters; Forces in Milling, specific cutting pressure.	08
2	**Theories on Mechanics of metal cutting for orthogonal cutting:** (Merchant, Lee and (Shaffer); Power and energy relationship; Thermal aspects of metal machining; Measurement of chip-Tool interface temperature, Friction in metal cutting. Measurement of Cutting Forces: Tool Dynamometer.	08
3	**Theory of Machinability:** Evaluation of machinability , Tool life, Tool life Plots, Types of tool failure, Flank wear and crater wear, variable influencing tool failure and tool life, Economics of metal machining.	06
4	**Principles of Metal Forming:** Principle of plastic flow of metals during hot and cold working. Hot and cold working processes: Forging, Rotary swaging, Rolling, Thread rolling, extrusion, wire drawing, Tube drawing, Sheet metal operations.	06
5	**Theory of Metal Forming:** Introduction of plasticity theories. Application of slab theory in the analysis of metal forming Processes (forging, wiredrawing, rolling, Extrusion, Deep drawing). Introduction to slip line concept and its application to simple plain strain problems.	08
6	**Powder Metallurgy:** Definition and scope of powder Metallurgy in Industry, Merits and demerits. Types of powders and their manufacturing. Fundamental properties of powders. Mech. Pulverisation, Electrolytic process, chemical reduction, Automization. Process of powder Metallurgy: Mixing, Compaction, Sintering infiltration, sieving, coining, Machining etc.	06
	Total	**42**

Suggested Books:

1. A.B. Chattopadhyay. “Machining and Machine Tools” Wiley Publication
2. Amitabha Bhattacharya. “Metal Cutting (Theory and Practice)” New Central Book Agency
3. M.C. Shaw. “Metal Cutting Principles”. CBS Publishers & Distributions
4. B.L. Juneja. “Fundamentals of Metal Forming Processes”. New Age International Publishers
5. Dr. Sadhu Singh. “Theory of Plasticity & Metal forming processes”. Khanna Publishers
6. P.C.Angelo, R.Subramaniam. “Powder Metallurgy”. Prentice Hall India Learning Pvt. Ltd

Production Engineering			
PE612	**Processing of Non-Metals.**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Classification of engineering materials and processing techniques, structure and properties of non-metals. Glass structure and properties, glass melting and forming, glass annealing.	05
2.	Classification of ceramics: crystal structures and properties, ceramic powder preparation, Synthesis of ceramic powders, fabrication of ceramic products from powders: pressing, casting, vapour phase techniques, sintering, finishing, machining. ceramic coatings.	07
3.	Structure and mechanical properties of plastics, thermoplastics and thermosets, Processing of Plastics: Extrusion. Injection moulding. Thermoforming. Compression moulding. Transfer moulding. General behavior of polymer melts, Machining of plastics	07
4.	Classification of composite materials, properties of composites, processing methods of polymeric matrix composites: hand lay-up, autoclaving, filament winding, pultrusion, compression molding, pre-pegging, sheet molding compounds etc., process capability and application areas of various techniques.	10
5.	Ceramic matrix composites, mechanical properties of ceramic matrix composites, different processing techniques for ceramic matrix composites, process capability and applications of various techniques	06
6.	Secondary processing of composite materials, Need of secondary operations, different type of secondary operations, machining and drilling of non-metals, machining induced damage, different methods of reducing the damage on account of secondary processing.	07
	Total	**42**

Suggested Books:

1. Manufacturing Processes for Engineering Materials : S. Kalpakjian, 3rd edition Addison - Wesley,
2. Composite Materials: Science and Engineering: Krishan Kumar Chawla, Springer Science & Business Media
3. Callister's Materials Science and Engineering: R. Balasubramaniam, 2nd edition,Wiley

Production Engineering			
PE613	**Surface Engineering**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1.	**Fundamentals of surface engineering** 1. Introduction: Engineering components, surface dependent properties and failures, importance and scope of surface engineering. 2. Surface and surface energy: Structure and types of interfaces, surface energy and related equations. 3. Surface engineering: classification, definition, scope and general principles.	04
2.	**Conventional surface engineering** Surface engineering by material removal: Cleaning, pickling, etching, grinding, polishing, buffing / puffing (techniques employed, its principle). Role and estimate of surface roughness. 5. Surface engineering by material addition: From liquid bath - hot dipping (principle and its application with examples). 6. Surface engineering by material addition: Electrodeposition / plating (theory and its scope of application). 7. Surface modification of steel and ferrous components: Pack carburizing (principle and scope of application).	08
3.	**Conventional surface engineering** 8. Surface modification of ferrous and non ferrous components: Aluminizing, calorizing, diffusional coatings (principle and scope of application). 9. Surface modification using liquid/molten bath: Cyaniding, liquid carburizing (diffusion from liquid state) (principle and scope of application). 10. Surface modification using gaseous medium: Nitriding carbonitriding (diffusion from gaseous state) (principle and scope of application).	08
4.	**Advanced surface engineering practices** 11. Surface engineering by energy beams: Laser assisted microstructural modification – surface melting, hardening, shocking and similar processes. 12. Surface engineering by energy beams: Laser assisted compositional modification – surface alloying of steel and non-ferrous metals and alloys. 13. Surface engineering by energy beams: Laser assisted compositional modification – surface cladding, composite surfacing and similar techniques. 14. Surface engineering by energy beams: Electron beam assisted modification and joining. 15. Surface engineering by energy beams: Ion beam assisted microstructure and compositional modification.	12
5.	**Characterization of coatings and surfaces** 16. Measurement of coatings thickness 17. Porosity & adhesion of surface coatings 18.. Measurement of residual stress & stability 19. Surface microscopy & topography by scanning probe microscopy 20. Spectroscopic analysis of modified surfaces	06

6.	**Functional Coatings & Applications** 21. Functional and nano-structured coatings and their applications in photovoltaics, bio- and chemical sensors 22. Surface passivation of semiconductors & effect on electrical properties 23. . Surface engineering of polymers and composites	04
	Total	**42**

Suggested Books:

1. K.G. Budinski, Surface Engineering for Wear Resistances, Prentice Hall, Englewood Cliffs.
2. M. Ohring, The Materials Science of Thin Films, Academic Press Inc, Introduction to Surface Engineering by P. A. Dearnley.

Production Engineering			
PE621	**Modern Manufacturing Process (MMP+RP)**	**L**	**T**
		3	**0**

Details of Course:

Sl. No.	**Contents**	**Contact Hours**
1	**Introduction:** Types of advanced manufacturing processes; Evolution, need, andclassification of modern machining processes (MMPs).	02
2	**MechanicalTypeMMPs:**USM,RotaryUltraSonicMachining(RUM),AJM,WJM, AWJM, Process principles and mechanisms of material removal, Process parameters,Processcapabilities,Applications,Operationalcharacteristics, Limitations.	06
3	**Chemical Type MMPs:** Process principle and details of Chemical Machining (CHM), Photo-Chemical Machining (PCM) processes.	03
4	**Electro Chemical Type MMPs:** ECM - Process principle, Mechanism of material removal, Process parameters, Process capabilities, Applications	04
5	**Thermal Type AMPs:** EDM, Wire Electro Discharge Machining (WEDM), LBM, EBM, IBM, PAM, Process principles and mechanisms of material removal, Process parameters and characteristics, Surface finish and accuracy, Process capabilities, Applications, Limitations.	14
6	**Derived and Hybrid AMPs:** Electro Stream Drilling (ESD), Shaped Tube Electro Machining (STEM), Electro Chemical Honing (ECH), Electro Chemical Deburring (ECDE), Electro Chemical Discharge Machining (ECDM), Process parameters, Process capabilities, Applications, Limitations, Introduction to form machining.	07

7	**Additive Manufacturing (AM):** Process chain in AM, CAD model, Slicing, Model orientation for AM processes, Support Structures, Seven families of AM processes (ASTM)- Process description, Types of materials, Strengths and Limitations.	08
	Total	**42**

Suggested Books:

1. Pandey P. C., Shan H. S. "Modern Machining Processes", Tata McGraw-Hill Publishing Co. Ltd, New Delhi
2. Ghosh A., Mallik A. K., "Manufacturing Science", Affiliated East-West Press Ltd, New Delhi
3. Benedict G. F., "Nontraditional Manufacturing Processes", Marcel Dekker, Inc. New York
4. McGeough J. A.,"Advanced Method of Machining", Chapman and Hall, New York
5. Mishra P. K., "Nonconventional Machining", Narosa Publishing House, New Delhi
6. Jain V. K.,"Advanced Machining Processes", Allied Publishers, New Delhi
7. Gibson, I, Rosen, D W., and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer.

Production Engineering			
PE622	**Product Development and Design**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1.	**Product Design**: Traditional and modern design processes; Organization objectives; Innovation, creation, and diffusion techniques; Evaluation of new product ideas – functional, technological, ecological, legal.	06
2.	**Product Modeling and Reverse Engineering:** Wireframe modeling; Surface modeling – boundary representation; Solid modeling – CSG; Concept of reverse engineering.	08
3.	**Product Data Exchange**: Neutral file formats for product data exchange–DXF, IGES, STEP	06
4.	**Concurrent Engineering**: Concept of concurrent engineering; Design for X; Design for manufacturability (DFM); Design for assemblability (DFA); Design for reliability (DFR); Design for quality (DFQ).	10
5.	**Rapid Prototyping Methods:** Liquid based RP methods – stereolithography apparatus (SLA), solid ground curing (SGC), solid creation system (SCS), etc.	06
6.	**Solid based RP methods:** Fused deposition modeling (FDM), laminated object manufacturing (LOM), etc.; Powder based RP methods– selective laser sintering (SLS), 3D printing (3DP), ballistic particle manufacturing (BPM), etc.	06
	Total	**42**

Suggested Books:

1. Andrearsen, M. M., and Hein, L., "Integrated Product Development", Springer.
2. Huang, G. Q., "Design for X: Concurrent Engineering Imperatives", Chapman and Hall.
3. Chitale, A. K. and Gutpa, R. C., "Product Design and Manufacturing", Prentice Hall.
4. ZeidI., "CAD/CAM: Theory and Practice", Tata McGraw Hill.
5. Boothroyd G., Dewhurst P., and Knight, "Product Design for Manufacture and Assembly", 2nd Ed., Marcel Dekker.
6. Chua, C. K and. Leong, K. F., "Rapid Prototyping: Principles and Applications in Manufacturing", John Wiley & Sons.

Production Engineering			
PE623	**Competitive Manufacturing Strategies**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1.	The competitive environment in the market, The WTO agreement and its effect on Indian Industries, Manufacturing as a competitive strategy, Competitive Advantages and Disadvantages	05
2.	Product Variety, Modular Design, Design for manufacturability, Selection of manufacturing technologies, Vendor Development, Vendor rating.	08
3.	Just in time manufacturing, Kanban system, and Agile Manufacturing, Reengineering, TQM, MRP	08
4.	ERP, and simulation as tools for competitive manufacturing, Intelligent Manufacturing	07
5.	Elementary of manufacturing systems for different manufacturing scenarios - Dedicated manufacturing system, Flexible manufacturing system (FMS), cellular manufacturing system (CMS), and Re-configurable manufacturing system (RMS); Selection of manufacturing systems.	08
6.	Concept of CIM, FOF, Network based manufacturing, and E-Manufacturing	06
	Total	**42**

Suggested Books:

1. Manufacturing Excellence in Global Markets by W. Euershelm
2. Manufacturing Systems Design & Analysis by B. Wa.
3. Computer Automation in Manufacturing by T.O.Boucher
4. Intelligent Manufacturing Planning by P. Gu.

Production Engineering			
PE631	**Operation Research**	**L**	**T**
		3	**0**

Details of Course:

S. No.	**Contents**	**Contact Hours**
1.	**Introduction**: Origin and development of operations research, general methodology of OR, applications of OR to industrial problems	02
2.	**Linear Programming** Mathematical formulation of the problem, Graphic solution, the simplex method, Big-M method, concept of duality, dual simplex method.	14
3.	**Transportation Model** Basic feasible solution by different methods, finding optimal solutions, degeneracy in transportation problems, unbalanced transportation problems	06
4.	**Assignment Model** Balanced and unbalanced assignments, assignment to given schedules **Sequencing Model** Processing of 2 jobs through machines –graphical method, Processing of n jobs through two machines, processing n jobs through three machines	08
5.	**Queuing Model** Queuing systems and their characteristics, The M/M/1/FIFO/Queuing system	06
6.	**Games Theory** Two-persons zero sum games, Pure and mixed strategies, Rules of dominance, Solution methods without saddle point	06
	Total	**42**

Suggested Books:

1. Operation Research by P.K. Gupta & D. S. Hira 7e, S.Chand
2. Operation Research by Hamdy A. Taha, Pearson publication 8e
3. Operation Research by Kanti swarup, Sultan Chand & Sons Publication

Production Engineering			
PE632	**Mathematical Modelling and Simulation**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction: Basic concepts of systems, Elements of systems, event driven models, simulation as a decision making tool, types of simulation, system modeling, types of modeling	05
2.	Basic factory dynamics: Basic definitions and Parameters; Simple relationships, Little's Law; Bottleneck Rates and Cycle Times; Labour Constrained Systems	05
3.	Statistical models in Simulation: Review of terminology and concepts, Probabilistic and statistical models in simulation. Introduction to some discrete and continuous probability distributions including Bernoulli, Poisson, Geometric, Uniform, Exponential, Gamma, Erlang, Normal, and Triangular distributions. Relevance to simulation modelling.	06
4.	Random Numbers: properties of random numbers, pseudo random numbers, techniques for generating random numbers, test for random numbers, techniques for random variate generation.	8
5.	Analysis of simulation data: Input data modelling, Data collection, parameter estimation, distributional assumptions and hypothesis testing. Chi-square and Kolmogorov-Smirnov Goodness-of-fit tests.	07
6.	Recent advances and case studies/mini project: Development of simulation models for systems like queuing systems production, inventory, maintenance, material handling and replacement systems-Investment analysis etc. Introduction to the special purpose simulation language	06
7.	Model verification and validation techniques. Output data analysis of terminating and non-terminating Systems. Variance reduction techniques. Introduction to simulation experimental design methods.	5
	Total	**42**

Suggested Books:

1. Gray Beal, Wajne J and Pooch U W, "Simulation Principles & Methods", Winthrop Publishing Incorporate.
2. Severance Frank, "System Modelling and Simulation", John Wiley and Sons
3. Banks, Carson, Nelson and Nicole, "Discrete Event System Simulation", Pearson Education, Asia
4. Hopp W.J. and Spearman M.L., Factory Physics, Mc-Graw Hill Higher Education

5. Kelton W.D., Sadowski R.P., and Swets N.B., Simulation with Arena, Mc-Graw-Hill
6. Banks Jerry and Carson John S., "Discrete event system simulation", Prentice Hall

Production Engineering			
PE633	**Maintenance Technology and Safety Engineering (MTSE)**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1	**Introduction:** Definition, Importance, Purpose and results of maintainability efforts, maintainability in product life cycle, maintainability tools	03
2	**Failure Analysis:** failure mode, effect and critical analysis, fault tree analysis, cause and effect diagram, total quality management, Reliability, maintainability, both-tub curve, concept of repair ability	08
3	**Maintenance Strategies:** Principle, relative advantage, limitation and application of various maintenance strategies like, preventive maintenance, predictive maintenance, condition based maintenance, Reliability based maintenance etc	08
4.	**Computer Integrated Maintenance: A Maintenance Data System, Processing Recorded Data and Analyzing Information,**Maintenance / e-Maintenance through Data Mining, E-CBM, E-CMMS, Maintenance through Expert System	08
5	**Costing and Budgeting of Maintenance System:** Concept and strategies for tero-technology and Maintainability testing, costing, budgeting and control index for maintained system	06
6	**Industrial Safety Principle:** Industrial safety-concept and relevance, occupational diseases, electrical and mechanical hazards, personal protective equipment and clothing	05
7	**Safety Functions:** Safety responsibility and function of various functionaries and departments, safety & profitably employee training and safety	04
		42

Suggested Books:

1. B.S. Dhillon, Engineering Maintainability, Eastern Economy Edition PHI
2. A.K. Gupta, Reliability Engineering and Technology, Macmillan India Limited
3. N.V.S. Raju, Plant Maintenance and Reliability Engineering ,Cengage Learning India Private Limited
4. S.K. Srivastava, Maintenance Engineering Principles, Practices & Management S. Chand Publishing
5. H.P.Garg, Industrial Maintenance Engineering, S. Chand Publishing
6. E.T. Newbrough, Effective Maintenance Management Mc Graw Hill

7. Mobley, R. Keith, Higgins, R. Lindley and Wikoff, J. Darrin, Maintenance Engineering Handbook
8. Mohamed Ben- Daya, Salih O. Duffuaa, Abdul Raouf, Maintenance Modelling and Optimization, Springer

Production Engineering			
PE641	**Industrial Automation & Robotics**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1.	**Basic Concepts of Automation:** Introduction of mechanization and automation, classification and strategies of automation, reasons for and arguments against automation, mechanical, electrical, hydraulic, and pneumatic devices and controls.	04
2.	**High Volume Manufacturing:** Automated flow lines, types of automatic transfer mechanisms, design and fabrication considerations, analysis of automated flow lines.	04
3.	**Assembly Systems:** Assembly systems and their types, manual assembly lines and line balancing. Assembly Automation: automated assembly lines and their types, automatic assembly transfer systems, automatic feeding and orienting devices- vibratory and mechanical feeders and their types, orientation of parts, performance and economics of assembly systems, feasibility study for assembly automation.	12
4.	**Basic concept in Robotics :** Introduction, Basic structure of robots, Resolution, Accuracy, and Repeatability Position representation, Classification and Structure of Robotic System: Point to point and continuous path Robotic systems: Trajectory planning, control loops of Robotic systems; The manipulator-Cartesian, Cylindrical, Spherical and articulated robots; Direct and indirect drives; Wrist, motions and grippers;	08
5.	**Drive and Control Systems**: Hydraulic systems; direct current servo motors control approaches of Robots. Kinematics Analysis and Co-ordinate Transformation: Direct kinematics problem in Robotics; Geometry based direct kinematics analysis. Homogeneous transformation. The necessity of interpolators; The generation of motion commands; Trajectory planning Basic structure of interpolators	08
6.	**Programming, Sensors and Application of Robots**: Manual teaching; lead-through teaching, programming languages, programming with graphics; storing and operating tasks programmes. Introduction to robotic sensors; vision systems, Range defectors: Assembly Aid Devices; force and torque sensors: artificial intelligence. Flexible manufacturing systems, Computer-Integrated Manufacturing Systems. Concept of group Technology.	06
	Total	**42**

Suggested Books:

1. Groover, M. P., “Automation, Production systems and Computer Integrated Manufacturing”, 2nd Ed., Prentice Hall.
2. Boothroyd, G., “Assembly Automation and Product Design”, 2nd Ed., Marcel Dekker.
3. Tergan, V., Andreev, I. and Lieberman, B., “Fundamentals of Industrial Automation”, Mir Publishers.
4. Craig John J., “Introduction to robotics: Mechanics & Control”, AddisonWesley
5. Schilling R. J., “Fundamentals of Robotics Analysis and Control”, Prentice Hall Inc
6. Mittal R. K. and Nagrath I. J., “Robotics and Control”, Tata McGraw Hill, New Delhi
7. Ghosal Ashitava, “Robotics: Fundamental Concepts and Analysis”, Oxford University Press

Production Engineering			
PE642	**Computer Integrated Manufacturing**	**L**	**T**
		3	**0**

Details of Course:

Sl. No.	Contents	Contact Hours
1	**Introduction:** Introduction to manufacturing systems and their performance analysis; Introduction to automation; Introduction to computer integrated manufacturing (CIM).	**04**
2	**Numerical Control (NC):** Introduction, numerical control – its growth and development, components of NC system, input devices, control systems – point to point, straight cut, and continuous path NC, open loop and closed loop NC systems, NC interpolations – linear, circular, helical, parabolic and cubic interpolation, applications of NC systems, merits and demerits.	**10**
3	**Extensions of NC:** Concepts of computer numerical control (CNC), machining center, and direct numerical control (DNC), and their advantages.	**06**
4	**Robotics:** Robot anatomy and related attributes, robot control systems – limited sequence, playback with point to point, playback with continuous and intelligent control; End effectors – gripper, tools; Sensors in robotics – tactile sensors, proximity, optical sensors and machine vision; Applications of industrial robots, robot programming.	**06**
5	**Material Handling and Storage:** Overview of material handling equipments, automated material handling equipments – AGVs,	**06**

	conveyor systems, performance analysis of material handling systems, automated material storage systems – ASRS and carousel storage, analysis of automated storage systems.	
6	**Manufacturing Support Functions:** Introduction to group technology (GT), computer aided process planning (CAPP), material requirement planning (MRP), capacity planning, scheduling etc.	**06**
	Total	**42**

Suggested Books

1. Groover, M. P., "Automation, Production systems and Computer Integrated Manufacturing", 3rd Ed., Prentice-Hall.
2. Singh, N., "Systems Approach to Computer Integrated Design and Manufacturing", John Wiley & Sons.
3. Chang,T.-C., Wysk,R. A. and Wang, H.-P. "Computer Aided Manufacturing", 3rd Ed., Prentice Hall.
4. Rembold,U., Nnaji,B. O. and Storr A., "Computer Integrated Manufacturing", Addison Wesley.
5. Besant,C. B. and Lui,C. W. K., "Computer Aided Design and Manufacture", Ellis Horwood Ltd.
6. Rao,P. N., Tiwari,N. K. and Kundra,T.K., "Computer Aided Manufacturing", Tata McGraw Hill.
7. Koren, Y. "Computer Control of Manufacturing Systems", McGraw Hill.
8. Lynch, M., "Computer Numerical Control for Machining", McGraw-Hill.
9. Sava,M. and Pusztai,J., "Computer Numerical Control Programming", Prentice Hall.

Production Engineering			
PE643	**System Dynamics**	**L**	**T**
		3	**0**

Details of Course:

S. No.	Contents	Contact Hours
1.	Introduction, Purpose and concepts of system dynamics, Building a model,Problem definition and model purpose, building theory with causal loop diagrams	06
2.	Mapping the stock and flow structure of systems,Dynamics of stocks and flows; linking feedback with stock and flow structure	06
3.	Understanding the Dynamics of Simple Systems,Analyzing Systems and Creating Robust Policies,Industry dynamics and diffusion models,Network externalities, complementarities, and path dependence,Mark Paich System Dynamics,Interactions of Operations, Strategy, and Human Resource Policy	08
4.	Mark Paich System Dynamics,Interactions of Operations, Strategy, and Human Resource Policy, Re-engineering the Supply Chain in a High-velocity Industry,Formulating and Testing Robust Models of Business Processes	08
5.	The Supply Line and Supply Chains,Forecasting and Feedback: Bounded Rationality or Rational Expectations,Service Quality Management,Service Quality Dynamics	08
6.	Applications of System Dynamics to Environmental and Public Policy Issues,Dynamics of Project Management,Project Dynamics Modeling in the Real World	06
	Total	**42**

Suggested Books:

1. Business Dynamics: Systems Thinking and Modeling for a Complex World, Sterman, McGraw-Hill
2. System Dynamics Modelling: A Practical Approach, R.G.Coyle ,Chapman and Hall/CRC
3. Systems Thinking, System Dynamics: Managing Change and Complexity,Kambiz E. Maani and Robert Y. Cavana,Pearson Education
4. Strategic Modelling and Business Dynamics: A Feedback Systems Approach, John D. W. Morecroft,Wiley
5. System Dynamics: Soft and Hard Operational Research, Martin Kunc,Palgrave macmillan

Production Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

1. Hisrich & Peters, “Entrepreneurship”, Tata McGraw Hill
2. Roy, Rajeev, “Entrepreneurship”, Oxford University Press
3. Norman M. Scarborough, “Essentials of Entrepreneurship & Small Business Management”, 6th ed., Prentice Hal
4. Dutta, Bholanath, “Entrepreneurship management” ,Excel Books

Metallurgical Engineering			
ML601	**Iron and Steel Making**	**L**	**T**
		3	**1**

Course objective:

- To impart the knowledge of iron and steel making.
- To make the candidate skilled to find out the parameters to produce quality steel at minimum cost.
- To make them expert to analyze the reasons of process difficulties in Blast Furnace and also in Steel Making processes.
- To develop methodology of producing sound conventional ingots as well as continuous casting products like blooms, billets, slabs, strips, etc.

Course outcomes:

After the successful completion of this course, the student would be able to:

CO1	Classify different kinds of furnaces and their ancillary equipment used for Iron & Steel making
CO2	Analyze various factors influencing quality of the product in blast furnace during Iron & Steel making.
CO3	Analyze the irregularities and cause of failures in blast furnace and apply the remedial measures for immediate rectification
CO4	Compare the traditional steelmaking to modern day manufacturing routes for the improvement of quality.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	2	-	-	-	-	1	2	-	2	-	-
CO 2	-	1	-	-	-	-	-	2	-	-	-	1
CO 3	1	-	-	2	-	-	1	-	-	-	2	-
CO 4	-	2	-	-	-	-	1	2	-	1	-	-

Course Detail -

Module 1: Blast furnace raw materials and their properties: Iron Ores, agglomerates and coke, Preparation of ores: sintering and pelletizing. Blast furnace burdening and distribution, testing of raw materials for blast furnace. (6 Hours)

Module 2: Blast furnace profile: Constructional feature of blast furnace, profile, Stove and gas cleaning units, instrumentation, refractories used in blast furnace. Charging mechanism, Bell and bell-less charging systems. (8 Hours)

Module 3: Blast furnace reactions: Physico-chemical principles of blast furnace, Reaction in stack, tuyere zone, bosh and hearth. Thermodynamics equilibria, Direct and indirect reduction, Kinetics of iron oxide reduction. Formation of primary and bosh slag, slag composition. Slag-metal reactions, Desiliconization, Desulphurization. (8 Hours)

Module 4: Blast furnace operation: Blast Furnace irregularities and remedial measures, operational steps, blast furnace gas properties, cleaning and utilization. (6 Hours)

Module 5: Modern Developments: High top pressure, Humidified and oxygen enriched blast and auxiliary fuel injection through tuyeres and their effect on productivity and coke rate. (6 Hours)

Module 6: Alternative methods of iron making: DRI, MIDREX, COREX, SL/RN, HYL-III, Fluidized bed reactor, Hismelt. (8 Hours)

Module 7: Steel Making: Different routes of steelmaking; Oxygen Steelmaking; Top and Bottom blown converter processes, Hybrid processes. Electric Steel making; Electric Arc furnaces, Induction furnaces. Secondary Steelmaking. Casting of liquid steel: Ingot Casting of Steel, Continuous Casting of Steel. Iron and Steel Scenario in India in the last decade. (6 Hours)

Essential Reading:

1. Ahindra Ghosh and Amit Chatterjee: ***Ironmaking and Steelmaking Theory and Practice,*** Prentice-Hall of India Private Limited,
2. R.H.Tupkary, Khanna Publishers
3. Anil K. Biswas: ***Principles of Blast Furnace Iron making***, SBA Publication, 1999.

Supplementary Reading:

1. David H. Wakelin (ed.): ***The Making, Shaping and Treating of Steel (Iron making Volume),*** The AISE Steel Foundation, 2002
2. Richard J. Fruehan (ed.): ***The Making, Shaping and Treating of Steel (Steel making Volume),*** The AISE Steel Foundation, 2004.

Metallurgical Engineering			
ML611	**Metal Forming Technology**	**L**	**T**
		3	**0**

Course objectives -

- To develop the fundamental aspects of mechanics of deformation and fracture of materials.
- To provide knowledge about various metal forming operations, their process parameters, and mathematical equations associated with the process.
- To develop the ability to solve the problem which encounters during metal forming

Course Outcomes:

After the successful completion of this course, the student would be able to:

CO1	Students will be able to solve the numerical problems to calculate stresses on inclined planes.
CO2	Student will be able to apply theory of failure for the given process.
CO3	Student will estimate the working loads for pressing, forging, wire drawing etc. processes.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	1	-	-	-	-	-	1	3	-	2	-	-
CO 2	-	2	-	-	2	-	-	2	-	-	-	1
CO 3	1	-	-	2	-	-	1	-	-	-	1	-

Course Detail -

Module 1: Fundamentals of Metal Working: Classification of forming processes; Temperature in Metal– working, Hot working, Cold working and Warm working of metals, Heating of metals and alloys for hot working, Friction in Metal working, Lubrication, concept of yield criteria.

(6 Hours)

Module 2: Rolling of Metals: Classification of Rolled products, Types of rolling mills, Terminology used in rolling; Forces and Geometrical relationships in rolling, rolling variables, Theories of rolling, Rolling Torque and HP calculations. Roll-pass Design: Fundamentals of

Roll-pass-design; Mill type, Layout and rolling practice adopted for some common products such as Slabs, Blooms, Billets, Plates, Sheets etc. Rolling defects and their control. (8 Hours)

Module 3: Forging of Metals: Forging principles, types of forging and equipment needed; calculation of forging load under sticking and slipping friction conditions. Forging defects and their control. Manufacture of rail wheels. (6 Hours)

Module 4: Extrusion: Types, Principles and Equipment. Variables in extrusion, deformations in extrusion, calculation of extrusion pressure under plane strain conditions; extrusion defects; production of tubes and seamless pipes. (8 Hours)

Module 5: Wire Drawing: Drawing of Rods, Wires and Tubes, calculation of drawing load; drawing defects. (6 Hours)

Module 6: Sheet Metal Forming: Forming methods such as bending, stretch forming, shearing and blanking, deep drawing, and redrawing. Defects in formed products. Special forming methods such as explosive forming (elementary ideas excluding mathematical treatment).

(8 Hours)

Essential Reading:

1. G. E. Dieter, Mechanical Metallurgy, Mc Graw Hill-1988
2. Roll pass Design, the united steel companies Ltd., U. K. -1960
3. Metal Forming: Fundamentals and Applications by Taylan Altan (ASM Series in Metal Processing)

Supplementary Reading:

1. G. W. Rowe, ***Principles of Industrial Metal Working processes,*** Crane Russak, 1977.
2. Amitabh Ghosh, Ashok Kumar Mallick, ***Manufacturing sciences,*** East-west press private ltd; latest reprint-1991.

Metallurgical Engineering			
ML612	**Sponge Iron Technology**	**L**	**T**
		3	**0**

Course objectives –

- To impart the knowledge of alternate method of production of iron.
- To make the candidate understand how to use low grade iron ore and coal for the production of iron.
- To develop the analyzing capacity in the field of better utilization of natural resources available in our country.

Course Outcomes:

After the successful completion of this course, the student would be able to:

CO1	Students are supposed to have the knowledge of low grade iron ore and coal for the production of sponge iron.
CO2	Students will be capable to lower the dependence on iron making through blast furnace
CO3	Conversion of waste into wealth.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	2	2	2	2	2	2	2	2	2	2	2
CO 2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	2	2	2	2	2	2	2	2	2	2	2

Course Detail -

Module 1: Present and future scope of sponge iron industries in India (2 Hours)

Module 2: Classification of DR processes (4 Hours)

Module 3: Mechanism of Iron ore reduction in coal- based and gas-based DR processes (4 Hours)

Module 4: Salient features of coal- based (rotary kilns) DR processes .Characteristics of raw materials for use in rotary kilns. All available Coal-based; processes using reactors other than rotary kilns (12 Hours)

Module 5: Salient features of all available gas-based DR processes. Strengths and weaknesses of different DR processes particularly in context to India (11 Hours)

Module 6: Properties and usage of DRI. Pollution issues in the Indian DR industries. (9 Hours)

Textbooks:

1. Ahindra Ghosh and Amit Chatterjee, Ironmaking and Steelmaking Theory and Practice**,** Prentice-Hall of India Private Limited,2008

2. R. G. Ward, ***Physical Chemistry of iron & steel making***, ELBS and Edward Arnold, 1962.

3. Modern Iron Making by R.H.Tupkary

Metallurgical Engineering			
ML613	**Computational Material Engineering**	**L**	**T**
		3	**0**

Course objectives -

- To acquaint the candidate with the ability of programming languages and various software packages like COMSOL, MATLAB, etc.
- To impart the knowledge and understanding of physical and chemical properties of complex materials.
- To make them understand molecular dynamics, thermodynamics, phase diagrams and processes of modelling.
- To develop the ability of designing of new materials with modified properties.

Course Outcomes:

After the successful completion of this course, the student would be able to:

CO1	To apply knowledge of mathematics, science, and engineering to solve the problems of materials engineering.
CO2	To identify, formulate, and solve engineering problems, particularly in the context of materials selection and design.
CO3	To use the techniques, skills, and experimental, computational and data analysis tools necessary for materials engineering practice.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	2	2	2	2	2	2	2	2	2	2	2
CO 2	-	-	-	-	-	-	-	-	-	-	-	-
CO 3	2	2	2	2	2	2	2	2	2	2	2	2

Course Detail -

Module 1: Review of Computer Basics and programming, Techniques in Computer simulation, Finite element analysis, Monte Carlo methods. (6 Hours)

Module 2: General Methodology, Understanding of the physical and chemical properties of complex materials by applying molecular dynamics, Monte Carlo method, and continuum mechanics. (8 Hours)

Module 3: Thermodynamics and Phase Diagrams, Kinetics & Microstructure Modelling, Process Modelling, Integrated Selection of Materials and Processes, Calculation of materials properties starting from microscopic theories. (12 Hours)

Module 4: Neural Networks, Fuzzy Logic, Genetic Algorithms, Molecular Modelling, Cellular Automata. (7 Hours)

Module 5: Designing of new materials, modifying materials properties and optimizing chemical processes. (6 Hours)

Module 6: Practical examples and programming in computational materials engineering. (3 Hours)

References:

1 K. Ohno, K. Esfarjani, and Y. Kawazoe: Computational Materials Science - From Ab Initio to Monte Carlo Methods, Springer, 1999.
2 Koenraad George Frans Janssens, Dierk Raabe, et al: Computational Materials Engineering-An Introduction to Microstructure Evolution, Academic Press, 2007.
3 June Gunn Lee: Computational Materials Science, CRC Press, 2011.
4 C R A Catlow: Computational Materials Science, IOS Pr Inc., 2003

Metallurgical Engineering			
ML614	**X- Ray Diffraction and Electron Microscopy**	**L**	**T**
		3	**0**

Course objectives –

- To impart the basic knowledge of material characterization with the help of SEM, TEM.
- To provide a thorough introduction to the principles and practice of X-ray diffraction.
- To provide practical experience in laboratory methods of material characterization and it's reporting.
- To analyze the variation in properties of materials with respect to the variation in their microstructure.

Course Outcomes:

CO1	An ability to use the techniques, skills, and modern tools necessary to perform x-ray diffraction, scanning electron microscopy, energy dispersive spectroscopy and related microanalytical techniques.
CO2	An ability to conduct experiments, analyse and interpret data, and to relate the composition and atomic, structural and microstructural configuration with other material properties
CO3	An understanding of the crystallography of simple structures, Miller indices, reciprocal space, structure factors and the general concepts of stereographic projections, pole figures and inverse pole figures.
CO4	An understanding of professional and ethical responsibilities with regard to preparing materials for structural and microstructural observation, reporting observations, and drawing engineering conclusions

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	1	-	-	2	-	1	-	-	1	-	1
CO 2	-	-	-	1	-	-	2	-	-	3	-	1
CO 3	1	2	-	-	-	-	-	-	-	1	2	-
CO 4	-	1	-	-	-	-	2	-	-	1	-	1

Course Detail -

Module 1: Introduction to crystallography, Symmetry – point group and space group, Reading of the space group tables. (4 Hours)

Module 2: X-ray diffraction – Generation of X-rays, characteristic X-ray spectrum, Bragg's Law, Diffraction methods – Laue method, rotating crystal method, powder method, Principle, equipment and applications, structure factor, derivation of diffraction conditions for SC, BCC and FCC Bravais lattice. (8 Hours)

Module 3: X-ray diffractometer, filters and counters/detectors, texture, importance of texture, measurement of texture, pole figures (stereographic projections), orientation distribution function, sample symmetry, and its importance, applications of X-ray diffraction in materials characterization – determination of crystal structure, lattice parameter, examples of textures in cubic materials. (8 Hours)

Module 4: Electrons as source, properties of electron beam, elastic and inelastic scattering of electrons, importance in electron microscopy. (3 Hours)

Module 5: Principles of transmission electron microscopy, construction, ray-diagram, working, sample preparation, contrast mechanisms, ring and spot diffraction patterns, detectors and imaging modes, Kikuchi lines, measurement of lattice parameter, orientation relationship determination. (10 Hours)

Module 6: Principles of scanning electron microscopy, construction, ray-diagram, working, sample preparation, contrast mechanisms, Bright field and dark field imaging. Detection of secondary electrons. Detection of backscattered electrons. (9 Hours)

References:

1 B D Cullity, S R Stock: Elements of X-ray Diffraction, Prentice Hall, Inc 2001
2 D. Brandon and W. Kaplan: Microstructural Characterization of Materials, Wiley & Sons, 2000.
3 K R Hebbar: Basics of X-Ray Diffraction and its Applications, I.K. International Publishing House Pvt Ltd, New Delhi, 2007
4 Goodhew, Humphreys and Beanland: Electron Microscopy and Microanalysis, Taylor and Francis, New York, 2001.

Metallurgical Engineering			
ML615	**Secondary Steel Making**	**L**	**T**
		3	**0**

Course objectives – To produce quality steel and quality steel products by removing impurities from the raw iron and by the addition of alloying elements to produce the required steel.

Course Outcomes:

After the successful completion of this course, the student would be able to:

CO1	Describe the physical and chemical processes that take place during iron making and steelmaking.
CO2	Analyze the effect of change in process parameters in iron making and steelmaking processes.
CO3	Describe the methods for control of quality in iron and steel production.
CO4	Solve numerical problems involving reaction kinetics and composition control.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	2	-	1	-	-	1	-	1
CO 2	-	-	-	1	-	-	-	2	-	3	-	1
CO 3	1	2	-	-	3	-	-	-	-	-	2	-
CO 4	-	1	-	-	-	-	2	-	-	-	-	1

Course Detail -

Module 1: Introduction, Sources of Inclusions, Sulphur, Phosphorus, and Gases in Steels, Development of Secondary Steel Making and its Importance under Indian Conditions, Metallurgical Principles in Secondary Steel Making. (8 hours)

Module 2: Ladle Injection Metallurgy, Desulphurization & Dephosphorization. Secondary Steel Making Processes, Ladle Furnaces (L.F.), Vacuum Systems and Vacuum treatment of Steel. (6 hours)

Module 3: Gases in steel. LF-VD processes and AOD, VOD, VAD techniques, R-H degassers. Ladle Stirring and its Advantages. ASEA-SKF processes- Principle and Technology. Deoxidation – Theory and practice, Floatation's of products. (8 hours)

Module 4: Modifications of Inclusions. Injection Metallurgy influence of Inclusions on Mechanical Properties of Steel, Inclusion Identification and Cleanness Assessment, Origin of Non Metallic Inclusions, Inclusion Control (8 hours)

Module 5: Ingot Casting: Types of Moulds, Advantages and Disadvantages. Ingot Defects and Remedies. Continuous casting: C.C. machines with its various units and types. C.C. Of Blooms, Slabs and Thin slabs. Re-oxidation prevention methods during Steel Casting. Advantage of C.C. Environmental issues related to Steel Making, Heat Transfer & Solidification Rate in Ingot Casting and Continuous Casting, Distinguishing Metallurgical Aspects of Continuous Casting of Steel. (12 hours)

Reading:

1. Ahindra Ghosh: Secondary Steel Making- Principles and Applications, CRC Press, 2001.
2. B IIschner& N J Grant (Eds): Ladle Metallurgy, Springer verlag, New York, 1989.

Metallurgical Engineering			
ML621	**Non-ferrous Technology**	**L**	**T**
		3	**0**

Course objective: A thorough knowledge of this topic helps an engineer for selecting of non-ferrous and an alloy for a component or structure. To evaluate the various microstructure of the non-ferrous metals and alloys using microscope and apply the concepts to make tailor made materials for given engineering design and applications.

Course outcomes:

At the end of this course, the students would be able to:

CO1	Differentiate various of microstructure of non-ferrous materials (Cu, Zn, Al, Mg, Ti etc) using microscope.
CO2	To analyse the microstructure of the given non-ferrous metal or alloy using microscope.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	1	-	2	-	-	2	-	-	-	2	1
CO 2	-	1	-	-	3	-	-	-	-	1	-	3

Course Detail -

Module 1: General principles of extraction of metals from oxides and sulphides; Mineral resources of non – ferrous metals in India; their production, consumption and demand; Future of non – ferrous metal industries in India. (6 Hours)

Module 2: Kinetics of leaching of ores and the effects of operation variables. Aluminum: Bayer's process and factors affecting its operation; Hall – Heroult process: principle & practices, use of electrodes, anode effect; Refining of Aluminum; Alternative methods of Alumina and Aluminum production. (8 Hours)

Module 3: Copper: Roasting of sulphides; Matte smelting; Converting; Refining; by – products recovery; Recent developments; Continues copper production processes, hydrometallurgy of copper. (6 Hours)

Module 4: Zinc: Pyrometallurgy of zinc; principles and practices of roasting, sintering and smelting; Hydrometallurgy of zinc. Lead: Roasting and agglomeration of galena concentrate; Blast furnace smelting; refining of lead bullion. (7 Hours)

Module 6: Uranium: Processes for the digestion of Uranium ores; Purification of crude salts; Production of reactor grade UO2. (5 Hours)

Module 7: Titanium: Methods for upgrading ilmenite; Chlorination of titanium; Kroll & Hunter processes; Consolidation and refining. (5 Hours)

Module 8: Other Metals: Simplified flow sheets and relevant chemical principles of extraction of Ni, Mg, Au, Be, etc. (5 Hours)

References:

1 K Grjotheim & B J Welch: Aluminum Smelter Technology, Aluminum – Verlag, 2nd Edn. 1988.
2 A K Biswas & W G Davenport: Extractive Metallurgy of Copper, Pergamon, 4th Edn. 2002.
3 W H Dennis, Metallurgy of Non – Ferrous Metals, Pitman, London, 1954.
4 J N Anderson & P Queneau, Pyrometallurgical Processes in Non – Ferrous Metallurgy, Gorden & Breach, New York, 1967.
5 N Sevryukov, Non – Ferrous Metallurgy, Trans. By I V Savin, Mir Publishers, Moscow, 1975.
6 J L Bray, Non – Ferrous Production Metallurgy, John Wiley, New York.
7 R D Pehlke, Unit Processes of Extraction Metallurgy, Elsevier, Amsterdam, 1982.

Metallurgical Engineering			
ML622	**Creep, Fatigue and Fracture Mechanics**	**L**	**T**
		3	**0**

Course objectives –

To develop the ability of the candidate to safe guard the material during its service before its failure to save the national properties of the country.

Course Outcomes:

CO1	Understand the deformation and fracture behavior of material at high temperature.
CO2	Calculate theoretical fracture strength and experimental fracture strength through EPFM, CTOD and J-integral.
CO3	Describe the effect of crack on the toughness of brittle and ductile materials.
CO4	Predict the life of materials under fatigue loading.
CO5	Select metals and alloys for desired uses at high temperature.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	-	2	-	-	-	-	2	-	2	-	-
CO 2	-	1	-	-	-	1	2	-	-	-	-	-
CO 3	3	-	-	-	-	3	-	-	1	-	2	-
CO 4	-	-	-	1	-	-	-	-	2	-	-	1
CO 5	-	1	-	-	-	-	2	-	-	1	-	2

Course Detail -

Module 1: Fracture- use of fracture mechanics in the prediction of mechanical failure, Griffith's analysis concept of energy release rate and fracture energy, Linear Elastic Fracture Mechanics, (LEFM). (6 Hours)

Module 2: Loading modes, stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, Plasticity at the crack tip and the principles behind the approximate derivation of plastic zone shape and size, limits on the applicability of LEFM. (8 Hours)

Module 3: The effect of constraint, definition of plane stress and plane strain and the effect of component thickness. (6 Hours)

Module 4: Elastic-Plastic Fracture Mechanics (EPFM)- Alternative failure prediction parameters, Crack Tip Opening Displacement, and J integral, measurement of parameters and examples of use, Effect of Microstructure on fracture mechanism and path, cleavage and ductile failure, factors improving toughness. (8 Hours)

Module 5: Fatigue- High Cycle Fatigue, Low Cycle Fatigue, mean stress, R ratio, strain and load control, S-N curves, Goodman diagram, fatigue limit, mechanism of fatigue failure, effect of stress concentration, specimen size, Total life and damage tolerant approaches, Paris law. (8 Hours)

Module 6: Creep- Creep curve, creep properties of metals, stress-rupture test, deformation and fracture at elevated temperature, theories of creep, prediction of long time properties. Effect of metallurgical variables on creep, Creep resistant materials. (8 Hours)

Reading:

1. G. E. Dieter: Mechanical Metallurgy, McGraw Hill, 1988.
2. Michael Kassner: Fundamentals of Creep in Metals and Alloys, 2nd Edition, Elsevier Science, 2009.
3. T. L. Anderson: Fracture Mechanics- Fundamentals and Applications, 3rd Edition, CRC Press, 2011.
4. R. W. Hertzberg: Deformation and Fracture Mechanics of Engineering Materials, 4th edition, John Wiley & Sons Inc., 1995.

Metallurgical Engineering			
ML623	**Experimental Techniques in Materials Engineering**	**L**	**T**
		3	**0**

Course objectives –

- To obtain knowledge on various structural and microstructural characterization techniques of materials.
- To study the principles, theory and practice of various characterization techniques

Course Outcomes:

At the end of this course, the students would be able to:

CO1	Understand the principles of optical and electron microscopy.
CO2	Interpret optical and electron micrographs.
CO3	Describe composition analysis techniques in SEM.
CO4	Understand the principle of XRD, thermal analysis techniques includes DSC and TGA.
CO5	Select characterization techniques for a given metallurgical problem

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	2	-	1	-	-	-	2	-	-	3	-
CO 2	-	1	-	-	2	-	1	-	-	1	-	1
CO 3	-	-	-	1	-	-	2	-	-	3	-	1
CO 4	1	2	-	-	-	-	-	-	-	1	2	-
CO 5	-	1	-	-	-	-	2	-	-	1	-	1

Course Detail -

Module 1: Optical Microscopy and Image analyser: Understanding of image formation, resolution, numerical aperture, magnification, depth of field and depth of focus of a microscope. Quantitative and phase analysis (inclusion, size distribution etc.). (7 Hours)

Module 2: X-ray diffraction and analysis: Production and properties of X-rays, X-ray diffraction, Structure factor and intensity calculations. (7 Hours)

Module 3: Effect of texture, particle size, micro strain on diffraction lines. Indexing of powder photographs. X-rays florescence: basics and applications in materials science. (7 Hours)

Module 4: SEM and FESEM: Principle and applications, Modes of operation, Image formation - plane and fractured surfaces. Microanalysis (EDX, WDS etc.) (7 Hours)

Module 5: TEM: Principle and operation. Bright field and dark field images, Sample preparation techniques. Selected area diffraction, Reciprocal lattice and Ewald sphere construction, indexing of selected area diffraction patterns. (7 Hours)

Module 6: Advanced Characterization Techniques: STEM, AFM, Nanoindentation Testing, EELS- Principle and applications. DTA/DSC-TG: Scope and applications in materials science. (7 Hours)

Essential Readings:

1 B. D. Cullity, ***Elements of X-ray Diffraction*** (II edition), Addison-Wesley Publishing Co. Reading, USA, 1978.

2 P. J. Goodhew and F. J. Humphreys, Taylor and Francis, ***Electron Microscopy and Analysis,*** London, 2001(ISBN-0-7484-0968-8).

Supplementary Readings:

1 S. H. Cohen and Marcia L. Light body (Editors), **Atomic Force Microscopy / Scanning Tunnelling Microscopy**, Plenum Press, New York, 1994.

2 P. J. Haines (Editor), **Principles of Thermal Analysis and Calorimetry** Royal Society of Chemistry (RSC), Cambridge, 2002.

3 G. F. Vander Voort, **Metallography: Principles and Practice** ASM International, Materials Park, USA, 1984

4 S. Amelinckx, D. van Dyck, J. van Landuyt and G. van Tendeloo (Editors), **Electron Microscopy: Principles And Fundamentals**,VCH, Weinheim, 1997.

5 C. Suryanarayana and M. Norton, **X-ray Diffraction, A Practical Approach**, Plenum Press, New York, (1998).

6 **Metallography and Microstructures, Metals Handbook, Volume 9**, 9th edition, American Society for Metals, Metals Park, Ohio, 1986.

7. Materials Characterization, Metals Handbook, Volume 10, 9th edition, American Society for Metals, Metals Park, Ohio, 1986.

Metallurgical Engineering			
ML624	**Energy Materials**	**L**	**T**
		3	**0**

Objectives of the course

- To inculcate the ability to develop engineered materials for utilizing it into energy generation and energy storage.
- To learn the operating principle of several eco-friendly energy technologies.
- To identify the material issues relevant to these technologies and to evaluate various operational aspects associated with these technologies.

Course Outcomes

After completing this course, the student should be able to:

CO1	Evaluate an energy technology for environmental friendliness
CO2	Explain the operating principle of several energy technologies
CO3	Indicate the material requirements for these energy technologies
CO4	Demonstrate the ability to understand the characterization, performance, and failure data related to these technologies

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	1	-	-	-	2	-	1	-	-	1	-	1
CO 2	1	-	-	2	-	-	2	-	-	3	-	1
CO 3	-	2	-	1	-	-	-	-	2	-	2	-
CO 4	-	-	-	-	2	-	2	-	-	1	-	1

Course Detail -

Module 1: Introduction to energy materials, energy requirements globally and locally in the Indian context. (2 Hours)

Module 2: Evaluation of energy sources, from the perspective of clean energy and Carbon equivalence. (3 Hours)

Module 3: Introduction to different types of energy storage and conversion devices and technologies.
Synthesis and characterization of materials used for these technologies, Properties desired in the materials. (10 Hours)

Module 4: Techniques to evaluate the properties and performance, failure modes and analysis, environmental impact, of the following:

i. Fuel cells (5 Hours)
ii. Batteries (5 Hours)
iii. Supercapacitors (3 Hours)
iv. Solar energy conversion devices (7 Hours)
v. Wind (3 Hours)
vi. Mechanical Energy storage (2 Hours)

Suggested books

1. Renewable Energy: Power for a Sustainable Future By Godfrey Boyle, Oxford University Press, 2004

Metallurgical Engineering			
ML625	**Functional Materials**	**L**	**T**
		3	**0**

Objectives of the course

To introduce the student to functional materials and the science behind the performance of the functional material. To enable the student to understand the applications of functional materials.

Course Outcomes

After completing the course, the student will be able to:

CO1	Indicate the various type of functional materials
CO2	Explain the principle of operation of the functional material
CO3	Indicate the applications of the functional materials

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	1	-	1	2	-	1	1	2	-	-	-
CO 2	-	-	-	1	-	-	2	-	-	3	-	1
CO 3	1	2	-	-	-	-	-	-	-	1	2	-

Detailed contents

Module 1: Characteristics and types of functional materials. Crystal structure and Properties. – Effect of size on properties, effect of interfaces on properties (6 Hours)

Module 2: Band structure, Semiconductor devices – Theory, examples and applications of Optically active materials (10 Hours)

Module 3: Dielectrics, piezo- and ferroelectric materials: (10 Hours)

Module 4: Magnetic materials and storage applications. (4 Hours)

Module 5: Smart materials (5 Hours)

Module 6: Applications in electronic, communication, aerospace, automotive, energy industries (5 Hours)

Suggested books

1. Functional Materials: Electrical, Dielectric, Electromagnetic, Optical and Magnetic applications; Deborah D L Chung, World Scientific Publishing, 2010.

Metallurgical Engineering			
ML631	**Mechanical Behavior of Materials**	**L**	**T**
		3	**0**

Course objectives -

- Primary objective is to present the basic fundamentals of failures of the materials.
- Help students to possess a solid foundation in advanced materials with emphasis on the fundamental engineering principles that govern the properties, processing and their applications.
- To apply the different methods or techniques in improving the properties of materials

Course Outcomes

CO1	Explain the theories of elastic and plastic behaviour of materials
CO2	Differentiate mechanical testing methods of materials.
CO3	Discuss the strengthening mechanisms of materials
CO4	Appreciate the failure mechanisms in materials

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	2	-	-	-	-	1	2	-	2	-	-
CO 2	-	1	-	-	-	-	-	2	-	-	-	1
CO 3	1	-	-	2	-	-	1	-	-	-	2	-
CO 4	-	2	-	-	-	-	1	2	-	1	-	-

Course Detail -

Module 1: Tensile Behavior of Metals: True stress-true strain curve, Strain hardening coefficient, Instability in tension, Effect of strain rate and temperature on flow properties. (8 Hours)

Module 2: Fracture: Theoretical cohesive strength of metals, Griffith's theory of brittle fracture, Mechanism of brittle and ductile fracture, Fractographic aspects of fracture, Notch effects. (9 Hours)

Module 3: Impact Behavior: Notched bar impact test, Transition temperature phenomenon, Factors affecting transition temperature. (6 Hours)

Module 4: Fracture Mechanics: Strain energy release rate, Stress intensity factor, Plane strain fracture toughness, Design approach (6 Hours)

Module 5: Fatigue: Micro mechanisms of crack initiation and growth, Stress and strain approaches of fatigue, Fracture mechanics approach, Fatigue crack growth (6 Hours)

Module 6: Environmental Assisted Cracking: Stress corrosion cracking, Hydrogen embrittlement, Corrosion fatigue. (4 Hours)

Module 7: Creep: Creep curves, Mechanisms of creep, Stress rapture test, Life prediction, High temperature alloys. Composites: Fracture and fatigue of composites. (6 Hours)

Essential Reading:

1. G E Dieter, ***Mechanical Metallurgy*** –McGraw – Hill Publication (1988).
2. R W Hertzberg, ***Deformation and Fracture Mechanics of Engineering Materials***, John Wiley & Sons Publication (1995).

Supplementary Reading:

1. R E Reed, ***Physical Metallurgy Principals*** —Hill Litton Education Publication (2004).
2. W. Soboyejo, ***Mechanical Properties of Engineering Materials*** –Marcel Dekker Publication (2003).

Metallurgical Engineering			
ML632	**Advanced Materials**	**L**	**T**
		3	**0**

Course objectives -

- To understand the various strengthening mechanisms and also failure mechanisms for alloy systems to achieve enhanced mechanical performance.
- To gain knowledge with regards to kinetics of phase transformations and their effect on mechanical properties of alloys.
- To gain knowledge about the characteristics, processing and applications of polymers and composite materials.

Course Outcomes:

CO1	Students will be able to compile about the properties, structure of ceramic materials and their need for newer applications and processing techniques.
CO2	Students will be able to express the different fabrication techniques, how the properties are improved after they are processed with different methods.
CO3	Students will be able to demonstrate the need for newer materials by comparing the limitations of conventional materials.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	2	-	-	-	-	1	2	-	2	-	-
CO 2	-	1	-	-	-	-	-	2	-	-	-	1
CO 3	1	-	-	2	-	-	1	-	-	-	2	-

Course Detail -

Module 1: Special purpose steels. Light metals and alloys, Titanium and Ti-based alloys and Intermetallic, Advanced Aluminium alloys. (7 Hours)

Module 2: High temperature materials, Ultra high temperature materials. Cryogenic materials, Functional and Functionally graded materials-synthesis and their thermal and mechanical treatment. (8 Hours)

Module 3: Quasi Crystals, Metallic Glasses, Amorphous materials. (6 Hours)

Biomaterials, Carbon-based materials, Advanced Magnetic. (5 Hours)

Module 4: Electrical and Electronic materials, Optical materials (6 Hours)

Shape Memory Alloys, Smart Materials. (4 Hours)

Module 5: Materials for Automobiles, Lasers, Sensors. (5 Hours)

References:
1. M.F. Ashby: Engineering Materials, 4th Edition, Elsevier, 2005.
2. M.F. Ashby: Materials Selection in Mechanical Design, Butterworth Heinemann, 2005.
3. ASM Publication, Vol.20: Materials Selection and Design, ASM, 1997.
4. Pat L. Mangonon: The Principles of Materials Selection and Design, Prentice Hall International, Inc. 1999.

Metallurgical Engineering			
ML633	**Bio-Materials**	**L**	**T**
		3	**0**

Course objectives –
To introduce students to biomaterials. Emphasis will be on the understanding of what is a biomaterial, how it is processed, how it behaves under loadings and usage in design for broken or failure parts of the human body.

Course Outcomes:

CO1	Understand materials requirements for bio applications.
CO2	List metallic, ceramic and polymeric materials for bio applications
CO3	Review thin films and coatings in bio applications
CO4	Differentiate bioresorbable and bio erodible materials.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	2	-	3	-	-	1	2	-	2	-	-
CO 2	-	1	-	-	-	-	-	2	-	-	-	1
CO 3	2	-	-	2	-	-	1	-	-	-	3	-
CO 4	-	2	-	-	-	-	1	2	-	1	-	-

Course Detail -

Module 1: Properties of Materials. Materials in Medical Applications (8 Hours)

Module 2: Stainless steel alloys, Cobalt based alloys. Titanium-based alloys (8 Hours)

Module 3: Polymers, Bio-resorbable and Bio-erodible materials. Bio-ceramics, porous ceramics, bio-active glasses. (11 Hours)

Module 4: Calcium phosphates, collagen. Thin films, grafts and coatings (8 Hours)

Module 5: Biological functional materials Latex products. (6 Hours)

References:

1. Shi, D, Biomaterials and Tissue Engineering, Springer, 2004
2. Buddy D. Ratner, Bio Material Science: An introduction to Materials in Medicine, Elsevier, 2004.
3. S. V. Bhatt, Biomaterials, Narosa, 2002.

Metallurgical Engineering			
ML634	**Polymer Technology**	**L**	**T**
		3	**0**

Course objective:

- To understand and learn technical knowledge in polymer materials like plastic, rubber, latex, their quality control, designing and production.
- To provide the students with overall knowledge on the manufacturing of plastic materials, their properties, applications, processing, product design, mold design, testing & quality control, and recycling through theory as well as practical training. To make the students competent to take up the challenging positions in Plastics material manufacturing industries, compounding industries, processing machinery manufacturing industries through offering specialized elective subjects and industry exposure.

Course Outcomes:

CO1	Understand individual polymers properties and their usefulness for engineering applications.
CO2	Understand processing and development of polymers and their properties
CO3	Select appropriate polymeric material for a particular application
CO4	State the factors controlling properties of polymers.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	-	2	-	-	-	-	1	-	2	-	1

CO 2	-	1	-	-	-	1	2	-	-	-	-	-
CO 3	3	-	-	-	-	3	-	-	1	-	2	-
CO 4	-	-	-	1	-	-	-	-	2	-	-	1

Course Detail –

Module 1: Introduction of Polymer, manufacturing of plastic materials, their properties, applications, processing, product design, mold design, testing & quality control, and recycling through theory as well as practical training (8 Hrs.).

Module 2: Thermodynamics of Polymer Structures. Molecular weight and its determination (8 Hours)

Module 3: Properties of Polymers. Techniques of Polymerization (6 Hours)

Module 4: Polymer Additives, blends and composites. Polymer processing and Rheology (8 Hours)

Module 5: Individual Polymers (8 Hours)

Module 6: Application of Polymers. (2 Hours)

References:

1 J R Fried: Polymer Science and Technology, Prentice Hall of India Pvt. Ltd., New Delhi, Eastern Economy Edition, 2000

2 V R Gowrarikar, M V Viswanathan & Jayadev Sridhar: Polymer Science, Wiley Eastern Ltd., 1988.

3 Premamoy Ghosh: Polymer Science & Technology, Tata McGraw-Hill Publishing Company, New Delhi, 2002.

4 R. Sinha: Outlines of Polymer Technology: Manufacture of Polymers, Prentice Hall of India Pvt. Ltd., New Delhi, 2000.

Metallurgical Engineering			
ML635	**Electronic Materials**	**L**	**T**
		3	**0**

Objectives of the course
To become familiar with the science, synthesis, evaluation, and applications of electronic materials. To know the manufacturing processes, use of electronic materials for devices.

Course Outcomes

After completing this course, the student will be able to:

CO1	Indicate and explain important scientific parameters associated with electronic materials
CO2	Describe different semiconductors and their properties with examples
CO3	Explain the features and functioning of several electronic devices
CO4	Describe the manufacturing processes associated with electronic materials and devices

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	2	-	-	-	-	1	2	-	2	-	-
CO 2	-	1	-	-	-	-	-	2	-	-	-	1
CO 3	1	-	-	2	-	-	1	-	-	-	2	-
CO 4	-	2	-	-	-	-	1	2	-	1	-	-

Detailed contents

Module 1: Intrinsic semiconductors. Electron and hole (carrier) concentrations. (2 Hours)

Module 2: Fermi energy level, effect of temperature on Fermi energy (2 Hours)

Module 3: Carrier mobility (1 Hour)

Module 4: Direct vs. indirect band gap materials (2 Hours)

Module 5: Elemental vs. compound semiconductors. Extrinsic semiconductors. Doping – p and n type semiconductors (4 Hours)

Module 6: Carrier concentration and Fermi level as a function of temperature. Drift mobility.

Light and heavy doping (3 Hours)

Module 7: Semiconductor diodes – p-n junctions at equilibrium. Forward and reverse bias. IV characteristics. Band diagram. Diode breakdown mechanisms (6 Hours)

Module 8: LEDs and solar cell materials. Transistors – MOSFETs. Band diagram and channel formation. Threshold voltage. I-V characteristics (6 Hours)

Module 9: Introduction to semiconductor manufacturing – history, process flow, manufacturing goals. Bulk Si crystal growth (4 Hours)

Module 10: Overview of manufacturing technology – oxidation, photolithography, etching, doping, deposition, planarization. Clean room classifications (6 Hours)

Module 11: CMOS manufacturing steps. Process monitoring – blank and patterned thin film measurement. Defect inspection. Electrical testing. Yield monitoring & statistical process control. Definitions of yield, process control, defect density. Process integration. Assembly and packaging (4 Hours)

Suggested books

1. Semiconductor Materials, Devices and Fabrication, Parasuraman Swaminathan, Wiley 2017

Suggested reference books

1. Principles of Electronic Materials and Devices, S. O. Kasap, McGraw Hill Education, 2017

Metallurgical Engineering			
ML641	**Joining of Materials**	**L**	**T**
		3	**0**

Course objectives –

Survey important ideas and concepts associated with welding technology; Provide a bridge between the academic and real world; Act as a capstone course by integrating knowledge from many areas of natural science and engineering through the wide range of issues that arise in a discussion of welding technology; provide a limited amount of experience welding.

Course Outcomes:

CO1	Classify and differentiate welding processes.
CO2	Explain heat flow in welding
CO3	Identify various defects and remedial measures in weldment.
CO4	Appreciate the importance of welding metallurgy.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	1	-	2	-	-	3	2	-	2	-	-
CO 2	-	3	-	-	-	-	-	-	-	1	-	1
CO 3	2	-	-	1	-	-	1	-	-	-	2	-
CO 4	-	2	-	-	2	-	1	1	-	1	-	-

Course Detail -

Module 1: Introduction: Principle, Theory and Classification of welding and other joining processes. (2 Hours)

Module 2: Manual metal arc (MMA): Equipment requirement, electrodes for welding of structural steels, coating constituents and their functions, types of coatings, current and voltage selection for electrodes, Arc welding power sources; Conventional welding transformers, rectifiers and current and voltage. The influence of these power sources on welding. Metal transfer. (10 Hours)

Module 3: Submerged arc welding (SAW): Process details, consumables such as fluxes and wires for welding mild steel, Variations in submerged arc welding process. (7 Hours)

Module 4: Gas metal arc welding (GMAW) or MIG/ MAG welding: Process details, shielding gases, electrode wires, their sizes, and welding current ranges. (4 Hours)

Module 5: TIG welding: Process details, power sources requirements, electrode sizes and materials, current carrying capacities of different electrodes, shielding gases, application of process. (8 Hours)

Module 6: Resistance welding: General principle of heat generation in resistance welding, application of resistance welding processes. Process details and working principle of spot, seam, and. projection welding, electrode materials, shapes of electrodes, electrode cooling, selection of welding currents, voltages. Welding metallurgy of carbon and alloy steels, Cast irons, Stainless steels, Al- and Cu-based alloys .Weldability and Heat affected zones (HAZ). Welding defects and detection techniques. (12 Hours)

Module 7: Soldering and brazing: Difference between both the processes, consumables used, methods of brazing, fluxes used, their purposes and flux residue treatment. High energy density welding techniques like: Electron beam welding and laser welding technique. (7 Hours)

Essential Reading:

1. J F Lancaster, Allen and Unwin, ***Metallurgy of Welding.***
2. R L Little, ***Welding and Welding Technology***, TMH.

Further Reading:

1. J Norrish, Woodhead, ***Advanced Welding Processes.***
2. K Weman, Woodhead. ***Welding Processes Handbook***

Metallurgical Engineering			
ML642	**Nano Science and Nano Technology**	**L**	**T**
		3	**0**

Course objectives -

- To foundational knowledge of the Nanoscience and related fields.
- To make the students acquire an understanding the Nanoscience and Applications
- To help them understand in broad outline of Nanoscience and Nanotechnology.

Course Outcomes:

After completing this course, the student should be able to:

CO1	Indicate the differences between nanomaterials and conventional materials
CO2	Indicate how specific synthesis techniques can result in nanomaterials
CO3	Give examples of specific nanomaterials and explain the scientific reasons for the properties displayed by them
CO4	Describe how specific characterization techniques can be used to analyze nanomaterials

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	-	2	-	-	-	-	2	-	2	-	-
CO 2	-	1	-	-	-	1	2	-	-	-	-	-
CO 3	3	-	-	-	-	3	-	-	1	-	2	-
CO 4	-	-	-	1	-	-	-	-	2	-	-	1

Course Detail -

Module 1: Significance of Nano materials, properties of materials at Nano level, Nano clusters, synthesis of metal and ceramic Nano materials, classical, chemical and biological methods, carbon Nano tubes, aerogels, zeolites and special nanomaterials, Changes in order behaviour and compositional changes due to reduction in size. (6 Hours)

Module 2: Carbon Nano structures- carbon molecules, carbon clusters, carbon Nano tubes-synthesis, formation mechanisms, strength, separation, stability and applications, Properties of Nano materials- Mechanical and structural properties, Elastic and plastic behaviour of Nano materials. Effect of temperature and nature of dislocations and their mobility super plasticity in

Nano materials, improvements in strength and ductility. (10 Hours)

Module 3: Nano indentation, principles and mechanisms leading to enhanced properties of composite materials, Fatigue, super plastic behaviour of Nano grained materials, Nano control for high strength and high ductility in light weight alloys. (4 Hours)

Module 4: Ceramic Nano systems- Nano ceramic powders, Nano grained ceramics, Quantum effects, quantum confinement, quantum wells, wires and dots, effect of size reduction on optical, electrical, electronic, mechanical, magnetic and thermal properties of materials due to size. Surface effects, Nano electronics, Differences between Nano and microelectronics, 1-D, 2-D, 3-D Nano structures, Nano fluidics, Nano layered composites, Nano filamentary and Nano wire composites. (11 Hours)

Module 5: Nano particulate composites, Capacity building in Nano materials such as capacitors, superconductors, super capacitors etc., (6 Hours)

Module 6: Nano electromechanical systems (NEMS) organic optoelectronic nanostructures, photonic crystals, biomimetic Nano structures. (5 Hours)

References:

1. Sulabha K. Kulkarni: Nanotechnology Principles and Practices, Capital Publishing Company, 2007.

2. H. Hosono, Y. Mishima, H. Takezoe and K.J.D Mackenzie: Nanomaterials- From Research to Applications, Elsevier Ltd., Noida, 2008.

3. Massimilano Di Ventra, S. Evoy and James R. Heflin, Jr.: Introduction to Nanoscale Science and Technology, Springer, Noida, 2009.

4. Charles P. Poole Jr. and Frank J. Owens: Introduction to Nanotechnology, Wiley India, 2010.

Metallurgical Engineering			
ML643	**Surface Engineering**	**L**	**T**
		3	**0**

Course objectives -

To understand the need for Surface Engineering and to become familiar with the techniques associated with Surface Engineering.

Course outcomes:

Upon completion of the course, the student will be able to:

CO1 Define different forms of processing techniques of surface engineering materials.

CO2 Know the types of Pre-treatment methods to be given to surface engineering.

CO3 Select the Type of Deposition and Spraying technique with respect to the application.

CO4 Study of surface degradation of materials.

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	1	-	-	-	2	-	-	1	-	-	-	-
CO 2	-	1	-	2	-	-	-	-	-	-	2	-
CO 3	-	-	-	2	1	-	-	3	-	-	-	1
CO 4	1	-	-	-	-	-	-	-	1	-	-	-

Course Detail -

Module 1: Introduction tribology, surface degradation, wear and corrosion. (3 Hours)

Module 2: Types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication. Overview of different forms of corrosion Chemical and electrochemical polishing, significance, specific examples. (11 Hours)

Module 3: Chemical conversion coatings, phosphating, chromating, chemical coloring, anodizing of aluminum alloys, thermochemical processes. Industrial practices Surface pre-treatment, deposition of copper, zinc, nickel and chromium - principles and practices, alloy plating, electro composite plating, properties of electro deposits, electroless, electroless composite plating; application areas, properties. (13 Hours)

Module 4: Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities, chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD. (9 Hours)

Module 5: Thermal spraying, techniques, advanced spraying techniques - plasma surfacing, detonation gun and high velocity oxy-fuel processes, laser surface alloying, laser cladding, specific industrial applications, tests for assessment of wear and corrosion. (10 Hours)

TEXT BOOKS

1. Sudarshan T S, „Surface modification technologies - An Engineer's guide‟, Marcel Dekker, New York, 1989
2. Varghese C.D, „Electroplating and Other Surface Treatments - A Practical Guide‟, TMH, 1993
3. Tadeusz Burakowski and Tadeusz Wierzchon, Surface Engineering of Metals: Principles, Equipment, Technologies, CRC Press LLC, 1999.
4. K. G. Budinski, Surface Engineering for Wear Resistance, Prentice Hall, New Jersey, 1998.
5. Surface Engineering, Process Fundamentals and Applications, Vol I &Vol II, Lecture Notes of SERC School on Surface Engineering, 2003.

Metallurgical Engineering			
ML644	**Industrial Automation and Control**	**L**	**T**
		3	**0**

Course objectives -

To develop required skills in the students so that they are able to acquire competency such maintain electronic circuitry of different types of industrial automation systems

Course outcomes:

The theory should be taught and practical should be undertaken in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domains to demonstrate the following course outcomes:

CO1	Describe working of various blocks of basic industrial automation system
CO2	Use various industrial motor drives for the Industrial Automation
CO3	Use various PLC functions and develop small PLC programs
CO4	Summarize Distributed control system and SCADA system

Mapping of course outcomes with program outcomes

Course Outcomes	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	-	2	-	-	-	-	2	-	-	-	2	-
CO 2	-	-	2	-	-	-	-	-	-	3	-	-
CO 3	-	-	2	-	-	1	-	-	-	-	1	-
CO 4	-	-	-	1	-	-	-	-	-	-	-	-

Course Detail -

Module 1: Introduction to Industrial Automation Systems. Measurement of physical quantities, e.g., temperature, pressure, force, displacement, speed, liquid flow, liquid level humidity.
(4 Hours)

Module 2: Signal conditioning and calibration. Actuators, Control Valves, Hydraulic Actuation, Switches and Gauges, Industrial Hydraulic Circuits, Pneumatic Control Systems. (7 Hours)

Module 3: Introduction to Process Control, PID control, Auto-tuning, Predictive control. Programmable Logic Controllers (PLC), Modelling of Sequence Control Specifications and Programming. (11 Hours)

Module 4: Electrical Machine Drives, Energy Savings with Variable Speed Drives, Stepper Motors, DC Motor Drives, Induction Motor Drives, BLDC Motor Drives. (7 Hours)

Module 5: Industrial Real Time Embedded Systems, Process Management, Control Networks. (10 Hours)

Essential Reading:

1. Smith Carlos and Corripio, "***Principles and Practice of Automatic Process Control***", John Wiley & Sons, 2006.
2. Jon Stenerson, "***Industrial Automation and Process Control***", Prentice Hall, 2003.
3. M. Gopal, "***Digital Control and State Variable Methods***" Tata McGraw Hill, 2003.

Suggested Reading:

1. G. F. Franklin, J. D. Powell, M. L. Workman: Digital Control of Dynamic Systems, Addison-Wesley, Reading, Ma-USA (1990)

Metallurgical Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

1. Hisrich & Peters, “Entrepreneurship”, Tata McGraw Hill
2. Roy, Rajeev, “Entrepreneurship”, Oxford University Press
3. Norman M. Scarborough, “Essentials of Entrepreneurship & Small Business Management”, 6^{th} ed., Prentice Hal
4. Dutta, Bholanath, “Entrepreneurship management” ,Excel Books.

Chemical Engineering			
CL601	**Process Equipment Design**	**L**	**T**
		3	**1**

Pre-requisites: Heat transfer and Mass transfer

Objective: Introduce the basic design concepts for chemical process equipment industrial pressure vessel, storage vessel, heat exchangers, distillation column, absorption column, and reactors used in chemical industries.

Course Outcome:
CO1. Understand the basic design concept of chemical process equipment
CO2. Design the pressure vessel and its closures, distillation column and absorption column
CO3. Design the heat exchanger as per TEMA standards.
CO4. Apply various designs in process plant.

Detailed syllabus

MODULEI **08 Lectures**

Heat-exchanger

Design of double pipe heat exchanger, Shell and tube type heat exchanger, over all heat transfer Co-efficient.

MODULE II

Evaporators **08 Lectures**

Design of evaporators (Double and triple effect), Over all heat transfer Co-efficient, heating surface and mechanism of vacuum system etc..

MODULE III **05 Lectures**

Piping system

Piping: Design of piping system for transfer of fluid covering pipes, valves, fittings, Instrumentation, insulation, Pumps etc.

MODULE IV **08 Lectures**

Design of distillation column

Design of distillation column-number of plates, stages arrangement of double caps, Dimeter and height of the tower and thickness of the shell.

MODULE V **06 Lectures**

Design of Absorption column

Design of absorption column, Number of transfer units, Dimeter, Height of the tower and the thickness of the shells

Text Book:

1. Bhattacharyya B.C., "Introduction to Chemical Equipment Design: Mechanical Aspects", 5th Ed., CBS Publishers, New Delhi, 2008.
2. Kern D.Q., "Process Heat Transfer", McGraw-Hill, New York, 1965.
3. Coulson & Richardson's Chemical Engineering, Vol. 6, 4th Ed., Elesevier, New Delhi, 2006.
4. Soares C., "Process Engineering Equipment Handbook", McGraw-Hill, New York, 2002.

Table1. Relationship of COs to POs for Process Equipment Design :

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1.	3	-	2	1	-	-	-	-	-	-	-
CO2.	2	2	3	2	2	-	-	-	-	-	-
CO3.	3	2	3	2	2	2	-	-	-	-	-
CO4.	3	2	3	2	-	-	-	-	-	-	-

Chemical Engineering			
CL611	**Chemical Engineering Thermodynamics**	**L**	**T**
		3	**0**

Prerequisite: Thermodynamics

Objective : To establish a criteria for determination of feasibility or spontaneity of a given transformation and to predict the energy exchanges that occur in chemical reactions.

Detailed Syllabus

Module I **8 Lectures**

Review of laws of thermodynamics & their applications, Thermodynamic analysis of the process. Thermodynamic properties of fluids and their inter-relations.

Module II **8 Lectures**

Heat Engine cycles: Power plant cycles, Rankine cycle, the Otto Engine, the Diesel Engine, the combustion gas cycle.

Module III **8 Lectures**

Refrigeration Cycles, The Carnot Cycle, The Air Refrigeration Cycle. The Vapor Compression cycle, Absorption Refrigeration machine and Heat pump.

Module IV **8 Lectures**

Introduction to Solution thermodynamics Partial Molar Properties, Chemical Potential, Gibbs-Duhem Equation,

Module V **8 Lectures**

Ideal and non-ideal solution. Residual and excess properties, Fugacity and fugacity coefficient. Activity and activity coefficient.

TEXTBOOK

1. Introduction to Chemical Engineering Thermodynamics, Smith, J.M., Van Ness, H.C., and Abbott, M.M., 7th Edition, McGraw Hill.

Reference Books:

1. Chemical Engineering Thermodynamics, Y.V. C. Rao, Universities press.
2. A Textbook of Chemical Engineering Thermodynamics, K. V. Narayanan. Publisher, PHI Learning Pvt. Ltd., 2004.

Course outcomes (COs)

At the end of the course, the students will be able to:

CO1: Apply the first, second, third and zeroth law of thermodynamics to the industrial process.

CO2: Calculate the properties of ideal and real mixtures.

CO3: Evaluate the performance, heat and energy balances for the process and cycle applicable to chemical industries.

CO4: Determine the coefficient of performance and energy calculations for different refrigeration and liquefaction cycles.

Course outcome mapping with Programme outcomes

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	3	3					1			3
CO2	3	3	2						1			2
CO3	3	3	3	3	3	3						2
CO4	3	3	3	3	3	3						2

Chemical Engineering			
CL612	**Solutions Thermodynamics**	**L**	**T**
		3	**0**

Objective: To impart fundamental concepts of solution thermodynamics involving ideal and non –ideal systems and to compute phase and reaction equilibrium data.

Detailed Syllabus

Module I **8 Lectures**

Equation of states, generalized correlations, acentric Factor, Calculation of thermodynamic properties using fugacity and fugacity coefficient and activity and activity coefficient, Excess properties of mixing, Gibbs Duhem equation and its correlation in terms of partial pressure.

Module II **8 Lectures**

Phase Rule and Phase Equilibria: Phase rule, Claussius- Claypron equation, VLE calculation-Bubble Point, Dew Point, Dew point and flash calculation. Phase Equilibrium VLE.

MODULE III **8 Lectures**

Excess Free Energy: Concept of excess free energy of mixing and its Gibbs-Duhem equation, in relation to Raoult's Law, Henry's Law, Lewis Randle Rule and partial pressure.

MODULE IV **8 Lectures**

Gibbs/Duhem equation and its interacted form like, Porter Van Laar, Margules, Wilson and Redlich/Kister Equation. Excess function of non-ideal solution.

MODULE V **8 Lectures**

Chemical Equilibria: Criteria for Equilibrium, Equilibrium Constant and its dependence on temperature and pressure, Evaluation of equilibrium constant. Equilibrium conversion for single and multiple reaction systems, Phase rule for reacting substances.

TEXTBOOK

1. Introduction to Chemical Engineering Thermodynamics, Smith, J.M., Van Ness, H.C., and Abbott, M.M., 7th Edition, McGraw Hill.

Reference Books:

1. Chemical Engineering Thermodynamics, Y.V. C. Rao, Universities press.
2. A Textbook of Chemical Engineering Thermodynamics, K. V. Narayanan. Publisher, PHI Learning Pvt. Ltd., 2004.

Course outcomes (COs)

At the end of the course, the students will be able to:

CO1: Apply basic equation of states to calculation of state variables for a chemical process.

CO2: Determine the thermodynamic properties of gas mixture/solution and their correlation to standard equation.

CO3: Calculate Bubble-P&T, Dew P&T, Flash P&T in VLE for a binary and multi component systems.

CO4: Determine Equilibrium constant & composition of the chemical solution at given state conditions.

Chemical Engineering			
CL613	**Physical and Chemical Equilibria**	**L**	**T**
		3	**0**

Course Objective: To impart fundamental concepts of solution thermodynamics involving ideal and non-ideal systems and to use solution thermodynamic concepts to compute phase & reaction equilibrium data.

Module I **10 Lectures**

Review of Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess's law, heat of formation, Second law, entropy, free energy and work function, Gibb's-helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Trouton's rule, Third law of thermodynamics.

Module II **8 Lectures**

Phase rule, phase diagram of water, two component systems with a simple eutectic-Pb, Ag system and construction of phase diagram by thermal analysis.

Phase equilibria: Fundamental VLE equation, VLE at low, moderate and high pressures, azeotropic data, multicomponent VLE, thermodynamic consistency test of VLE data, liquid-liquid equilibria, chemical reaction equilibria.

Module III **4 Lectures**

Thermodynamic properties of mixtures: Ideal-gas mixtures, ideal or Lewis mixtures - chemical potential and fugacity, partial molar properties, calculation of fugacity and fugacity coefficients, excess properties, concept of activity coefficient, correlative activity coefficient models.

Module IV **4 Lectures**

Colligative properties: Raoult's law, elevation of boiling point, depression of freezing point, osmotic pressure (no thermodynamic derivations) elementary treatment of vapor pressure.

Module V **10 Lectures**

Chemical equilibria: Reversible reactions, law of mass action, Lechatelier principle, Effect of temperature on equilibrium-VanHoff equation, Ionic Equilibria: Solubility, solubility product, common ion effect, Hydrolysis of salts, pH, buffer and their application in chemical analysis, equilibrium constants (Kc, Kp, Kx) for homogeneous reactions.

Course Outcomes:

After completion of this course, the student will be able to

CO1	Differentiate fundamental equations that govern the estimation of solution properties.
CO2	Analyze phase equilibrium data and construct P-x-y, T-x-y diagram for ideal binary miscible vapour-liquid systems.
CO3	Evaluate bubble and flash point for a given data.
CO4	Evaluate phase equilibrium data for non-ideal binary miscible vapour-liquid systems .
CO5	Estimate equilibrium conversion in reversible reactions .

Mapping of course outcomes with program specific outcomes :

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**2**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**2**	**2**	**1**	**1**	**-**							

Text/Reference Books:

1.Prausnitz, J.M.; Lichtenthaler, R.N.; Gomes de Azevedo, E. "Molecular Thermodynamics of Fluid Phase Equilibria", Prentice Hall, 3rd Edition, 1998.
2. Sandler, S.I. "Chemical, Biochemical and Engineering Thermodynamics", Wiley, 4th Edition, 2006.
3. Rao, Y.V.C. "Chemical Engineering Thermodynamics", Universities Press, 1997.
4. Smith, J.M.; Van Ness, H.C.; Abbott, M.M. "Introduction to Chemical Engineering Thermodynamics", 7th Edition, 2005.
5. Koretsky, M.D. "Engineering and Chemical Thermodynamics", Wiley, 2004.

Chemical Engineering			
CL621	**Advance Mass Transfer**	**L**	**T**
		3	**0**

Pre-requisite: Mass Transfer and Separation Processes

Syllabus

Module 1: Mechanism of Transfer **7 Lectures**

Expressions for diffusion coefficient in gases and liquid, Von Karman and Marternell: Analogy for Transfer, Knudsen diffusion, thermal diffusion, Recent theories of inter phase mass transfer.

Module 2: Multi component Distillation **15 Lectures**

Determination of key components at minimum reflux ratio by the method of Shiras et al., Minimum reflux ration by Underwood's method, Fenske equation for total reflux and computation of product distribution; Flash vaporization of feed to the distillation column; Rigorous methods of Lewis-Matheson, Thiele-Geddes, Bubble Point.sum rates method.

Module 3: Azeotropic Distillation **8 Lectures**

Stage wise calculations for multicomponent with multiple feed streams, Graphical method for location of feed plates for multiple feeds.

Module 4: Liquid-liquid Extraction **6 Lectures**

Stage wise calculations for multicomponent with multiple feed streams using reflux and mixed solvents.

Module 5: Multi component Gas Adsorption **6 Lectures**

Horton-Franklin method, Edmister method, Mass transfer in gas adsortption with and without chemical reaction, model solutions by Dankwerts; Brain; Perry and Pigford.

Text Books / Reference Books

1. Multi-component Mass Transfer by R. Taylor and R. Krishna, John Wiley and Sons (1993).
2. Multi-component Diffusion by E. L. Cussler, Elsevier (1976).
3. Principles of Mass Transfer and Separation Process. B.K. Dutta, Prentice-Hall of India Pvt. Ltd, New Delhi, (2007).
4. Mass Transfer from Fundamentals to Modern Industrial Applications by Koichi Asano
5. Principles and Modern Applications of Mass Transfer Operations, Ed. 2nd by Jaime Benitez

6. Kinetics of Gas-Liquid Reaction by Lucien H. Hosten

Course Outcomes (COs):

After completing this course, you should be able to:

CO1: Understand the mass transfer operations and various methods of conducting mass transfer operations for multi-component system.

CO2: Estimate the diffusivity for the molecular diffusion in gases and liquids.

CO3: Understand various models of inter-phase mass transfer and estimate multi-component mass transfer coefficients.

CO4: Understand and be able to handle the physical and mathematical complexities involved in multi-component mass transfer.

Course outcome mapping with Programme outcomes:

	POs1	POs2	POs3	POs4	POs5	POs6	POs7	POs8	POs9	POs10	POs11	POs12
CO1	3	3		2		2	2					2
CO2	3	3	3	3			2					2
CO3	3	3	2	2		2	2	1				1
CO4	3	3	3	3		3	2	1				2

Chemical Engineering			
CL622	**Separation Processes**	**L**	**T**
		3	**0**

Pre-requisites:

- Chemical engineering thermodynamics, Mass and energy balances.

Syllabus

Module-1: Membrane Separation Processes: 12 Lectures

Principle, Classification, structure & characteristics of membranes; Membrane modules and application; Reverse osmosis, ultrafiltration, micro-filtration, nano-filtration, dialysis; Analysis and modeling of membrane separation processes gas separation and pervaporation processes; Ion selective membranes and their application in electro-dialysis, Liquid membranes; Membrane Reactors.

Module-2: Adsorption Technique: 8 Lectures

Adsorbents-Molecular sieves; Single component adsorption equilibrium and multi component adsorption equilibrium calculation, Langmuir, BET and Gibbs isotherms; Pressure and temperature swing adsorption techniques.

Parametric Pumping: Batch, continuous and semi-continuous pumping; thermal, pH and heatless parametric pumping.

Module-3: Cromatography Separation: **6 Lectures**
Principle, classification and techniques of chromatography, Chromatographic column, Development of gradient-elution separations, Equipment and commercial processes.

Module-4: Thermal Separation: **10 Lectures**
Thermal Diffusion: Basic rate law, Theory of thermal Diffusion Phenomena for gas and liquid mixtures. Equipments design and Applications, Zone Melting: Equilibrium diagrams. Adductive and extractive crystallization: Molecular addition compounds, Clathrate compounds and Adducts; Equipments; Applications.

Module-5: Foam and Bubble Separation: **5 Lectures**
Principle, Classification and separation techniques, Surface Adsorption; Nature of foams; Apparatus, Applications and Controlling factors.

Text Books / Reference Books:

- Seader, Henleyand Roper, Separation Process Principles, 3rdEdition, John Wiley and Sons, Inc. 2011.
- Foust A S et al. Principles of Unit Operations 2nd Edn (John Wiley & Sons, NY)
- Geankoplis C J Transport Processes and Separation Process Principles (Includes Unit Operations) 4th Edn (Prentice Hall, NJ)
- McCabe W L et al. Unit Operations of Chemical Engineering 4th Edn (McGraw-Hill)
- Treybal R E Mass Transfer Operations 3rd Edn (McGraw-Hill)

Course Outcomes (COs)

On successful completion of this course students will be :

CO1: Understand the basic principles of various membrane processes.

CO2: Able to select appropriate separation technique for intended problem.

CO3: Ability to analyze the separation system for multi-component mixtures.

CO4: Analyze and design different membrane modules, chromatographic and ion exchange systems for intended applications.

Course outcome mapping with Programme outcomes:

	POs1	POs2	POs3	POs4	POs5	POs6	POs7	POs8	POs9	POs10	POs11	POs12
CO1	3	2		1		2	2					2
CO2	3	3	3	3		1						2
CO3	3	3	1	2		1	2					2
CO4	3	3	3	3		2	2	1				2

Chemical Engineering			
CL623	**Multi Component Separations**	**L**	**T**
		3	**0**

Course objective

The basic course objective are to give the students a comprehensive background in all aspects of separation process as pertaining to process engineering practice.

Module – I **8 Lectures**

Introduction: Overview of binary systems: Gibbs phase rule, flash, bubble point and dew point calculations, diffusive, equilibrium and rate-based methods.

Module-II **8 Lectures**

Multicomponent cascade systems**:** Cascade configurations, liquid-liquid extraction cascades, vapor liquid cascades, membrane cascades, specifications for counter current cascades

Module-III **8 Lectures**

Approximate methods for multicomponent-multistage separation: Fenske-Underwood-Gilliland method, Fenske equation for minimum equilibrium stages, Underwood equations for minimum reflux, Gilliland correlation for actual reflux ratio and theoretical stages, Kramer Group method for strippers and liquid-liquid extraction.

Module-IV **8 Lectures**

Equilibrium based methods for multi-component systems: Theoretical model for equilibrium stage, general strategy of mathematical solution, equation –tearing procedure: Bubble point method for distillation, sum rates method for absorption and stripping, Newton Raphson method, MESH equations.

Module-V **8 Lectures**

Design of multicomponent systems: Design of multicomponent distillation column using Lewis-Matheson method, azeotropic and extractive distillation, reactive multistage separations, diffusion in non-ideal system and development of generalized Maxwell-Stefan formulation, Study of generalized Fick,s law.

Course Outcomes:

After completion of this course, the student will be able to

CO1	Knowledge of various chemical engineering separation processes
CO2	Select appropriate separation technique for intended problem
CO3	analyze the separation system for multi-component mixtures
CO4	design separation system for the effective solution of intended problem

Textbook:

1. Separation Processes and Principles By Seader J. D.; Henly E. J., (John Wiley, 2010, 3nd edition).

2. Multicomponent Mass Transfer, Taylor R.; Krishna R. (John Wiley, 1993).
3. Principles and Modern Applications of Mass Transfer Operations By Bendaitez (J. Wiley, 2nd edition, 2011.)
4. Fundamentals of Multicomponent Distillation By Holland, C. D. (McGraw Hill, 1981).
5. Separation Process Engineering By Wankat P. C., (Prentice Hall, 2011, 3nd edition).

Chemical Engineering			
CL631	**Heterogeneous Catalysis**	**L**	**T**
		3	**0**

Course objective

This course will provide students understand the kinetics of reaction heterogenous catalytic and non-catalytic reaction.

Module-I Heterogenous catalysts: Homogeneous processes, global and intrinsic rates, and mechanism of catalytic reactions. Engineering properties of catalysts-BET surface area, pore volume, pore size distribution. **8 Lectures**

Module-II. Development of rate equations for solid catalyzed fluid phase reactions. Estimation of Kinetic parameters Catalysts poisoning, deactivation of catalyst. **8 Lectures**

Module-III Kinetics of Fluid Solid Reactions: External transport processes. Reaction & diffusion within porous catalysts. **8 Lectures**

Module-IV Effective diffusivity, thermal conductivity & effectiveness factor. Analysis of rate data. Rate expressions for non-catalytic fluid solid system. **8 Lectures**

Module-V Design of Reactors: Designing outline & selection criteria of fixed bed, fluidized bed reactors. **8 Lectures**

Textbook:

1. Chemical Reaction Kinetics by J.M. Smith (3rd Edition Mc Graw Hill)
2. Chemical Reaction Theory an Introduction by K.G. Denbigh & K.G. Turner (2nd Edition United Press & ELBS 1972)
3. Chemical Kinetic and Reactor Engineeringby G. Copper & GVJ jeffery`s (Prentice Hall 1972)
4. Chemical reaction engineering by O.Levenspiel (2nd Edition Willey Eastern, Singapore)
5. Chemical process Principal Part-III by Houghen Watsn & Ragatz [Kinetics & catalysis (2nd Edition asian publication House Bombay)]
6. Element of Chemical Reaction Engineering by Fogler ,H.S. (2nd edition Prentice Hall of India Pvt. Ltd. New Delhi 1999)

Course Outcomes:

After completion of this course, the student will be able to

CO1	Interpret heterogeneous catalytic and non-catalytic processes.
CO2	Evaluate the mass transfer process in reaction system.
CO3	Examine kinetics of catalytic and noncatalytic heterogeneous system.
CO4	Design reactors for heterogeneous processes.

Mapping of course outcomes with program outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO2	**3**	**3**	**2**	**3**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**-**
CO3	**3**	**3**	**2**	**3**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**
CO4	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**1**	**-**	**-**	**-**

Chemical Engineering			
CL632	**Chemical Reactor Analysis**	**L**	**T**
		3	**0**

Course Objective:

This course will prove advanced knowledge in reactor design and analysis along with providing kinetics of heterogeneous catalytic process.

MODULE I **8 Lectures**

Heterogeneous processes, global and intrinsic rates, Mechanism of catalytic reactions. Engineering properties of catalysts-BET surface area, pore volume, pore size, pore size distribution. Development of rate equations for solid catalyzed fluid phase reactions, Estimation of kinetic parameters.

MODULE II **8 Lectures**

External mass and heat transfer in catalyst particles. Stability and selectivity, Packed bed reactor, slurry reactor, Trickle bed reactor and fluidized bed reactor. Intra-particle heat and mass transfer-Wheeler’s parallel pore model, random pore model of Wakao and smith.

MODULE III **8 Lectures**

Effective diffusivity isothermal and non-isothermal effectiveness factor, deactivation of catalyst. Ideal and non ideal flow in reactors,

MODULE IV **8 Lectures**

Design of fixed bed catalytic reactor-isothermal, adiabatic, non-isothermal programmed reactors: one dimensional, two dimensional approaches, Reactor-stability control and optimization.

MODULEV **8 Lectures**

Computer aided reactor design. Transient CSTR analysis. Hot spot equation, optimization using Lagrange multiplier, and poyntrogin's maximum principle.

Textbook:

1. Chemical Reaction Kinetics by J.M. Smith (3rd Edition Mc Graw Hill)
2. Chemical Reaction Theory an Introduction by K.G. Denbigh & K.G. Turner (2nd Edition United Press & ELBS 1972)
3. Chemical Kinetic and Reactor Engineeringby G. Copper & GVJ jeffery`s (Prentice Hall 1972)
4. Chemical reaction engineering by O.Levenspiel (2nd Edition Willey Eastern, Singapore)
5. Chemical process Principal Part-III by HoughenWatsn&Ragatz [Kinetics & catalysis (2nd Edition asian publication House Bombay)]
6. Element of Chemical Reaction Engineering by Fogler ,H.S. (2nd edition Prentice Hall of India Pvt. Ltd. New Delhi 1999)

Course Outcomes:

After completion of this course, the student will be able to

CO1	Interpret heterogeneous catalytic and non-catalytic processes.
CO2	Evaluate the mass transfer process in reaction system.
CO3	Examine kinetics of catalytic and noncatalytic heterogeneous system.
CO4	Design reactors for heterogeneous processes.

Mapping of course outcomes with program specific outcomes:

Course outcomes	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10	PSO11	PSO12
CO1		**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**3**	**3**	**2**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

Chemical Engineering			
CL633	**Material Characterization**	**L**	**T**
		3	**0**

Objective: Characterization of materials is essential to the systematic development of new materials and understanding how they behave in practical applications. This course focuses on the principal methods required to characterize broad range of materials such as polymers, ceramics, nanostructures etc. for their applications based on mechanical, optical, thermal properties of materials.

Course outcomes: At the end of the course, student will be able to

CO1	Identifies the various characterization techniques applicable for the material
CO2	Understand the physical and chemical properties of material
CO3	Analyzed the structural properties, thermal properties and morphology of the material.
CO4	Explain the of the properties of material.

Detailed Syllabus:

MODULE I **8 Lectures**

Introduction to materials and Techniques, Production and properties of X-ray, absorption of X-rays and filters, X-ray - diffraction directions, diffraction methods. X-ray - diffraction intensities, factors affecting intensity, 'structure factor' calculations for simple, body centered, face centered, diamond cubic and hexagonal crystal structures. Working principles of diffractometer. Indexing of XRD patterns. Precise lattice parameter determination, Chemical analysis by X-ray diffraction & fluorescence, determination of particle size and micro/macro strains), energy dispersive X-ray microanalysis (EDS).

MODULE II **8 Lectures**

Fundamentals of optics and microscopy techniques, Optical microscope and its instrumental details, Variants in the optical microscopes and image formation.Sample preparation and applications. Introduction to scanning electron microscopy (SEM), sample preparation and applications, Instrumental details and image formation, various imaging techniques and spectroscopy, electron diffraction, and low energy electron diffraction.

MODULE III **6 Lectures**

Introduction to Transmission electron microscopy (TEM), instrumental details and working principles of TEM. Image formation, science of imaging and diffraction, sample preparation procedures and instruments for various materials

MODULE IV **6 Lectures**

Thermal analysis technique: Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC),Thermogravimetric analysis (TGA), UV-VIS spectroscopy

MODULE V **8 Lectures**

principles of characterization of other materials properties: BET surface area; chemisorption; particle size; zeta potential; rheology; and interfacial tension. Introduction to spectroscopy (UV-vis, IR and Raman)

Texts/References:

1. Y. Leng, Materials Characterization: Introduction to microscopic and spectroscopic methods, 1st Ed., John Wiley & Sons, 2008.
2. A.W. Adamson and A.P. Gast, Physical Chemistry of Surfaces, John Wiley, New York, 1997.
3. D.G. Baird and D.I. Collias, Polymer Processing Principles and Design, Butterworth-Heinemann, Massachusetts, 1995.
4. A.J. Milling, Surface Characterization Methods: Principles, techniques, and applications, Marcel Dekker, 1999.
5. G. Ertl, H. Knozinger and J. Weitkamp, Handbook of Heterogeneous Catalysis, Vol. 2, Wiley-VCH, 1997.
6. W.D. Callister (Jr.), Material Science and Engineering: An introduction, 8th Ed., John Wiley & Sons, 2010.

Chemical Engineering			
CL634	**Reactor Design**	**L**	**T**
		3	**0**

Course objective: To increase the student's ability to do chemical reactor design by providing the knowledge and tools required to obtain, evaluate, and improve rate equations for use in design, operation and optimization of chemical reactors.

MODULE I **6 Lectures**

Introduction to Reactor design: Single ideal Reactor: Ideal batch reactor, space time and space velocity, steady state mixed flow reactor, steady state plug flow reactor, holding time and space time for flow systems.

MODULE II **3 Lectures**

Introduction to design for heterogeneous reacting systems: Rate equations for heterogeneous reactions, contacting patterns for two phase systems.

MODULE III **7 Lectures**

Thermal characteristics and design of reactors: Batch reactor, PFR, CSTR under adiabatic conditions for first order irreversible reactions

Reactor design: Reactor principles, performance. Reactor and catalyst equipment- Selection of Catalyst, Types of Reactors, Selection of Reactors and Design of Reactor Systems.

MODULE IV **8 Lectures**

Calculation of equilibrium compositions of a set of simultaneous reactions, Performance calculation for batch reactor, plug flow reactor and CSTRs, homogeneous and heterogeneous flow reactors for specific reactions.

MODULE V **12 Lectures**

Design for Single Reactions: Size comparison of single reactors, multiple reactor systems, recycle reactor, autocatalytic reactions.

Design for multiple reactions: Reactions in parallel, reactions in series, contacting patterns, product distribution.

Course Outcomes:

After completion of this course, the student will be able to

CO1	Analyze the rates of chemical reactions for both homogeneous and heterogeneous reactions
CO2	Evaluate the performance calculation for CSTR, PFR , Batch reactors.
CO3	Understand catalyst activity, selectivity and stability in reactor design.
CO4	Explain Thermal characteristics and design of reactors.
CO5	Differentiate single and multiple reactor systems.

Mapping of course outcomes with program specific outcomes

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO2	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO3	**2**	**1**	**1**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO4	**1**	**-**	**1**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
CO5	**1**	**2**	**1**	**3**	**2**							

Textbook:

1. Fogler S.H., "Elements of Chemical Reaction Eng.", 3rd Ed., Prentice Hall,1999.

2. Levenspiel, O., "Chemical Reaction Eng." John Wiley & Sons 1972,

3. Froment G.F. and Bischoff K.B., "Chemical Reactor Analysis and Design" John Wiley, 1990.

4. Roberts, G.W., "Chemical Reactions and Chemical Reactors", Wiley, 2009.

Chemical Engineering			
CL641	**Energy Option**	**L**	**T**
		3	**0**

Course objective

To impart basic knowledge of current energy sources, scenario, energy conservation, audit and management**.**

MODULE I **8 Lectures**

Fuels: Solids, liquids and gaseous fuels, Availability and classification. Coal: Theories of formation, Coal composition petrography of Coal calorific value of Coal, Chemical Constitution of Coal, Action of heat and solvent on coal, Coal preparation, handling and storage.

MODULE II **8 Lectures**

Industrial Coal Carbonization low and high temperature carbonization processes Design of Coke ovens with recovery system. Numerical problems based on Combustion, use of grates, combustion of pulverized fuel and fluidized bed combustion, efficient utilization of Indian coals

MODULE III **8 Lectures**

Liquid fuels: Indian cruds & refinery products. Chemical Coal tar distillation Hydrogenation of

Coal, FiacherTropse process, other liquefaction process, Synthesis gas from petroleum fractions. Gaseous fuel: Natural gas producer gas reactions and its manufacture, water gas, carbureted water gas

MODULE IV **8 Lectures**

Analysis of flue gases, complete gasification of Coal Lurgi, Kopper'sTotzek, and Winkler process synthesis gas form Coal. Renewable sources of energy and their potential, low Temperature application of solar Energy.

MODULE V **8 Lectures**

Conversion of Bio-mass and their characteristic, physical thermo-chemical and Biological methods of their conversion, Fuel cell

Course Outcomes:

After completion of this course, the student will be able to

CO1	Understand the basic concepts of coal energy and Indian cruds & refinery products.
CO2	Numerical problems based on Combustion and fluidized bed combustion.
CO3	Analyse of different different energy sources.
CO4	Examine and apply for applications.

Textbook:

1. Coal Energy system by Bruce Miller, (Published-Academic Press)

2. Fuels and their Combustion by Robert T.HASLAM (5th edition, McGraw Hill)

Chemical Engineering			
CL642	**Fuel and combustion Technology**	**L**	**T**
		3	**0**

Course Objective: This course will provide knowledge regarding solid, liquid and gaseous fuels, their origin, classification, properties, preparation and combustion characteristic of fuel.

Module 1 **8 Lectures**

Solid fuels: Classification, preparation, cleaning, analysis, ranking and properties - action of heat, oxidation, hydrogenation, carbonization, liquefaction and gasification.

Liquid fuels: Petroleum origin, production, composition, classification, petroleum processing, properties, testing - flow test, smoke points, storage and handling.

Module 2 **8 Lectures**

Secondary liquid fuels: Gasoline, diesel, kerosene and lubricating oils. Liquid fuels - refining, cracking, fractional distillation, polymerization. Modified and synthetic liquid fuels. ASTM methods of testing the fuels.

Module 3 **10 Lectures**

Gaseous fuels: Types, natural gas, methane from coal mine, water gas, carrier gas, producer gas, flue gas, blast furnace gas, biomass gas, refinery gas, LPG - manufacture, cleaning, purification and analysis. Fuels for spark ignition engines, knocking and octane number, anti knock additives, fuels for compression, engines, octane number, fuels for jet engines and rockets. Flue gas analysis by chromatography and sensor techniques.

Module 4 **6 Lectures**

Combustion: Stochiometry, thermodynamics. Nature and types of combustion processes – Mechanism-ignition temperature, explosion range, flash and fire points, calorific value, calorific intensity and theoretical flame temperature.

Module 5 **6 Lectures**

Combustion calculations, theoretical air requirements, flue gas analysis, combustion kinetics– hydrogen-oxygen reaction and hydrocarbon-oxygen reactions.

Rocket propellants and Explosives - classification, brief methods of preparation, characteristics; storage and handling

Text/Reference Books:

1. Fuels and Combustion, Samir Sarkar, Orient Longman Pvt. Ltd, 3rd edition, 2009
2. Fuels - Solids, liquids and gases - Their analysis and valuation, H. Joshua Philips, Biobliolife Publisher, 2008.
3. An introduction to combustion: Concept and applications - Stephen R Turns, Tata Mc. Graw Hill, 3rd edition, 2012.
4. Fundamentals of Combustion, D P Mishra, 1st edition, University Press, 2010
5. Engineering Chemistry - R. Mukhopadhyay and Sriparna Datta, Newage International Pvt. Ltd, 2007.

Course Outcomes: After completion of this course students will able to

CO1: Classify different kinds of fuels used in process industries.

CO2: Examine the quality of fuel using different test methods.

CO3: Report the flue gas analysis from combustion process.

CO4: Demonstrate the combustion process mechanism of fuel.

Course outcome mapping with Programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	1	1	1	1	-	-	-	-	2
CO2	3	3	2	1	2	1	2	-	-	-	-	3
CO3	3	2	3	2	3	2	2	-	-	-	-	3
CO4	3	3	3	2	3	2	2	-	-	-	-	3

Chemical Engineering			
CL643	**Fertilizer Technology**	**L**	**T**
		3	**0**

Course objective

To enable the students to learn the fertilizer manufacturing including new or modified fertilizer products and new techniques.

Module – I **10 Lectures**

Definition of fertilizer, nutrient requirement of different plants paddy, wheat, sugarcane

Natural way of fixing nitrogen, Nitrogen cycle, carbon cycle, different nitrogen fixing plants, bacteria and algae. Role of C/N ratio in the growth of different plants. Organic manure.

Module-II **10 Lectures**

Production of ammonia-its feed preparation, limitations of using different feed material for hydrogen generation, Reforming process and reformer design. Partial oxidation process and partial oxidation reactor design.

Module-III **10 Lectures**

Removal of Impurities from synthesis gas CO removal and shift reactor design.CO_2 removal methods, Design of CO_2 absorber, NH_3 synthesis loop design, Design considerations for different types of NH_3 Reactors.

Module-IV **10 Lectures**

Phosphate fertilizers-different methods of production, NPK, production and drying of NPK fertilizers, Bio-fertilizer.

Module-V **10 Lectures**

Urea production; special features of urea reactor, prilling tower design.

Course Outcomes:

After completion of this course, the student will be able to

CO1	Understand the basic concepts of fertilizer for agriculture and manufacturing process.
CO2	Design of ammonia reactor and urea pilling tower.
CO3	Analyze of different fertilizers.

CO4	Examine different fertilizer for different agriculture purpose.

Textbook:

1. Chemistry and Technology of Fertilizers by V. Sauchelli, (Reinhold Publications)

2. Hand book on Fertilizers by Vasant Gowariler, V.N.Krishnamurthy and Sudha Gowariker (published, Fertilizer Association of India, New Delhi)

3. Dryden's Outlines of Chemical Technology by M. Gopala Rao Sitting Marshal (Affiliated East West Press (Pvt) Ltd, 3 rd Ed., New Delhi).

4. Shreve's Chemical Process Industries,by Austin G.T. (5th edition, McGraw Hill publication, New Delhi)

5. Chemical Technology – by Pandey G.N. and Shukla Vol. I and II, 2nd edition (Vani Books Company – Hyderabad)

Chemical Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

[1]. Hisrich & Peters, “Entrepreneurship”, Tata McGraw Hill

[2]. Roy, Rajeev, “Entrepreneurship”, Oxford University Press

[3]. Norman M. Scarborough, “Essentials of Entrepreneurship & Small Business Management”, 6^{th} ed., Prentice Hal

[4]. Dutta, Bholanath, “Entrepreneurship management” ,Excel Books

Civil Engineering			
CE601	**Structural Analysis II**	**L**	**T**
		3	**1**

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Analysis of fixed beams, continuous beam, simple frames and redundant frames with and without translation of points. Method of consistent deformation, Strain energy method, Slope deflection method, Moment distribution method.	**12**
2.	Analysis of two hinged arches. Suspension bridges with two hinged stiffening girder.	**10**
3.	Structural theorems:-Linearity principle of superposition,virtual work,energy theorems, reciprocal theorems, Muller's Breslau's principles.	**6**
4.	Basics of force and displacement matrix methods for beams,plane frame (rigid and pin-pointed)	**10**
5.	Influence lines:-Influence lines for propped cantilevers,continuous beams and two hinged arches	**10**

Course Outcomes: At the end of the course, the students will be able to

CO1	Analyze the reaction forces and design of building frames
CO2	To analyze the arches of various constraints and calculations of forces
CO3	To understand the various procedure for the analysis of beams and plane frames
CO4	To assess the importance and significance of influence line and their applications

Prerequisites: Structural Analysis I

Civil Engineering			
CE611	**Transportation Engineering**	**L**	**T**
		3	**0**

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Highway development and planning-Classification of roads, road development in India, Current road projects in India; highway alignment and project preparation.	**6**
2.	Geometric design of highways-: Introduction; highway cross section elements; sight distance, design of horizontal and vertical alignment; Grade compensation	**12**
3.	Traffic engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; Design of signals, design of road intersections; design of parking facilities; highway lighting; problems	**10**
4.	Design of pavements- Introduction; flexible pavements, factors affecting design and performance; stresses in flexible pavements; design of flexible pavements as per IRC; rigid pavements- components and functions; factors affecting design and performance of CC pavements; stresses in rigid pavements; design of concrete pavements as per IRC; problems	**12**
5.	Pavement materials- Materials used in Highway Construction- Soils, Stone aggregates, bituminous binders, bituminous paving mixes; Portland cement and cement concrete: desirable properties, tests, requirements for different types of pavements. Problems	**8**

Course Outcomes: At the end of the course, the students will be able to

CO1	carry out surveys involved in planning and highway alignment
CO2	design the geometric elements of highways and expressways
CO3	carry out traffic studies and implement traffic regulation and control measures and intersection design
CO4	characterize pavement materials and design flexible and rigid pavements as per IRC

Prerequisites: None

Civil Engineering			
CE612	**Soil Dynamics**	**L**	**T**
		3	**0**

Pre-requisites: Geotechnical Engineering

Course Outcomes: At the end of the course, the students will be able to

CO1	Acquire knowledge on the various types of dynamic forces acting and propagating through soil
CO2	Understand the mass spring damper system in solving the problems of soil dynamics
CO3	Acquainted with the various laboratory techniques and their working principle to understand the dynamics properties of soil
CO4	An in depth understanding of the liquefaction behaviour of soil.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	3	-	-	-	2	-	-	-	2	-
CO2	3	-	-	3	-	-	2	-	-	-	-	-
CO3	-	2	-	2	-	-	-	-	-	3	-	-
CO4	2	-	-	2	3	-	2	-	2	-	-	2

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Principle of soil dynamics and vibration. Basic definitions related to dynamic analysis of machine foundations. Different types of machines.	**8**
2.	Different types of machine foundations mass spring system. Vibration of spring mass system with damping (free vibration). Forced vibration: Derivation of expression for forced vibration. Amplitude of deflection magnification factor, frequency ratio, damping, ration graphical repressor amplitude frequency relation for damped forced vibrations. Wave propagation in soil media, vibration Isolation and control. Bulb of pressure concept	**14**
3.	Natural frequency of foundation soil system block foundation. Degree of freedom of a block foundation. Barkaun’s method of design of block foundation. General vibration for design of machine foundation vibration analysis of machine foundation	**10**
4.	Laboratory and in site determination of dynamic properties of	**8**

	soil. Determination of Mass, spring constant or stiffness and damping. Determination of natural frequency coefficient of elastic uniform compression design criteria for foundation of reciprocating machine. Indian standard code of practice for design of foundation for impact type machine, Reinforcement and construction details.	
5	Liquefaction of sands. Numerical problem related to soil dynamics and machine fluid.	**4**

Reading:

- Soil Dynamics and Machine Foundation by Swami Saran
- Fundamentals of Soil Dynamics by Braja M. Das.

Civil Engineering			
CE613	**Modern Surveying Techniques**	**L**	**T**
		3	**0**

Prerequisites: Survey

Course Outcomes: At the end of the course, the students will be able to

CO1	Learn the use of modern survey instruments and their use in surveying
CO2	Assess the importance of photogrammetric survey and its significance
CO3	Learn and apply the concept of remote sensing in geodetic survey
CO4	Understand the concept of GIS in survey

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Modern surveying electronic equipments: digital levels, digital theodolites, EDMs, Total stations; Principles, working and applications; Lasers in surveying.	**6**
2.	Photogrammetric terms; Applications; Type of photographs; Perspective geometry of near vertical and tilted photographs, heights and tilt distortions; Flight planning; Stereoscopy, base lining, floating marks, parallax equation and stereo measurements for height determination; Developments in photogrammetry: analogue, analytical and digital methods; photogrammetric instruments.	**12**

3.	Introduction- Remote sensing system- data acquisition and processing; Applications; Multi concept in remote sensing. Physical basis of remote sensing- Electro-magnetic radiation (EMR)- nature, nomenclature and radiation laws; Interaction in atmosphere- nature, its effects in various wavelength regions, atmospheric windows; Interaction at ground surface- soils and rocks, vegetation, water, etc.; Geometric basis of interaction. Platform and sensors- Terrestrial, aerial and space platforms; Orbital characteristics of space platforms, sun- and geo-synchronous; Sensor systems- radiometers, optomechanical and push broom sensor; Resolution- spectral, spatial, radiometric and temporal; Data products from various air and spaceborne sensors- aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS, etc. Image interpretation- Elements of interpretation; Manual and digital interpretation; Field verification.	**16**
4.	Components of GIS- data acquisition, spatial and attribute data, pre-processing, storage and management; Data structures- raster and vector data; GIS analysis functions; Errors and corrections; Data presentation and generation of thematic maps; Applications	**08**

Reading:

- Surveying and Levelling Vol. II by T.P. Kanetkar

Civil Engineering			
CE614	**Airport Planning and Design**	**L**	**T**
		3	**0**

Prerequisites: Transportation Engineering

Course Outcomes: At the end of the course, the students will be able to

CO1	Learn the importance of airport planning and design
CO2	Understand the runway capacity and function of airport terminal
CO3	Learn the design of airport freight terminals
CO4	Understand the function of air traffic control

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Aircraft characteristics; Aircraft performance characteristics: Airport planning and air travel demand forecasting: Airport Site Selection; Geometric Design of the Airfield	**10**
2.	Determination of Runway Capacity and Delay - Taxiway and Gate Capacity - Holding Aprons - Terminal Aprons – Airport drainage - Function of Airport Passenger and Cargo Terminal	**10**
3.	Design of Air Freight Terminals - Airport access - Airport Landside planning - Capacity; Air Traffic Management: Navigational aids: ground based systems, satellite based systems	**10**
4.	Air traffic control and surveillance facilities – Airfield lighting – airtraffic management.	**10**

Reading:

Civil Engineering			
CE615	**Bridge Engineering**	**L**	**T**
		3	**0**

Prerequisites: Transportation Engineering

Course Outcomes: At the end of the course, the students will be able to

CO1	Classify the various types of bridges based on various criteria
CO2	Assess the load on the bridge and its serviceability
CO3	Understand the requirements of a Prestressed concrete bridge
CO4	Understand the seismic design considerations for bridge design

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	General; classification of bridges, site selection, geometric and hydraulic design consideration	**6**
2.	Loading standards for highway and railway bridges, general design consideration; optimum spans; Concrete bridges: culverts; Slab, T-beam, box girder bridges, balanced cantilever bridge, cable stayed bridge, extrados bridges; arch bridge;	**12**
3.	Special requirements for Prestressed Concrete bridges; Steel bridges: plate girder bridge, truss bridge, suspension cable bridge, cable stayed bridge; Substructures: design of piers and abutments, pile and well foundations, bearings and expansion joints, special wearing coats	**12**
4.	seismic design considerations; Aerodynamic stability considerations; special durability measures; provisions for inspection and maintenance;	**10**

Civil Engineering			
CE621	**Steel Structures-II**	**L**	**T**
		3	**0**

Prerequisites: Steel Structure I

Course Outcomes: At the end of the course, the students will be able to

CO1	In depth understanding of moment resistant connection
CO2	Understand the various types of trusses
CO3	Assess the loading and design of bridges and water tanks
CO4	Analyze the design of towers

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Moment Resistant Connections : i. Eccentric Connections: Bolted Bracket Connections, Bracket Connection–type–I and type– II ii. Welded Bracket Connections iii. Bolted Framed Connections – Seat Connections, Design of Unstiffened seat connection. Stiffened Seat Connection, Beam to Column connection, Beam to Beam Connection. Welded Seat Connections	**12**
2.	Industrial Building :- i. Roof Truss : Types, Selection of the type of roof truss, General arrangements ii. Load on the roof truss - dead load, live load, snow load, wind load, load combination. iii. Design of purlins iv. Analysis and Design of Roof Truss v. Bracings of truss vi. Design of Gantry Girder: Introduction, Crane Girder, Loads acting on gantry : Vertical loads, Lateral Loads, Longitudinal Load, Impact Loads, Design procedure.	**12**
3.	Bridge : Steel foot bridge with rankers and lateral restraining including end bearings Water Tank : Pressed steal water tank: Introductions, Permissible stresses, Thickness specifications Design procedure, staging for tanks	**10**
4.	Towers : Introduction, transmission line towers, Microwave towers, design loads, classification, analysis and design of transmission line towers. Tubular Structures : Introduction to tubular structures	**8**

Civil Engineering			
CE622	**Water Resources Engineering-II**	**L**	**T**
		3	**0**

Prerequisites: Water Resources Engineering I

Course Outcomes: At the end of the course, the students will be able to

CO1	In depth knowledge of irrigation principle and planning
CO2	Understand the canal design and layout
CO3	Assess the various design theories
CO4	Analyze the cross drainage work

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Irrigation Principles and planning Definition of Irrigation, development of irrigation in India. Benefits and ill effects of Irrigation. Types of method of irrigation system. quality of irrigation water, water requirements and irrigation scheduling, duty and data & base periods and their relationship, improvements of duty.	**10**
2.	Canal design and layouts , types of canal Canal alignment – Canal design – Kennedy’s Silt theory method, Laceyes regime theory.RangaRaju and Misri Method.Basak Method, Tractive shear approach ,layout of canals. Conveyance losses.	**10**
3.	Diversion head Works, Layout of diversion head works, Components of head works, Bligh’s and lane’s theories, Khosla theory, Design of weir& Barrage	**8**
4.	Canal Regulation Works: Different types of regulation works, Types and Design of falls. Types and design of regulators, Cross regulator, head regulator, canal escapes, canal modulus etc.	**8**
5	Cross – Drainage Works Types of cross-drainage works and design of aqueducts. River Training Works Meandering of rivers, cut off, spurs, guide banks ,marginal embankment. Channel Improvements	**6**

Civil Engineering			
CE623	**Structural Dynamics**	**L**	**T**
		3	**0**

Prerequisites: Structural Engineering I

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand the concept of dynamic vibration of structures
CO2	Assess the behavior of structure under dynamic loading
CO3	Understand the basic dynamic parameters of vibratory and impact forces
CO4	Assess the damage and design considerations for dynamic loads

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	THEORY OF VIBRATIONS Difference between static loading and dynamic loading – Degree of freedom – idealisation of structure as single degree of freedom, – Formulation of Equations of motion of SDOF system – D'Alemberts principles – effect of damping – free and forced vibration of damped and undamped structures – Response to harmonic and periodic forces.	**9**
2.	Two degree of freedom system – modes of vibrations – formulation of equations of motion of multi degree of freedom (MDOF) system – Eigen values and Eigen vectors – Response to free and forced vibrations – damped and undamped MDOF system – Modal superposition methods.	**9**
3.	Elements of Engineering Seismology – Causes of Earthquake – Plate Tectonic theory – Elastic rebound Theory – Characteristic of earthquake – Estimation of earthquake parameters – Magnitude and intensity of earthquakes – Spectral Acceleration.	**9**
4.	Effect of earthquake on different type of structures – Behaviour of Reinforced Cement Concrete, Steel and Prestressed Concrete Structure under earthquake loading – Pinching effect – Bouchinger Effects – Evaluation of earthquake forces as per IS:1893 – 2002 – Response Spectra – Lessons learnt from past earthquakes.	**9**
5	Causes of damage – Planning considerations / Architectural concepts as per IS:4326 – 1993 – Guidelines for Earthquake resistant design – Earthquake resistant design for masonry and Reinforced Cement Concrete buildings – Lateral load analysis – Design and detailing as per IS:13920 – 1993.	**9**

Civil Engineering			
CE624	**Systems Engineering & Economics**	**L**	**T**
		3	**0**

Pre requisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	To understand the formulation and the solution of civil engineering problems
CO2	The importance of mathematical modelling in Civil Engineering
CO3	The application of network theory and other techniques
CO4	The application of dynamic programming to civil engineering problems

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Introduction to the formulation and solution of civil engineering problems. Engineering economy, mathematical modeling, and optimization.	**12**
2.	Techniques, including classical optimization, linear and nonlinear programming, network theory, critical path methods, simulation, decision theory	**14**
3.	Dynamic programming applied to a variety of civil engineering problems.	**12**

Civil Engineering			
CE625	**Metal Structure Behaviour**	**L**	**T**
		3	**0**

Prerequisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	To learn the designing of metal structures
CO2	To understand the behavior of structural members and their connections
CO3	To study the behavior of metal members under combined loading
CO4	To understand the stress calculations under various structural joints

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction to the design of metal structures;	**10**
2.	Behavior of members and their connections; and theoretical, experimental, and practical bases for proportioning members and their connections.	**10**
3.	Metal members under combined loads; connections, welded and bolted; moment- resistant connections;	**10**
4	Plate girders, conventional behavior, and tension field action.	**10**

Civil Engineering			
CE626	**Masonry Structures**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Analyze the design of masonry structures
CO2	To assess the mechanical properties of clay mortar etc.
CO3	To assess the strength behavior of bearing walls
CO4	To analyze the lateral force resisting building system.

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction to analysis, design and construction of masonry structures.	**8**
2.	Mechanical properties of clay and concrete masonry units, mortar, and grout	**8**
3.	Compressive, tensile, flexural, and shear behavior of masonry structural components.	**8**
4	Strength and behavior of unreinforced bearing walls. Detailed design of reinforced masonry beams, columns, structural walls with and without openings	**8**
5	Complete lateral-force resisting building systems.	**8**

Civil Engineering			
CE631	**Environment Impact Assessment**	**L**	**T**
		3	**0**

Prerequisites: Environmental Engineering

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand the need and importance of EIA
CO2	Understand the need for characterization and site assessment
CO3	gain a knowledge about the cost benefit analysis
CO4	to have a knowledge on the case studies on EIA

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Evolution of EIA: Concepts of EIA methodologies, Screening and scoping;	**8**
2.	Rapid EIA and Comprehensive EIA; General Framework for Environmental Impact Assessment, Characterization and site assessment. Environmental Risk Analysis	**8**
3.	Definition of Risk, Matrix Method. Checklist method, Faulttree analysis, Consequence Analysis; Socioeconomic aspects, measures of effectiveness of pollution control activities	**12**
4	Environmental Legislation; Introduction to Environmental Management Systems; Environmental Statement - procedures; Environmental Audit: Cost Benefit Analysis; Life Cycle Assessment; Resource Balance, Energy Balance & Management Review; Operational Control;	**14**
5	Case Studies on EIA.	**2**

Civil Engineering			
CE632	**Operational Research Technique**	**L**	**T**
		3	**0**

Prerequisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand the characteristics of different types of decision-making environments and the appropriate decision making approaches and tools to be used in each type
CO2	Generate mathematical formulation of L-P problems using Simplex method, Two Phase Simplex method
CO3	Interpret the principle of Dual Simplex And Sensitivity Analysis
CO4	Build and solve Transportation Models and Assignment Models
CO5	Build and solve Integer Programming Problems

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Introduction: History of operation research, nature and scope of operations research, allocation.	**10**
2.	Linear programming: Mathematical formulations of the problem, Graphical solution methods, mathematical solution of L-P problems, matrix formulation of general linear programming.	**10**
3.	Simplex Method: Algorithm and computational procedures, Two phase Simplex method, Problems of degeneracy, Principles of duality in simplex method, Sensitivity analysis, Transportation problem.	**10**
4	Game Theory: Introduction, Two persons zero sum games, the maxmini and minimax principles. Integer Programming: Formulation and solution of integer programming problems	**10**

Suggested Reading

1. Taha,H A, "Operations Research - An Introduction", Sixth Edition, Prentice Hall of India Private Limited, N. Delhi, 2004.
2. Hillier, F S, "Operations Research", First Indian Edition, CBS Publishers & Distributors, Delhi, 1994.

Civil Engineering			
CE633	**Rock Mechanics**	**L**	**T**
		3	**0**

Prerequisites: Geotechnical Engineering I

Course Outcomes: At the end of the course, the students will be able to

CO1	Distinguish various types of rocks
CO2	Classify the rocks based on various parameters
CO3	assess the stress strain behavior of rock mass
CO4	understand the rock support

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Introduction Brief historical development; Mechanical nature of rock; Index properties of rocks and rock masses Continuum and discontinue.	**10**
2.	Classification of Rocks Geological and engineering classification of intact and in situ rocks; Classification of ..rock mass continuity; RQD, RMR and Q index; Comparison of various systems used in practice.	**10**
3.	Engineering Properties of Rocks and Rock Masses Mechanical properties of rocks; Stress-strain behavior in compression; Brittle and plastic failures; Engineering behavior of intact and in situ rocks; Anisotropy, Deformability and elastic modulus;. Permeability.	**10**
4	Shear Strength of Rocks	**10**

	Triaxial compression test; Failure criteria; Shear strength of discontinuities; Dilatancy; Effective stress ill rocks. In Situ Stress ill Rock and Their Measurement, Nature of primitive stress, Stress measurement.	

Civil Engineering			
CE634	**Environmental Laws and Policy**	**L**	**T**
		3	**0**

Prerequisites: Environmental Engineering

Course Outcomes: At the end of the course, the students will be able to

CO1	To understand the laws to protect the environment
CO2	To have an in depth understanding of the environmental laws and policies
CO3	To understand the international humanitarian law and other laws
CO4	To gain knowledge about famous international protocols

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Overview of environment, nature and eco system, Concept of laws and policies, Origin of environmental law,	**14**
2.	Introduction to environmental laws and policies, Environment and Governance, sustainable development and environment, understanding climate change, carbon crediting, carbon foot print etc.,	**12**
3.	Introduction to trade and environment. International environmental laws, Right to Environment as Human Right International Humanitarian Law and Environment, environment and conflicts management, Famous international protocols like Kyoto.	**14**

Civil Engineering			
CE635	**Value and Ethics in Engineering**	**L**	**T**
		3	**0**

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Human Values: Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.	**10**
2.	Engineering Ethics: Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles – Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories	**10**
3.	ENGINEERING AS SOCIAL EXPERIMENTATION Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.	**10**
4	SAFETY, RESPONSIBILITIES AND RIGHTS Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination	**10**
5	GLOBAL ISSUES Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons	**8**

	Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility	

Civil Engineering			
CE641	**Remote Sensing & Its Application**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	To understand the importance of electromagnetic spectrum in Civil survey
CO2	To assess the remote sensing data acquisition
CO3	To interpret the data obtained for the civil engineering applications
CO4	To analyze the digital image processing

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Introduction and definition of Remote sensing Technology photogrammetry types of photograph geometry of photograph stereophotogrammetry	**10**
2.	Remote Sensing: stages and success electromagnetic radiation and Spectrum signature atmospheric window characteristics of different types in cells images are of platforms orbital parameters of a satellite	**10**
3.	Interpretation of images principles of interpretation of satellite and area images equipment at 8 week ground truth collection and verification advantages of multi and multi band images Digital satellite data: Digital satellite data products and their characteristics Histogram and its utility enhancement different magnitude of digital satellite data interpretation	**12**
4	Application of Remote sensing applications in water	**10**

	resource management river morphology of Estimation and forecast snow survey blood joining and damage can land use mapping and monitoring environmental studies urban pollution atmospheric pollution studies environmental science and Highway planning engineering and regional planning natural resources service required to Graphic application	

Civil Engineering			
CE642	**Decision and Risk Analysis**	**L**	**T**
		3	**0**

Prerequisites: None

Course Outcomes: At the end of the course, the students will be able to

CO1	To understand the importance of risk analysis in Civil Engineering
CO2	To understand the various risk assessment theories
CO3	To assess the formulation of risk based design criteria
CO4	To analyses the benefits of optimal decisions in Civil Engineering

Detailed Syllabus:

MODULE	**CONTENTS**	**Hrs**
1.	Development of modern statistical decision theory and risk analysis, and application of these concepts in civil engineering design and decision making;	**10**
2.	Bayesian statistical decision theory, decision tree, utility concepts, and multi-objective decision problems;	**8**
3.	Modeling and analysis of uncertainties, practical risk evaluation, and formulation of risk-based design criteria,	**12**
4	Risk benefit trade-offs, and optimal decisions.	**10**

Civil Engineering			
CE643	**Engineering Materials for Sustainability**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	To assess the impact of industrial waste on environment
CO2	To study the materials for sustainable construction
CO3	To understand the importance of using green construction materials

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Environmental impact of materials used in infrastructure development	**10**
2.	Life-cycle assessment durability and sustainability, material selection to optimize structural performance such as use of plastic in roads, fly ash in filling, recycled aggregates in construction and renovative chemicals etc.	**15**
3.	Design, evaluation, and production of green construction materials.	**15**

Civil Engineering			
CE644	**Industrial Structure**	**L**	**T**
		3	**0**

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Detailed Design of Steel Gantry Girders. Detailed Design of Portal Frames-Single bay two storey.	**9**

2.	Detailed Design of Gable Structures. Detailed Design of Knee Brace.	**9**
3.	Detailed Design of Light weight metal structures. Design of connections-Shear and Flexure Design.	**9**
4	Detailed Design of Steel Bunkers. Detailed Design of Silos.	**9**
5	Detailed Design of Self Supported Chimneys.	**9**

Reading:

1. Design of Steel Structures, Arya and Azmani, Nem Chand Brothers, Roorkee, 2004

2. Punmia B.C, Ashok Kr. Jain, Arun Kr. Jain, RCC Designs (Reinforced Concrete Design), 10th Edition, Lakshmi Publishers, 2006.

3. Ramachandra, Design of Steel Structures, 12th Edition, Standard Publishers, 2009

Civil Engineering			
CE645	**Construction Technology and Management**	**L**	**T**
		3	**0**

Detailed Syllabus:

MODULE	CONTENTS	Hrs
1.	Importance of Project Management, Role of Project manager, Stakeholders in construction project, Different types of projects, similarities & dissimilarities in projects	**8**
2.	Time, Scope & Money, Knowledge areas & Processes involved in construction projects, WBS of a major work, with examples	**8**
3.	Planning, monitoring & executing, Planning, sequencing, scheduling, Bar Charts, Networks, CPM, PERT, Upgrading, Cash flow diagram, resource leveling & resource allocation	**8**
4	Crashing of project, Cost Optimization, Invoicing, Preparation of RA bill, Safety in construction, Estimation, Tenders & Contracts.	**8**
5	Equipment for construction, Construction Finances – decision making, Construction of piles, Construction of Tunnels, Construction of cofferdams.	**8**

Reading:

1. Puerifoy R.L. - Construction Planning Equipment & methods.
2. Punmia and Khandelwal K.K. - Project Planning and Control - Laxmi Publ. Delhi.
3. Srivatsava, 1998. Management in Construction Industry.
4. Antil & Woodh - Critical Path Method in Construction - Wiley International.
5. Mahesh Varma - Construction Planning and Equipment - Metropolitan Co.

Civil Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

[1]. Hisrich & Peters, “Entrepreneurship”, Tata McGraw Hill

[2]. Roy, Rajeev, “Entrepreneurship”, Oxford University Press

[3]. Norman M. Scarborough, “Essentials of Entrepreneurship & Small Business Management”, 6th ed., Prentice Hal

[4]. Dutta, Bholanath, “Entrepreneurship management” ,Excel Books

Electronics & Communication Engineering			
ECE601	**VLSI Design**	**L**	**T**
		3	**1**

Course Outcomes: After completion of the course student will be able to:

CO1	APPLY the knowledge of semiconductor to review MOSFET characteristics, small geometry effects and scaling.
CO2	DEVELOP voltage, current sources and amplifiers and Operational amplifier made by CMOS.
CO3	CONSTRUCT switched capacitor filters, ADC, DAC and interconnects
CO4	ANALYZE CMOS Inverter, Dynamic CMOS, Pass transistor and transmission gates
CO5	DESIGN CMOS combinational, sequential circuits and memories

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	1	-	-	-	-	-	-	1
CO2	3	3	3	3	3	-	-	-	-	-	-	1
CO3	3	3	3	3	3	-	-	-	-	-	-	1
CO4	3	3	3	3	3	-	-	-	-	-	-	1
CO5	3	3	3	3	3	-	-	-	-	-	-	1

Detailed Syllabus:

Module	Content	No. of Lectures
1	**Introduction:** Review of MOSFET characteristics, scaling and small-geometry effects, and MOSFET capacitances. MOS resistor, MOS current source, current mirror circuits. MOS voltage source, linear voltage and current converters.	**6**
2	**CMOS operational amplifier (OPAMP) design:** Differential amplifier, level shifter, source follower, output stage voltage and power amplifiers. Cascode OP-AMP. Compensation techniques. **Analog Filters:** Switched capacitor (SC) fundamentals, first order SC circuits, second-order SC circuits and cascade design. Analog to digital and digital to analog converters, speed of conversion and over sampling issues. **VLSI Interconnects:** Distributed RC model, transmission line model. Future inter connect technologies.	**14**
3	**Digital VLSI Circuit Design:** MOS inverters, CMOS inverter, state characteristics, switching characteristics, power dissipation issues. **CMOS logic gates:** NAND, NOR, XOR, CMOS logic design of half and full adders. CMOS transmission gates, pseudo-nMOS, domino logic gates.	**9**

4	**Sequential MOS Logic Circuits:** The SR latch circuit, clocked latch and flip-flop, CMOS D-latch and edge-triggered circuits, Schmitt trigger circuit, Comparator. **Dynamic Logic Circuits:** Pass transistor logic, synchronous dynamic circuit techniques.	**8**
5	**Semiconductor Memories:** ROM circuits, SRAM circuits, DRAM circuits, drivers and buffers, Buffer scaling and design issues	**5**

Text Books:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective, 4th Edition, Pearson Education, 2015.

Electronics & Communication Engineering			
ECE611	**Digital Signal Processing**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Find DFT of a given signal through Fast Fourier Transform Techniques.
CO2	Design FIR and IIR type digital filters.
CO3	Identify various filter structures and evaluate the finite word length and the coefficient quantization effects.
CO4	Understand the concepts of sample rate conversion techniques and its applications.
CO5	Compare the key architectural features of DSP Processors.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2		3	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-
CO5	-	2	-	-	-	-	-	-	-	-	-	1

Detailed Syllabus:

Module	**Content**	**No. of Lectures**
1	**Signals and systems:** Basic elements of DSP, concepts of frequency in Analog and Digital Signals, sampling theorem, Discrete time signals, systems analysis of discrete time LTI systems, Z transform, Convolution, Correlation.	**6**
2	**Frequency transformations:** Introduction to DFT, Properties of DFT, Circular Convolution, Filtering methods based on DFT, FFT Algorithms, Decimation in time Algorithms, Decimation in frequency Algorithms, Use of FFT in Linear Filtering, DCT, Use and Application of DCT.	**10**
3	**IIR filter design:** Structures of IIR, Analog filter design, Discrete time IIR filter from analog filter, IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives (LPF, HPF, BPF, BRF) filter design using frequency translation.	**10**
4	**FIR filter design:** Structures of FIR, Linear phase FIR filter, Fourier Series, Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques.	**8**

5	**Finite word length effects in digital filters:** Binary fixed point and floating point number representations, Comparison, Quantization noise, truncation and rounding, quantization noise power, input quantization error, coefficient quantization error, limit cycle oscillations-dead band, Overflow error-signal scaling.	**8**

Text Books:

1. J.G.PROAKIS & D.G.MANOLAKIS, Digital Signal Processing - Principles, algorithms & Applications, PHI, 2000.
2. .B.Venkataramani, M.Bhaskar, "Digital Signal Processors, Architecture, Programming and Application", Tata McGraw Hill, New Delhi, 2003
3. A.V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, 2nd Edition, PHI, 2000.
4. S.K.MITRA, Digital Signal Processing – A computer Based Approach, 2nd Edition, MGH, 2001.
5. Multi Rate Systems and Filter Banks – P.P.Vaidyanathan – Pearson Education.
6. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007.

Electronics & Communication Engineering			
ECE612	**System on Chip Design**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	To understand the basic concepts of SOC design.
CO2	To summarize and explain the performance evaluation methods.
CO3	To classify and understand the power management process and modeling design tools.
CO4	To understand and study the micro-architecture design and modeling, software and hardware design verifications.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	2	1	2	-	-	-	-	2	2
CO2	1	-	-	1	2	2	-	-	-	-	2	2
CO3	-	-	-	-	2	2	-	-	-	-	2	2
CO4	1	-	-	-	3	2	-	-	-	1	2	2

Detailed Syllabus:

Module	**Content**	**No. of Lectures**
1	**System Level Design:** System level design-Tools & methodologies for system level design, System level space & modeling languages, SOC block based design & IP assembly, Performance evaluation methods for multiprocessor SOC design.	**8**
2	**Power Management And Synthesizing** : System level power management, Processor modeling & design tools, Embedded software modeling & design Using performance metrics to select microprocessor for IC design, Parallelizing High-Level Synthesize, A code transformational approach to High Level Synthesize.	**12**
3	**Micro-Architecture Design and Power Optimization**: Micro-architecture design, Cycle accurate system – level modeling, Performance evaluation, Micro architectural power estimation optimization, Design planning.	**8**
4	**Software Design Verification**: logical verification, Design & Verification languages, Digital simulation, using transactional, level models in an SOC design, Assertion based verification.	**8**
5	**Hardware Design Verification**: Hardware acceleration & emulation, Formal property verification, TEST, DFT, ATPG, Analog & mixed signal test.	**6**

Text Books:

1. Louis Scheffer Luciano Lavagno and Grant Martin, “EDA for IC System verification and Testing”,
   CRC, 2006.
2. Wayone Wolf, “Modern VLSI Design: SOC Design”
3. Prakash Rashnikar, Peter Paterson, Lenna Singh “System-On-A-Chip Verification methodology & Techniques”, Kluwer Academic Publishers.
4. Alberto Sangiovanni Vincentelli,” Surviving the SOC Revolution: A Guide to Platform based Design”, Kluwer Academic Publishers.

Electronics & Communication Engineering			
ECE613	**Digital Image Processing**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the need for image transforms and their properties.
CO2	Choose appropriate technique for image enhancement both in spatial and frequency domains.
CO3	Identify causes for image degradation and apply restoration techniques.
CO4	Compare the image compression techniques in spatial and frequency domains.
CO5	Select feature extraction techniques for image analysis and recognition.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	-	-	-	2	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	2	3	-	-	-	-	-	-	-	-	-	-
CO4	-	3	-	-	-	-	-	-	-	-	-	-
CO5	-	3	-	-	-	-	-	-	-	-	-	2

Detailed Syllabus:

Module	**Content**	**No. of Lectures**
1	**Introduction**: Digital Image Representation, Fundamental Steps in Image Processing, Elements of Digital Image Processing Systems. **Digital image fundamentals**: Elements of Visual Perception, A Simple image model, Sampling and Quantization, Neighborhood of Pixels, Pixel Connectivity, Labeling of Connected Components, Distance Measures, Arithmetic and Logic Operations, Image Transformations, Perspective Transformations, Stereo Imaging.	**10**

2	**Image enhancement**: Spatial Domain Methods, Frequency Domain Methods, Point processing, Intensity Transformations, Histogram Processing, Spatial filtering, Smoothing Filters, Sharpening Filters, Enhancement in the Frequency Domain, Low Pass Filtering, High Pass Filtering, Homomorphic filtering.	**8**
3	**Wavelets and multi resolution processing**: Sub band Coding, Haar Transform, Multi resolution Series Expansions, Wavelet Transforms in One Dimension, Discrete Wavelet Transform, Fast Wavelet Transform, Wavelet Transforms in Two Dimensions, Wavelet Packets. **Image compression**: Fundamentals of Compression, Image Compression Model, Error free Compression, Lossy Predictive Coding, and Transform Coding.	**10**
4	**Image segmentation**: Detection of Discontinuities, Line Detection, Edge Detection, Edge Linking and Boundary Detection, Thresholding, Threshold Selection on Boundary Characteristics, Region Growing, Region Splitting and Merging, Use of motion in Segmentation. **Image representation and description:** Chain Codes, Polygonal Approximations, Signatures, Skeleton, Boundary Descriptions, Shape Numbers, Fourier descriptors, Moments, Topological Descriptors.	**10**
5	**Image recognition and interpretation**: Elements of Image Analysis, Pattern and Pattern Classes, Minimum Distance Classifier, Matching by Correlation, Baye's Classifier, Neural Network Training Algorithm, Structural methods.	**6**

Text Books:

1. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, Pearson Education Asia, New Delhi, 2000.
2. B. Chanda, D. Dutta Majumder, Digital Image Processing and Analysis, PHI, New Delhi, 2000.
3. A.K. Jain, Fundamentals of Digital Image Processing, PHI, New Delhi, 2001.

Electronics & Communication Engineering			
ECE621	**Microcontrollers and their Applications**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the evolution of 8051 microcontroller and its Harvard architecture**.**
CO2	Understand the evolution and Harvard Architecture of RISC, CISC**.**
CO3	Analyze and understand the instruction set and Assembly language programming of 8051 microcontroller**.**
CO4	Understand the Interfacing of 8051 microcontroller with Different I/O and ADC and DAC peripherals**.**
CO5	Understand the applications of microcontrollers in different area**.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	3	-	-	-	-	-	-	-	2
CO2	-	3	-	3	-	-	-	1	-	-	-	2
CO3	-	3	-	-	-	-	-	1	-	-	-	2
CO4	-	3	-	3	-	-	-	1	-	-	-	2
CO5	2	3	-	3	-	-	-	1	-	-	2	3

Detailed Syllabus:

Module	Course Content	No. of Lecture
1	**Introduction to Embedded Systems:** Introduction to 8051, Embedded systems, Microprocessor vs. Microcontrollers., Desirable Features of embedded systems, Overview to 8051 family, Introduction to Harvard Architecture, RISC, CISC.	**8**
2	**Architecture of 8051**: 8051 microcontroller hardware: Oscillator and Clock, Role of PC and DPTR, Flags and PSW, CPU registers, Internal RAM and RAM organization, Internal Memory, Special Function Registers, I/O pins, ports and circuits, External memory, Counter and Timers, Serial Transmission, Interrupts.	**9**
3	**Assembly Language Programming of 8051:** Assembly language programming, Jump Loop and Call Instructions, I/O Port Programming, Addressing Modes, Arithmetical and Logical Instructions, **8051: Programming in C:** Data types and time delays, I/O Programming in 8051, Logical operations in C Data conversion programs in C.	**10**

4	**Peripheral Programming and Interfacing.** 8051 timer programming, serial port and its programming, interrupt programming, LCD and keyboard interfacing, ADC and DAC interfacing, interfacing to external memory.	**7**
5	**Applications:** Interfacing with relays and Opto isolators, Stepper Motor Interfacing, DC motor interfacing, PWM generation using 8051.	**4**

Text Books:

1. Kenneth J. Ayala, 'The 8051 Microcontroller', Cengage Learning, 2004
2. Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D. McKinlay, 'The 8051 Microcontroller
3. and Embedded Systems' , Second Edition , Pearson Prentice Hall,
4. 8051 Microcontrollers: MCS51 family and its variants by Satish Shah, Oxford University Press.
5. Programming and Customizing the 8051 Microcontroller by Myke Predko Tata McGraw Hill.

Electronics & Communication Engineering			
ECE622	**Microwave Engineering**	**L**	**T**
		3	**1**

Course Outcomes: After completion of the course student will be able to:

CO1	Study the performance of specialized microwave tubes such as klystron, reflex klystron, magnetron and Travelling wave tube.
CO2	Understand the operation of passive waveguide components.
CO3	Analyze microwave circuits using scattering parameters
CO4	Identify and characterize different components of an Optical Fiber Communication link
CO5	Analyze optical source, Fiber and Detector operational parameters.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	-	-	-	-	-	-	-	-	2	-
CO2	1	2	-	-	-	-	-	-	-	-	2	-
CO3	2	3	-	-	-	-	-	-	-	-	2	2
CO4	2	-	-	-	1	-	-	-	-	-	2	2
CO5	1	-	-	-	2	1	-	-	-	-	2	2

Detailed Syllabus:

Module	Content	No. of Lectures
1	**Introduction:** RF and microwave spectrum, historical background, application of RF and Microwave Impedance Matching–Unknown impedance measurement using shift in minima technique and impedance matching using single and double stub matching.	**8**

2	**Microwave waveguides and components**: Rectangular waveguide and circular waveguide, mode structure, cutoff frequency, wall current, attenuation; microwave cavities – rectangular cavity resonator, Q factor, power divider, scattering matrix and transmission matrix, attenuator, phase shifter, directional coupler, Bethe hole coupler, magic tee, hybrid ring, circulator, isolator, Ferrite Devices	**10**
3	**Planar structures:** Strip line, microstrip line, coplanar structure **Microwave Tubes:** Limitations of conventional tubes, Multicavity Klystron, Reflex Klystron, Magnetron, Travelling Wave Tube, Backward Wave Oscillator Semiconductor Microwave Devices – Tunnel diode, Gunn diode and their waveguide mounts	**10**
4	**Avalanche diodes:** IMPATT, TRAPATT, Microwave bipolar transistor, heterojunction bipolar transistor. **Microwave field effect transistor:** JFET, MOSFET, MESFET **Applications of microwave:** Industrial Applications of microwave.	**8**
5	**Microwave Measurement:** VSWR measurement, power measurement, impedance measurement, frequency Measurement Equivalent RF circuit parameters Low pass filter, high pass filter, band pass filter, RF amplifier.	**6**

Text Books:

1. Golio M, Golio J (2008) The RF and Microwave Handbook. CRC Press.
2. Pozar DM (2005) Microwave Engineering. John Wiley & Sons.
3. Hong JS, Lancaster MJ (2001) Microstrip Filters for RF/Microwave Applications. John Wiley & Sons.

Electronics & Communication Engineering			
ECE623	**Wireless Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the evolution of cellular communication systems upto and beyond 3G.
CO2	Design a cellular link and estimate the power budget.
CO3	Choose proper multiple accessing methods depending on channel model.
CO4	Identify traffic channels for call processing.
CO5	Calculate key performance metrics of a cellular communication system.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	1	2	2	-	-	-	2	-
CO2	2	-	-	-	2	2	1	-	-	2	2	2
CO3	2	-	-	-	2	2	1	-	-	-	2	2
CO4	1	-	-	-	2	-	2	-	-	-	2	2
CO5	2	-	-	-	3	2	2	-	-	2	2	2

Detailed Syllabus:

Module	Content	No. of Lectures
1	Introduction to Wireless Communication Systems – evolution of mobile radio communications, mobile radio systems around the world, radio communication systems – paging systems, cordless telephone systems, cellular telephone systems; comparison of common wireless communications, trends in cellular radio and personal communication.	**8**
2	Basics of mobile communication – Limitations of conventional mobile system, mobile cellular communication – introduction, concept of frequency reuse, cluster size, cellular system architecture – mobile station, base station, MSC, channel assignment strategies, call handover strategies, interference and system capacity, improving capacity in cellular systems – cell splitting, sectoring, repeaters, microcell zone concept.	**12**
3	Second generation (2G) cellular networks, third generation (3G) wireless networks, introduction to radio wave propagation, free space propagation model	**4**
4	Global system for mobile communication – GSM services and features, system architecture, GSM radio subsystem, GSM channel types, location updating and call setup, introduction to CDMA digital cellular standard, comparison between GSM and CDMA.	**10**

5	Wireless networking – wireless local area network standards, technology RF and IR wireless LAN, diffuse, quasi-diffuse and point-to-point IR wireless LAN, advantages and applications of Wireless LAN, introduction to WI-FI, Bluetooth, 3G and 4G wireless systems	**8**

Text Books:

1. William C Y Lee, “Mobile Cellular Telecommunications, McGraw Hill.(Main Book)
2. Stallings, Wireless Communications and Networks, Prentice Hall.
3. Schwartz, Mobile Wireless Communications, Cambridge University Press.(Main Book)
4. Theodore S Rappaport, “Wireless Communications Principles and Practice”, Prentice Hall.

Electronics & Communication Engineering			
ECE631	**Analog and Digital Communication***	**L**	**T**
		3	**0**

(This course is not offered to Electronics and Communication Engg. students)

Course Outcomes: After completion of the course student must be able to:

CO1	UNDERSTAND the basic principles and fundamentals of analog & digital communication.
CO2	ANALYZE different types of modulation techniques and their performance in presence of noise.
CO3	APPLY analytical skills for error detection and correction in communication.
CO4	UNDERSTAND the concept of noise as a random process and its effect on communication receivers, ISI, Eye Pattern.
CO5	UNDERSTAND the concept of information theory and source encoding.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	1	-	-	-	-	-	2	3	1
CO2	3	3	2	3	3	2	-	-	-	-	-	-
CO3	2	-	2	3	3	-	-	-	-	3	-	-
CO4	3	2	-	-	-	-	-	-	-	-	3	-
CO5	3	-	-	2	3	-	-	-	-	3	2	-

Detailed Syllabus:

Module	Course content	No. of Lectures
1	Signals and Signal Analysis: Periodic and nonperiodic signals, Composite signals, Signal analysis, Time and frequency domain representation. Introduction to Data and signal fundamentals, Analog and digital signals.	**8**
2	Analog Transmission: Concepts of carrier signal, noise, modulating signal and modulated signal; Amplitude modulation – double sideband suppressed carrier, double sideband transmitted carrier, single sideband; Frequency modulation – Narrowband FM and wideband FM; Digital to analog conversion – Amplitude shift keying, Frequency shift keying, Phase shift keying, Quadrature amplitude modulation, Performance.	**8**
3	Digital Transmission: Problems with digital transmission, Different line coding schemes, Block coding schemes, Scrambling techniques; Analog to digital conversion – Sampling techniques, Sampling theorem, Pulse amplitude modulation, Pulse code modulation, Differential pulse code modulation, Delta modulation (along with advantages and disadvantages of each technique), Transmission modes (serial	**10**

	and parallel).	
4	Multiplexing and Spreading: Concept of multiplexing, Frequency division multiplexing, Time division multiplexing – Synchronous and Statistical time division multiplexing.	**10**
5	Error Detection and Correction: Types of errors, Basic concepts of error detection and correction, Redundancy, Hamming distance, Error detection – Simple parity check codes, Two-dimensional parity check, Cyclic redundancy check, Polynomials and cyclic code analysis, Checksum, Error correction – Hamming code.	**8**

Text Books:

1. S. Haykin, Digital Communications, John Wiley & Sons, 2009.
2. B. Sklar, Digital Communications, 2nd Edition, Pearson Education, New Delhi, 2009.
3. John G. Proakis, Digital Communications, 3rd edition, McGraw Hill, 1995.
4. BP Lathi Communication System BS Publication
5. Singh & Sapre, Analog Communication, TMH

Electronics & Communication Engineering			
ECE632	**Nano Electronics**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understanding of Nano Computing.
CO2	Understanding of tunneling phenomenon.
CO3	Understanding of Spin transport.
CO4	Understanding of molecular electronics.
CO5	Simulation of Nano electronics computational methods.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	-	-	-	-	-	-	-	-	-
CO2	1	2	2	-	-	-	-	-	-	-	-	-
CO3	1	3	2	3	-	-	-	-	-	-	-	-
CO4	1	3	2	2	-	-	-	-	-	-	-	-
CO5	1	2		-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Module	Content	No. of Lectures
1	**Evolution of nanoelectronics:** Moore's Law, Silicon Electronics, Limitations, Discussion of the International Technology Roadmap characteristics: Need for new concepts in electronics, Silicon MOS Transistor from Micro to Nano, Future Opportunities Nano-computing.	**6**
2	**Tunnel junctions and applications of tunneling:** Tunneling Through a Potential Barrier - Potential Energy Profiles for Material Interfaces, Metal Insulator, Metal Semiconductor, and Metal – Insulator - Metal Junctions - Applications of Tunneling - Field Emission – Gate - Oxide Tunneling and Hot Electron Effects in MOSFETs - Double Barrier Tunneling and the Resonant Tunneling Diode	**10**
3	**Ballistic and spin transport:** Coulomb Blockade - Tunnel Junction Excited by a Current Source - Coulomb Blockade in a Quantum Dot Circuit – Single Electron Transistor - Ballistic Transport - Electron Collisions and Length Scales - Ballistic Transport Model Quantum Resistance and Conductance - Transport of Spin and Spintronics Devices, Applications.	**10**
4	**Molecular electronics:** Introduction to molectronics - An atomistic view of electrical resistance Schrodinger equation, Self - consistent field, Band structure, Level broadening, Coherent transport, Non-coherent transport in molecular electronics devices, Molecular Devices, Logic Switches, Interface Engineering-Issues.	**8**
5	**Nanoelectronics simulation:** Computational Methods – Molecular Wire Conductance: Some Theoretical and Computational Aspects, Monte Carlo Method, Simulations from ab initio to multiscale modeling, Modeling of nanodevices, Applications.	**6**

Text Books:

1) Advanced Nanoelectronics:- Sohail Anwar, Mohammad Taghi Ahmadi, Razali Bin Ismail CRC press
2) Introduction to Nanoelectronics: Science, Nanotechnology, Engineering, and applications, Vladimir V. Mitin, Viatcheslav A. Kochelap, Michael A. Stroscio,Cambridge press
3) Handbook of Nanotechnology,Bharat Bhusan,Springer Publications.

Electronics & Communication Engineering			
ECE633	**Communication Protocols for Instrumentation**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand and estimate errors in a measurement system
CO2	Understand PLC,SCADA & DCS
CO3	Estimate accurately the values of R,L and C employing suitable bridges
CO4	Understand the basic principles of transducers for displacement, velocity, temperature and pressure.
CO5	Operate special measuring instruments such as Wave Analyzer, Harmonic Distortion Analyzer and Spectrum Analyzer.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	-
CO2	2	1	-	-	-	-	-	-	-	-	-	2
CO3	1	2	-	-	-	-	-	-	-	-	-	1
CO4	2	1	-	-	-	-	-	-	-	-	-	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-

Detailed Syllabus:

Module	Course content	No. of Lectures
1	**Overview:** Standards, OSI model, Protocols, Physical standards, Modern instrumentation and control systems, PLCs, Smart instrumentation systems, Communication principles and modes, error detection, Transmission, UART.	**6**
2	**Serial communication standards:** Standards, serial data communication interface standards, EIARS232 interface standard, RS-449, RS-422, RS-423 and RS-485 standards, Troubleshooting and testing with RS-485, GPIB standard, USB interface.	**8**

3	**Error Detection, Cabling and Electrical Noise**: Errors, Types of error detection, control and correction, copper and fiber cables, sources of electrical noise, shielding, cable ducting and earthling.	**7**
4	**Modems and Multiplexers:** Synchronous and Asynchronous modes, flow control, modulation techniques, types of a modem, modem standards, terminal and statistical multiplexers. **Communication Protocols:** Flow control protocols, XON/XOFF, BSC, HDLC and File transfer protocols, OSI model and layers, ASCII protocols, Modbus protocol.	**10**
5	**Industrial Protocols:** Introduction to HART protocol, Smart instrumentation, HART physical layer, HART data link layer, HART application layer, ASD_i interface, Seriplex, CANbus, Devicenet, Profibus, FIP bus, Fieldbus. **Local Area Networks**: Circuit and packet switching, Network topologies, Media access control mechanisms, LAN standards, Ethernet protocol, Token ring protocol.	**9**

Text Books:

1. Bernard M. Oliver and John M. Cage, Electronic Measurements and Instrumentation, McGraw Hill Inc., 1971.
2. W. D. Cooper and Felbrick, Electronic Instrumentation & Measurement Techniques, 2nd Edition, PHI, 2009.
3. D.A. Bell, Electronic Instrumentation and Measurements, Reston Pub. Co., 1983.
4. H S Kalsi, Electronic Instrumentation, McGraw Hill, 3rd Edition, 2011.

Electronics & Communication Engineering			
ECE641	**Digital Signal Processing***	**L**	**T**
		3	**0**

(This course is not offered to Electronics and Communication Engg. students)

Course Outcomes: After completion of the course student will be able to:

CO1	Find DFT of a given signal through Fast Fourier Transform Techniques.
CO2	Design FIR and IIR type digital filters.
CO3	Identify various filter structures and evaluate the finite word length and the coefficient quantization effects.
CO4	Understand the concepts of sample rate conversion techniques and its applications.
CO5	Compare the key architectural features of DSP Processors.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	-
CO2		3	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	-	-	-	-	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	-	-	-
CO5	-	2	-	-	-	-	-	-	-	-	-	1

Detailed Syllabus:

Module	Content	No. of Lectures
1	**Signals and systems:** Basic elements of DSP, concepts of frequency in Analog and Digital Signals, sampling theorem, Discrete time signals, systems analysis of discrete time LTI systems, Z transform, Convolution, Correlation.	**6**
2	**Frequency transformations:** Introduction to DFT, Properties of DFT, Circular Convolution, Filtering methods based on DFT, FFT Algorithms, Decimation in time Algorithms, Decimation in frequency Algorithms, Use of FFT in Linear Filtering, DCT, Use and Application of DCT.	**10**
3	**IIR filter design:** Structures of IIR, Analog filter design, Discrete time IIR filter from analog filter, IIR filter design by Impulse Invariance, Bilinear transformation, Approximation of derivatives (LPF, HPF, BPF, BRF) filter design using frequency translation.	**10**
4	**FIR filter design:** Structures of FIR, Linear phase FIR filter, Fourier Series, Filter design using windowing techniques (Rectangular Window, Hamming Window, Hanning Window), Frequency sampling techniques.	**8**
5	**Finite word length effects in digital filters:** Binary fixed point and floating point number representations, Comparison, Quantization noise, truncation and rounding, quantization noise power, input quantization error, coefficient quantization error, limit cycle oscillations-dead band, Overflow error-signal scaling.	**8**

Text Books:

1. J.G.PROAKIS & D.G.MANOLAKIS, Digital Signal Processing - Principles, algorithms & Applications, PHI, 2000.
2. .B.Venkataramani, M.Bhaskar, "Digital Signal Processors, Architecture, Programming and Application", Tata McGraw Hill, New Delhi, 2003
3. A.V. Oppenheim and Ronald W. Schafer, Discrete Time Signal Processing, 2nd Edition, PHI, 2000.
4. S.K.MITRA, Digital Signal Processing – A computer Based Approach, 2nd Edition, MGH, 2001.
5. Multi Rate Systems and Filter Banks – P.P.Vaidyanathan – Pearson Education.
6. Fundamentals of Digital Signal Processing using Matlab – Robert J. Schilling, Sandra L. Harris, Thomson, 2007.

Electronics & Communication Engineering			
ECE642	**Value and Ethics**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Students are able to **analyze** the ethical use of energy and the necessity of sustainable development.
CO2	Students are able to **understand** the core values that shape the ethical behavior of an engineer and exposed awareness on professional ethics and human values.
CO3	Students are able to **estimate** the link between social values and happiness.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	3	1	-	3	3	3	-	1	-	1
CO2	-	-	2	1	-	3	3	3	-	1	-	1
CO3	-	-	1	1	-	3	3	3	-	1	-	1

Detailed Syllabus:

Module	Course content	No. of Lectures
1	Science, Technology and Engineering as knowledge and as Social and Professional Activities. Effects of Technological Growth. Rapid Technological growth and depletion of resources, Reports of the Club of Rome. Limits of growth: sustainable development Energy Crisis: Renewable Energy Resources Environmental degradation and pollution.	**8**
2	Eco-friendly Technologies. Environmental Regulations, Environmental Ethics Appropriate Technology Movement of Schumacher; later developments Technology and developing notions. Problems of Technology transfer, Technology assessment impact analysis. Human Operator in Engineering projects and industries. Problems of man, machine, interaction, Impact of assembly line and automation. Human centered Technology.	**8**
3	Ethics of Profession. Engineering profession: Ethical issues in Engineering practice, Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond, Case studies. Profession and Human Values.	**10**

4	Values Crisis in contemporary society Nature of values: Value Spectrum of a good life Psychological values: Integrated personality; mental health Societal values: The modern search for a good society, justice, democracy, secularism, rule of law, values in Indian Constitution.	**8**
5	Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity Moral and ethical values: Nature of moral judgements; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility. .	**6**

Text Books:

1. Professional Ethics: R. Subramanian, Oxford University Press, 2015.
2. Ethics in Engineering Practice & Research, Caroline Whitbeck, 2e, Cambridge University Press 2015.
3. Engineering Ethics, Concepts Cases: Charles E Harris Jr., Michael S Pritchard, Michael J Rabins, 4e , Cengage learning, 2015.
4. Business Ethics concepts & Cases: Manuel G Velasquez, 6e, PHI, 2008.
5. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001
6. World Community Service Centre, “Value Education”, Vethathiri publications, Erode, 2011.

Electronics & Communication Engineering			
ECE643	**Analog Integrated Electronics***	**L**	**T**
		3	**0**

(This course is not offered to Electronics and communication Engg. students)

Course Outcomes: After the completion of the course the student will be able to:

CO1	Design op-amp circuits to perform arithmetic operations
CO2	Analyze and design linear and non-linear applications using op-amps
CO3	Analyze and design oscillators
CO4	Analyze and design filters
CO5	Understanding of PLL and Timers.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	1	-	-	-	-	-	-	-	-	-

CO2	1	2	2	-	-	-	-	-	-	-	-	-
CO3	1	3	2	3	-	-	-	-	-	-	-	-
CO4	1	2	2	2	-	-	-	-	-	-	-	-
CO5	1	1		-	-	-	-	-	-	-	-	-

Details Syllabus:

Module	Course Content	No. of Lecture
1	Op-Amp equivalent circuits, ideal Op-Amp, Op-Amp DC characteristics, AC characteristics, non-ideal Op-Amp characteristics. DC and AC amplifiers, summing, scaling, and averaging amplifiers, instrumentation amplifiers, I/V, V/I converter, integrator, differentiator, differential amplifiers. Op-amp with negative feedback, voltage series, voltage shunt feedback amplifier.	**8**
2	Logarithmic Amplifiers, Rectifiers, Peak detection and voltage regulation.	**5**
3	Comparator and its applications, Schmitt trigger, free-running, one-shot multivibrators, Barkhausen Criterion, sine wave generators, phase-shift, wein-bridge oscillators, square/Triangular/saw tooth wave function generator.	**10**
4	Filter Classifications, Frequency and Impedance Scaling, First and second order Low Pass and High Pass Designs, Band-Pass Filter, Notch filter.	**8**
5	PLL and Timers, Voltage controlled Oscillator, Closed loop analysis of PLL, Astable and Monostable Multivibrators using 555 Timer, Voltage regulators-linear and switched mode types.	**8**

Text Books:

1) OP-Amps and Linear Integrated Circuits: - Ramakant Gayakwad (Pearson Education)
2) Linear Integrated Circuits: - D Roy Choudhury, Shail Bala Jain (New Age International Publishers

Design with Operational amplifiers and Analog integrated circuits: - Sergio Franco (TATA McGraw-Hill 3rd Edition)

Electronics & Communication Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

[1].Hisrich & Peters, “Entrepreneurship”, Tata McGraw Hill

[2].Roy, Rajeev, “Entrepreneurship”, Oxford University Press

[3]. Norman M. Scarborough, “Essentials of Entrepreneurship & Small Business Management”, 6th ed., Prentice Hal

[4]. Dutta, Bholanath, “Entrepreneurship management” ,Excel Books.

Mining Engineering			
MN601	**Surface Mining Technology**	**L**	**T**
		3	**1**

Course objective:

Develop students into design and construction of surface mines under various geo-environmental conditions,
To expose students to the modes of conversion of underground mines into surface mines and reclamation practices.

Syllabus:

Basic Concept of Surface Mining: Status of surface mining in India. Selection between surface mining and underground mining. Different stages of exploration and principles of ore reserve estimation, Calculation of reserves, Collection of planning information. Optimal size and output different stages of development, design of pit layout and method of advance, Opening up of deposits with Box Cut: Factors affecting selection of site of box-cut, Production benches -- formation parameters and factors affecting their selection, Preparation for Excavation: Working principle of ripper and Scraper-- their cycle of operation, application and limitation, Development of infrastructural facilities-communication power supplies, illumination, dewatering and other maintenance services, Site selection for mineral handling/ beneficiation plant, Classification of surface mining systems vis-à-vis machinery deployment. Functional units of Dragline, Shovel, Dozer, Front-End-Loader, Scraper and their design aspects, power requirements for the above machinery, various capacity available. Dumpers of various capacities, their functional units, operation and maintenance. High capacity conveyors, high angle conveyors their functional units, various capacity available. Functional units of Bucket Wheel Excavator and Bucket Chain Excavator, their design aspects, operation and maintenance. Rippers, Continuous Miners, their design aspects, operation and maintenance. Various types of opencast drilling machines, pneumatic and hydraulic rock breakers. Control of opencast mining induced hazards- rock fall, fly rock, blast vibration, noise and mine dusts. Planning for reclamation of mined out area.

Modules:

Module-1: Introduction: Basic Concept of Surface Mining: Status of surface mining in India.Selection between surface mining and underground mining. Applicability, advantages and disadvantages of surface mining.

Module-2: Preliminary evaluation of deposits:Different stages of exploration and principles of orereserve estimation, Calculation of reserves, Collection of planning information. Optimal size and output different stages of development, design of pit layout and method of advance

Module-3: Opening up of deposits:Box Cut-Objective, types, parameters and methods; factorsaffecting the selection of site of box-cut. Production benches -- formation parameters and factors affecting their selection.

Module-4: Preparation for Excavation using Ripper and Scrappers:types, classification,applicability and limitations, working principle, method and cycle of operation.

Module-5: Development of infrastructural facilities: Communication power supplies, illumination, dewatering and other maintenance services, Site selection for mineral handling/ beneficiation plant.

Module-6: Classification of surface mining systems vis-à-vis machinery deployment. Discontinuous/cyclic methods of excavation and transports: Functional units ofDragline, Shovel, Dozer, Front-End-Loader, Scraper and their design aspects, power requirements for the above machinery, various capacity available. Dumpers of various capacities, their functional units, operation and maintenance. Continuous methods of excavation and transports:Conveyors: High capacity conveyors, high angleconveyors their functional units, various capacity available. Bucket Wheel Excavator:Functional units of Bucket Wheel Excavator and Bucket ChainExcavator, their design aspects, operation and maintenance. Rippers, Continuous Miners: their design aspects, operation and maintenance. Various types of opencastdrilling machines, pneumatic and hydraulic rock breakers.

Module-7: Control of opencast mining induced hazards: Rock fall, fly rock, blast vibration, noiseand mine dusts. Planning for reclamation of mined out area.

Text/Reference Books:

1. S.K. Das, Surface Mining Operations
2. Misra, G.B., Surface Mining
3. D. Biswas, Modern concepts of Surface Mining
4. N. Banerjee, Opencast Mining
5. AMIE Publication, Surface Mine Blast Evaluation
6. T.N. Singh, Surface Mining Technology
7. B.A. Kennedy, Surface Mining.
8. W. Hustrulid, M. Kuchta and R. Martin, Open pit Mine Planning and Design.
9. Eugeniusz Rusinski, Jerzy Czmochowski, PrzemyslawMoczko, Damian Pietrusiak, Surface Mining Machines: Problems of Maintenance and Modernization.
10. LVA Sendlein, Surface mining: Environmental Monitoring and Reclamation Handbook.

Goals and Outcomes:

This course qualifies participants to apply an advanced body of knowledge in the area of surface mining and equips them with highly developed skills for research and enquiry. Students enrolled in this course will be able to apply the body of knowledge to a range of contexts within the mining industry enabling them to undertake professional or highly skilled work within the mining industry and allow them to undertake further study.

Knowledge:

1. Analyse the development of surface mines
2. Analyse mining systems used in surface operations
3. Analyse the operation and application of the equipment used in surface mining and advanced appreciation of the systems engineering involved with interacting machines.
4. Compare and contrast reclamation and land management of surface mines, during both mining and post-mining phases of operation.

Skills:

1. Review, analyze, consolidate and synthesizes knowledge to identify and provide solutions to complex surface mining problems
2. Assess and evaluate complex ideas in surface mining and selection of the number required and the size of appropriate equipment
3. Apply specialized technical and creative skills using appropriate tools to solve problems in surface mining

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							3				
CO2		3		2		2	3		2	3		3
CO3	2	2		2	3	2		3			2	2
CO4			2			2	2		3	1	3	
Avg.	2.5	2.5	2	2	3	2	2.5	3	2.5	2	2.5	2.5

Mining Engineering			
MN611	**Rock Mechanics**	**L**	**T**
		3	**0**

Course Objective:

The course is designed to provide a better understanding to evaluate physico-mechanical properties of rocks, elastic and time dependent behaviour, laboratory and field test procedure, rock mass characteristics. Theories of rock failure, Influence of water on rock and soil behaviour. Dynamic characteristics of rocks. Concept of in - situ stress and post mining redistribution of stress.

Syllabus:

Concept of stress and strain in rock: Analysis of stress, strain and constitutive relations in isotropic and anisotropic rocks. Physico-mechanical properties rocks: Determination of physical properties, strength, strength indices and static elastic constants, parameters influencing strength, abrasivity and its determination. Physico-mechanical properties of soil: Physico-mechanical properties including consistency and gradation, classification of engineering soils, engineering properties of soils- compressibility, consolidation, compaction and strength. Time dependent properties of the rock. Creep formation and strength behaviour, creep test and simple rheological models. Behaviour of Rock Mass: Rock mass structure, in-situ elastic properties and strength determination. Failure criteria for rock and rock mass: Theories of rock failure, Column, Mohr, Griffith and Empirical criteria. Pre-mining state of stress: Sources, methods of determination including over coring and hydro-fracturing methods. Ground water: Influence of water on rock and soil behaviour, permeability of rocks, measurement of permeability, ground water flow in rock mass, measurement of water pressure. Dynamic property of the rock and rock mass: Propagation of elastic wave in rock media, determination of properties and elastic constants.

Modules:

Module 1. Introduction to Stress and Strain: Concept of stress and strain in rock, Analysis of stress, strain and constitutive relations in isotropic and anisotropic rocks.

Module 2. Physico-mechanical properties rocks: Determination of physical properties, strength, strength indices and static elastic constants, parameters influencing strength, abrasivity and its determination.

Module 3. Time dependent properties of the rock: Creep formation and strength behaviour, creep test and simple rheological models.

Module 4. Behaviour of Rock Mass: Rock mass structure, in-situ elastic properties and strength determination.

Module 5. Rock mass Failure criteria:Failure criteria for rock and rock mass. Theories of rock failure, Coulomb - Napier, Mohr, Griffith and Empirical criteria.

Module 6. Influence of water on rock and soil behaviour:Ground water: Influence of water on rock and soil behaviour, permeability of rocks, measurement of permeability, ground water flow in rock mass, measurement of water pressure.

Module 7. Dynamic behaviour of Rock and Rock mass:Dynamic property of the rock and rock mass. Propagation of elastic wave in rock media, determination of properties and elastic constants.

Text/Reference Books:

1. Fundamental of Rock Mechanics by J.C Jaeger & N.G.W. Cook, Blackwell Publishing
2. Coal Mining Ground Control by Syd S. Peng, West Virginia University.
3. Rock Mechanics for underground Mining– BHG Brady & E T Brown, George Allen & Unwin Ltd, 1992.
4. Introduction to Rock Mechanics, Second Edition, Richard E. Goodman
5. Fundamental and Applied Rock Mechanics, D. Deb, A.K. Verma

Course Outcome:

After completion of the course, students will be able to:

1. Understand mechanical properties of rock, different theories of rock failure.
2. Know Causes and impacts of rock failure, rock strength and stresses induced in rocks.
3. Understand the time dependent deformation in rock structure.
4. Understand the effect of water on rock structure and their stability.
5. Understand the dynamic characteristics of rock and rock mass

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				2			3				
CO2	2	3		2		2	3		2	3	2	3
CO3	2	2		2	3			2			2	3
CO4			2			2	2		2	2	2	
Avg.	2	2.5	2	2	2.5	2	2.5	2.5	2	2.5	2	3

Mining Engineering			
MN612	**Rock Fragmentation Engineering**	**L**	**T**
		3	**0**

To educate students on rock explosive interaction, various theories of rock fragmentation

Syllabus:

General theory of rock cutting, selection of cutting tools for optimum penetration and wear characteristics. Mechanics of rotary, percussive and rotary-percussive drilling; short and long hole drilling equipment; different types of bits; bit wear; drilling in difficult formations; drillibality of rocks; drilling performance and costs. Mechanism of rock breaking machines, Pneumatic and Hydraulic rock hammers. Mechanics of rock fragmentation and fracture by explosive action; explosives; blasting accessories, blasting parameters, design of blasting rounds for opencast and underground mines; Blastability of rocks, blasting efficiency, mean fragment size. Computational models of blasting; transient ground motion, misfires, blown out shots, incomplete detonation-their causes and remedial measures. Controlled blasting techniques; perimeter blasting; safety precautions; ground vibrations and air over pressure from blasting. Instrumentation in blasting: Borehole pressure transducer, V.O.D probe, vibration monitor, high speed video camera; impact of ground vibration and sound on the neighbouring structures and communities, and mitigative measures.

Modules:

Module-1: Introduction: General theory of rock cutting, selection of cutting tools for optimum penetration and wear characteristics.

Module-2: Drilling: Mechanics of rotary, percussive and rotary-percussive drilling; short and long hole drilling equipment; different types of bits; bit wear; drilling in difficult formations; drillibality of rocks; drilling performance and costs.

Module-3: Rock fragmentation: Mechanism of rock breaking machines, Pneumatic and Hydraulic rock hammers. Mechanics of rock fragmentation and fracture by explosive action; explosives; blasting accessories, blasting parameters, design of blasting rounds for opencast and underground mines; Blast ability of rocks, blasting efficiency, mean fragment size.

Module-4: Computational models of blasting: transient ground motion, misfires, blown out shots, incomplete detonation-their causes and remedial measures. Controlled blasting techniques; perimeter blasting; safety precautions; ground vibrations and air over pressure from blasting.

Module-5: Instrumentation in blasting: Borehole pressure transducer, V.O.D probe, vibration monitor, high speed video camera; impact of ground vibration and sound on the neighbouring structures and communities, and mitigative measures.

Text/Reference Books:

1. Manual on rock mechanics: Ramamurthy & Sharma.
2. Blasting Practices: G.K. Pradhan
3. Explosives and Blasting Practices in Mines: Dr. Sameer Kumar Das

4. Drilling: G. Chugh
5. Introduction to Mining: Hartman

Goals and Outcomes:

On completion of the course, student will be able to:

1. Describe theories of rock tool interaction and Rock Cutting.
2. Demonstrate Concepts of drilling and advanced blasting techniques.
3. Define concept of rock fragmentation.
4. Demonstrate Computational models of blasting.
5. Define concept of Instrumentation in blasting.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				2			3				
CO2		3	2	2		2	3		2	3	2	3
CO3	3			2	3			3			2	3
CO4			2			2	2		3	2	2	
Avg.	2.5	3	2	2	2.5	2	2.5	3	2.5	2.5	2	3

Mining Engineering			
MN613	**Rock Excavation Engineering**	**L**	**T**
		3	**0**

Course Objectives:

When the students enter the college to pursue a degree in Mining Engineering and as well pursue a career in Mining Engineering after graduation, they need to understand the breadth and depth available in this field for different rock excavation methods. When many alternative disciplines of engineering appear to offer apparently more glamorous avenues for advancement, the Mining Engineering student should realize the solid foundations available in this mother of all engineering disciplines. The students should understand the enormous possibilities available for creative and innovative works in this all-pervasive field of engineering.

This course is designed to address the following:

- To give an understanding to the students of the vast breadth and numerous areas of engagement available in the overall field of Mining Engineering
- To motivate the student to pursue a career in one of the many areas of Mining Engineering with deep interest and keenness.
- To expose the students to the various avenues available for doing creative and innovative work in this field by showcasing the many monuments and inspiring projects of public utility.

Syllabus:

Scope and importance:Rock excavation engineering in mining and construction industries;physico-mechanical and geotechnical properties of rocks Vis-à-vis excavation method; selection of excavation method.

Drilling: Mechanics of rock drilling; design and operating parameters of surface andunderground drilling; evaluation of drill performance; drillability of rocks; mechanism of bit wear; bit selection; problems of drilling; economics of drilling.

Blasting: mechanics of rock fragmentation by explosives; advances in explosives and their selection criteria for rock excavation; blast design for surface excavations and optimization; advanced blast initiation systems; blast performance evaluation; cast blasting; techno-economic and safety aspects of surface and underground blasting; advances in blast design for underground excavations; contour blasting; computer aided blast designs; review of tunnel blasting techniques in recent advances.

Rock Cutting: theories of rock tool interaction for surface excavation machinery- rippers,bucket wheel excavators, continuous surface miners; theories of rock tool interaction for underground excavation machinery- ploughs, shearers, road headers, continuous miners and tunnel boring machines; selection criteria for cutting tools; Advanced rock cutting techniques- high pressure water jet assisted cutting.

Modules:

Module 1: Basic Understanding: What is Rock Excavation Engineering? Basics of RockExcavation Engineering in mining and construction industries; Importance of Rock Excavation Engineering; Possible scopes for a career in Rock Excavation Engineering.

Module 2: Selection Criteria for Rock Excavation: Physical and mechanical properties of rockmaterials; Geotechnical properties of rock materials in regard to method of excavation; Selection of excavation method.

Module 3: Drilling Mechanism, Performance and Problems: Mechanics of drilling; Design andoperating parameters of surface drilling and underground drilling. Performance parameters of drilling; Evaluation of drilling performance; Drillability of rock; Selection of drill bit. Drill bit wear; Mechanism of drill bit wear; Economics of drilling.

Module 4: Blasting Operation, Blast Design, Performance and Advance underground blast:Mechanism of rock fragmentation by explosives; Advances in explosives and their selection criteria for rock excavation. Blast design for surface excavation; Optimization of blast design; Initiation system; advanced blast initiation system; Powder factor; Calculation of powder factor; techno-economic aspects in surface and underground blasting; safety aspects in surface and underground blasting. New technology for underground blast design for excavation; contour blasting; computer aided blast design; recent advances in tunnel blasting.

Module 5: Rock cutting technology and Selection: Theories of rock cuttings; rock and toolinteraction for surface and underground excavation. Criteria for selecting cutting tools; advanced rock cutting techniques; High pressure jet assisted cutting.

Module 6: Surface and Underground excavation machineries: Ripper; Bucket wheelExcavator; Surface continuous miner; Ploughs; Shearers; Road headers; Continuous miner and Tunnel boring machines.

Module 7: Computational Methods, IT in Rock Excavation Engineering: Typical softwareused in Rock Excavation Engineering- Finite Element Method, Computational Fluid Dynamics; Computational geotechnical methods; Highlighting typical available software system (FLAC 2D, FLAC 3D, PLAXIS 2D and PLAXIS 3D)

Module 8: Industrial lectures: Case studies of large tunnelling and shaft sinking engineering projects by industry professionals, covering comprehensive planning to commission the same.

Module 9: Basics of Professionalism: Professional Ethics, Entrepreneurial possibilities in Rock Excavation Engineering, Possibilities for creative & innovative working, Technical writing Skills enhancement; Facilities Management; Quality & HSE Systems in excavation method.

Text/Reference Books:

1. Ratan Raj Tatiya, Surface and underground excavation method.
2. Principles of Rock fragmentation,Cark G.B-John Wiley & Sons
3. Diamond Drilling, Chugh C.P-Oxford Publication
4. Introduction to Mining Engineers – Hartman. H.L, John Wiley & Sons.

Course outcomes

* Introduction to what constitutes Rock Excavation Engineering.
* Identifying the various areas available to pursue and specialize within the overall field of Rock Excavation Engineering.
* Highlighting the depth of engagement possible within each of these areas.
*Exploration of the various possibilities of a career in this field.
*Understanding the vast interfaces this field has with the society at large.
*Providing inspiration for doing creative and innovative work in Rock Excavation Technology.
* Showcasing the many tunnel construction, vertical shaft and incline for accessing the deposits, nationally important infrastructure, and impressive projects to serve as sources of inspiration.
* Highlighting possibilities for taking up entrepreneurial activities in this field.
* Providing a foundation for the student to launch off upon an inspired academic pursuit into this subject of engineering.
* Know about rock excavation, excavation methods, drill bit wear and drillability to cut rocks.
* Optimize, safety aspects of surface and underground blasting.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			3			2	3
CO4		2	2	2		2	2		3	2		
Avg.	2	2.5	2	2	3	2	2.5	3	2.5	2.5	2	3

Mining Engineering			
MN614	**Rock Slope Engineering**	**L**	**T**
		3	**0**

Pre-requisite: Surface mining technology

Course Objectives:

To introduce the basic mechanics of rock slope failure to learn the types of rock failure and its influencing parameters

Syllabus:

Basic mechanics of rock slope failure: Rock slope economics, slope parameters, effect of water pressure, factor of safety of slopes, slope height vs. slope angle, design of slopes. Geological and strength properties: Geological parameters affecting slope stability; physico-mechanical properties affecting slope stability, shearing on incline plane, determination of shear strength of rock and rock discontinuities; Ground water flow in rock masses; field measurement of permeability; measurement of water pressure. Plane Failure: Plane failure analysis; graphical analysis of stability; influence of ground water on stability, Influence of tension crack; rock reinforcement; analysis of failure on a rough plane; case studies. Wedge Failure: Analysis of wedge failure; wedge analysis including cohesion and water pressure; case studies. Circular and toppling Failure: Conditions for circular failure; derivation of circular failure analysis; effect of ground water; Types of toppling failure; analysis of toppling failure; Influence of slope curvature on stability; slope depressurization: protection of slopes: control of rock falls. Slope Monitoring: Monitoring and instrumentation techniques of rock slopes. Investigations of failed slopes, Remedial Measure: Remedial and corrective measures. Remedial measures for slope stabilization. Numerical Analysis: Numerical analysis of slopes. Use of FLAC Software.

Modules:

Module 1: Basic mechanics of rock slope failure:Rock slope economics, slope parameters,effect of water pressure, factor of safety of slopes, slope height vs. slope angle, design of slopes.

Module 2: Geological and strength properties:Geological parameters affecting slope stability;physico-mechanical properties affecting slope stability, shearing on incline plane, determination of shear strength of rock and rock discontinuities; Ground water flow in rock masses; field measurement of permeability; measurement of water pressure.

Module 3: Plane Failure:Plane failure analysis; graphical analysis of stability; influence ofground water on stability, Influence of tension crack; rock reinforcement; analysis of failure on a rough plane; case studies.

Module 4: Wedge Failure:Analysis of wedge failure; wedge analysis including cohesion andwater pressure; case studies.

Module 5: Circular and toppling Failure:Conditions for circular failure; derivation of circularfailure analysis; effect of ground water; Types of toppling failure; analysis of toppling failure; Influence of slope curvature on stability; slope depressurization: protection of slopes: control of rock falls.

Module 6: Slope Monitoring:Monitoring and instrumentation techniques of rock slopes. Investigations of failed slopes.

Module 7: Remedial Measure: Remedial and corrective measures. Remedial measures for slopestabilization.
Module 8: Numerical Analysis: Numerical analysis of slopes. Use of FLAC Software.

Text/Reference Books:

1. Hoek, E and Bray, J.W., Rock Slope Engineering, Institution of Mining and Metallurgy, 1991.
2. Goodman, R.E., Rock Mechanics, John Wiley and Sons, 1989
3. Singh, R.N. and Ghose, A.K., Engineered Rock Structures in Mining and Civil Construction, A.A. Balkema, Netherlands, 2006.
4. Rock Slope Engineering: Civil and Mining by Duncan C. Wyllie
5. Cumming A.B. & Given I &V. & SME Vol. I & II, Society of Mining Engineers, USA.
6. Introduction to Mining Engineering, Hartman H.L. – John Willey & Sons.
7. Soil Slope Instability and Stabilization, Bruce F. Walker, Robin Fell, Proceedings of an Extension Course on Soil Slope Instability and Stabilization, Sydney
8. Rock Mechanics by Alfreds R. Jumikis, Trans Tech Publications,
9. Rock Mechanics by BGH Brady, ET Brown/Springer Publishing

Course Outcomes:

At the end of the course, students will be able to,

1. Understand Basic mechanics of rock slope failure
2. Understand Geological parameters and physico-mechanical properties affecting slope stability
3. Understand basics of Plane failure
4. Understand basics of Wedge failure
5. Understand basics of Circular and toppling failure.
6. Understand about data interpretation for slope stability analysis
7. Understand about mechanism of failure of rock mass,
8. Understand about influence of ground water on slopes and techniques of depressurization,
9. Understand about instrumentation techniques of rock slopes, use of software like FLAC.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2			2				3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			3			2	3
CO4	2	2	2			2	2		3	2	2	
Avg.	2	2.5	2	2	3	2	2.5	3	2.5	2.5	2	3

Mining Engineering			
MN621	**Mine Environmental Engineering**	**L**	**T**
		3	**0**

Course objective:

Assess environmental issues associated with air, land, and water systems and their accompanying human health and ecological impacts due to mining activities. Synthesize technical knowledge of engineering analysis and design to identify, formulate, and solve problems of professional interest and importance. This course streams into more specialised areas including: water quality engineering, air and noise pollution control, solid and hazardous waste management, environmental engineering design, and site remediation related to mining engineering.

Syllabus :

Land environment:visual impacts, landscape analysis, land use, landscape planning, physicalreclamation and subsidence management. Land reclamation principles and requirement; Topsoilmanagement inventory, removal, preservation and redistribution; Ecological restoration technology –objectiveand guidelines ;Technical reclamation – stability, drainage and erosion control; Factors effecting the development of vegetation cover in mine degraded areas; estimation of sediment load and design of sedimentation pond; Mine closure planning – environmental impacts of mine closure, development of closure plan, closure guidelines, mine closure activity, closure cost.

Water regime: Water quality–physical, chemical, biological, criteria and standards, Waste water management – sources characteristics, techniques of treatment. Acid mine drainage – occurrence, effects and treatment techniques. Groundwater hydrology: Measurement of yield, Laws of groundwater movement: Darcy`s law, Thiems equilibrium formula, Duipuits formula etc. CPCB standards.

Air pollution: sources of gaseous and particulate pollutants, their physical, chemical (special preference to greenhouse gases and ozone) physiological effects Classification of Air Pollutants, Particulates and Gaseous pollutants, Sources of air pollution, Effects of air pollution on Human Beings, Materials, Vegetation, Animals. Major Global and Regional impacts, monitoring and control. Control of air borne respirable dust:ventilation, water spray, cyclone dust collector, dust filtration, dust scrubber. Control technologies of motor vehicle emissions and indoor air pollution’s standards for air pollution control.

Noise pollution/ ground vibration: Fundamentals of Noise: Basics of Acoustics: Sound power, Sound intensity and Sound pressure levels; Plane, Point and Line sources, Multiple sources; Outdoor and indoor noise propagation; Effects of noise –noise induced deafness, presbycusis, acoustic trauma, other physiological and psychological effects; Noise standards and indices. Vibration problems in surface mines and control measures. Ground Vibration and Air Blast - Environmental impacts, strategic planning and abatement/ prevention.

Illumination*:* Cap lamps; Layout and organization of lamp rooms; Standards of illumination; Photometry and illumination survey.

Modules:

Module 1 Land environment: visual impacts, landscape analysis, land use, landscape planning, physical reclamation and subsidence management. Land reclamation principles and requirement; Topsoil management inventory, removal, preservation and redistribution;

Module 2: Ecological restoration technology –objective and guidelines ;Technical reclamation – stability, drainage and erosion control; Factors effecting the development of vegetation cover in mine degraded areas; estimation of sediment load and design of sedimentation pond; Mine closure planning – environmental impacts of mine closure, development of closure plan, closure guidelines, mine closure activity, closure cost.

Module 3 :Water regime: Water quality–physical, chemical, biological, criteria and standards, Waste watermanagement – sources characteristics, techniques of treatment. Acid mine drainage – occurrence, effects and treatment techniques. Groundwater hydrology: Measurement of yield, Laws of groundwater movement: Darcy`s law, Thiems equilibrium formula, Duipuits formula etc. CPCBstandards.

Module 4: sources of gaseous and particulate pollutants, their physical, chemical (specialpreference to greenhouse gases and ozone) physiological effects Classification of Air Pollutants, Particulates and Gaseous pollutants, Sources of air pollution, Effects of air pollution on Human Beings, Materials, Vegetation, Animals. Major Global and Regional impacts, monitoring and control.

Module 5: Control of air borne respirable dust: ventilation, water spray, cyclone dust collector, dust filtration, dust scrubber. Control technologies of motor vehicle emissions and indoor air pollution’s standards for air pollution control

Module 6: Fundamentals of Noise: Basics of Acoustics: Sound power, Sound intensity and Sound pressure levels; Plane, Point and Line sources, Multiple sources; Outdoor and indoor noise propagation; Effects of noise –noise induced deafness, presbycusis, acoustic trauma, other physiological and psychological effects; Noise standards and indices. Vibration problems in surface mines and control measures. Ground Vibration and Air Blast - Environmental impacts, strategic planning and abatement/ prevention.

Module 7: Cap lamps; Layout and organization of lamp rooms; Standards of illumination; Photometry and illumination survey.

Course outcomes:

After successful completion of the course the learner will be able to:

- Identify, formulate, and solve complex mine environmental engineering problems in land degradation, water and wastewater, air pollution, solid waste, and related areas by selecting and applying appropriate tools and techniques.

- Specify or design unit processes or systems associated with traditional areas of environmental engineering.

- Synthesize advanced technical knowledge in a traditional or emerging specialization area of mine environmental engineering.

References /textbooks

- Environmental Land use planning and Management, John Randolph, Island Press,

- Land Use in Mining Areas of India, Rekha Ghosh, Envis, ISM Dhanbad, ISSN 0972 4656.
- Eco restoration of the coalmine degraded lands- Subodh Kumar Maiti, Springer (2013).
- Air Pollution Control Equipment. H. Brauer and Y. B. G. Verma, Berlin Heidelberg, New York, latest edition.
- Environmental Impact of Mining – Down CG and Stocks J. Applied Science Publishers, London,1978.
- Best Practices Environmental Management in Mining" - EPA (Australia): 1997-2004.
- Environmental Management in Mining Areas– Saxena NC, Singh Gurdeep and Ghosh R, (Ed.), Scientific Publishers (India), Jodhpur 2003.
- Industrial Noise Control and Acoustics – Randall F Barron, Marcel Dekker, Inc., New York, 2003.
- Engineering Noise Control: Theory and Practice – David Bies et. al., Routledge Publishers, 2003.
- Vibrations – Balakumar Balachandran and Edward B. Magrab, Thomson Asia Pte. Ltd., Singapore, 2003.
- Noise control: Principles and Practice - Bruel&Kjaer, 2nd ed. B & K Pub., Denmark, 1986.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2		3		2		2	3		2	3	2	3
CO3	3	3		2	3						2	2
CO4						2	2		3	2	2	
Avg.	2.5	3		2	3	2	2.5		2.5	2.5	2	2.5

Mining Engineering			
MN622	**Mine Ventilation Planning**	**L**	**T**
		3	**0**

Course objectives:

This course applies ventilation principles to the design of underground mines and enables the ventilation requirements for underground mining methods to be met. Students work in groups for projects work that are focused on the ventilation requirements of the mine in question. The projects are structured in such a way as to lead each group through the processes that are required. In addition to the projects work, a site visit where ventilation techniques and data collection is practiced. A minor report completes this visit where the student provides a summary of the learning's from the visit. The visit is structured around a ventilation survey.

The objective of this course are to:

- Apply ventilation principles to mine design
- Quantify ventilation requirements
- Identify risks associate with ventilation management
- Identify controls to manage ventilation.
- Determine fan / system performance and specification of requirements in complex coal and metalliferous ventilation systems, including trouble shooting and problem solving.
- Identify the requirements, and issues associated with, the application of appropriate ventilation monitoring systems in both coal and metalliferous mines.
- Develop ventilation designs for a coal mine and a metalliferous mine.
- Identify the requirements of appropriate management plans for the designed systems

Syllabus:

Ventilation planning: Objective and steps in ventilation planning, system analysis of the planning procedure, desirable features of ventilation systems, ventilation plans.

Types of ventilation system, Central, Boundary and Combined ventilation systems, Air distribution with different mining methods: Board and Pillar method, Longwall methods, Shrinkage and Cut and Fill stopes, Open and Underhand stopes, Sublevel stopes. Top slicing and Sub-level caving, Block caving.

Air quantity requirement: Air quantity requirement in the workings, Strata gas, Diesel exhaust fumes, dust, heat, workshop and other ancillary areas, air requirements in drifts and tunnels, leakage of air, expansion in up cast, air velocities.

Pressure Requirement, Selection of fans, output control in fans, series and parallel combination of mine fans, forcing and exhaust, maintenance and monitoring of fans, booster fans, auxiliary ventilators, fan installations, diffuser and evasee.

Network Analysis: solution of complex ventilation network, solution by Hardy Cross Method of successive approximation, ventilation network analysis by digital computer, recent development in ventilation planning

Ventilation Economics: Analysis of ventilation cost, Interest payments, time value of money, present value, Equivalent annual cost, ventilation operating cost, optimum size of airway and shaft.

Modules:

Module-1: Introduction: Objective and steps in ventilation planning, desirable features of ventilation systems, ventilation plans.

Module-2: Types of ventilation system: Central, Boundary and Combined ventilation systems.

Module-3: Air distribution with different mining methods: Bord and Pillar method, Longwallmethods, Shrinkage and Cut and Fill stopes, Open and Underhand stopes, Sublevel stopes. Top slicing and Sub-level caving, Block caving.

Module-4: Air quantity requirement: Air quantity requirement in the workings, Strata gas,Diesel exhaust fumes, dust, heat, workshop and other ancillary areas, air requirements in drifts and tunnels, leakage of air, expansion in up cast, air velocities.

Module-5: Pressure Requirement: Selection of fans, output control in fans, series and parallel combination of mine fans, forcing and exhaust, maintenance and monitoring of fans, booster fans, auxiliary ventilators, fan installations, diffuser and evasee.

Module-6: Network Analysis: solution of complex ventilation network, solution by Hardy Cross Method of successive approximation, ventilation network analysis by digital computer, recent development in ventilation planning.

Module-7: Ventilation Economics: Analysis of ventilation cost, Interest payments, time value of money, present value, Equivalent annual cost, ventilation operating cost, optimum size of airway and shaft.

Course outcomes

Upon successful completion of this course, the student will be able to:

Knowledge based

- To familiarize with the steps in ventilation planning.
- Know the various types of ventilation system.
- To get acquainted with the various air quality requirement in the working.
- To know the various causes of leakage of air.
  To have the knowledge of effects on various leakage of air.

Text/Reference Books:

1. Skochinsky, A. and Komarov, V., (1969) Mine ventilation, Mir Publisher, Moscow.
2. Roberts, A., (1960), mine ventilation, Clever Hume Press Ltd.
3. Graham, J.I., (1949-50), the methane content of unworked coal seams, ibid 109;2.
4. Penman, D and Penman, J.S., (1947), mine ventilation, Charles griffin &Co.
5. Ower. E., (1949), the measurement of air flow, 3rd., chapman and hall, London.
6. Rouse, H., (1956) elementary mechanics of fluids, Jhonwilley and sons Inc.
7. Hinsely, F.B., (1950-51) ‘natural and mechanical ventilation ‘, Tr. I.M.E 110;67.
8. Hall, C.J., (1953), thermodynamics of mine ventilation’, col.eng. 30; 66, 102, 158, 189 and 246.
9. Misra,G.B., (1964) mine ventilation, thackerspink&Co.
10. Rouse, H., (1956), elementary of mechanis of fluids,Jhonwiley and Sons Inc.
11. Ower.E., (1949), the measurement of air flow, 3rd ed, Chapman and Hall, London.
12. ‘mine fans’, (1952), N.C.B bull.66.
13. Bromilow, J.G., (1962), ventilation of mechanised heading’, Jr. Min met. F. special issue.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			3			2	3
CO4			2			2	1		3	2	2	
Avg.	2	3	2	2	3	2	2	3	2.5	2.5	2	3

Mining Engineering			
MN623	**Environmental Impact Assessment**	**L**	**T**
		3	**0**

Pre-requisite: Environmental Science

Course Objectives:

The objective of this course is to provide a working knowledge of current environmental, social and economic impacts and methods relating to EIA, and consider in detail how these impacts can be quantified and analysed. This course introduces the methodology of environmental impact assessment (EIA) as a vital tool for sound environmental management and decision-making. The course provides an overview of the concepts, methods, issues and various forms and stages of the EIA process. Different levels and systems of EIA are examined to highlight the diversity of approach and impact of the EIA process.

Syllabus:

Introduction: Environmental Impact Assessment (EIA), Environmental Impact Statement, EIA in Project Cycle, Legal and Regulatory aspects in India according to Ministry of Environment and Forests, Types and limitations of EIA, Cross sectoral issues and terms of reference in EIA Participation of Public and Non-Governmental Organizations in environmental decision making; Components and methods: Components of EIA, Processes, screening, scoping, setting, analysis, mitigation. Matrices, Networks, Checklists, Connections and combinations of processes, Cost benefit analysis, Analysis of alternatives, Software packages for EIA, Expert systems in EIA; Prediction, Assessment of impacts and reporting: Prediction tools for EIA Mathematical modeling for impact prediction, Assessment of impacts, air , water , soil, noise, biological, socio-cultural environments, Cumulative Impact Assessment Documentation of EIA findings, planning, organization of information and visual display materials, Report preparation; environmental management plan : Environmental Management Plan - preparation, implementation and review, Mitigation and Rehabilitation Plans, Policy and guidelines for planning and monitoring programmes, Post project audit, Ethical and Quality aspects of Environmental Impact Assessment; Case Studies: Case studies related to the following sectors Infrastructure, Mining, Industrial, Thermal Power, River valley and Hydroelectric, Nuclear Power.

Modules:

Module 1: Introduction: Environmental Impact Assessment (EIA), Environmental Impact Statement, EIA in Project Cycle, Legal and Regulatory aspects in India according to Ministry of Environment and Forests, Types and limitations of EIA, Cross sectoral issues and terms of reference in EIA, Participation of Public and Non-Governmental Organizations in environmental decision making

Module 2: Components and methods: Components of EIA, Processes, screening, scoping setting, analysis, mitigation. Matrices, Networks, Checklists, Connections and combinations of processes, Cost benefit analysis, Analysis of alternatives, Software packages for EIA, Expert systems in EIA

Module 3: Prediction, assessment of impacts and reporting: Prediction tools for EIA, Mathematical modeling for impact prediction, Assessment of impacts, air, water, soil, noise, biological, socio-cultural environments, Cumulative Impact Assessment, Documentation of EIA findings, planning, organization of information and visual display materials, Report preparation

Module 4: Environmental Management Plan: Environmental Management Plan, preparation, implementation and review, Mitigation and Rehabilitation Plans, Policy and guidelines for planning and monitoring programmes, Post project audit, Ethical and Quality aspects of Environmental Impact Assessment;

Module 5: Case Studies: Case studies related to the following sectors, Infrastructure, Mining, Industrial, Thermal Power, River valley and Hydroelectric, Nuclear Power.

Text/Reference Books:

1. D. P. Lawrence, Environmental Impact Assessment – Practical Solutions to recurrent Problems, Wiley-Interscience, New Jersey. 2003
2. J. Petts, Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science London. 1999.
3. R. Therivel, J. Glasson & A. Chadwick, Introduction to Environmental Impact Assessment, 3rd Edition, Routledge, 2005.
4. L. W. Canter, Environmental Impact Assessment, McGraw-Hill, New York. 1996.
5. A. K. Biswas, and S. B. C. Agarwala, Environmental Impact Assessment for Developing Countries, Butterworth Heinemann, London. 1994
6. The World Bank Group, Environmental Assessment Source Book Vol. I, II and III. The World Bank, Washington. 1991.

Course Outcomes:

1. To generate information on the environmental impacts of a project,
2. Facilitate the consideration of environmental issues in planning and decision-making processes,
3. Understand the different steps within environmental impact assessment
4. Discuss the implications of current jurisdictional and institutional arrangements in relation to environmental impact assessment
5. Communicate both orally and in written form the key aspects of environmental impact assessment

6. Understand how to liaise with and the importance of stakeholders in the EIA process
7. Be able to access different case studies/examples of EIA in practice

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				3			3				
CO2		3		2		2	3		3	3	2	2
CO3	2			2	3			3			2	2
CO4			2			2	2		3	2	2	
Avg.	2	3	2	2	3	2	2.5	3	3	2.5	2	2

Mining Engineering			
MN624	**Mine Environment Administration and Management**	**L**	**T**
		3	**0**

Course Objectives:

This course introduces how to enable effective protection and maintenance of regional biodiversity, ecosystem structure and function, using internationally accepted conservation management tools, control water pollution and maintain the water quality for domestic use, land restoration after mining

Syllabus:

Air Pollution*:* Sources of gaseous and particulate pollutants, their physical, chemical (with special emphasis to ozone and greenhouse gases) and physiological effects, monitoring and control. Land Environment: Visual impacts; landscape analysis; land use; landscape planning; physical reclamation and subsidence management. Water Regime: Availability; water quality; water pollution and water management. Ecological Environment: Ecological environment and its management including biological reclamation. Societal Environment: Societal environment and its management including resettlement and rehabilitation; socio-economic impacts; sustainable development; concept of carrying capacity-based planning, mine closure. Administration and Management: Environmental administration in India; Environmental modeling and prediction, Environmental laws and standards, environmental impact assessment and its methodologies, preparation of environmental management plan.

Modules:

Module 1: Air Pollution: Sources of gaseous and particulate pollutants, their physical, chemical(with special emphasis to ozone and greenhouse gases) and physiological effects, monitoring and control.

Module 2: Land Environment: Visual impacts; landscape analysis; land use; landscape planning; physical reclamation and subsidence management.

Module 3: Water Regime: Availability; water quality; water pollution and water management.

Module 4: Ecological Environment: Ecological environment and its management including biological reclamation.

Module 5: Societal Environment: Societal environment and its management including resettlement and rehabilitation; socio-economic impacts; sustainable development; concept of carrying capacity-based planning, mine closure.

Module 6: Administration and Management: Environmental administration in India; Environmental modeling and prediction, Environmental laws and standards, environmental impact assessment and its methodologies, preparation of environmental management plan.

Text/Reference Books:

1) Mine and Environmental Science by S K Tiwari
2) Environmental Management in Mining Area by N C Saxena, G Singh, R Ghosh
3) Introduction to Environmental Management by Mary K Theodore, Louis Theodore
4) Mine Environmental Handbook by Jerrold J Marcus
5) Mining and the Environment from ore to metal by Karlheinz Spitz, John Trudinger
6) Environmental Impact of Mining and Mineral Processing (Management, Monitoring and Auditing Strategy) by Ravi Jain
7) Environmental Impacts of Mining: Monitoring, Restoration and Control – M Sengupta, Lewis Publishers, Boca Raton, 1993.
8) Values for the Environment: A Guide to Economic Approach – JT Winpeny, Overseas Development Institute, London, HMOS, 1991.
9) Economic Analysis of Environmental Impacts - D John, LF Scura, RA Carpenter, and PB Sherman, Earthscan Publications Ltd., London 1995.
10) Environmental Assessment Source Book (Vol. 1) World Bank, Environment Department, Washington DC, The World bank, 1991.
11) Valuing the Environment – J Barde and DW Pearce (Ed.), Earthscan Publication, London, 1991.
12) Air pollution control equipment calculations - L Theodore, John Wiley & Sons, Inc., Hoboken, New Jersy, 2008
13) Water Resources Engineering - LW Mays, Wiley Text Books, 2000.
14) Environmental Engineering- HS Peavy, RR Donald and G Tchobanoglous, MGH Int. Ed. NY, 1985.
15) Water Quality and Treatment Handbook - AWWA, McGraw-Hill Pub. 1999.

Course Outcomes:

At the end of the course, students will be able to understand how to minimize the pollution due to dust, how to improve the quality of contaminated water, how to restore the ecology, how to resettle and rehabilate to the social environment, do get the proper know how about the environmental management plan to model a safety environment for the betterment of the society.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2			2	2			3				
CO2		3	3	2		2	3		2	3	2	3
CO3	2			2	3			3			2	2
CO4		2	2			2	2		3	2	2	
Avg.	2	2.5	2.5	2	3	2	2.5	3	2.5	2.5	2	2.5

Mining Engineering			
MN631	**Mine System Engineering**	**L**	**T**
		3	**0**

Course objective:

Students will be imparted with the basic knowledge of system engineering and its application to mining field.

Syllabus

Introduction to system engineering, system concept analysis, models in system analysis. System approach to mine design, sub-system, engineering design phases of planning. Economic considerations in planning of opencast and underground mining, optimal size, capacity and development parameters. Tactical and strategic planning, project planning, project appraisal, preparation of project feasibility report. Introduction to Statistical decision theory and its applications in the mineral industries, Technological forecasting, Introduction to operations research techniques, network analysis, application of PERT and CPM to mining projects.

Modules

Module-1: Introduction to system engineering, system concept analysis, models in system analysis.
System approach to mine design, sub-system and engineering design phases of planning.

Module-2: Economic considerations in planning of opencast mining, optimal size, capacity and development parameters.

Module-3: Economic considerations in planning of underground mining, capacity and development parameters.

Module-4: Tactical and strategic planning, project planning, project appraisal, preparation of project feasibility report.

Module-5: Introduction to Statistical decision theory and its applications in the mineral industries, Technological forecasting

Module-6: Introduction to operations research techniques, network analysis, application of PERT and CPM to mining projects.

Text/Reference Books:

1. Handy A. Taha, An Introduction to Operation Research, University of Arkansas, Fayettiville. 8th Edition. Pearson Education Inc. London (2003).
2. D. Biswas, Modern concepts of Surface Mining
3. W. Hustrulid, M. Kuchta and R. Martin, Open pit Mine Planning and Design.
4. S. Kalavathy, Operations Research, 4th Edition, Vikas Publishing House
5. Wayne L. Winston. Operation Research Application.
6. Surface Mining: Methods, Technologies and Systems. Volume-2
7. SME Mining Engineering Handbook, Third Edition
8. Handy A. Taha, An Introduction to Operation Research, University of Arkansas, Fayettiville. 8th Edition. Pearson Education Inc. London (2003).
9. S.K. Das, Surface Mining Operations.

Goals and Outcomes:

This course qualifies participants to apply an advanced body of knowledge in the area of mine system engineering and equips them with highly developed skills for research and enquiry. Students enrolled in this course will be able to apply the body of knowledge to a range of contexts within the mining industry enabling them to undertake professional or highly skilled work within the mining industry and allow them to undertake further study.

Knowledge:

1. Analyze mining systems used in surface operations
2. Identify and develop operational research models from the verbal description of the real system. E.g. Solve transportation problems during the allocation of trucks to excavators
3. Formulate operation research models to solve real life problem
4. Turn real life problems into formulation of models to be solve by linear programming etc.
5. Determine critical path analysis to solve real life project scheduling time and timely delivery

Skills:

1. Review, analyze, consolidate and synthesizes knowledge to identify and provide solutions to complex surface mining problems
2. Assess and evaluate complex ideas in mine system engineering and selection of the number required and the size of appropriate equipment
3. Apply specialized technical and creative skills using appropriate tools to solve problems in surface mining.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							3				
CO2		3	3	2		2	3		2	3	3	3
CO3	2	2		2	3	2		3				2
CO4			2			2	2		3	2	1	
Avg.	2.5	2.5	2.5	2	3	2	2.5	3	2.5	2.5	2	2.5

Mining Engineering			
MN632	**Reliability Engineering**	**L**	**T**
		3	**0**

Course objective

This course introduces students to concepts and methods of modern statistical quality control. Students learn to apply standard quality control tools. They learn the theoretical statistical concepts that justify the use of particular quality control tools in particular situations. They learn theory and methods for analyzing the performance of different quality control tools.

Principles of statistical quality control including control by variable and by attribute, construction and use of control charts for variables, fraction defectives and number of defects and use of standard plans, reliability and life cycle testing.

The objective of this course are to:

- To define and describe concept of system structures
- To apply the principles of reliability, quality and asset management to mechanical engineering processes, production and manufactured products
- The use of appropriate software for statistical and quality analysis is taught and is necessary for successful completion of some homework assignments. Issues of ethics and professional responsibility and their relation to product quality are discussed.

Syllabus:

Introduction to reliability concept. System Structures: Status functions, series systems, parallel systems, and equivalent structures. Reliability of System Structures: Series systems, parallel systems, equivalent structures. Unit and system reliability- forward models, density and distribution functions, fault tree analysis, HAZOP analysis, risk and criticality analysis, maintainability analysis, calculation of maintainability parameters, availability calculations, maintenance management. Introduction to product quality. Introduction to ISO 9000 series, concept of TQM and Business performance, HRD and quality management, organizing for TQM, CI.

Modules:

Module-1: Introduction to reliability concept: Introduction to system and reliability, System Structures: Status functions, series systems, parallel systems, and equivalent structures

Module-2: Reliability of System Structures: Series systems, parallel systems, equivalent structures

Module-3: Unit and system reliability: forward models, density and distribution functions

Module-4: System Reliability Analysis: fault tree analysis, HAZOP analysis, risk and criticality analysis

Module-5: System Reliability Analysis: Maintainability analysis, calculation of maintainability parameters, availability calculations, maintenance management

Module-6: Introduction to product quality: Introduction to ISO 9000 series, concept of TQM and Business performance

Module-7: Quality Management: HRD and quality management, organizing for TQM, CI.

Text/Reference Books:

1. Introduction to Quality and Reliability Engineering by Renyan Jiang, Springer, 2015
2. An Introduction to Reliability and Quality Engineering by John P. Bentley, Longman Scientific & Technical, 1993
3. Reliability Engineering, by E. Bala Guruswamy, Tata McGraw Hill, 1994.
4. Reliability Engineering, (3rd Edition), by LS Srinath, Affiliated East West Pvt Ltd, 1991.
5. Optimization &Variation Reduction in Quality, by W.A. Taylor, Tata McGraw Hill, 1991.

Course outcomes

Upon successful completion of this course, the student will be able to:
(Knowledge based)

- Understand and able to describe different system's structure
- Understand the concepts of reliability and maintainability
- Acquire basic knowledge of total quality management

(Skills)

Use reliability and quality engineering to:

- Use System structure concept to examine reliability of different systems
- Use different reliability analysis techniques to appraise and manage a system or process
- Describe standard control charts and use it to analyze and improve the product quality.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			3			2	2
CO4			2			3	2		3	2	2	
Avg.	2	3	2	2	3	2.5	2.5	3	2.5	2.5	2	2.5

Mining Engineering			
MN641	**Operation Research**	**L**	**T**
		3	**0**

Course Objectives:

Operation Research (OR) is application of scientific methods, techniques and tools of mathematical science to problems involving the operations of a system. OR provides the control in the system and its component with optimum solutions to the problems. It is a decision taking tool, which searches for the optimum results in coequality with the overall objectivewithin the constraints of the organization.

Thus, OR is to solve complex problems that involves management of large systems of men, machines, materials, and money in industry, business, government and defence. The distinctive approach is to develop a scientific model of the system incorporating measurement of factors such as chance and risk, to predict and compare the outcome of alternative decisions, strategies or controls.

Its purpose is to give administration, on the basis of predicting most effective quantitative results of an operation, under given set of variable conditions and thereby to provide a sound basis for "decision-making". Though it is very clear that operation research never makes decisions for the management, instead the method presents management with a careful scientific and quantitative analysis of problem so that the management will be in a better position to make sounder decisions.

In the wider sense, operation research does not deal with the everyday problems such as output by the one worker or machine capacity; instead it is concerned with the overall aspect of business operation such as something as the relationship between inventory, sales, production and scheduling. It may also deal with the overall flow of goods and services from plants to consumers.

The team doing operation research may have, psychologists, labour specialists, mathematicians, analysts, statisticians and others depending upon the requirement for the problems.

Course Description:

This course is an introductory and practical course to the study of operations research application in mining projects. It is designed primarily for mining engineering students to replicate what is happening in the mining industry in classroom so as to be able to apply the knowledge and skills gained during and after course of study to real life situations they might face in the industry. It involves demonstration of principles and techniques of operations research using real life projects. Topics to be covered include operation research and model formulation, solution of the operation research model, phases of an 2 operation research study, techniques of operation research or operations research solution tools such as Linear Programming (LP) (Two phase (two variables) LP, Three phase (three variables) LP); Transportation models, Network models, Queuing systems (models) etc.

The objective of this course is to:

- Introduce students to the techniques of operations research in mining operations
- Provide students with basic skills and knowledge of operations research and its application in mineral industry
- Introduce students to practical application of operations research in big mining projects

Syllabus:

Introduction: Objective and scope of Quantitative methods; Classification or types of Quantitative methods; A brief history with particular reference to mining industry. Linear Programming: Concepts, graphical solutions, simplex method, sensitivity analysis, transportation and assignment problems. Network Analysis: CPM and PERT methods, their relative suitability vis-à-vis specific applications, time cost trading. Dynamic Programming: Introduction, basic concept, Stage coach problem. Stochastic Methods: Discrete and continuous probability distributions, Stochastic process and Markov chains. Basic queuing models with constant arrival and service rates; inventory models.Monte-Carlo method- Introduction.

Modules:

Module 1: Introduction and course overview: Definition of Operation Research, Objective and scope of Quantitative methods, Classification of Quantitative methods: Different types of Quantitative methods.

Module 2: History of OR:A brief history with particular reference to mining industry.

Module 3: Linear Programming Solving Techniques: Concepts, Graphical solutions and Simplex methods, Linear Programming Application: Sensitivity analysis, Transportation and assignment problems.

Module 4: Network analysis methods: CPM and PERT methods, Network analysis method's application and suitability: Relative suitability vis-à-vis specific applications of CPM and PERT methods and Time cost trading.

Module 5: Dynamic Programming: Introduction, basic concept, Stage coach problem, Stochastic approach to OR: Discrete and continuous probability distributions, stochastic process and Markov chains.

Module 6: Problems which involves queuing or waiting: Basic queuing models with constant arrival and service rates.

Module 7: Inventory models: Mathematical models in determining optimum level of inventories.

Module 8: Introduction to statistical simulation: Introduction to Monte-Carlo method.

Text/Reference Books:

1. Handy A. Taha, An Introduction to Operation Research, University of Arkansas, Fayettiville. 8th Edition. Pearson Education Inc. London (2003). 81p.
2. Hiller, F.S. And L.J. Lieberman: Introduction to operation research, Holden Day, San Francisco (6th Ed.) (1995).
3. S. Kalavathy, Operations Research, 4th Edition, Vikas Publishing House
4. K.A. Stroud: Further Engineering Mathematics. Programmes and problems. 3rd Edition Macmillan Press Ltd (1996). 974p.
5. P. Herrison, Operational Research: Quantitative Decision Analysis; Mike Morris Publication (1983).
6. TaiwoOwoeye: Operation Research; Olugbenga Press Publication (2001). ISBN 987-2430. 60p
7. Wayne L. Winston. Operation Research Application. 415p

Course outcomes

Upon successful completion of this course, the student will be able to:

Knowledge based

- Explain the meaning of operations research
- Know the various techniques of operations research techniques;
- Apply the techniques used in operations research to solve real life problem in mining industry
- Select an optimum solution with profit maximization;
- Have complete understanding of the significant role operation research play in mining Project completion at every stage of the mines

Skills

Use operations research to:

- Identify and develop operational research models from the verbal description of the real system. E.g. Solve transportation problems during the allocation of trucks to excavators
- Formulate operation research models to solve real life problem
- Proficiently allocating scarce resources to optimize and maximize profit
- Eliminate customers / clients waiting period for service delivery
- Turn real life problems into formulation of models to be solve by linear programming etc.
- Determine critical path analysis to solve real life project scheduling time and timely delivery
- Use critical path analysis and programming evaluation production and review techniques for timely project scheduling and completion and
- Conduct literature search on the internet in the use of operation research techniques in mining projects execution and completion.
- Understand the mathematical tools that are needed to solve optimization problems.
- Use mathematical software to solve the proposed models.
- Develop a report that describes the model and the solving technique, analyze the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				3			3				
CO2		3	2	2		2	3		2	3	3	2
CO3	3			2	3			3			2	2
CO4		2	2			2	1		3	1		
Avg.	2.5	2.5	2	2	3	2	2	3	2.5	2	2.5	2

Mining Engineering			
MN642	**Tunnelling Engineering**	**L**	**T**
		3	**0**

Course Objectives:

When the students enter the college to pursue a degree in Mining Engineering and as well pursue a career in Mining Engineering after graduation, they need to understand the breadth and depth available in this field for different tunneling or shaft sinking methods. When many alternative disciplines of engineering appear to offer apparently more glamorous avenues for advancement, the Mining Engineering student should realize the solid foundations available in this mother of all engineering disciplines. The students should understand the enormous possibilities available for creative and innovative works in this all pervasive field of engineering. This course introduces Geological concept of tunneling, Stresses and displacements associated with excavating tunneling, Design of supports of tunnels, Numerical techniques etc

Syllabus:

Introduction to tunneling: geological concept of tunnelling, influence of geological aspects on design & construction of tunnels. Tunneling Methods: Soft ground, drill & blast, roadway drivage machines, tunnel boring machines (TBM).Stresses and displacements associated with excavating tunnels. Ground control or treatment in tunneling and drivages. Design of Supports of Tunnels: Steel supports, rock enforcements, new Australian tunneling methods (NATM). Design of Tunnels: Rock conditions, RMR, Q-system, RSR, rock mass behaviour, stress-strain behaviour, and stress analysis of tunnels. Maintenance: Dewatering, ventilation and illumination of drivages and tunnels Numerical techniques: Introductory use of FLAC, PLAXIS etc.

Modules:

Module1: Introduction to tunnelling: Geological concept of tunnelling, influence of geological aspects on design & construction of tunnels. Scope and application, historical developments, art of tunnelling, tunnel engineering, future tunnelling considerations.

Module2: Types of Underground Excavations: Tunnel, adit, decline, shaft; parameters influencing location, shape and size; geological aspects; planning and site investigations

Module3: Tunnelling Methods: Types and purpose of tunnels; factors affecting choice of excavation technique;Methods - soft ground tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling;Soft ground, drill & blast, roadway drivage machines, tunnel boring machines (TBM)Tunnelling Methods: Types and purpose of tunnels; factors affecting choice of excavation technique; Methods - soft ground tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling; Shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.

Module4: Stress distribution around the tunnel opening: Stresses and displacements associated with excavating tunnels.

Module5: Ground Control techniques during tunnel excavation: Ground control or treatment in tunneling and drivages.

Module6: Design of Supports of Tunnels: Steel supports, rock enforcements, new Australian tunneling methods (NATM). Design of Tunnels: Rock conditions, RMR, Q-system, RSR, rock mass behaviour, stress-strain behaviour, and stress analysis of tunnels.

Module7: Maintenance and Numerical Techniques: Dewatering, ventilation and illumination of drivages and tunnels Numerical techniques: Introductory use of FLAC, PLAXIS etc.

Text/Reference Books:

1. Tunnelling and Underground Construction Techniques, Richards Lee. Bullock, Proceedings 1981 Rapid Excavation and Tunneling Conference, San Francisco, California,
2. Hand Book of Mining and Tunnelling Machinery, Stack Barbara – John Wiley & Sons.
3.Rock Tunneling with Steel Supports, R.V. Proctor, T.L. White,1961
4. Modern trends in Tunneling and Blast Designs, John Johansen, C.F. Mathiesen, John Johansen publishing

Course Outcomes:

1. Showcasing many tunnel construction, vertical shaft and incline for accessing the deposits, nationally important infrastructure, and impressive projects to serve as sources of inspiration.
2. Highlighting possibilities for taking up entrepreneurial activities in this field.
3. Providing a foundation for the student to launch off upon an inspired academic pursuit into this subject of engineering.
4. Know about tunnel excavation, different tunnel excavation methods.
5. Student gets knowledge about design of tunnels, Stresses and displacements associated with excavating tunnels,
6. Use of numerical techniques i.e. FLAC, PLAXIS etc.

CO-PO Mapping:

Enter correlation levels1, 2 or 3 as defined below:
1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

Os/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2	3	2	3		2	3	2	3
CO3	2	2		2	3			3			2	3
CO4			2			2	2		3	2	2	
CO5	2	2						3		3		2
CO6			2	3	3		2				2	
Avg.	2	2.33	2	2.33	3	2	2.33	3	2.5	2.66	2	2.66

Mining Engineering			
IC601	**Entrepreneurship**	**L**	**T**
		2	**0**

Course objective:

1. To have Understanding of the dynamic role of entrepreneurship and small businesses
2. To know about Organizing and Managing a Business
3. To know about Financial Planning and Control
4. To know about Business Plan Creation
5. To know about Forms of Ownership for Small Business

Details of Course:

S. No.	Contents	Contact Hours
1.	**Introduction:** An Overview of Entrepreneurs and Entrepreneurship, Definition, Concept of Entrepreneurship & Intrapreneurship, Characteristics and skills of entrepreneurs	08
2.	**Entrepreneurial Development:** Entrepreneurship & Economic development, Contribution of Small and big enterprises to the economy, Entrepreneurial environment, Types of Entrepreneurs.	08
3.	**Developing the Business Plan :** Identification of Business idea, Elements of a Business Plan, Building Competitive Advantage, Conducting feasibility Analysis, Strategy and Planning for Starting Your Small Business, Developing Marketing Strategies, Managing Human Resources.	08
4.	**Sources of Finance:** Equity vs. Debt Capital, Sources of Equity Finance, Institutional finance, Venture Capital, Lease Finance,Obtaining the Right Financing.	06
5.	**Forms of Business Ownership:** Forms of Ownership, Becoming an Owner ,Sole Proprietorship, Partnership, Corporations and other forms of ownership.	04
6.	**Intellectual Property Management:** Importance of innovation, patents& trademarks in small businesses, introduction to laws relating to IPR in India.	04
7.	**Institutional support for small businesses in India:** Support in areas of technology, finance, inputs & infrastructure, marketing, entrepreneurship development .	04
	Total	**42**

Suggested Books:

[1].Hisrich & Peters, “Entrepreneurship”, Tata McGraw Hill

[2].Roy, Rajeev, “Entrepreneurship”, Oxford University Press

[3]. Norman M. Scarborough, “Essentials of Entrepreneurship & Small Business Management”, 6th ed., Prentice Hal

[4]. Dutta, Bholanath, “Entrepreneurship management” ,Excel Books.

6th Semester Syllabus

Computer Science& Engineering and Information Technology			
CS632	**Artificial Intelligence &Machine Learning**	**L**	**T**
		3	**0**

Course objectives -

The aim of Artificial Intelligence & Machine Learning course is to prepare students for career in computer science & engineering where knowledge of AI & ML techniques leading to the advancement of research and technology. Artificial Intelligence and Machine Learning are the terms of computer science.Machine Learning is the learning in which machinecan learn by its own without being explicitly programmed. It is an application of AI that provide system the ability to automatically learn and improve from experience.

Course Outcomes: After completing this course the student will be able to:

CO1	Demonstrate fundamental understanding of artificial intelligence (AI) and expert systems.
CO2	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning.
CO3	Demonstrate proficiency in applying scientific method to models of machine learning.
CO4	Discuss the basics of ANN and different optimizations techniques.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	2	-	-	-	-	-	-	-
CO2	2	-	3	2	-	-	-	-	-	-	-	-
CO3	3	2	-	3	-	-	-	-	-	-	-	-
CO4	2	-	1	-	3	-	2	-	-	-	-	-

Course Detail -

MODULE 1. **Overview and Search Techniques:** Introduction to AI, Problem Solving, State space search, Blind search: Depth first search, Breadth first search, Informed search: Heuristic function, Hill climbing search, Best first search, A* & AO* Search, Constraint satisfaction problem; Game tree, Evaluation function, Mini-Max search, Alpha-beta pruning, Games of chance.

MODULE 2. **Knowledge Representation (KR**): Introduction to KR, Knowledge agent, Predicate logic, Inference rule & theorem proving forward chaining, backward chaining, resolution; Propositional knowledge, Boolean circuit agents; Rule Based Systems, Forward reasoning: Conflict resolution, backward reasoning: Structured KR: Semantic Net - slots, inheritance, Conceptual Dependency.

MODULE 3. **Handling uncertainty and Learning**: Source of uncertainty, Probabilistic inference, Bayes' theorem, Limitation of naïve Bayesian system, Bayesian Belief Network (BBN); Machine learning, Basic principal, Utility of ML Well defined learning system, Challenges in ML, Application of ML.

MODULE 4. **Learning and Classifier:** Linear Regression (with one variable and multiple variables), Decision Trees and issue in decision tree,Clustering (K-means, Hierarchical, etc), Dimensionality reduction, Principal Component Analysis, Anomaly detection, Feasibility of learning, Reinforcement learning.

MODULE 5. **Artificial Neural Networks:** Introduction, Artificial Perceptron's, Gradient Descent and The Delta Rule, Adaline, Multilayer Networks, Back-propagation Rule back-propagation Algorithm- Convergence; Evolutionary algorithm,Genetic Algorithms – An Illustrative Example, Hypothesis Space Search, Swarm intelligence algorithm.

Text Book:

1. Artificial Intelligence by Elaine Rich and Kevin Knight, Tata MeGraw Hill
2. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press.
3. Artificial Neural Network, B. Yegnanarayana, PHI, 2005

Reference Book:

1. Christopher M. Bishop. Pattern Recognition and Machine Learning (Springer)
2. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Prentice Hall of India

Computer Science& Engineering and Information Technology			
CS611	**Computer Graphics**	**L**	**T**
		3	**0**

Objectives of the course

This course covers basics of computer graphics. Computer graphics are pictures and films created using computers. Usually, the term refers to computer-generated image data created with the help of specialized graphical hardware and software. It is a vast and recently developed area of computer science. Computer graphics is responsible for displaying art and image data effectively and meaningfully to the consumer. It is also used for processing image data received from the physical world. Computer graphics development has had a significant impact on many types of media and has revolutionized animation, movies, advertising, video games, and graphic design in general.

Course Outcomes

After completing this course, the student will be able to:

CO1	Understand the basics of computer graphics, different graphics systems and applications of computer graphics.
CO2	Discuss various algorithms for scan conversion and filling of basic objects and their comparative analysis.
CO3	Use of geometric transformations on graphics objects and their application in composite form.
CO4	Extract scene with different clipping methods and its transformation to graphics display device.
CO5	Render projected objects to naturalize the scene in 2D view and use of illumination models for this

Detailed Syllabus:

MODULE 1. Introduction to computer graphics and graphics systems. Raster and vector graphics systems, video display devices, physical and logical input devices, simple color models.

MODULE 2. Points & lines, Line drawing algorithms; DDA algorithm, Bresenham's line algorithm, Circle generation algorithm; scan line polygon, fill algorithm, boundary fill algorithm, flood fill algorithm.

MODULE 3. 2D Transformation : Basic transformations : translation, rotation, scaling ; Matrix representations & homogeneous coordinates, transformations between coordinate systems ; reflection shear ; Transformation of points, lines, parallel lines, intersecting lines.

MODULE 4. Viewing pipeline, Window to Viewport co-ordinate transformation, clipping operations, point clipping, line clipping, clipping circles, polygons & ellipse.

MODULE 5. Hidden Surfaces: Depth comparison, Z-buffer algorithm, Back face detection, BSP tree method, the Printer's algorithm, scan-line algorithm; Hidden line elimination, wire frame methods, fractal - geometry. Rendering of a polygonal surface; Flat, Gouraud, and Phong shading; Texture mapping, bump texture, environment map; Introduction to ray tracing; Image synthesis, sampling techniques, and anti-aliasing.

Text / Reference Books

1. Donald Hearn and Pauline Baker Computer Graphics, Prentice Hall, New Delhi, 2012

2.Steven Harrington, "Computer Graphics- A programming approach", McGraw 3. Hill, 2nd Edition, 1987.

3. Foley J.D., Van Dam A, "Fundamentals of Interactive Computer Graphics", Addison Wesley, 1990

Computer Science& Engineering and Information Technology			
CS612	**Distributed System**	**L**	**T**
		3	**0**

Course objective:

This course covers the basic understanding of distributed computing system. The course aims to provide an understanding of the principles on which the Internet and other distributed systems are based; their architecture, algorithms and how they meet the demands of contemporary distributed applications. The course covers the building blocks for a study of distributed systems, and addressing the characteristics and the challenges that must be addressed in their design: scalability, heterogeneity, security and failure handling being the most significant.Distributed computing is a field of computer science that studies distributed systems. A distributed system is a system whose components are located on different networked computers, which communicate and coordinate their actions by passing messages to one another.The components interact with one another in order to achieve a common goal. Three significant characteristics of distributed systems are: concurrency of components, lack of a global clock, and independent failure of components.

Course Outcomes:

At the end of this course the students will be able to:

CO1	Demonstrate knowledge of the basic elements and concepts related to distributed system technologies.
CO2	Demonstrate knowledge of the core architectural aspects of distributed systems
CO3	Demonstrate knowledge of details the main underlying components of distributed systems (such as RPC, file systems);
CO4	Use and apply important methods in distributed systems to support scalability and fault tolerance;
CO5	Demonstrate experience in building large-scale distributed applications.

Detailed Syllabus:

MODULE 1. Introduction to distributed computing system, evolution different models, gaining popularity, definition, issues in design, DCE, message passing –introduction, desirable features of a good message passing system, issues in IPC, synchronization, buffering, multigram messages, encoding and decoding of message data, process addressing, failure handling, group communication.

MODULE 2. Introduction, model, transparency, implementation mechanism, stub generation, RPC messages, marshallingarguments and results, server management, parameter - passing semantics, call semantics, communicationprotocols for RPCs, client – server binding, exception handling, security, mini project using Java RMI.

MODULE 3. General architecture of DSM systems, design and implementation issues of DSM systems, granularity, structure ofshared memory space, consistency model, replacement strategy, thrashing, advantages of DSM, clocksynchronization DFS and security- Desirable features of good DFS, file models, file accessing Models, file sharingsemantics, file catching schemes, file replication, fault Tolerance, atomic transaction, potential attacks to computersystem, cryptography, authentication, access control. Digital signatures, DCE security service.

MODULE 4. Operating Systems, Client-Server Model, Distributed Database Systems, Parallel Programming Languages andAlgorithms. Distributed Network Architectures-Managing Distributed Systems. Design Considerations.

MODULE 5. For development, implementation & evaluation of distributed information systems, workflow, softwareprocesses, transaction management, and data modeling, infrastructure e.g. middle-ware to glueheterogeneous, autonomous, and partly mobile/distributed data systems, such as e.g. client/server-,CORBA-, and Internet-technologies. Methods for building distributed applications.

Text / Reference

1. Pradeep K. Sinha, "Distributed Operating Systems: Concepts Design", 2007

2.Crichlow Joel M, "An Introduction to Distributed and ParallelComputing", PHI, 1997

3.Black Uyless, "Data Communications and Distributed Networks", PHI, 5th Edition,1997

Computer Science& Engineering and Information Technology			
CS633	**Image Processing**	**L**	**T**
		3	**0**

Objectives of the course

Course Outcomes:

After completing this course, students will be able to:

CO1	To study the image fundamentals and mathematical transforms necessary for image processing
CO2	To study the image enhancement techniques and image restoration procedures.
CO3	To study the image compression procedures.
CO4	To study the image segmentation and representation techniques.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	2	-	-	-	-	-	-	-	-	
CO2	3	2	2	3	-	-	-	-	-	-	-	-
CO3	2	-	3	2	-	-	-	-	-	-	-	-
CO4	1	2	3	-	-	-	-	-	-	-	-	-
CO5	2	-	2	3	-	-	-	-	-	-	-	-

Course Details-

Module 1 : DIGITAL IMAGE FUNDAMENTALS

Introduction – Origin – Steps in Digital Image Processing – Components – Elements of Visual Perception – Image Sensing and Acquisition – Image Sampling and Quantization – Relationships between pixels – color models.

Module 2: DIGITAL IMAGE FORMATION

A Simple Image Model, Geometric Model-Basic Transformation (Translation, Scaling, Rotation), Perspective Projection, Sampling & Quantization-Uniform & Non uniform.

Module 3: MATHEMATICAL PRELIMINARIES

Neighbour of pixels,Connectivity,Relations,Equivalence & Transitive Closure; DistanceMeasures, Arithmetic/Logic Operations, FourierTransformation, Properties of the two Dimensional Fourier Transform, Discrete Fourier Transform, Discrete Cosine & Sine Transform

Module 4 : IMAGE ENHANCEMENT

Spatial Domain: Gray level transformations – Histogram processing – Basics of Spatial Filtering–Smoothing and Sharpening Spatial Filtering – Frequency Domain: Introduction to Fourier Transform – Smoothing and Sharpening frequency domain filters – Ideal, Butterworth and Gaussian filters.

Module 5 : IMAGE RESTORATION AND SEGMENTATION

Noise models – Mean Filters – Order Statistics – Adaptive filters – Band reject Filters – Band pass Filters – Notch Filters – Optimum Notch Filtering – Inverse Filtering – Wiener filtering Segmentation: Detection of Discontinuities–Edge Linking and Boundary detection – Region based segmentation- Morphological processing- erosion and dilation.

TEXT BOOK:

- Rafael C. Gonzales, Richard E. Woods, "Digital Image Processing", Third Edition, Pearson Education, 2010.

REFERENCES:

- Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, "Digital Image Processing Using MATLAB", Third Edition Tata Mc Graw Hill Pvt. Ltd., 2011.

Computer Science& Engineering and Information Technology			
IT641	**Information retrieval**	**L**	**T**
		3	**0**

Course objective:

To provide an overview of Information Retrieval systems. Expose them to various retrieval models with emphasis on pros and cons of these models. Discuss mechanisms of web search along with the details of ranking algorithms. Introduce basic concepts of text categorization and recommender systems.

Course Outcomes:

At the end of the course the student will be able to:

CO1	To understand the different information retrieval models
CO2	To know about evaluation methods of the information retrieval model
CO3	To know about text categorization and its implementation
CO4	To demonstrate the challenges associated with each topic on new domain of retrieval and classification

Detailed Syllabus:

MODULE 1. **Introduction to Information Retrieval:** The nature of unstructured and semi-structured text. Inverted index and Boolean queries. Text Indexing, Storage and Compression Text encoding: tokenization; stemming; stop words; phrases; index optimization. Index compression: lexicon compression and postings list compression. Gap encoding, gamma codes, Zipf's Law. Index construction. Postings size estimation, dynamic indexing, positional indexes, n-gram indexes, real-world issues.

MODULE 2. **Information Retrieval Models:** Boolean; vector space; TFIDF; Okapi; probabilistic; language modeling; latent semantic indexing. Vector space scoring. The cosine measures. Efficiency considerations. Document length normalization. Relevance feedback and query expansion. Rocchio algorithm.

MODULE 3. **Web Information Retrieval:** Hypertext, web crawling, search engines, ranking, link analysis, PageRank, HITS. Retrieving Structured Documents: XML retrieval, semantic web.Performance Evaluation of IR systems: Evaluating search engines. User happiness, precision, recall, F-measure. Creating test collections: kappa measure, interjudge agreement.

MODULE 4. **Text Categorization and Filtering:** Introduction to text classification. Naive Bayes models. Spam filtering. Vector space classification using hyperplanes; centroids; k Nearest Neighbors. Support vector machine classifiers. Kernel functions. Boosting.

MODULE 5. **Advanced Topics:** Summarization, Topic detection and tracking, Personalization, Question answering, Cross language information retrieval (CLIR). Recommender System.

Text Book:

1. Manning, Raghavan and Schutze, "Introduction to Information Retrieval", Cambridge University Press, 2009.
2. Baeza-Yates and Ribeiro-Neto, "Modern Information Retrieval", Addison Wesley.

Reference Books

1. Charles L. A. Clarke, Gordon Cormack, and Stefan Büttcher, "Information Retrieval: Implementing and Evaluating Search Engines", MIT Press Cambridge, 2010.
2. Baeza-Yates / Ribeiro-Neto, "Modern Information Retrieval: The Concepts and Technology behind Search", Pearson Education India, 2010.

Computer Science& Engineering and Information Technology			
CS642	**Cloud Computing**	**L**	**T**
		3	**0**

Objectives of the course:

The aim this course to understand the basics and importance of cloud computing. Cloud computing is a general term for anything that involves delivering hosted services over the Internet. These services are broadly divided into different categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The name cloud computing was inspired by the cloud symbol that's often used to represent the Internet in flowcharts and diagrams. Cloud computing is the on-demand availability of computer system resources, especially data storage and computing power, without direct active management by the user. The term is generally used to describe data centers available to many users over the Internet. Large clouds, predominant today, often have functions distributed over multiple locations from central servers.

Course Outcomes:

At the end of the course, the student should be able to:

CO1	To identify the appropriate cloud services for a given application and perform cloud-oriented analysis.
CO2	To design the composition of a cloud services.
CO3	To analyze authentication, confidentiality and privacy issues in Cloud computing environment.
CO4	To Determine financial and technological implications for selecting cloud computing platforms.

Mapping of course outcomes with program outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	3	2	-	-	-	-	-	-	-
CO2	2	-	3	2	-	-	-	-	-	-	-	-
CO3	3	1	-	2	-	-	-	-	-	-	-	-
CO4	2	-	2	-	3	-	2	-	-	-		-

Detailed syllabus:

MODULE 1. Introduction to cloud computing: Emergence of cloud computing in distributed computing; Cloud computing Definition, Architecture, Cloud-Based Services, Benefits of using a Cloud Model, Key Characteristics of Cloud Computing, Understanding- Public & Private cloud environments, The Evolution of Cloud Computing – Hardware & Internet Software Evolution, SPI framework.

MODULE 2. Cloud services: Communication-as-a-Service (CAAS), Infrastructure-as-a-Service (IAAS), Monitoring-as-aService (MAAS), Platform-as-a-Service (PAAS), Software-as-a-Service (SAAS).

MODULE 3. Cloud security challenges: Security Management People, Security Governance, Security Portfolio Management, Security Architecture Design, Identity Access Management (IAM), Data Security. Cloud computing threats, Case studies-Amazon EC2, Google App engine, IBM clouds.

MODULE 4. The MSP Model: Evolution from the MSP Model to Cloud Computing and Software-as-a-Service, TheCloud Data Center, Basic Approach to a Data Center-Based SOA, Open Source Software, Service- Oriented Architectures as a Step Toward Cloud Computing.

MODULE 5. Virtualization concepts & Smartphone: virtualization benefits, Hardware &Software Virtualization, Memory Virtualization, Storage Virtualization, Data Virtualization, Network Virtualization, Virtualization Security Recommendations, Introduction to Various Virtualization OS VMware, KVM, Virtual Machine Security, Smartphone, Mobile Operating Systems for Smartphone's (iPhone, Windows Mobile), Google (Android).

Course outcomes:

At the end of this course

1. Student will be able to identify the appropriate cloud services for a given application and perform cloud-oriented analysis.
2. Students will be able to design the composition of a cloud services.
3. Student will be able to analyze authentication, confidentiality and privacy issues in Cloud computing environment.
4. Determine financial and technological implications for selecting cloud computing platforms.

Text Book:

1. Toby Velte, Anthony Vote and Robert Elsenpeter, “Cloud Computing: A Practical Approach”, McGraw Hill, 2002
2. Gautam Shroff, Enterprise Cloud Computing, Cambridge, 2010.

Reference Book:

1. Tim Matherm, Subra Kumara swamy and Shahed Latif, “Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance”, O’Reilly Media, 2005.
2. Ronald Krutz and Russell Dean Vines, Cloud Security, 1st Edition, Wiley, 2010

Computer Science& Engineering and Information Technology			
IT611	**System Software**	**L**	**T**
		3	**0**

Objectives of the course

To introduce the student to key concepts in Phase transformations and enable an understanding of the steps involved in several important phase transformations.

Course Outcomes

After completing this course, the student should be able to:

CO1	Explain the organization of basic computer, its design and the design of control unit.
CO2	Understand the organization of memory and memory management hardware.
CO3	Distinguish between Operating Systems software and Application Systems software.
CO4	Identify the primary functions of an Operating System.
CO5	Master attributes and assessment of quality, reliability and security of software.

Detailed Syllabus:

MODULE 1. INTRODUCTION: System Software, Application Software, components of a programming system: Assembler, Loader, Linker, Macros, Compiler, Program Development Cycle, Evolution of Operating Systems, Functions of Operating System, Machine Structure: General Machine Structure, Approach to a new machine, Memory Registers, Data, Instructions, Evolution of Machine Language: Long Way, No looping, Address Modification, Looping, Introduction to Assembly Language Program.

MODULE 2. ASSEMBLERS: Review of Computer Architecture – Machine Instructions and Programs – Assemblers –Basic Assembler Functions – Assembler Features – Assembler Design Options. LOADERS AND LINKERS: Loaders and Linkers – Basic Loader Functions – Machine-Dependent Loader Features – Machine-Independent Loader Features– Loader Design Options-Dynamic Linking and Loading- Object files-Contents of an object file – designing an object format – Null object formats- Code sections- Relocation – Symbols and Relocation – Relocatable a.out- ELF.

MODULE 3. MACROPROCESSORS AND EMULATORS: Microprocessors – Basic Macro Processor Functions – Machine-Independent Macro Processor Features – Macro Processor Design Options - Introduction to Virtual Machines (VM) - Emulation - basic Interpretation – Threaded Interpretation – Interpreting a complex instruction set – binary translation.

MODULE 4. VIRTUAL MACHINES: Pascal P-Code VM – Object-Oriented VMs – Java VM Architecture – Common Language Infrastructure – Dynamic Class Loading. ADVANCED FEATURES: Instruction Set Issues – Profiling – Migration – Grids – Code optimizations- Garbage Collection - Examples of real-world implementations of system software.

TEXT BOOKS:

1. Leland L. Beck, "System Software", 3rd ed., Pearson Education.
2. John R. Levine, "Linkers & Loaders", Morgan Kauffman.
3. James E Smith and Ravi Nair, "Virtual Machines", Elsevier.

REFERENCES:

1. Srimanta Pal, " Systems Programming " , Oxford University Press.
2. John J.Donovan, " "Systems Programming", Tata McGraw-Hill.
3. Systems Programming by John J Donovan (McGraw-Hill Education)
4. Operating System and System Programming – Dhamdhere (McGraw-Hill Education)

Computer Science& Engineering and Information Technology			
CS622	**Natural Language Processing**	**L**	**T**
		3	**0**

Objectives of the course:

This course provides an introduction to the field of natural language processing (NLP). Purpose is to make students learn how systems can understand and produce language, for applications such as information extraction, machine translation, automatic summarization, question-answering, and interactive dialogue systems. The course will cover linguistic (knowledge-based) and statistical approaches to language processing in the three major subfields of NLP: syntax (language structures), semantics (language meaning), and pragmatics/discourse (the interpretation of language in context).

Course Outcomes

After completing this course, the student should be able to:

CO1	Understand approaches to syntax and semantics in NLP.
CO2	Understand approaches to discourse, generation, dialogue and summarization within NLP
CO3	Understand current methods for statistical approaches to machine translation
CO4	Understand machine learning techniques used in NLP, including hidden Markov models and probabilistic context-free grammars
CO5	Understand clustering and unsupervised methods, log-linear and discriminative models, and the EM algorithm as applied within NLP

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Mapping of course outcomes with program outcomes:

Detailed Syllabus:

Module-I

Introduction to Natural Language Processing (NLP). Sound: Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

Module-II

Words and Word Forms: Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic

Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

Module-III

Structures: Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.

Module-IV

Meaning: Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors; Co-references.

Module-V

Web 2.0 Applications: Sentiment Analysis; Named Entity Recognition; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

Text Books:

1. Dan Jurafsky and James Martin, “Speech and Language Processing”, 2nd Edition, Prentice Hall, 2008.
2. Andrew Radford, Martin Atkinson, David Britain, Harald Clahsen and Andrew Spencer, “Linguistics: An Introduction”, Cambridge University Press, 2009.

Reference Books:

1. Chris Manning and HinrichSchütze, “Foundations of Statistical Natural Language Processing”, MIT Press. Cambridge, 1999.
2. Allen James, “Natural Language Understanding”, 2nd edition, Benjamin Cumming, 1995.
3. Eugene Charniack, “Statistical Language Learning”, MIT Press, 1993.
4. Steven Bird, “Natural Language Processing with Python”, 1st Edition, O'Reilly, 2009.
5. Jacob Perkins, “Python Text Processing with NLTK 2.0 Cookbook”, Packt Publishing, 2010.

Computer Science& Engineering and Information Technology			
CS621	**Soft Computing**	**L**	**T**
		3	**0**

Course objective:

Thiscoursewillcoverfundamentalconceptsusedin Softcomputing.SoftComputingrefersto a partnership of computational techniques in computer science, artificial intelligence,machine learning and some engineering disciplines, which attempt to study, model, and analyze complexphenomena.TheconceptsofArtificialNeuralNetworks(ANNs)willbecoveredfirst, followed by Fuzzy logic (FL) and optimization techniques using Genetic Algorithm (GA). Applications of Soft Computing techniques to solve a number of real-life problems will be coveredtohavehandsonpractices.Insummary,thiscoursewillprovideexposuretotheoryas well as practical systems and software used in softcomputing.

Course outcomes:

At the end of the course students will be able to:

CO1	**Present** the feasibility of applying a soft computing methodology for specific problem.
CO2	**Identify** and describe soft computing techniques and their roles in building intelligent machines.
CO3	**Apply** neural networks to pattern classification and regression problems.
CO4	**Apply** fuzzy logic and reasoning to handle uncertainty and solve engineering problems.
CO5	**Apply** genetic algorithms to combinatorial optimization problems.

Mapping of course outcomes with program outcomes:

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**P10**	**P11**	**P12**
CO 1	3	3	3	2	3	-	-	-	-	1	-	2
CO 2	3	3	2	2	-	-	-	-	2	-	-	-
CO 3	3	2	2	2	2	-	-	-	-	-	-	2
CO 4	3	3	2	2	2	-	-	-	-	-	-	-
CO 5	3	2	2	2	2	-	-	-	-	-	-	2
Avg	3	2.6	2.2	2	2.25				2	1		2

Detailed Syllabus:

MODULE 1. INTRODUCTION TO SOFT COMPUTING: Soft computing: Soft computing concepts, soft computing versus hard computing, various types of soft computing techniques, applications of soft computing.

MODULE 2. ARTIFICIAL NEURAL NETWORKS: NeuralNetworks:History,overviewofbiologicalNeuro-system,MathematicalModelsofNeurons, ANN architecture, learning rules, Learning Paradigms- Supervised, Unsupervised and reinforcement Learning, ANN training, Algorithms-perceptions; Training rules, Delta, Back Propagation Algorithm, Multilayer Perceptron Model.

MODULE 3. SPECIAL LEARNING NETWORK: Competitive learning networks, Kohonen Self-organizing networks, Hebbian learning, Hopfield Networks, Associative memories, The Boltzman machine**,** Applications of Artificial Neural Networks.

MODULE 4. FUZZY LOGIC: Fuzzy Logic: Introduction to Fuzzy Logic, Classical and Fuzzy Sets: Overview of Classical Sets, MembershipFunction,Fuzzyrulegeneration.OperationsonFuzzySets:Compliment,Intersections, Unions, Combinations of Operations, Aggregation Operations. Fuzzy Arithmetic: Fuzzy Numbers, Linguistic Variables, Arithmetic Operations on Intervals & Numbers, Lattice of Fuzzy Numbers, Fuzzy Equations. Fuzzy Logic: Classical Logic, Multivalued Logics, Fuzzy Qualifiers, Linguistic Hedges, Introduction & features of membershipfunctions.

MODULE 5. FUZZY RULE BASED SYSTEM: Fuzzy rule base system: Fuzzy Propositions, implications and inferences, Fuzzy reasoning, Defuzzification techniques, Fuzzy logic controller design, Fuzzy decision making & Applications of fuzzy logic.

MODULE 6. GENETIC ALGORITHMS: Genetic Algorithms: An Overview of Genetic algorithm (GA), Evolution strategies (ES), Evolutionary programming (EP), Genetic programming (GP); GA operators: Encoding, Selection, Crossover, Mutation, schema analysis, analysis of selection algorithms; convergence; optimization, of travelling salesman problem using genetic algorithm approach; Markov & other stochastic models. Other Soft Computing Techniques: Simulated annealing, Tabu search, Ant colony-based optimization (ACO), etc.

Text Book:

1. P. R. Beeley, Foundry Technology, Newnes-Buttterworths, 2001.
2. P. D. Webster, Fundamentals of Foundry Technology, Portwillis press, Red hill, 1980.

Supplementary Reading:

1. P. C. Mukherjee, Fundamentals of Metal casting Technology, Oxford IBH, 1980.
2. R. W. Hein, C. R. Loper and P. C. Rosenthal, Principles of Metal casting, Mc Graw Hill, 1976.

Computer Science& Engineering and Information Technology			
CS601	**Computer Network**	**L**	**T**
		3	**1**

Course objective:

Thiscoursewillcoverfundamentalconceptsof computer network. A computer network is a digital telecommunications network which allows nodes to share resources. In computer networks, computing devices exchange data with each other using connections (data links) between nodes. These data links are established over cable media such as wires or optic cables, or wireless media such as Wi-Fi. Network computer devices that originate, route and terminate the data are called network nodes.[1] Nodes are generally identified by network addresses, and can include hosts such as personal computers, phones, and servers, as well as networking hardware such as routers and switches. Two such devices can be said to be networked together when one device is able to exchange information with the other device, whether or not they have a direct connection to each other.

Course outcomes:

At the end of the course students will be able to:

CO1	Students will be able to explain the types of transmission media with real time applications
CO2	Students will be able to describe the functions of each layer in the OSI and TCP/IP model.
CO3	Students will be able to classify the routing protocols and analyze how to assign the IP addresses for the given network

Detailed syllabus:

MODULE 1. Data communication Components: Representation of data and its flow Networks, Various Connection Topology, Protocols and Standards, OSI model, Transmission Media.

MODULE 2. LAN: Wired LAN, Wireless LANs, Connecting LAN and Virtual LAN, Techniques for Bandwidth utilization: Multiplexing - Frequency division, Time division and Wave division, Concepts on spreadspectrum.

MODULE 3. Data Link Layer and Medium Access Sub Layer: Error Detection and Error Correction - Fundamentals, Block coding, Hamming Distance, CRC.

MODULE 4. Flow Control and Error control protocols - Stop and Wait, Go back – N ARQ, Selective Repeat ARQ, Sliding Window, Piggybacking, Random Access, Multiple access protocols -Pure ALOHA, Slotted ALOHA, CSMA/CD, CDMA/CA

MODULE 5. Network Layer: Switching, Logical addressing – IPV4, IPV6; Address mapping – ARP, RARP, BOOTP and DHCP–Delivery, Forwarding and Unicast Routingprotocols.

MODULE 6. Transport Layer:Process toProcess Communication, User Datagram Protocol (UDP), Transmission Control Protocol (TCP), SCTP Congestion Control; Quality ofService, QOS improving techniques: Leaky Bucket and Token Bucketalgorithm.

Text Book:

1. Data Communication and Networking, 4th Edition, Behrouz A. Forouzan, McGraw-Hill.

Reference Books

1. Data and Computer Communication, 8th Edition, William Stallings, Pearson Prentice HallIndia.

2. Computer Network, 8th Edition, Andrew S. Tanenbaum, Pearson International Edition.

Computer Science& Engineering and Information Technology			
Code: CS651	**Computer Networks Lab**	**L**	**P**
		0	**3**

Course Outcomes:

CO 1: Students will be able to design the different type of topologies in the network.
CO 2: Students will be able to configure the Switch, Router, Gateway and different network devices.

List of Experiments: -

1. Introduction to Local Area Network with its cables, connectors and topologies.

2. Installation of Switch, hub their cascading and network mapping.

3. Installation of UTP, Co-axial cable, Cross cable, parallel cable NIC and LAN card.

4. Case Study of Ethernet (10 base 5, 10 base 2,10 base T)

5. Installation and working of Net meeting and Remote Desktop.

6. Installation and working with Telnet (Terminal Network).

7. Installation and working with FTP (File Transfer Protocol).

8. Installation and Computers via serial or Parallel ports and enable the computers to share disk and printer port.

9. To connect two Personal Computer with Telephone line.

10. Installation of Modem and Proxy Server.

11. Installation of Windows 2003 server/ Windows 200 server.

12. Configuration of DHCP.

13. Introduction to Server administration.

Reference Books

1. Computer Network and internet by Dougles E. Comer (Pearson Education)

2. List of Software required: - Windows 2003 server/Windows 2000 server.

3. List of Hardware required: - LAN Trainer Kit LAN Card Cable, Connectors, HUB, Switch, and Crimping Tools.

IT621	**INTERNET OF THINGS**	**L**	**T**
		3	**0**

COURSE OUTCOMES:

1. Understand the building blocks of Internet of Things and characteristics.
2. Describe the various application areas of IoT.
3. Design a basicIoT product using Raspberry Pi and sensors.
4. Deploy an IoT application and connect to the cloud.

Module1. FUNDAMENTALS OF IOT

Introduction to IOT, Characteristics, Sensing, Actuation,Basics of Networking and Protocols – Physical design, Logical design – Enabling technologies – IoT Levels – Domain Specific IoTs – IoT vs M2M.

Module2. IOT DESIGN METHODOLOGY

IoT systems management – IoT Design Methodology – Specifications Integration and Application Development, Interoperability in IoT.

Module 3. BUILDING IOT WITH RASPBERRY PI USING PYTHON

Introduction to Python Programming,Introduction to Raspberry Pi, Raspberry Pi Interfaces, Physical devices, Integration of Sensors and Actuators with Raspberry Pi.

Module 4. ADVANCED TOPICS

Software Defined Networks for IoT, Cloud Computing, Cloud Storage forIoT, Sensor Data

Handling and Analytics; Software & Management Tools for IoT, Recent trends in IoT.

Module5. CASE STUDIES

Various Real time applications of IoT- Smart cities, Smart Homes, Agriculture, HealthCare, Industrial IOT, Activity monitoring.

REFERENCES:

1. ArshdeepBahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press,

2015.

2. Marco Schwartz, “Internet of Things with the Arduino Yun”, Packt Publishing, 2014.

3. "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", by Pethuru Raj and Anupama C. Raman (CRC Press).

4.WaltenegusDargie,Christian Poellabauer, "Fundamentals of Wireless Sensor Networks: Theory and Practice.

5. Manoel Carlos Ramon, “Intel® Galileo and Intel® Galileo Gen 2: API Features and Arduino Projects for Linux Programmers”, Apress, 2014.

6. Research papers.

IT613	**E-commerce**	**L**	**T**
		3	**0**

Course Outcome: At the completion of the course a student will be able to –

- Discuss fundamental of e-business and e-commerce, types and application.
- Comprehend the underlying economic mechanisms and driving forces of E-Commerce
- Discuss information distribution and messaging in E-commerce.
- Describe and Utilize different Payment systems.
- Asses Security & legal issues and User Experience.

CO-PO Mapping-

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**1**	**2**									
CO2											**3**	**1**
CO3	**1**	**3**		**2**								
CO4	**2**	**2**			**3**	**2**						
CO5				**1**	**2**	**3**		**2**				

Module 1. INTRODUCTION: What is E-Commerce, Forces behind E-Commerce, E-Commerce Industry Framework, and Brief History of Ecommerce. Inter Organizational E-Commerce, Intra Organizational E-Commerce, and Consumer to Business Electronic Commerce, Architectural framework, Logical layers of E-commerce.

Module 2. ELECTRONIC PAYMENT SYSTEM: Requirement and types of electronic payment systems, digital token-based electronic payment systems, smart cards & electronic payment systems, credit card based electronic payment systems, electronic cheque, e-cash, risk and solution in electronic payment systems, designing electronic payment systems.

Module 3. INFORMATION DISTRIBUTION AND MESSAGING: FTP, E-Mail, www server, HTTP, Web service implementation, Information publishing, Web Browsers, HTML, Common Gateway Interface, Electronic data interchange (EDI), technology & standards, Communication, implementation & securing EDI.

Module 4. E-BUSINESS: Supply chain management, Internet bookshop, Software supplies & support, E-payment system, Internet banking Gambling on net, E-diversity & case studies through Internet.

Module 5. LEGAL AND SECURITY ISSUES: Paper Vs Electronic document, Authentication of E-document, Legal issues of E-commerce, Copyright & jurisdiction issues, Security solutions, Symmetric & asymmetric cryptography DES, RSA, Digital signature, Protocols for securing message, SET, Internet security.

Text Book:

1. Frontiers of E-commerce by Kalakota & Whinston, Addison Wesley.
2. E-business road map for success by Dr. Ravi Kalakota& Marcia Robinson, Addison Wesley

Reference Book:

1. Electronic Commerce by Bharat Bhasker, TMH

IT614	**Enterprise Resource Planning**	**L**	**T**
		3	**0**

Course Outcome: At the completion of the course a student will be able to –

- Explain the different applications of ERP systems
- Identify and describe typical functional modules in ERP system;
- Describe the process of developing and implementing ERP systems;
- Describe the basic concepts and technologies used in ERP;

CO-PO Mapping-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	**3**	**1**	**2**									
CO2		**3**		**2**	**1**							
CO3	**2**	**2**	**3**	**1**								
CO4	**2**		**2**		**3**	**2**						

Module 1. INTRODUCTION: ERP: An Overview, Enterprise – An Overview, Origin, Evolution and Structure: Conceptual Model of ERP, The Benefits of ERP, ERP and Related Technologies, Business Process Reengineering (BPR), Data Warehousing, Data Mining, OLAP, Product Life Cycle Management (PLM), Supply chain Management (SCM).

Module 2.ERP IMPLEMENTATION: ERP Implementation Lifecycle, Implementation Methodology, Hidden Costs, Organizing the Implementation, Role of SDLC/SSAD, Object Oriented Architecture Vendors, Consultants and Users, Contracts with Vendors, Consultants and Employees, Project Management and Monitoring, Success or Failure of ERP Implementation.

Module 3.THE BUSINESS MODULES: Business modules in an ERP Package, Finance, Manufacturing, Human Resources, Plant Maintenance, Materials Management, Quality Management, Sales and Distribution.

Module 4.THE ERP MARKET: ERP Marketplace and Marketplace Dynamics: Market Overview, Marketplace Dynamics, The Changing ERP Market. ERP- Functional Modules: Introduction, Functional Modules of ERP Software, Integration of ERP, Supply chain and Customer Relationship Applications, Sales and service.

Module 5.ERP – PRESENT AND FUTURE: ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture Using ERP tool: ERP Market Place, SAP AG, PeopleSoft, Turbo Charge the ERP System, EIA, ERP and e-Commerce, ERP and Internet, Future Directions. Case studies: my SAP Business Suite Implementation at ITC, Oracle ERP Implementation at Maruti Suzuki, Siebel CRM Implementation at Bharti Airtel.

Text Book:

1. Alexis Leon, "ERP Demystified", Tata McGraw Hill, New Delhi, 2000

2. Enterprise Resource Planning by Rajesh Ray, Tata McGraw Hill Education, 2011.

Reference Book:

1. ERP, Concepts & Practices by V.K. Garg & N.K. Venkatkrishnan, PHI, 2004.

2. Enterprise Resource Planning by Ashim Raj Singla, Cengage Learning, 2008.

Computer Science & Engineering			
IT612	**Management Information System**	**L**	**T**
		3	**0**

CO.1	Define the Information System the importance of Information System in Business and management.
CO.2	Understand the common management problems in the organization.
CO.3	Describe the structure of a typical organization and people and their roles in the organization.
CO.4	Analyze various real world management information systems and review.
CO.5	Apply the knowledge of Information System to solve common business problems.
CO.6	Design and develop management information system.

Module1. Management within organizations:

Management activities, roles and levels, Management Planning and Control, Strategic Planning within an organization: activities, techniques and results. The nature of decision-making: decision making models and classification of decision-making situations, the nature of information: classifications and characteristics. MIS sub types, Measurement of MIS performance and capabilities.

Module2. MIS applications and relationships:

Kinds of Information Systems: Transaction Processing System(TPS) – Office Automation System (OAS) – Management Information System (MIS) – Decision Support System (DSS) and Group Decision Support System (GDSS) – Expert System (ES) – Executive Support System (ESS) Data warehouses and data mining facilities: the relationship between data warehousing and other MIS facilities

Module3. Development of MIS:

Development of Long range plans, Determining information requirement, Development and Implementation, Organization for Development of MIS, Choice of Information Technology, Strategic decision, Configuration design, IT implementation plan, Phases of MISD implementation Assessing information needs, Identification and development of information sources, design and development of information flow network and cost considerations, need and design of an integrated information system for MIS, role of computers in MIS: Processing information flow, Maintaining records and generating outputs for decision making. Implementation and evaluation of MIS

Module4. Information System Application:

Transaction Processing Applications, Applications for Budgeting and Planning, Automation, Manufacturing Management System,

Module5. Database Management System:

Architecture of RDBMS. Brief history of DBMS development. ER Model. Relational Data Model, Relational algebra, Database design, Conceptual and physical model, MIS and RDBMS.

Module6. Enterprise System:

Enterprise Resources Planning (ERP)-Features, selection criteria, merits, issues and challenges in Implementation.

Suggested Text Books:

1. Kenneth C. Laudon, Jane Price Laudon, "Management Information Systems: Managing the digital firm", Pearson Education, PHI, Asia, 2012.

2. O'Brien, James A, Marakas, George M, "Management Information Systems", 2006, Ninth Edition, Tata McGraw Hill.

Suggested Reference Books:

Jawadekar W S, “Management Information Systems”, Second Edition, 2002, Tata McGraw Hill.

“Introduction to Information Technology” Turban E.F, Potter R.E, Wiley.

“Modern Systems Analysis and Design” Jeffrey A.Hoffer, Joey F.George, Joseph S. Valachich, Prentice Hall

“Database System Concepts” Avi Silberschatz · Henry F.Korth · S. Sudarshan.

Robert Schultheis, Mary Summer, “Management Information Systems – The ManagersView”, Tata McGraw Hill, 2008.

Davis, Gorden B. Olson, M.H, “Management Information Systems”, 2000, Tata McGraw Hill.

Haag, Cummings and Mc Cubbrey, “Management Information Systems for the Information Age”, McGraw Hill, 2005. 9th edition, 2013.

Turban, McLean and Wetherbe, “Information Technology for Management –

Transforming Organizations in the Digital Economy”, 6th Edition, 2008.

Course Structure of Undergraduate
Vinoba Bhave University , Hazaribagh

Mechanical Engineering

Semester -VII

Branch: Mechanical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ME701	Automation in Manufacturing	3	0	0	3
2	PEC-V		3	0	0	3
3	PEC-VI		3	0	0	3
4	OEC IV		3	0	0	3
5	OEC V		3	0	0	3
6	ME751	Lab VII (RAC)	0	0	3	1
7	ME752	Project-I	0	0	4	2
8	ME753	Internship Assessment	0	0	2	2
					Total credits	20

Code	Professional Elective-V (Any one)	Code	Professional Elective-VI (Any one)
ME711	Refrigeration and Air Conditioning	ME721	Power Plant Engineering
ME712	Cryogenics	ME722	Finite Element Analysis
ME713	Gas Dynamics	ME723	Tool Design

Code	Open Elective-IV (Any one)	Code	Open Elective-V (Any one)
ME731	Mechanical Vibrations	ME741	Rapid Prototyping
ME732	Convective Heat Transfer	ME742	Industrial Automation
ME733	Micro and Nano Manufacturing	ME743	Technology management
ME734	Energy Systems and Management	ME744	Computer Aided Manufacturing
ME735	Condition Monitoring	ME745	Maintenance Engineering & management

Semester -VIII

Branch: Mechanical Engineering

S.N.	Code	Course Title	L	T	P	Credits
5	ME851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Electrical Engineering

Semester -VII

Branch: Electrical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EE701	Protection of Power Apparatus	3	0	0	3
2	PEC-V	**Professional Elective-V**	3	0	0	3
3	PEC-VI	**Professional Elective-VI**	3	0	0	3
4	OEC IV	**Open Elective-IV**	3	0	0	3
5	OEC V	**Open Elective-V**	3	0	0	3
6	EE751	Power System Protection and	0	0	3	1
7	EE752	Project Part - I	0	0	4	2
8	EE753	Internship Assessment	0	0	2	2
Total credits						20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
EE711	Electrical Drives and Control	EE721	High Power Converters
EE712	Utilization of Electrical Power	EE722	HVDC Transmission and FACTS
EE713	Power System Dynamics and Control	EE723	Smart Grid Technology
EE714	Power Quality	EE724	Electrical and Hybrid Vehicles

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
EE731	Soft Optimization Techniques	EE741	High Power Converters *
EE732	Illumination Technology	EE742	Digital Control Systems
EE733	Process Instrumentation and Control	EE743	Electrical machine and Power Systems*

* Not for EE Students

Semester -VIII

Branch: Electrical Engineering

S.N.	Code	Course Title	L	T	P	Credits
5	EE851	Project-II			17	08
				Total Credits		08

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Electrical & Electronics Engineering

Semester -VII

Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EEE701	Protection of Power Apparatus	3	0	0	3
2	PEC-V	Professional Elective-V	3	0	0	3
3	PEC-VI	Professional Elective-VI	3	0	0	3
4	OEC IV	Open Elective-IV	3	0	0	3
5	OEC V	Open Elective-V	3	0	0	3
6	EEE751	Power System Protection and	0	0	3	1
7	EEE752	Project Part - I	0	0	4	2
8	EEE753	Internship Assessment	0	0	2	2
					Total credits	20

Code	Professional Elective-V (Any one)	Code	Professional Elective-VI (Any one)
EEE711	Electrical Drives and Control	EEE721	Antennae & Wave Propagation
EEE712	Utilization of Electrical Power	EEE722	Smart Grid Technology
EEE713	Power Quality	EEE723	Electrical and Hybrid Vehicles
EEE714	HVDC Transmission and FACTS		

Code	Open Elective-IV (Any one)	Code	Open Elective-V (Any one)
EEE731	Soft Optimization Techniques	EEE741	High Power Converters *
EEE732	Illumination Technology	EEE742	Digital Control Systems
EEE733	Process Instrumentation and Control	EEE743	Electrical machine and Power Systems

* Not for EEE Students

Semester -VIII

Branch: Electrical & Electronics Engineering

S.N.	Code	Course Title	L	T	P	Credits
5	EEE851	Project-II			17	08
					Total Credits	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Production Engineering

Semester -VII

Branch: Production Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	PE701	Production Planning and Control	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	PE651	Optimization Lab	0	0	3	1
7	PE652	Project-I	0	0	4	2
8	PE653	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
PE711	Statistical Quality Control	PE721	Tool Design
PE712	Total Quality Management	PE722	Advance Casting and Welding
PE713	Quality and Reliability Engineering	PE723	Material Deformation Process

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
PE731	Supply Chain Management	PE741	Finite Element Method
PE732	Enterprises Resource Planning	PE742	Modern Optimization Technique
PE733	Management Information System	PE743	Mechatronics
PE734	Marketing Management	PE744	Project Engineering
PE735	Intelligent Manufacturing Systems		

Semester -VIII

Branch: Production Engineering

S.N.	Code	Course Title	L	T	P	Credits
5	PE851	Project-II			17	08
					Total Credit	08

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Metallurgical Engineering

Semester -VII

Branch: Metallurgical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	ML701	Foundry Technology	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	ML751	Foundry Lab.	0	0	3	1
7	ML752	Project-I	0	0	4	2
8	ML753	Internship Assessment	0	0	2	2
Total credits						20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
ML711	Advances in Steel Making	ML721	Principles of Management
ML712	Non Destructive Testing	ML722	Alloys Steels and High Temperature Alloys
ML713	Light Metal Alloys Steels	ML723	High Temperature Materials
ML714	Special Steels and Cast Irons	ML724	Computer applications in materials and Engineering
ML715	Non Metallic Materials	ML725	Physical Chemistry of Iron and Steel Making

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
ML731	Composite Materials	ML741	Nano Materials
ML732	Advanced Engineering Materials	ML742	Nanostructured Materials
ML733	Emerging Materials	ML743	Nano Materials

Semester -VIII

Branch: Metallurgical Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	ML851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Chemical Engineering

Semester -VII

Branch: Chemical Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CL701	Transport Phenomenon	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	CL751	Chemical Engineering Lab II (PRE+ EO)	0	0	3	1
7	CL752	Project-I	0	0	4	2
8	CL753	Internship Assessment	0	0	2	2
					Total credits	20

Code	Professional Elective-V (Any one)	Code	Professional Elective-VI (Any one)
CL711	Computer Aided Design	CL721	Chemical Process & Operational Safety
CL712	Process Modelling and Simulation	CL722	Chemical Plant Management
CL713	Computational Fluid Dynamics	CL723	Solid Waste Management

Code	Open Elective-IV (Any one)	Code	Open Elective-V (Any one)
CL731	Polymer Science & Technology	CL741	Bio Chemical Engineering
CL732	Mineral Beneficiation	CL742	Petrochemical Technology
CL733	Fuel Cell Technology	CL743	Petroleum Refining Engineering

Semester -VIII

Branch: Chemical Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	CL851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Civil Engineering

Semester -VII

Branch: Civil Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CE701	CONCRETE STRUCTURE-II	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	CE751	CONCRETE STR. DETAILING	0	0	3	1
7	CE752	Project-I	0	0	4	2
8	CE753	Internship Assessment	0	0	2	2
					Total credits	20

Code	Professional Elective-V (Any one)	Code	Professional Elective-VI (Any one)
CE711	Hydraulic Structures	CE721	Construction Planning And Management
CE712	Composite Materials	CE722	Industrial waste treatment
CE713	Prestressed Concrete	CE723	Sustainable Construction Methods
CE714	Ground Water Hydrology	CE724	Elements of fluivial hydraulics
CE715	Earthquake Engineering	CE725	Railway Engineering

Code	Open Elective-IV (Any one)	Code	Open Elective-V (Any one)
CE731	Reliability Engineering	CE741	Basics of computational hydraulics
CE732	Geographical Information System	CE742	Urban Hydrology and Hydraulics
CE733	Quality Control and Management	CE743	Intelligent Transportation Systems
CE734	Repairs & Rehabilitation of Structure	CE744	Structural geology
CE735	Engineering Economics and Accounts	CE745	Environmental Health and Safety Management

Semester -VIII

Branch: Civil Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	CE851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Electronics & Communication Engineering

Semester -VII

Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	EC701	Optical Fiber Communication	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	EC751	Optical Fiber Communication	0	0	3	1
7	EC752	Project-I	0	0	4	2
8	EC753	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
EC711	Mobile Communication	EC721	Antenna & Wave Propagation
EC712	Satellite Communication	EC722	RF IC Design
EC713	Nanotechnology and Applications	EC723	Real Time Embedded System

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
EC731	Internet of things	EC741	Low Power VLSI Circuits
EC732	VLSI Design *	EC742	Biomedical Instrumentation
EC733	5G Communication	EC743	MEMs Technology
		EC744	Smart Antenna

* Not for ECE Students

Semester -VIII

Branch: Electronics & Communication Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	EC851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Mining Engineering

Semester -VII

Branch: Mining Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	MN701	Mine Legislation & Safety Engineering	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	MN751	Mine Design Exercise II Lab Lab	0	0	3	1
7	MN752	Project-I	0	0	4	2
8	MN753	Internship Assessment	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
MN711	Applied Rock Mechanics	MN721	Mine Planning and Design
MN712	Numerical Methods in Geomechanics	MN722	Mine Closure Planning
MN713	Geo - statistics	MN723	Mine Reclamation & Rehabilitation
MN714	Instrumentation in Rock Mechanics	MN724	Sustainable Mining Practices

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
MN731	Mine Economics & Resource Management	MN741	Remote Sensing & GIS
MN732	Mine Management	MN742	Socio-Environmental Impacts of Opencast Mines
		MN743	Sustainable Energy Resources
		MN744	Opencast Mine Machinery

Semester -VIII

Branch: Mining Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	MN851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Computer Science & Engineering

Semester -VII

Branch: Computer Science & Engineering

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	CS701	Artificial Intelligence	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	CS751	Artificial Intelligence Lab.	0	0	3	1
7	CS752	Project-I	0	0	4	2
8	CS753	Internship Assessment II	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
CS711	Machine Learning	IT721	Data Mining and Data Warehousing.
CS712	Multimedia and Applications	IT722	Information Security.
CS713	Human Computer Interaction	CS721	Natural Language Processing

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
IT701	Software Engineering	IT741	Information Security
CS732	Values and Ethics in Profession.	CS741	Cryptography
CS733	*Data Mining	IT742	Knowledge Domain Development

* Not for CSE Students

Semester -VIII

Branch: Computer Science & Engineering

S.N.	Code	Course Title	L	T	P	Credits
1.	CS851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Information Technology

Semester -VII

Branch: Information Technology

S.N.	Code	Course Title	Lecture	Tutorial	Practical	Credits
1	IT701	Software Engineering	3	0	0	3
2	PEC-V	**Professional Elective -V**	3	0	0	3
3	PEC-VI	**Professional Elective -VI**	3	0	0	3
4	OEC IV	**Open Elective -IV**	3	0	0	3
5	OEC V	**Open Elective -V**	3	0	0	3
6	IT751	Software Engineering Lab.	0	0	3	1
7	IT752	Project-I	0	0	4	2
8	IT753	Internship Assessment II	0	0	2	2
					Total credits	20

Code	**Professional Elective-V (Any one)**	**Code**	**Professional Elective-VI (Any one)**
CS711	Machine Learning	IT721	Data Mining and Data Warehousing.
CS712	Multimedia and Applications	IT722	Information Security.
CS713	Human Computer Interaction	CS721	Natural Language Processing

Code	**Open Elective-IV (Any one)**	**Code**	**Open Elective-V (Any one)**
CS701	Artificial Intelligence	IT741	Information Security
CS732	Values and Ethics in Profession.	CS741	Cryptography
CS733	*Data Mining	IT742	Knowledge Domain Development

* Not for IT Students

Semester -VIII

Branch: Information Technology

S.N.	Code	Course Title	L	T	P	Credits
1.	IT851	Project-II			17	08
					Total Credit	08

NOTE- A Student can be allowed to do project outside after the permission of departmental Academic Committee. Those students doing project outside has present their project progress every month. Those students doing project outside can be permitted to present progress every fortnight though video conferencing. Students doing project in house has present their project progress every week.

Mechanical Engineering			
ME701	**Automation in Manufacturing**	**L**	**T**
		3	**0**

Course Objectives:

1. To understand the importance of automation in the of field machine tool based manufacturing
2. To get the knowledge of various elements of manufacturing automation – CAD/CAM, sensors, pneumatics, hydraulics and CNC.
3. To understand the basics of product design and the role of manufacturing automation

DETAILED SYLLABUS

Module 1

Introduction: Why automation, Current trends, CAD, CAM, CIM; Rigid automation: Part handling, Machine tools. Flexible automation: Computer control of Machine Tools and Machining Centers. **(10)**

Module 2

NC and NC part programming, CNC-Adaptive Control, Automated Material handling. Assembly, Flexible fixturing. **(6)**

Module 3

Computer Aided Design: Fundamentals of CAD - Hardware in CAD-Computer Graphics Software and Data Base, Geometric modeling for downstream applications and analysis methods; Computer Aided Manufacturing: CNC technology, PLC, Micro-controllers, CNC Adaptive Control. **(10)**

Module 4

Low cost automation: Mechanical & Electro mechanical Systems, Pneumatics and Hydraulics, Illustrative Examples and case studies Introduction to Modeling and Simulation. **(6)**

Module 5

Product design, process route modeling, Optimization techniques, Case studies & industrial applications, Autonomous vehicles. **(10)**

Course Outcomes:

Upon completion of this course, the students will get a comprehensive picture of computer based automation of manufacturing operations.

Text Books:

i. Mikell P. Groover, Automation, Production Systems, and Computer-integrated Manufacturing, prentice Hall.

ii. SeropeKalpakjian and Steven R. Schmid, Manufacturing – Engineering and Technology, 7th edition,Pearson.

Mechanical Engineering			
ME711	**Refrigeration and Air Conditioning**	**L**	**T**
		3	**0**

Objectives:
1. To familiarize with the terminology associated with refrigeration systems and air conditioning 2. To understand basic refrigeration processes
3. To understand the basics of psychrometry and practice of applied psychrometrics
4. To acquire the skills required to model, analyse and design different refrigeration as well as air conditioning processes and components

DETAILED SYLLABUS

Module 1
Classification of refrigeration systems: Advanced vapour compression cycles, Refrigerants and their mixtures: properties and characteristics - Ozone depletion and global warming issues - System components. **(10)**
Module 2
Compressors, Condensers, Expansion devices and Evaporators -Performance matching of components of refrigeration systems. **(8)**
Module 3
Advanced sorption refrigeration systems and their components. **(4)**
Module 4
Review of Psychrometry and Air-conditioning processes - Comfort air conditioning and Cooling load calculations. **(8)**
Module 5
Applications of AC systems - Concept of enthalpy potential – Air washers, Cooling towers, Evaporative condensers, Cooling and dehumidifying coils. **(10)**

Course Outcomes:
A student who has done the course will have a good understanding of the working principles of refrigeration and air-conditioning systems.

Text Books:
1. Gosney, W.B, Principles of Refrigeration, Cambridge University Press, 1982.
2. Stoecker, W.F. and Jones, J.W., Refrigeration and Air conditioning, Tata McGraw Hill,1986.
3. Arora, C.P., Refrigeration and Air conditioning, Tata McGraw Hill, 2nd Edition, 2000.
4. Kuehn, T.H., Ramsey, J.W. and Threlkeld, J.L., Thermal Environmental Engineering, 3rd Edition, Prentice Hall, 1998.

Mechanical Engineering			
ME712	**Cryogenics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand principles of cryogenic systems.
2. Understand air and helium liquefaction processes.
3. Classify cascade refrigeration systems.
4. Understand principles of ultra-low temperature systems and their applications.
5. Evaluate storage systems used in cryogenic applications.

DETAILED SYLLABUS

Module 1

Introduction: Definition and Engineering Applications of Cryogenics, Properties of solids for cryogenic systems. **(5)**

Module 2

Refrigeration and Liquefaction: Simple Linde cycle, Pre-cooled Joule-Thomson cycle, dual-pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle. **(10)**

Module 3

Ultra-low-temperature refrigerators: Definition and Fundamentals regarding ultra-low-temperature refrigerators, Equipment associated with low-temperature systems, Various Advantages and Disadvantages. **(10)**

Module 4

Storage and Handling of Cryogenic Refrigerants: Storage and Transfer systems, Insulation, Various Types of Insulation typically employed, Poly Urethane Foams (PUFs) and Polystyrene Foams (PSFs), Vacuum Insulation, and so on. **(10)**

Module 5

Applications: Broad Applications of Cryogenic Refrigerants in various engineering systems. **(5)**

Text Books:

1. Traugott H.K. Frederking and S.W.K. Yuan, Cryogenics - Low Temperature Engineering and Applied Sciences, Yutopian Enterprises, 2005.
2. Arora, C.P., Refrigeration and Air-conditioning, Tata-McGraw Hill, 2008.

Mechanical Engineering			
ME713	**Gas Dynamics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Solve flow equations for quasi one dimensional flow through variable area ducts.
2. Analyze the flow through constant area ducts with friction and heat transfer.
3. Analyze flows with normal and oblique shocks.
4. Solve flow problems with supersonic velocities using shock-expansion theory.
5. Solve linearized velocity potential equation for multi-dimensional flows.

DETAILED SYLLABUS

Module 1

Introduction: Review of basic fluid dynamic and thermodynamic principles, Conservation equations for inviscid lows. **(10)**

Module 2

One Dimensional flow: One-dimensional wave motion, normal shock waves, Oblique shock waves, Prandtl-Meyer expansions and applications, Generalized one-dimensional flow Nozzle.

(10)

Module 4

Flow: Isentropic flow with area change, Flow with friction (Fanno flow), Flow with heat addition (Rayleigh flow), Method of characteristics (application to one-dimensional unsteady isentropic flow). **(10)**

Module 5

Supersonic Flow: Velocity Potential Equation, Numerical Techniques for Steady Supersonic Flow, Time Marching Technique for Supersonic Blunt Bodies and Nozzles. **(10)**

Text Books:

1. Anderson, J.D Jr., Modern Compressible Flows, Tata McGraw Hill, 2012.
2. Yahya, S.M., Fundamentals of Compressible Flow, New age International Pub., 2013.
3. Zucrow, M., Gas Dynamics, Wiley India, 2013.

Mechanical Engineering			
ME721	**Power Plant Engineering**	**L**	**T**
		3	**0**

Objectives:
To provide an overview of power plants and the associated energy conversion issues.

DETAILED SYLLABUS

Module 1
Coal based thermal power plants, basic Rankine cycle and its modifications, layout of modern coal power plant, super critical boilers, FBC boilers, turbines, condensers, steam and heating rates, subsystems of thermal power plants, fuel and ash handling, draught system, feed water treatment, binary cycles and cogeneration systems. **(10)**

Module 2
Gas turbine and combined cycle power plants, Brayton cycle analysis and optimization, components of gas turbine power plants, combined cycle power plants, Integrated Gasifier based Combined Cycle (IGCC) systems. **(8)**

Module 3
Basics of nuclear energy conversion, Layout and subsystems of nuclear power plants, Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), CANDU Reactor, Pressurized Heavy Water Reactor (PHWR), Fast Breeder Reactors (FBR), gas cooled and liquid metal cooled reactors, safety measures for nuclear power plants. **(10)**

Module 4
Hydroelectric power plants, classification, typical layout and components, principles of wind, tidal, solar PV and solar thermal, geothermal, biogas and fuel cell power systems Energy. **(5)**

Module 5
Economic and environmental issues, power tariffs, load distribution parameters, load curve, capital and operating cost of different power plants, pollution control technologies including waste disposal options for coal and nuclear plants. **(10)**

Course Outcomes:
Upon completion of the course, the students can understand the principles of operation for different power plants and their economics.

Text Books:

1. Nag P.K., Power Plant Engineering, 3rd ed., Tata McGraw Hill, 2008.
2. El Wakil M.M., Power Plant Technology, Tata McGraw Hill, 2010.
3. Elliot T.C., Chen K and Swanekamp R.C., Power Plant Engineering, 2nd ed., McGraw Hill, 1998.

Mechanical Engineering			
ME722	**Finite Element Analysis**	**L**	**T**
		3	**0**

Objectives:

1. To illustrate the principle of mathematical modeling of engineering problems
2. To introduce the basics and application of Finite Element Method

DETAILED SYLLABUS

Module1

Historical Background, Mathematical modeling of field problems in engineering, governing equations, discrete and continuous models, boundary and initial value problems, Weighted Residual Methods, Variational formulation of boundary value problems, Ritz technique, Basic concept of Finite Element Method. **(10)**

Module2

One dimensional second order equation, discretization, linear and higher order elements,derivation of shape functions, Stiffness matrix and force vectors, assembly of elementalmatrices, solution of problems from solid mechanics and heat transfer, longitudinal vibrationand mode shapes, fourth order beam equation, transverse deflections and natural frequencies.

(12)

Module3

Two dimensional equations, variational formulation, finite element formulation, triangular elements- shape functions, elemental matrices and RHS vectors. **(6)**

Module 4

Application to thermal problems, torsion of non-circular shafts, quadrilateral and higher order elements. Planestresses and plane strain problems, body forces and thermal loads, plate and shell elements. **(8)**

Module 5

Natural coordinate systems, isoparametric elements and shape functions, numerical integration and application to plane stress problems, matrix solution techniques, solution of dynamic problems, introduction to FE software. **(6)**

Course Outcomes:

Upon completion of the course, students will understand the FEM formulation and itsapplication to simple structural and thermal problems

Text Books:

1. Reddy J.N., An Introduction to Finite Element Method, 3rd ed., Tata McGraw Hill, 2005.
2. Seshu P., Text Book of Finite Element Analysis, Prentice Hall, New Delhi, 2007.
3. Rao S.S., The Finite Element Method in Engineering, 3rd ed., Butterworth Heinemann,2004.
4. Chandraputla & Belegundu, Introduction to Finite Elements in Engineering, 3rd ed., Prentice Hall, 1990.

Mechanical Engineering			
ME723	**Tool Design**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Interpret the geometrical and dimensional details of a production drawing.
2. Understand principles of locating and clamping systems.
3. Design jigs and fixtures for conventional and NC machining
4. Select and design progressive, compound or combination dies for press working operations
5. Design single point and multipoint cutting tools

DETAILED SYLLABUS

Module 1

Basic principles of tool design: Tool design – An overview, Introduction to Jigs and fixtures.

Work holding devices: Basic principle of six point location, Locating methods and devices, Principle of clamping and Types of clamps. (10)

Module 2

Design of jigs: Type of Drill bushes, Classification of drill jigs, Design of drill jigs. (3)

Design of fixtures: Design of milling fixtures, Design of turning fixtures (3)

Module 3

Introduction of press tool design: Introduction to Die cutting operations, Introduction to press and classifications, Die set assembly with components, Introduction to Centre of pressure, Examples of centre of pressure, Design of piercing die, Design of blanking die, Progressive, Compound and Combination dies . (10)

Module 4

Design of cutting tools: Introduction to cutting tools, Design of single point tool, Design of drill bit, Design of milling cutter (4)

Module 5

Brief introduction of NC machines work holding devices: Tool design for NC machines- An introduction, Fixture design for NC Machine, Cutting tools for NC Machine, Tool holding methods for NC Machine, ATC and APC for NC Machine, Tool presetting for NC Machine. (10)

Text Books:

1. F.W.Wilson.F.W. "Fundamentals of Tool Design", ASME, PHI, New Delhi, 2010

2. Donaldson.C, G.H.Lecain and V.C.Goold "Tool Design", TMH, New Delhi, 2010

Mechanical Engineering			
ME731	**Mechanical Vibrations**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand the causes and effects of vibration in mechanical systems.
2. Develop schematic models for physical systems and formulate governing equations of motion.
3. Understand the role of damping, stiffness and inertia in mechanical systems
4. Analyze rotating and reciprocating systems and compute critical speeds.
5. Analyze and design machine supporting structures, vibration isolators and absorbers.

DETAILED SYLLABUS

Module 1

Introduction: Causes and effects of vibration, Classification of vibrating system, Discrete and continuous systems, degrees of freedom, Identification of variables and Parameters, Linear and nonlinear systems, linearization of nonlinear systems, Physical models, Schematic models and Mathematical models. (6)

Module 2

SDF systems: Formulation of equation of motion: Newton –Euler method, De Alembert's method, Energy method, (4)

Module 3

Free Vibration:: Undamped Free vibration response, Damped Free vibration response, Case studies on formulation and response calculation. (5)

Module 4

Forced vibration response: Response to harmonic excitations, solution of differential equation of motion, Vector approach, Complex frequency response, Magnification factor Resonance, Rotating/reciprocating unbalances, Force Transmissibility, Motion Transmissibility, Vehicular suspension, Vibration measuring instruments, Case studies on forced vibration. (6)

Module 5

Two degree of freedom systems: Introduction, Formulation of equation of motion: Equilibrium method, Lagrangian method, Case studies on formulation of equations of motion.

Free vibration response, Eigen values and Eigen vectors, Normal modes and mode superposition, Coordinate coupling, decoupling of equations of motion, Natural coordinates, Response to initial conditions, free vibration response case studies, Forced vibration response, undamped vibration absorbers, Case studies on undamped vibration absorbers. (10)

Module 6

Multi degree of freedom systems: Introduction , Formulation of equations of motion, Free vibration response, Natural modes and mode shapes, Orthogonally of model vectors, normalization of model vectors, Decoupling of modes, model analysis, mode superposition technique, Free vibration response through model analysis, Forced vibration analysis through model analysis, Model damping, Rayleigh’s damping, Introduction to experimental model analysis.

(6)

Module 7

Continuous systems: Introduction to continuous systems, Exact and approximate solutions, free vibrations of bars and shafts, Free vibrations of beams, Forced vibrations of continuous systems Case studies, Approximate methods for continuous systems and introduction to Finite element method. (4)

Text Books:

1. L. Meirovich, Elements of Vibration analysis, 2nd Ed. Tata Mc-Grawhill 2007
2. Reference Books:
3. Singiresu S Rao, Mechanical Vibrations. 4th Ed. , Pearson education 2011
4. W.T., Thompson, Theory of Vibration. CBS Publishers
5. Clarence W. de Silva , Vibration: Fundamentals and Practice, CRC Press LLC, 2000

Mechanical Engineering			
ME732	Convective Heat Transfer	L	T
		3	0

Course Outcomes: At the end of the course, the student will be able to:

1. Understand principles of forced and free convection heat transfer processes.
2. Formulate and solve convective heat transfer problems.
3. Estimate heat dissipation from heat transfer devices.
4. Evaluate energy requirements for operating a flow system with heat transfer.
5. Understand current challenges in the field of convective heat transfer.

DETAILED SYLLABUS

Module 1

Introduction: Course structure, Basics of Thermodynamics, Fluid mechanics and Heat transfer Fundamental Principles: Continuity, momentum and energy equations, Reynolds transport theorem, Second law of TD, Rules of Scale analysis, Concept of Heat line visualization. (8)

Module 2

Laminar forced convection: External flows: Boundary layer concept, velocity and thermal boundary layer, Governing equations, Similarity solutions, various wall heating conditions, Flow over sphere, wedge and stagnation flow. (8)

Module 3

Laminar forced convection: Internal flows: Fully developed laminar flow: Constant heat flux, Constant wall temperature, developing length. (4)

External Natural convection: Governing equations for natural convection, Boussinesq approximation, Dimensional Analysis, Boundary layer equations, Scale analysis, Low and high Prandtl number fluids, vertical walls, horizontal walls, sphere. (6)

Module 4

Internal Natural Convection: Natural convection in enclosures: isothermal and constant heat flux side walls, triangular enclosures, heated from below, inclined enclosures, annular space between horizontal cylinders. (8)

Module 5

Turbulent boundary layer flow: Boundary layer equations, mixing length model, flow over single cylinder, cross flow over array of cylinders, Natural convection along vertical walls, Turbulent duct flow. (6)

Text Books:

1. Bejan, A., Convection Heat Transfer, John Willey and Sons, New York, 2001.
2. Louis, C. Burmeister, Convective Heat Transfer, John Willey and Sons, New York, 2003.

3. Kays, W.M. and Crawford, M. E., Convective Heat and Mass Transfer, McGraw Hill, New York, 2001.

Mechanical Engineering			
ME733	**Micro and Nano Manufacturing**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand manufacturing considerations at the micro and nano scale.
2. Understand design-and-analysis methods and tools used for micro and nano manufacturing
3. Select manufacturing methods, techniques and process parameters for material processing quality
4. Design and select industrially-viable processes, equipment and manufacturing tools for specific industrial products

DETAILED SYLLABUS

Module 1

Introduction: Importance of Nano-technology, Emergence of Nanotechnology, Bottom-up and Top-down approaches,, challenges in Nanotechnology.

Nanomaterials Synthesis and Processing: Methods for creating Nanostructures; Processes for producing ultrafine powders- Mechanical grinding; Wet Chemical Synthesis of nanomaterials- sol-gel process, Liquid solid reactions; Gas Phase synthesis of nanomaterials- Furnace, Flame assisted ultrasonic spray pyrolysis; Gas Condensation Processing(GPC), Chemical Vapour Condensation(CVC)- Cold Plasma Methods, Laser ablation, Vapour – liquid –solid growth, particle precipitation aided CVD, summary of Gas Condensation Processing(GPC). (11)

Module 2

Structural Characterization: X-ray diffraction, Small angle X-ray Scattering, Optical Microscope and their description, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). (9)

Module 3

Spectroscopic characterizations: Basic concepts of spectroscopy, operational principle and application for analysis of nanomaterials, UV-VIS-IR Spectrophotometers, Principle of operation and application for band gap measurement, Raman spectroscopy.

Surface Characterization: X-ray Photoelectron Spectroscopy (XPS), Auger electron spectroscopy, Low Energy Ion Scattering Spectroscopy (LEISS), Secondary Ion Mass Spectroscopy (SIMS), Rutherford Backscattering Spectroscopy (RBS). (10)

Module 4

Thermal Characterization of Nanomaterials: DTA, TGA, DSC (Principle and Applications), Determination of thermo physical parameters.

Microfabrication Techniques: Lithography, Thin Film Deposition and Doping, Etching and Substrate Removal, Substrate Bonding. MEMS Fabrication Techniques, Bulk Micromachining, Surface Micromachining, High- Aspect-Ratio Micromachining. (6)

Module 5

Nanofabrication Techniques: E-Beam and Nano-Imprint Fabrication, Epitaxy and Strain Engineering, Scanned Probe Techniques, Self-Assembly and Template Manufacturing.

MEMS devices and applications: Pressure sensor, Inertial sensor, Optical MEMS and RF-MEMS, Micro-actuators for dual-stage servo systems. (4)

Text Books:

1. Mark James Jackson, Microfabrication and Nanomanufacturing, CRC Press, 2005.
2. Gabor L. Hornyak, H.F Tibbals, Joydeep Dutta & John J Moore, Introduction to Nanoscience and Nanotechnology, CRC Press, 2009.
3. Ray F. Egerton , Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM , Springer, 2005.
4. Robert F Speyer, Thermal Analysis of Materials, Marcel Dekker Inc, New York, 1994. 5. B.D. Cullity - Elements of X-Ray Diffraction, 3rd edition, Prentice Hall , 2002.
5. Tai-Ran Hsu, “MEMS and Microsystems: Design and Manufacture,” McGraw- Hill, 2008.

Mechanical Engineering			
ME734	**Energy Systems and Management**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand principles of energy management and its influence on environment.
2. Comprehend methods of energy production for improved utilization.
3. Improve the performance of thermal systems using of energy management principles
4. Analyze the methods of energy conservation for air conditioning, heat recovery and thermal energy storage systems.
5. Evaluate energy projects on the basis of economic and financial criteria.

DETAILED SYLLABUS

Module 1

Introduction to Thermodynamics, Fluid Flow and Heat Transfer

Heat transfer media: Water, steam, Thermal fluids, Air-water vapour mixtures. (8)

Module 2

Heat transfer equipment: Heat exchangers, Steam plant

Energy storage systems: Thermal energy storage methods, Energy saving, Thermal energystorage systems (10)

Module 3

Energy conversion systems: Furnaces, turbines

Heat recovery systems: Incinerators, regenerators and boilers

Energy Management: Principles of Energy Management, Energy demand estimation, Organising and Managing Energy Management Programs, Energy pricing. (10)

Module 4

Energy Audit: Purpose, Methodology with respect to process Industries, Characteristic method employed in Certain Energy Intensive Industries. (8)

Module 5

Economic Analysis: Scope, Characterization of an Investment Project, Case studies. (5)

Text Books:

1. Turner, W. C., Doty, S. and Truner, W. C., Energy Management Hand book, 7th edition, Fairmont Press, 2009.
2. De, B. K., Energy Management audit & Conservation, 2nd Edition, Vrinda Publication, 2010.
3. Murphy, W. R., Energy Management, Elsevier, 2007.
4. Smith, C. B., Energy Management Principles, Pergamon Press, 2007.

Mechanical Engineering			
ME735	**Condition Monitoring**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Understand and apply maintenance schemes in industries.
2. Monitor condition of rotating machinery using signature, temperature and corrosion analysis.
3. Apply oil analysis technique to diagnose the wear debris.
4. Understand modern technologies for effective plant maintenance.

DETAILED SYLLABUS

Module 1

Introduction: Failures – System, component and services failures – classification and its causes, Maintenance Schemes – objectives – types and economic benefits, break down, preventive and predictive monitoring. (8)

Module 2

Vibration Monitoring – causes and effects of vibration, review of mechanical vibration concepts – free and forced vibrations, vibration signature of active systems – measurement of amplitude, frequency and phase. (5)

Module 3

Vibration monitoring equipment– vibration sensors (contact and non-contact type) –factors affecting the choice of sensors, signal conditioners, recording and display elements, vibration meter and analyzers, measurement of overall vibration levels. (6)

Module 4

Contaminant analysis: Contaminants in used lubricating oils – monitoring techniques (wear debris) – SOAP technique, Ferrography, X-ray spectrometry, Particle classification.

Temperature Monitoring – Various techniques – thermograph, pyrometers, indicating paint and NDT methods. (11)

Module 5

Special Techniques: Ultrasonic measurement method, shock pulse measurement, Kurtosis, Acoustic Emission mentoring, critical speed analysis, shaft orbit analysis, Cepstrum analysis. Non-destructive techniques, Structural health monitoring weldments for surface and subsurface cracks. (10)

Text Books:

1. Rao J. S., Vibration Condition Monitoring, Narosa Publishing House, 2/e 2000.
2. Isermann R., Fault Diagnosis Application, Springer-Verlag Berlin, 2011.
3. Allan Davis, Hand book of Condition Monitoring, Chapman and Hall, 2000.
4. Choudary K K., Instrumentation, Measurement and Analysis, Tata McGraw Hill.
5. Collacott, R. A., Mechanical Faults Diagnosis, Chapman and Hall, London, 1990

Mechanical Engineering			
ME741	**Rapid Prototyping**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Identify suitable time compression techniques for rapid product development.
2. Model complex engineering products and develop process plans for rapid production.
3. Analyse and select a rapid manufacturing technology for a given component.
4. Identify the errors during generation of STL files and minimize them.
5. Optimize FDM process parameters to improve the quality of the parts.

DETAILED SYLLABUS

Module 1

Introduction: Introduction to Prototyping, Traditional Prototyping Vs. Rapid Prototyping (RP), Need for time compression in product development, Usage of RP parts, Generic RP process, Distinction between RP and CNC, other related technologies, Classification of RP. (5)

Module 2

RP Software: Need for RP software, MIMICS, Magics, SurgiGuide, 3-matic, 3D-Doctor, Simplant, Velocity2, VoXim, SolidView, 3DView, etc., software, Preparation of CAD models, Problems with STL files, STL file manipulation, RP data formats: SLC, CLI, RPI, LEAF, IGES, HP/GL, CT, STEP.

Photopolymerization RP Processes: Stereolithography (SL), SL resin curing process, SL scan patterns, Microstereolithography, Applications of Photopolymerization Processes. (9)

Module 3

Powder Bed Fusion RP Processes: Selective laser Sintering (SLS), Powder fusion mechanism and powder handling, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Applications of Powder Bed Fusion Processes.

Extrusion-Based RP Systems: Fused Deposition Modelling (FDM), Principles, Plotting and path control, Applications of Extrusion-Based Processes. (6)

Module 4

Printing RP Processes: 3D printing (3DP), Research achievements in printing deposition, Technical challenges in printing, Printing process modelling, Applications of Printing Processes.

Sheet Lamination RP Processes: Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. (6)

Module 5

Beam Deposition RP Processes: Laser Engineered Net Shaping (LENS), Direct Metal Deposition (DMD), Processing-structure-properties, relationships, Benefits and drawbacks.

Rapid Tooling: Conventional Tooling Vs. Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect Tooling Methods, Soft and Hard Tooling methods. (6)

Module 6

Reverse Engineering: Reverse Engineering (RE) Methodologies and Techniques, Selection of RE systems, RE software, RE hardware, RE in product development.

Errors in RP Processes: Pre-processing, processing, post-processing errors, Part building errors in SLA, SLS, etc.

RP Applications: Design, Engineering Analysis and planning applications, Rapid Tooling, Reverse Engineering, Medical Applications of RP. (6)

Text Books:

1. Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, Rapid Prototyping: Principles and Applications in Manufacturing, World Scientific, 2010.
2. Ian Gibson., David W Rosen., Brent Stucker., Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.
3. RafiqNoorani, Rapid Prototyping: Principles and Applications in Manufacturing, John Wiley & Sons, 2006.

Mechanical Engineering			
ME742	**Industrial Automation**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the student will be able to:

1. Enumerate principles, strategies and advantages of industrial automation.
2. Select level of automation and calculate manpower requirement.
3. Design material handling and material storage systems for an automated factory.
4. Automate shop floor controls and part/device identification methods.
5. Study the effect of automation by simulation and experimentation.

DETAILED SYLLABUS

Module 1

Principles and Strategies of Automation-Power to Accomplish the Automated Process, program of Instruction, Control System, Advanced automation Functions-safety Monitoring, maintenance and repair Diagnostics, error Detection and Recovery, levels of automations-Five levels of automation and control in manufacturing. (10)

Module 2

Material Handling systems and Design-Introduction to Material Handling, Material Transport Equipment, analysis of Material Transport Systems, Storage systems-Storage System Performance and Location Strategies, Conventional Storage Methods and Equipment. (10)

Module 3

Automation Storage Systems, Engineering Analysis of Storage Systems.

Automatic identification methods-Overview of Automatic Identification Methods, Bar Code Technology, Radio Frequency Identification, Other AIDC Technologies. (6)

Module 4

Industrial control systems-Process Industries Vs Discrete Manufacturing Industries, Levels of Automation in the two industries, Variables and Parameters in the two industries.

Continuous Vs Discrete control- Continuous Control System, Discrete Control System.

Computer process control and its forms- Control Requirements, Capabilities of Computer Control, and Forms of Computer process Control. (10)

Module 5

Control system components-Sensors, Actuators, Analog-to-Digital Convertors, Digital-to-Analog Convertors, Input/output Devices for Discrete Data. (4)

Text Books:

1. Groover, M.P., Automation production Systems and Computer Integrated Manufacturing, Pearson Education, 2003.
2. Krishna Kant, Computer Based Industrial Control, Prentice Hall of India, New Delhi, 2000.
3. Tiess Chiu Chang and Richard A.W., An Introduction to Automated Process planning Systems, Tata McGraw-Hill Publishing company, New Delhi, 2000.

Mechanical Engineering			
ME743	**Technology Management**	**L**	**T**
		3	**0**

Objectives: In the Management of Technology programme the students learn to explore andunderstand technology as a corporate resource - a resource that allows a firm to keep many differentballs in the air. It shows how firms can use technology to design and develop products and servicesthat maximize customer satisfaction on the one hand, while maximizing corporate productivity,profitability and competitiveness on the other.

Outcomes: The programme addresses challenging questions most companies face such as:

1. What technologies do we need and when?
2. Do we procure the technology we need with our own research capabilities, in collaborationwith outside parties, or by acquiring it or licensing it from others?
3. How can we use the abundant technological opportunities to affect our mission, objectives and strategies?

DETAILED SYLLABUS

Module 1: Introduction to Technology Management

Definition, Concept of creativity, Components, Features, Classification of Technology, Concept andNature of Technology Management, Drivers of MOT, Significance and Scope of MOT, Role ofChief Technology Officer, Responding to Technology challenges. (8)

Module-2: The Role of Technology in the Creation of Wealth

The creation of wealth, Long-wave cycle, Evolution of production technology, Critical Factors inManaging Technology: The creativity factor, Types of innovation, Technology, price relationship,Managing change. (6)

Module 3: Management of Technology

The New Paradigms Essential issues in technology management, Project planning and management,Management paradigm and the technology factor. (4)

Module-4: Technology Life Cycles

S-curve of technological progress, Multiple generation technologies ,Diffusion of technology (2)

Module-5: The Process of Technological Innovation

Innovation and creative transformation in the knowledge age: critical trajectories, Case-Xerox, Amodel for technological innovation in biomedical devices. (5)

Module-6: Strategic planning

Competitiveness, Business Strategy and Technology Strategy, Technology Planning. TheAcquisition and Exploitation of Technology: Acquisition of technology. Exploitation of technology,Stages of technology development, Technology Transfer (6)

Module-7: Technology Diffusion

Concept of Diffusion, Integrated Diffusion Strategy, Influencing factors, Innovation adoption, Diffusion strategies, Community effects and network externalities, Distribution of Adopters,Crossing the Chasm, Market dynamics.Technology Absorption and Deployment, Technology Absorption, Influencing factors, Deploymentstrategies, Corporate Venturing, Benefits and Drawbacks of Corporate Venturing, Spin-offCompanies. (9)

Text Book:

1. Management of Technology by Tarek Khalil.
2. Rastogi P.N: “Management of Technology and Innovation”, Sage Publications, New Delhi, 2009.
3. Scott Shane: “Technology Strategy for Managers and Entrepreneurs”, Pearson Education, New Delhi, 2009.
4. CSG Krishnamacharyulu, Lalitha Ramakrishnan, “Management of Technology”, Himalaya, Publishing House Private Limited, New Delhi, 2008.

Mechanical Engineering			
ME744	**Computer Aided Manufacturing**	**L**	**T**
		3	**0**

Objectives

1. This course introduces students with computer assisted modern manufacturing technologies.
2. The objective of this course is to make students learn the important theoretical concepts, and the state-of-the-art technological developments in the area of modern manufacturing.
3. Various topics to be covered are basics of automation, NC programming (Manual and APT),
4. concepts of group technology, Flexible Manufacturing system, CIM and robotics.

Outcomes: Student will be able to:

1. Understand the current status of CAM systems in industry.
2. Learn the concepts of group technology, automation, FMS and CIM.
3. To write manual part programs using G and M codes for lathe and milling m/c.
4. To write APT part programs milling m/c.

DETAILED SYLLABUS

Module 1

Automation: Definition of Automation, Need for Automation, building block of automationtechnology, Types of automation systems, Automation strategies, levels of automation, types of control system, Advantages, Disadvantages and applications of Automation. (8)

Module 2

NC, CNC and Adaptive control: Introduction, history, components of NC machines, classificationof NC machines, input media for NC machines, microprocessor based CNC systems, block diagramof a typical CNC system, features of CNC, advantages of CNC, direct numeric control (DNC) and itsadvantages, Adaptive control and its types. (10)

Module 3

Part programming: Introduction, NC coordinate system, fixed and floating zero machines, NC motion control systems, part programming methods, Manual part programming for milling and latheusing G and M codes, various canned cycles, Computer aided part programming: Introduction toAPT language, simple problems on APT programming. (10)

Module 4

Group Technology: Introduction, part families, part classification and coding, production flow analysis, composite part concept, machine cell design, benefits of GT. (4)

Module 5

FMS and CIM: Concept and definition of Flexible Manufacturing System (FMS), components ofFMS, FMS workstations, Automated material handling and storage systems, Automated storage andretrieval system and Industrial robots, FMS layout and benefits, Introduction and concept ofComputer Integrated manufacturing (CIM) through CIM wheel. (8)

Text books:

1. Groover M. P., Automation, Production Systems And Computer-integrated Manufacturing, PHI.
2. Kundra, Rao and Tiwari., Computer Aided manufacturing, Tata McGraw Hill Publishers.

Reference books:

1. Steve Krar, Arthur Gill, “CNC technology and programming”, McGraw-Hill, 1990
2. James Madison, “CNC machining hand book”, Industrial Press Inc., 1996
3. Jha, N. K., Handbook of Flexible Manufacturing Systems, Academic Press Inc.
4. Miller R. K., FMS/CIM Systems Integrated Handbook, Prentice Hall.

Mechanical Engineering			
ME745	**Maintenance Engineering & Management**	**L**	**T**
		3	**0**

Objectives:

1. To keep asset in productivity and availability state based on requirement level of reliability and effectiveness.
2. To spend optimal maintenance cost in relation to achieve the availability and effectiveness of equipments.
3. To prevent or reduce the likelihood or frequency of failures of engineering components and systems.
4. To increase the quality, quantity of the product with minimal cost and increase the productivity of the plant.
5. To identify and correct the causes of failures that does occur in engineering system.

Outcomes: Student will be able to:
1. Maintenance management skill
2. Need of safety devices
3. Increase the productivity of the plant at minimal cost
4. Failure analysis of plant machineries
5. Concept of tribology, conditioning monitoring
6. Concept of maintainability and availability of mechanical components and systems.

DETAILED SYLLABUS

Module 1

Introduction: Fundamentals of Maintenance Engineering, Maintenance engineering its importance in material &energy conservation, Inventory control, Productivity, Safety, Pollution control, Safety Regulations,Pollution problems, Human reliability. (8)

Module 2

Maintenance Management: Types of maintenance strategies, Planned and unplanned maintenance, Breakdown, Preventive &Predictive maintenance their comparison, Computer aided maintenance, Maintenance scheduling,Spare part management, Inventory control, TPM.

(8)

Module 3

Tribology In Maintenance: Friction wear and lubrication, Friction & wear mechanisms, Prevention of wear, Types of lubricationmechanisms, Lubrication processes. Lubricants types, General and special purpose, Additives,Testing of lubricants, Degradation of lubricants, Seal & packing. (8)

Module 4

Machine Health Monitoring: Condition based maintenance, Signature analysis, Oil analysis, NDT, Vibration, Noise and thermalsignatures, On line & off line techniques, Instrumentation &

equipment used in machine healthmonitoring. Instrumentation in maintenance, Signal processing, Data acquisition and analysis,Application of intelligent systems, Data base design.

(8)

Module 5

Reliability, Availability & Maintainability (RAM) Analysis: Introduction to RAM failure mechanism, Failure data analysis, Failure distribution, Reliability ofrepairable and non-repairable systems, Improvement in reliability, Reliability testing, Reliabilityprediction, Utilization factor, System reliability by Monte Carlo Simulation Technique. (8)

Text Books:

1. Krishnan Gopal and Banerji S. K., Maintenance & Spare parts Management, PHI
2. Mishra R. C. and Pathak K., Maintenance Engineering and Management, PHI
3. Shrivastava S.K., Industrial Maintenance Management, S. Chand Publications.
4. Rao C. N. R., Handbook of Condition Monitoring,.
5. Banga and Sharma, Industrial Engineering & Management Science, Khanna Publishers.

Reference Books:

1. Higgins L., Mobley R. K. and Mobley K., Maintenance Engineering Hand Book, Mc-Graw Hill, 7th edition.
2. Higgins L., Mobley R. K. and Mobley K., Maintenance Engineering Standard Hand Book, Mc-Graw Hill, 6th edition

ELECTRICAL ENGINEERIG

Electrical Engineering			
EE701	**Protection of Power Apparatus and System**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO1: **Analyze** the need of power system protection and **classify** the different types of relay and their operating principle.
CO2: **Distinguish** the difference between the distribution line protection and transmission line protection.
CO3: **Explain** the protection of generator, busbar and transformer and its limitations.
CO4**: Select** the different kind of circuit breaker based on their application.
CO5: **Choose** different type of protective devices against overvoltage as well as for earthing purpose.

CO-PO Mapping Matrix:

Enter correlation levels 1, 2 or 3 as defined below-

1. Slight (low)   2. Moderate (Medium)   3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2								1
CO2	3	2		2								1
CO3	2	1		2								1
CO4	3	3		3								1
CO5	3	3		2	3							1
Avg.	**2.8**	**2.4**		**2.2**	**3**							**1**

DETAILED SYLLABUS

Module – I **(5 Lectures)**

Basic concept & components of power system protection, types of relays-their operating principles, characteristics and their uses, Introduction to static relays and its advantages over electromagnetic relays.

Module – II **(8 Lectures)**

Protection of Alternators: Protection of generators against Stator faults, Rotor faults, and abnormal Conditions. Restricted earth fault and Inter-turn fault Protection. Numerical problems on % winding unprotected.

Module-- III **(8 Lectures)**

Protection of transformers: Percentage Differential Protection, Numerical Problem on Design of CT's Ratio, Buchholz relay Protection.

Module – IV **(8 Lectures)**

Protection of Lines: Over Current, Carrier Current and Three - zone distance relay protection using Impedance relays. Translay relay. Protection of Bus bars –differential Protection.

Module – V **(8 Lectures)**

Theory of arc interruption, types of circuit breakers – air, air-blast, minimum oil, vacuum & SF6, resistance switching, current chopping, auto-reclosing, circuit breaker ratings.

Protection against lightning over voltages - valve type and zinc - oxide lighting arresters,

Module – VI **(5 Lectures)**

Grounded and ungrounded neutral systems, methods of neutral grounding: solid, resistance, reactance, resonant grounding.

Text Books

[1]. Badri Ram, D. Vishwakarma, "Power System Protection and Switchgear", McGraw Hill, 2nd Edition.
[2]. Y.G. Paithankar, S.R. Bhide, "Fundamentals of Power System Protection", PHI, 2nd Edition
[3]. BhuvaneshOza, Nirmal-Kumar Nair, Rashesh Mehta, Vijay Makwana, "Power System Protection & Switchgear, McGraw Hill, 1st Edition.

Reference Books

[1]. Stanley H. Horowitz, Arun G. Phadke, James K. Niemira, "Power System Relaying", Wiley, 4th Edition.
[2]. R. van C. Warrington, "Protective Relays Their Theory and Practice", Springer, 1st Edition.

Electrical Engineering			
EE711	**Electrical Drives and Control**	**L**	**T**
		3	**0**

Course Outcomes: After successful completion of the course students will be able to:

COs-POs Mapping:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1								1
CO2	3	3	1	1								1
CO3	3	3	2	1								1
CO4	3	3	3	1								1
CO5	3	3	3	1								1
Avg.	**3**	**3**	**2.25**	**1**								**1**

DETAILED SYLLABUS

Module – I: Introduction to Electrical Drives (9 Lectures)

Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Multi quadrant operation of drives. Load equalization.

Module – II: Starting and Braking of Electrical Drives (9 Lectures)

Effect of starting on Power supply, motor and load. Methods of stating of electric motors. Acceleration time Energy relation during stating, methods to reduce the Energy loss during starting. Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking.

Module – III: Solid State Speed Control of DC Motor (7 Lectures)

Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. DC chopper drives.

Module – IV: Solid State Speed Control of Induction Motor (7 Lectures)

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications, Static Scherbius drive, Static Kramer drive.

Module-V: Synchronous Motor Drive (10 Lectures)

Synchronous motor V/f control, Cycloconverter control, self-controlled synchronous motor drive. Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

Text Books

[1]. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
[2]. Electric Drives, Vedam Subrahmanyam, TMH
[3]. A first course on Electrical Drives, S.K. Pillai, New Age International Publication.

Reference Books

[1]. Electric motor drives, R. Krishnan, PHI
[2]. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
[3]. Electric Motor & Drives. Austin Hughes, Newnes.

Electrical Engineering			
EE712	**Utilization of Electrical Power**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO's	CO Description
CO1	**Classify electric** drives and their specific application in industry.
CO2	**Explain** the operation of electric traction, energy consumption and it's advantages.
CO3	**Make use of** electric heating based on induction principle.
CO4	**List** different light sources and illumination parameters.
CO5	**Demonstrate** electrolytic process and **design** motor control circuit.

CO's-PO's Mapping Matrix:

Enter correlation levels 1, 2 or 3 as defined below

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	3							1
CO2	3	2	2				2					1
CO3	3	2	2		2							1
CO4	3	2	2									1
CO5	3	2	2	2	2							1
Avg.	**3**	**2**	**2**	**2**	**2.33**		**2**					**1**

DETAILED SYLLABUS

Module I: Industrial Drives (12 Lectures)

Characteristics of electrical motors and their particular application for industrial drives. Motor enclosures, bearing, transmission of drives, choice of motor, motor used for lifts, cranes and general purpose machines, typical application in sugar, textile, paper and steel industries. Motors used in mining operations, rating of electric motors, calculation of size load equation of flywheels electric breaking; plugging, dynamic and regenerative breaking, breaking current, torque, speed time curves (number of revolutions made before stop)

Module II: Electrical Traction (10 Lectures)

General features and systems of track electrification, Tractive effort calculation of traction motors, traction motor control (series-parallel control).

Track equipment and collection gear, train movement, speed-time curve, Specific Energy Consumption (SEC) and factors affecting it.

Module III: Electric Heating **(5 Lectures)**
Introduction – Classification of methods of electric heating – Requirements of a good heating material – Design of heating element – Temperature control of resistance furnace – Electric arc furnace – Induction heating.

Module IV: Welding and Illumination **(13 Lectures)**
Dielectric heating – Electric welding – Resistance welding – Electric arc welding. Sources of light, incandescent and fluorescent lamps, Lighting Fittings, reflection factor illumination, calculation, solid angle, candle power, units of light and illumination, power curves, M. H. C. P and M. S. C. P. Illumination level and its measurement coefficient of utilization, waste light factor, illumination calculations for building and playgrounds, flood lighting, industrial lighting, Street lighting.

Module V **(2 Lectures)**
Electrolytic process and motor control circuit

Text Books:

[1]. "A first course on Electric Drives", S.K.Pillai, Wiley Eastern Ltd.
[2]. "Utilization of Electrical Energy", (S.I. Units), E.Open Shaw Taylor and V.V.L.Rao, Orient Long man.
[3]. "Generation, Distribution and Utilization of Electrical Energy", C.L. Wadhwa; Wiley Eastern Ltd.

Electrical Engineering			
EE713	Power System Dynamics and Control	L	T
		3	0

Course Outcomes:

After successful completion of the course student will be able to:

COs	CO Description
CO1	**Outline** basic concepts of synchronous machine and its modeling
CO2	**Model** excitation systems, prime-mover, transmission line and load
CO3	**Apply** the concept of equal area criteria and critical clearing angle to transient stability of the machine.
CO4	**Explain** various methods for transient stability improvement
CO5	**Classify** voltage stability and outline its modeling requirements

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1										1
CO2	2	2										1
CO3	2	2	2									1
CO4	2	1	1									1
CO5	2	2										1
Avg.	**2**	**1.6**	**1.5**									1

DETAILED SYLLABUS

Module I **(12 Lectures)**

A review of synchronous machine (cylindrical rotor and salient pole), Equations, Phasor diagrams under steady state and transient condition.

Meaning of stability in power system, explanation of steady state and transient stability, development of swing equations for a multi machine system; assumptions generally made for solution of swing equation**.**

Module II **(10 Lectures)**

Synchronous machine modeling: sub- transient model , two axis model , one axis (flux decay) model , classical model .

Excitation systems modeling: DC excitation, AC excitation and static excitation. Prime mover and energy supply systems modeling. Transmission line modeling, load modeling.

Module III **(10 Lectures)**

Equal area criterion for a two machine system without and including transmission losses; pre-determined swing curves; application of equal area criteria to understand the effect of various factors on transient stability limit. equal area criterion, critical clearing angle, application of critical clearing angle to transient stability of synchronous machine.

Module IV **(5 Lectures)**

Methods of improving transient stability: reducing fault clearance time, automatic reclosing, single phase reclosing, electric braking, voltage regulators, fast governor action, high speed excitation system.

Module V **(5 Lectures)**

Classification of voltage stability, modeling requirement s of voltage stability analysis: static and dynamic, sensitivity analysis, modal analysis, voltage collapse, prevention of voltage collapse.

Text Books:

[1]. P. Kundur, 'Power System Stability and Control', McGraw Hill Inc, New York, 1995.
[2]. Edward Wilson Kimbark, "Power System Stability, Volumes I, II, III," Wiley-IEEE Press, 1995.

Reference Books:

[1]. K.R.Padiyar, "Power System Dynamics, Stability & Control", 2nd Edition, B.S. Publications, Hyderabad, 2002.
[2]. P.Sauer&M.A.Pai, "Power System Dynamics & Stability", Prentice Hall, 1997.

Electrical Engineering			
EE714	**Power Quality**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course students will be able to:

COs	CO Description
CO1	To understand the various power quality issues.
CO2	Evaluate the power quality indices used in industrial power system.
CO3	Understand various mitigation techniques for compensating devices to improve the power quality.
CO4	Simulate the compensating devices to improve the power quality

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	2	1	-	1	-	2
CO2	2	-	3	2	-	2	-	-	-	-	-	-
CO3	2	3	-	2	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	2		-	2	-	-	2
Avg.	**2**	**3**	**3**	**2.33**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**

DETAILED SYLLABUS

Module - I: Overview of Power Quality (10 Lectures)
Classification of power quality issues, characterization of electric power quality, power acceptability curves – power quality problems: poor load power factor, non linear and unbalanced loads, dc offset in loads, notching in load voltage, disturbance in supply voltage, flicker, transient phenomenon, voltage fluctuations, sags/swells, voltage unbalance, power quality indices, distortion index, C-message index, IT product, IEEE guides and recommended practices.

Module- II: Measurement and Analysis Methods (8 Lectures)
Voltage, current, power and energy measurements, power factor measurement and definitions, time domain methods, Instantaneous Reactive Power Theory, Synchronous Frame Theory, Synchronous Detection Method, instantaneous symmetrical components, Instantaneous real and reactive powers

Module- III: Harmonics & Voltage Fluctuations (8 Lectures)
Sources and effect of harmonics and inter harmonics, voltage fluctuations, flicker and impulses, flicker calculations, effect of voltage fluctuations and impulses, occurrence and causes of voltage unbalance, standardization, decomposition into symmetrical components.

Module IV: Power Quality Improvement-I **(8 Lectures)**

Utility- Customer interface, harmonic filter: passive, active and hybrid filter, compensation using shunt devices-DSTATCOM, voltage regulation using DSTATCOM, principle, working and construction, algorithms for control of DSTATCOM, some case study examples.

Module V: Power Quality Improvement-II **(8 Lectures)**

Series compensation, protecting sensitive loads using DVR, principle, working construction and control schemes for DVR, hybrid devices –UPQC, principle, working and construction, some case study examples.

Text /reference Books:

[1]. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh, Gerard Ledwich, Springer, 2009

[2]. Power Quality: VAR Compensation in Power Systems R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2008

[3]. Understanding Power Quality Problems: Voltage Sags and Interruptions, Math H.J. Bollen, Wiley India Pvt Ltd, 2011.

[4]. Power Quality: Mitigation Technologies in a Distributed Environment,A Moreno Munoz, Springer India Private Limited 2007.

[5]. Power System Quality Assessment J.Arrillaga, N.R.Watson, S.Chen, Wiley India Pvt Ltd, 2011.

Electrical Engineering			
EE721	**High Power Converters**	**L**	**T**
		3	**0**

Prerequisite: Power Electronics

Course Outcomes:

After successful completion of course, the students will be able to:

COs	Description
CO 1	**Analyze** controlled rectifier circuits.
CO 2	**Explain** in basic operation and compare the performance of various power semiconductor devices and switching circuits.
CO3	**Design** and **analyze** power converter circuits and learn to select suitable power electronic devices and assessing the requirements of applications field.
CO 4	**Illustrate** the operation of line-commutated rectifiers–6 pulse and multi-pulse configurations.
CO 5	**Explain** the operation of PWM rectifiers–operation in rectification and regeneration modes and lagging, leading and unity power factor mode.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	2	1							
CO2	1	3	1	2								
CO3	1	1	2	2	1							
CO4	2	2		1	2							
CO5	2	1	2	1	2							
Avg.	**1.8**	**1.6**	**1.5**	**1.6**	**1.5**							

DETAILED SYLLBUS

Module I: Diode rectifiers with passive filtering (6 Lectures)

Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current wave shape, effect of source inductance; commutation overlap.

Module II: Thyristor rectifiers with passive filtering (6 Lectures)

Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

Module III: Multi-Pulse converter (8 Lectures)

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

Module IV: Single-phase AC-DC single-switch boost converter (6 Lectures)
Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module V: AC-DC bidirectional boost converter (6 Lectures)
Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Module VI: Isolated single-phase AC-DC flyback converter (10 Lectures)
DC-DC flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure

Text / References Books:

[1]. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.

[2]. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics", Addison-Wesley, 1991.

[3]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

[4]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.

[5]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2001

Electrical Engineering			
EE722	**HVDC Transmission and Facts**	**L**	**T**
		3	**0**

Prerequisite: Power Electronics, Power System-II

Course Outcome:-

After successful completion of the course, the students will be able to:

COs	CO Description
CO1	**Compare** HVDC and EHVAC transmission systems
CO2	**Analyze** converter configurations used in HVDC and evaluate the performance metrics.
CO3	U**nderstand** controllers for controlling the power flow through a dc link and compute filter Parameters
CO4	**Apply** impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems with FACTS controller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	2	3	-	-	2	1	2	2	-	-	-	2
CO2	1	2	-	1	2	2	2	-	-	-	2	-
CO3	-	3	-	2	2	-	-	-	-	-	-	2
CO4	-	3	-	3	3	2	1	-	-	-	-	-
Avg.	**1.5**	**2.75**	**-**	**2**	**2.25**	**1.67**	**1.67**	**2**	**-**	**-**	**2**	**2**

DETAILED SYLLABUS

Module I: HVDC Power Transmission Technology **(4 Lectures)**

Evolution of HVDC transmission, Comparison of HVDC & HVAC system, Economics of power transmission, Technical performance, Reliability, Applications of HVDC transmission, Types of HVDC transmission links, Components of Converter station, Planning for HVDC transmission, Operating problems in HVDC system.

Module II: Analysis of HVDC converter **(7 Lectures)**

Introduction, Types of converters, Line commutated converter, Analysis of Line commutated converter, Choice of converter configuration for any pulse number, Analysis of voltage source converter, Basic 2-level Graetz bridge converter, 3 level voltage source converter, Converter charts.

Module III: HVDC System control **(7 Lectures)**

Principles of HVDC control links, Converter control characteristics, Control schemes & control comparisons, Firing angle control, current & Extinction angle control, Energization & de-energization of bridges, Starting & stopping of DC links, power control. Effects of Harmonics, sources of harmonic generation, Types of filters–Design examples

Module- IV: Flexible AC Transmission Systems (FACTS) **(5 Lectures)**

FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters.

Module V: Static Shunt Compensators (8 Lectures)

Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics.

Module VI: Static Series Compensators (6 Lectures)

Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control.

Module VII: Combined Compensators (5 Lectures)

Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power

Text Books:

[1]. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011

[2]. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.

[3]. Narain G.Honorani, Laszlo Gyugyi: Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems, Wiley-IEEE Press, 2000.

[4]. Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems, The Institution of electrical Engineers, 1999.

Reference Book:

[1]. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley Inter science, 1971.

Electrical Engineering			
EE723	**Smart Grid Technology**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** features of Smart Grid in the context of Indian Grid
CO2	**Assess** the role of automation in Transmission/Distribution
CO3	**Apply** Evolutionary Algorithms for the Smart Grid/Distribution Generation.
CO4	**Understand** operation and importance of PMUs, PDCs, WAMS, Voltage and Frequency control in Micro Grids

CO's- PO's Mapping:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	2	2	-	1	-	-	-	-	-	-
CO2	3	2	2	2	-	2	-	-	1	-	-	-
CO3	3	2	2	2	-	2	-	-	2	-	-	-
CO4	3	2	2	2	-	2	-	-	1	-	-	-
Avg.	**3**	**2**	**2**	**2**		**1.75**			**1**			

DETAILED SYLLABUS

Module I: **(5 Lectures)**

Introduction to Smart Grid, Architecture of Smart Grid System, Standards for Smart Grid System, Elements and Technologies of Smart Grid System.

Module II **(14 Lectures)**

Communication Technologies for Power System: Fiber Optical Networks, WAN base on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Zigbee. Information System for Control Centers (ICCS): ICCS Configuration, ICCS communication Network, ICCS Time Synchronization. E-Commerce of Electricity, GIS, GPS.

Module III **(8 Lectures)**

Integration, Control and Operation of Distributed Generation: Distributed Generation Technologies and its benefits, Distributed Generation Utilization Barriers, Distributed Generation integration to power grid.

Module IV: **(12 Lectures)**

Monitoring the smart grid: Load dispatch centers, wide-area monitoring system (WAMS), Phasor Measurement Unit(PMU), ;Smart sensors/telemetry, advanced metering infrastructure

(AMI);smart metering; smart grid system monitoring; communication infrastructure and technologies; self-healing. Concept of Islanding.

Module V: **(3 Lectures)**

Micro grid: Integration of distributed energy sources; concept, operation, control and protection of Micro.

Text/Reference Books:

[1]. Smart power grids by A Keyhani, M Marwali.

[2]. Computer Relaying for Power Systems by Arun Phadke

[3]. Microgrids Architecture and control by Nikos Hatziargyriou

[4]. Renewable Energy Systems by Fang Lin Luo, Hong Ye

[5]. Voltage-sourced converters in power systems_ modeling, control, and applications by Amirnaser Yazdani, Reza Iravani"grid. Hybrid Power Systems: Integration of conventional and non-conventional energy sources.

Electrical Engineering			
EE724	**Electrical and Hybrid Vehicles**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Demonstrate** the drive train and propulsion unit of hybrid vehicles and their performance
CO2	**Identify** the different possible ways of energy storage.
CO3	**Generalize** the different strategies related to energy management system.
CO4	**Design** the hybrid electric vehicle and battery electric vehicle.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	2	3	3	-	-	-	1	3
CO2	-	2	3	1	3	-	2	1	-	-	-	-
CO3	2	3	-	2	2	-	2	1	-	-	3	1
CO4	3	1	3	3	2	1	2	-	-	-	1	3
Total	**2.67**	**2**	**3**	**1.75**	**2.25**	**2**	**2.25**	**1**	**-**	**-**	**1.67**	**2.33**

DETAILED SYLLABUS

Module I: Introduction to Hybrid Electric Vehicles and Conventional Vehicles (3 Lectures)

Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Module II: Hybrid Electric Drive-trains (6 Lectures)

Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module III: Electric Propulsion Unit (9 Lectures)

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module IV: Energy Storage (6 Lectures)

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Electrical overlay harness and communications.

Module V: Sizing the Drive System (5 Lectures)

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

Module VI Energy Management Strategies (13 Lectures)

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, Rule and optimization based energy management strategies (EMS).

Case studies-Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books:

[1]. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", , John Wiley & Sons, 2011.
[2]. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.

Reference Books:

[1]. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
[2]. T. Denton , "Electric and Hybrid Vehicles", Routledge, 2016.

Electrical Engineering			
EE731	Soft Optimization Techniques	L	T
		3	0

Pre-requisite: None

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	Descriptions
CO1	**Understand** the concepts of population based optimization techniques.
CO2	**Evaluate** the importance of parameters in heuristic optimization techniques.
CO3	**Apply** for the solution of multi-objective optimization.

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	-	-	-	-	-	2
CO2	3	3	2	1	2	-	-	1	-	-	-	2
CO3	3	3	2	1	2	-	-	1	-	-	3	2
Avg.	**3**	**3**	**2**	**1**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

Module I: Genetic Algorithm and Particle Swarm Optimization (12 Lectures)

Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.

Module II: Ant Colony Optimization and Artificial Bee Colony Algorithms (10 Lectures)

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Module III: Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm (10 Lectures)

Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation-Movement of Virtual Bats- Loudness and Pulse Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes -memeplex formation- memeplex updation.

Module IV: Multi Objective Optimization (4 Lectures)

Application to multi-modal function optimization.Introduction to Multi- Objetive optimization-Concept of Pareto optimality.

Module V: Evolutionary Computing (6 Lectures)

Evolutionary Computing, Simulated Annealing, Random Search, Downhill Simplex Search.

Text Books/Reference:

[1]. Xin-She Yang, "Recent Advances in Swarm Intelligence and Evolutionary Computation,Springer International Publishing, Switzerland, 2015.

[2]. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley &
Sons, 2001.

[3]. James Kennedy and Russel E Eberheart, Swarm Intelligence, The Morgan Kaufmann Series in Evolutionary Computation, 2001.

[4]. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm Intelligence-From natural to Artificial Systems, Oxford university Press, 1999.

[5]. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pearson Education, 2007.

[6]. Konstantinos E. Parsopoulos and Michael N. Vrahatis, Particle Swarm Optimization and Intelligence: Advances and Applications, Information science reference, IGI Global, 2010.

[7]. N P Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005.

Electrical Engineering			
EE732	**Illumination Technology**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students should be able to:

COs	CO Description
CO1	**Evaluate** the characteristics of illumination sources/devices.
CO2	**Understand** and determine the performance of various lighting systems.
CO3	**Design** of lighting controls and management.
CO4	**Understand** the standards of lighting systems and commissioning.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1.Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	1	-	-	-	-	-	2
CO2	3	3	2	1	1	-	-	1	-	-	-	2
CO3	3	3	2	1	1	-	-	1	-	-	3	2
CO4	3	3	2	1	1	-		1	-	-	-	2
Avg.	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

Module I: Ballast based Systems (6 Lectures)

Introduction - Magnetic and Electronic Ballast – Dimming Electronic Ballast for Fluorescent lamps - Lamp Ballast interactions – Electronic Ballast for HID Lamps - Pulse start metal halide system, Compact Fluorescent lamp.

Module II: Solid State Lamps (13 Lectures)

Introduction - Review of Light sources - white light generation techniques- Characterization of LEDs for illumination application. Power LEDs- High brightness LEDs- Electrical and optical properties – LED driver considerations.

Power management topologies- Thermal management considerations- Heat sink design- photometry and colorimetry - color issues of white LEDs- Dimming of LED sources -Designing usable lamp from white LEDs,- Luminaire design steps-SSL test standards. Dimming control scheme - Lighting controls for LED lamps.

Module III: Lighting Controls & Management (8 Lectures)

Introduction to lighting control – lighting control strategies - Energy Management strategies – Switching Control – sensor technology - occupancy sensors – PIR – Ultrasonic – location, coverage area & mounting configuration – special features –

Module IV: Applications of Sensors **(3 Lectures)**

Application. Photo sensors – spectral sensitivity – Photo sensor based control algorithms – Daylight-artificial light integrated schemes.

Module V: Commissioning of lighting controls **(10 Lectures)**

NASHRAE / IESNA standards & energy codes – international energy conservation code – compliance with controls Lighting Control Applications: Commercial lighting – stage and entertainment lighting – Architectural lighting – Residential Lighting Energy Management and building control systems.

Text Books/Reference:

[1]. Arturas Zukauskus, Michael S. Shur and Remis Gaska, "Introduction to solid state lighting", Wiley- Interscience, 2002.

[2]. E. Fred Schubert, "Light Emitting Diodes" (2nd edition), Cambridge University Press, 2006.

[3]. Craig DiLouie, Advanced Lighting Controls: Energy Saving Productivity, Technology & Applications, Fairmont Press, Inc., 2006.

[4]. Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons, 1989.

[5]. Steve Winder, "Power Supplies for LED Driving" Newnens Publication, 2008.

[6]. Robert S Simpson, Lighting Control: Technology and Applications, Focal Press, 2003.

[7]. IES Lighting Handbook, 10th Edition IESNA, 2011.

Electrical Engineering			
EE733	**Process Instrumentation and Control**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	-	-	-	-	-	-	2
CO2	3	3	2	1	1	-	-	-	-	-	-	2
CO3	3	3	2	1	1	-	-	-	-	-	-	2
CO4	3	3	2	1	1	-		-	-	-	-	2
Avg.	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

MODULE I: Introduction **(7 Lectures)**

Special Characteristics of process systems: Large time constants, Interaction, Multistaging, Pure Lag; Control loops for simple systems: Dynamics and stability.

MODULE II: **(10 Lectures)**

Generation of control actions in electronic pneumatic controller. Tuning of controllers Zeigler Nichols and other techniques. Different control techniques and interaction of process parameters e.g. Feed forward,cascade, ratio, Override controls. Batch and continuous process controls. Multi variable control. Feed forward control schemes.

MODULE III: **(8 Lectures)**

Control valves, Valve positioners, Relief and safety valves, Relays,Volume boosters, Pneumatic transmitters for process variables.Various process schemes/ Unit operations and their control schemese.g. distillation columns , absorbers, Heat exchangers, Furnaces,Reactors, Mineral processing industries pH and blending processes.

MODULE IV: **(12 Lectures)**

Measurement, control and transmission of signals of process parameters like flow, pressure, level and temperature.

MODULE V: (5 Lectures)

Computer control of processes: Direct Digital Control, Supervisory Control and advanced control strategies.

Text/Reference Books:

[1]. Stephananopoulos G- Chemical Process control- An Introduction to theory and practice, PHI,1990

[2]. Luyben W L – Simulation and control for chemical engineers,1989, 2nd Edition, McGraw Hill,1989.

Electrical Engineering			
EE741	**High Power Converters**	**L**	**T**
		3	**0**

(This course is not offered to Electrical Engg. students)

Prerequisite: Power Electronics

Course Outcomes:

After successful completion of course, the students will be able to:

COs	Description
CO 1	**Analyze** controlled rectifier circuits.
CO 2	**Explain** in basic operation and compare the performance of various power semiconductor devices and switching circuits.
CO3	**Design** and **analyze** power converter circuits and learn to select suitable power electronic devices and assessing the requirements of applications field.
CO 4	**Illustrate** the operation of line-commutated rectifiers–6 pulse and multi-pulse configurations.
CO 5	**Explain** the operation of PWM rectifiers–operation in rectification and regeneration modes and lagging, leading and unity power factor mode.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							2
CO2	3	3	2	2	1							2
CO3	3	3	2	2	1							2
CO4	3	3	2	1	2							2
CO5	3	3	2	1	2							2
Avg.	**3**	**3**	**2**	**1.6**	**1.4**							**2**

<u>DETAILED SYLLBUS</u>

Module I: Diode rectifiers with passive filtering (6 Lectures)

Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current wave shape, effect of source inductance; commutation overlap.

Module II: Thyristor rectifiers with passive filtering (6 Lectures)

Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

Module III: Multi-Pulse converter **(8 Lectures)**

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

Module IV: Single-phase AC-DC single-switch boost converter **(6 Lectures)**

Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module V: AC-DC bidirectional boost converter **(6 Lectures)**

Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Module VI: Isolated single-phase AC-DC flyback converter **(10 Lectures)**

DC-DC flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure

Text / References Books:

[1]. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.

[2]. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics", Addison-Wesley, 1991.

[3]. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.

[4]. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.

[5]. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2001

Electrical Engineering			
EE742	**Digital Control Systems**	**L**	**T**
		3	**0**

Prerequisite: Control Systems

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	1	1	1					1
CO2	3	1	3	2	2							
CO3	3	2		2	2							
CO4	3	3	3	3	3		1					2
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1.5**

DETAILED SYLLABUS

Module I: Sampling and Reconstruction (8 Lectures)

Introduction, Examples of Data control systems, Sampler, Sampling Theorem, Signal Reconstruction-Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

Module II: The Z – Transforms (9 Lectures)

Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, inverse Z-transforms, Z-Transform method for solving difference equations; Pulse transforms function

Module III: State Space Analysis (12 Lectures)

State variables, State model for linear continuous-time system. Types of state models, Eigen value and Eigen vectors, Solution of state equation, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, State Space Representation of discrete time systems, Matrix solving discrete time state space equations, Discretization of continuous time state – space equations

Module IV: Controllability, Observability & Stability (9 Lectures)
Concepts of Controllability and Observability, Tests for controllability and Observability Duality between Controllability and Observability, Transfer matrix. Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation.

Module V: State Feedback Controller (4 Lectures)
Design of state feedback controller through pole placement – Necessary and sufficient conditions.

Text Books:

[1]. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition
[2]. B. C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

Reference Books:

[1]. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison-Wesley Longman, Inc., Menlo Park, CA , 1998.
[2]. Digital Control and State Variable Methods by M.Gopal, TMH.

Electrical Engineering			
EE743	Electrical Machines and Power Systems	L	T
		3	0

Course Outcomes:
After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Understand** the construction and principle of operation of transformers, auto transformers, asynchronous and synchronous machines.
CO2	**Evaluate** performance characteristics of induction machine and synchronous machines.
CO3	**Analyze** the effects of excitation and mechanical input on the operation of synchronous machine.
CO4	**Understand** different elements and supply systems of power systems.
CO5	**Determine** the parameters of transmission lines

COs-POs Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	1	1	1					1
CO2	3	1	3	2	2							1
CO3	3	2	3	2	2							1
CO4	3	3	3	3	3		1					1
CO5	3	2	3	2	2							1
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Transformers **(8 Lectures)**
Constructional features, types, Special constructional features – cruciform and multiple stepped cores, cooling methodology, conservators, breather, Buchholz relay, voltage, current and impedance relationships, equivalent circuits and phasor diagrams at no load and full load conditions,voltage regulation, losses and efficiency, all day efficiency, auto transformer and equivalent circuit, parallel operation and load sharing.

Module II: Asynchronous Machines **(8 Lectures)**
General constructional features of poly phase asynchronous motors, concept of rotating magnetic field, principle of operation, phasor diagram, Equivalent circuit, torque and power equations, torque-slip characteristics, losses and efficiency.

Module III: Synchronous Machines **(9 Lectures)**

General constructional features, armature winding, emf equation, effect of distribution and pitch factor,flux and mmf relationship, phasor diagram, non-salient pole machine, equivalent circuit, determination of equivalent circuit parameters by open and short circuit tests, voltage regulation using synchronous impedance method, power angle characteristics.

Module IV: Introduction to Power Systems **(9 Lectures)**

Single line diagram of power system, brief description of power system elements, synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator. Supply System: different kinds of supply system and their comparison, choice of transmission voltage.
Transmission Lines: configurations, types of conductors, resistance of line, skin effect.

Module V: Transmission Lines **(8 Lectures)**

Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit ,transmission lines, representation and performance of short, medium and long transmission lines, Ferranti effect,surge impedance loading.

Text/Reference Books:

[1]. Fitzgerald. A.E., Charles KingselyJr, Stephen D.Umans, ‘Electric Machinery’, Tata McGraw Hill, 2006.
[2]. M.G. Say, ‘Performance and Design of Alternating Current Machines’, CBS Publishers, New Delhi, 2008 Nagrath I. J and Kothari D.P. ‘Electric Machines’, Tata McGraw Hill Publishing company Ltd, 2010.
[3]. Power System Analysis, J. Grainger and W.D. Stevenson, TMH, 2006.
[4]. Electrical Power Systems,C. L.Wadhwa, New age international Ltd. Third Edition,2010
[5]. Electric Power Generation, Transmission&Distribution,S.N.Singh, PHI Learning.

Electrical & Electronics Engineering

Electrical & Electronics Engineering			
EEE701	**Protection of Power Apparatus and System**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO1: **Analyze** the need of power system protection and **classify** the different types of relay and their operating principle.
CO2: **Distinguish** the difference between the distribution line protection and transmission line protection.
CO3: **Explain** the protection of generator, busbar and transformer and its limitations.
CO4**: Select** the different kind of circuit breaker based on their application.
CO5: **Choose** different type of protective devices against overvoltage as well as for earthing purpose.

CO-PO Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2								1
CO2	3	2		2								1
CO3	2	1		2								1
CO4	3	3		3								1
CO5	3	3		2	3							1
Avg.	**2.8**	**2.4**		**2.2**	**3**							**1**

DETAILED SYLLABUS

Module – I **(5 Lectures)**

Basic concept & components of power system protection, types of relays-their operating principles, characteristics and their uses, Introduction to static relays and its advantages over electromagnetic relays.

Module – II **(8 Lectures)**

Protection of Alternators: Protection of generators against Stator faults, Rotor faults, and abnormal Conditions. Restricted earth fault and Inter-turn fault Protection. Numerical problems on % winding unprotected.

Module III **(8 Lectures)**

Protection of transformers: Percentage Differential Protection, Numerical Problem on Design of CT's Ratio, Buchholz relay Protection.

Module – IV **(8 Lectures)**

Protection of Lines: Over Current, Carrier Current and Three - zone distance relay protection using Impedance relays. Translay relay. Protection of Bus bars –differential Protection.

Module – V **(8 Lectures)**

Theory of arc interruption, types of circuit breakers – air, air-blast, minimum oil, vacuum & SF6, resistance switching, current chopping, auto-reclosing, circuit breaker ratings.

Protection against lightning over voltages - valve type and zinc - oxide lighting arresters,

Module – VI **(5 Lectures)**

Grounded and ungrounded neutral systems, methods of neutral grounding: solid, resistance, reactance, resonant grounding.

Text Books

1. Badri Ram, D. Vishwakarma, "Power System Protection and Switchgear", McGraw Hill, 2nd Edition.
2. Y.G. Paithankar, S.R. Bhide, "Fundamentals of Power System Protection", PHI, 2nd Edition
3. BhuvaneshOza, Nirmal-Kumar Nair, Rashesh Mehta, Vijay Makwana, "Power System Protection & Switchgear, McGraw Hill, 1st Edition.

Reference Books

1. Stanley H. Horowitz, Arun G. Phadke, James K. Niemira, "Power System Relaying", Wiley, 4th Edition.
2. R. van C. Warrington, "Protective Relays Their Theory and Practice", Springer, 1st Edition.

Electrical & Electronics Engineering			
EEE711	**Electrical Drives and Control**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course students will be able to:

CO1: **Classify electric** drives and their specific application in industry.
CO2: **Explain** the operation of electric traction, energy consumption and it's advantages.
CO3: **Make use of** electric heating based on induction principle.
CO4: **List** different light sources and illumination parameters.
CO5: **Demonstrate** electrolytic process and **design** motor control circuit.

COs-POs Mapping:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		1								1
CO2	3	3	1	1								1
CO3	3	3	2	1								1
CO4	3	3	3	1								1
CO5	3	3	3	1								1
Avg.	**3**	**3**	**2.25**	**1**								**1**

DETAILED SYLLABUS

Module – I: Introduction to Electrical Drives **(9 Lectures)**

Concept, classification, parts and advantages of electrical dives. Types of Loads, Components of load toques, Fundamental torque equations, Equivalent value of drive parameters for loads with rotational and translational motion. Determination of moment of inertia, Multi quadrant operation of drives. Load equalization.

Module – II: Starting and Braking of Electrical Drives **(9 Lectures)**

Effect of starting on Power supply, motor and load. Methods of stating of electric motors. Acceleration time Energy relation during stating, methods to reduce the Energy loss during starting. Types of braking, braking of DC motor, Induction motor and Synchronous motor, Energy loss during braking.

Module – III: Solid State Speed Control of DC Motor **(7 Lectures)**

Single phase, three phases fully controlled and half controlled DC drives. Dual converter control of DC drives. DC chopper drives.

Module – IV: Solid State Speed Control of Induction Motor **(7 Lectures)**

Speed control of three phase induction motor – Voltage control, voltage / frequency control, slip power recovery scheme – Using inverters and AC voltage regulators – applications, Static Scherbius drive, Static Kramer drive.

Module-V: Synchronous Motor Drive **(10 Lectures)**

Synchronous motor V/f control, Cycloconverter control, self-controlled synchronous motor drive. Drive consideration for Textile mills, Steel rolling mills, Cement mills, Paper mills, Machine tools. Cranes & hoist drives.

Text Books

1. Fundamental of Electrical Drives, G.K. Dubey, New Age International Publication.
2. Electric Drives, Vedam Subrahmanyam, TMH
3. A first course on Electrical Drives, S.K. Pillai, New Age International Publication.

Reference Books

1. Electric motor drives, R. Krishnan, PHI
2. Modern Power Electronics & Ac drives, B.K. Bose, Pearson Education.
3. Electric Motor & Drives. Austin Hughes, Newnes.

Electrical & Electronics Engineering			
EEE712	**Utilization of Electrical Power**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course students will be able to:

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1 0	PO11	PO12
CO1	3	2	2	2	3							1
CO2	3	2	2				2					1
CO3	3	2	2		2							1
CO4	3	2	2									1
CO5	3	2	2	2	2							1
Avg.	**3**	**2**	**2**	**2**	**2.33**		**2**					**1**

DETAILED SYLLABUS

Module I: Industrial Drives **(12 Lectures)**

Characteristics of electrical motors and their particular application for industrial drives. Motor enclosures, bearing, transmission of drives, choice of motor, motor used for lifts, cranes and general purpose machines, typical application in sugar, textile, paper and steel industries. Motors used in mining operations, rating of electric motors, calculation of size load equation of flywheels electric breaking; plugging, dynamic and regenerative breaking, breaking current, torque, speed time curves (number of revolutions made before stop)

Module II: Electrical Traction **(10 Lectures)**

General features and systems of track electrification, Tractive effort calculation of traction motors, traction motor control (series-parallel control).

Track equipment and collection gear, train movement, speed-time curve, Specific Energy Consumption (SEC) and factors affecting it.

Module III: Electric Heating **(5 Lectures)**

Introduction – Classification of methods of electric heating – Requirements of a good heating material – Design of heating element – Temperature control of resistance furnace – Electric arc furnace – Induction heating.

Module IV: Welding and Illumination **(13 Lectures)**

Dielectric heating – Electric welding – Resistance welding – Electric arc welding. Sources of light, incandescent and fluorescent lamps, Lighting Fittings, reflection factor illumination, calculation, solid angle, candle power, units of light and illumination, power curves, M. H. C. P and M. S. C. P. Illumination level and its measurement coefficient of utilization, waste light factor, illumination calculations for building and playgrounds, flood lighting, industrial lighting, Street lighting.

Module V **(2 Lectures)**

Electrolytic process and motor control circuit

Text Books:

1. "A first course on Electric Drives", S.K.Pillai, Wiley Eastern Ltd.
2. "Utilization of Electrical Energy", (S.I. Units), E.Open Shaw Taylor and V.V.L.Rao, Orient Long man.
3. "Generation, Distribution and Utilization of Electrical Energy", C.L. Wadhwa; Wiley Eastern Ltd.

Electrical & Electronics Engineering			
EEE713	**Power Quality**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course students will be able to:

COs	CO Description
CO1	To understand the various power quality issues.
CO2	Evaluate the power quality indices used in industrial power system.
CO3	Understand various mitigation techniques for compensating devices to improve the power quality.
CO4	Simulate the compensating devices to improve the power quality

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low)   2. Moderate (Medium)   3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	2	1	-	1	-	2
CO2	2	-	3	2	-	2	-	-	-	-	-	-
CO3	2	3	-	2	3	2	2	-	-	-	-	-
CO4	-	3	-	3	3	2		-	2	-	-	2
Avg.	**2**	**3**	**3**	**2.33**	**3**	**2**	**2**	**1**	**2**	**1**	**-**	**2**

DETAILED SYLLABUS

Module - I: Overview of Power Quality (10 Lectures)
Classification of power quality issues, characterization of electric power quality, power acceptability curves – power quality problems: poor load power factor, non linear and unbalanced loads, dc offset in loads, notching in load voltage, disturbance in supply voltage, flicker, transient phenomenon, voltage fluctuations, sags/swells, voltage unbalance, power quality indices, distortion index, C-message index, IT product, IEEE guides and recommended practices.

Module- II: Measurement and Analysis Methods (8 Lectures)
Voltage, current, power and energy measurements, power factor measurement and definitions, time domain methods, Instantaneous Reactive Power Theory, Synchronous Frame Theory, Synchronous Detection Method, instantaneous symmetrical components, Instantaneous real and reactive powers

Module- III: Harmonics & Voltage Fluctuations (8 Lectures)
Sources and effect of harmonics and inter harmonics, voltage fluctuations, flicker and impulses, flicker calculations, effect of voltage fluctuations and impulses, occurrence and causes of voltage unbalance, standardization, decomposition into symmetrical components.

Module IV: Power Quality Improvement-I **(8 Lectures)**
Utility- Customer interface, harmonic filter: passive, active and hybrid filter, compensation using shunt devices-DSTATCOM, voltage regulation using DSTATCOM, principle, working and construction, algorithms for control of DSTATCOM, some case study examples.

Module V: Power Quality Improvement-II **(8 Lectures)**
Series compensation, protecting sensitive loads using DVR, principle, working construction and control schemes for DVR, hybrid devices –UPQC, principle, working and construction, some case study examples.

Text /reference Books:

1. Power Quality Enhancement Using Custom Power Devices, Arindam Ghosh, Gerard Ledwich, Springer, 2009
2. Power Quality: VAR Compensation in Power Systems R. Sastry Vedam, Mulukutla S. Sarma, CRC Press, 2008
3. Understanding Power Quality Problems: Voltage Sags and Interruptions, Math H.J. Bollen, Wiley India Pvt Ltd, 2011.
4. Power Quality: Mitigation Technologies in a Distributed Environment,A Moreno Munoz, Springer India Private Limited 2007.
5. Power System Quality Assessment J.Arrillaga, N.R.Watson, S.Chen, Wiley India Pvt Ltd, 2011.

Electrical & Electronics Engineering			
EEE714	**HVDC Transmission and Facts**	**L**	**T**
		3	**0**

Prerequisite: Power Electronics, Power System-II

Course Outcome:-

After successful completion of the course, the students will be able to:

COs	CO Description
CO1	**Compare** HVDC and EHVAC transmission systems
CO2	**Analyze** converter configurations used in HVDC and evaluate the performance metrics.
CO3	U**nderstand** controllers for controlling the power flow through a dc link and compute filter Parameters
CO4	**Apply** impedance, phase angle and voltage control for real and reactive power flow in ac transmission systems with FACTS controller

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/ POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO 12
CO1	2	3	-	-	2	1	2	2	-	-	-	2
CO2	1	2	-	1	2	2	2	-	-	-	2	-
CO3	-	3	-	2	2	-	-	-	-	-	-	2
CO4	-	3	-	3	3	2	1	-	-	-	-	-
Avg.	**1.5**	**2.75**	**-**	**2**	**2.25**	**1.67**	**1.67**	**2**	**-**	**-**	**2**	**2**

DETAILED SYLLABUS

Module I: HVDC Power Transmission Technology (4 Lectures)

Evolution of HVDC transmission, Comparison of HVDC & HVAC system, Economics of power transmission, Technical performance, Reliability, Applications of HVDC transmission, Types of HVDC transmission links, Components of Converter station, Planning for HVDC transmission, Operating problems in HVDC system.

Module II: Analysis of HVDC converter (7 Lectures)

Introduction, Types of converters, Line commutated converter, Analysis of Line commutated converter, Choice of converter configuration for any pulse number, Analysis of voltage source converter, Basic 2-level Graetz bridge converter, 3 level voltage source converter, Converter charts.

Module III: HVDC System control (7 Lectures)

Principles of HVDC control links, Converter control characteristics, Control schemes & control comparisons, Firing angle control, current & Extinction angle control, Energization & de-energization of bridges, Starting & stopping of DC links, power control. Effects of Harmonics, sources of harmonic generation, Types of filters–Design examples

Module- IV: Flexible AC Transmission Systems (FACTS) (5 Lectures)
FACTS concepts and general system conditions: Power flow in AC systems, Relative importance of controllable parameters, Basic types of FACTS controllers, shunt and series controllers, Current source and Voltage source converters.

Module V: Static Shunt Compensators (8 Lectures)
Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics.

Module VI: Static Series Compensators (6 Lectures)
Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC-operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control.

Module VII: Combined Compensators (5 Lectures)
Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power

Text Books:

1. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011
2. J. Arrillaga, "High Voltage Direct Current Transmission", Peter Peregrinus Ltd., 1983.
3. Narain G.Honorani, Laszlo Gyugyi: Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems, Wiley-IEEE Press, 2000.
4. Yong Hua Song, Allan T Johns: Flexible AC Transmission Systems, The Institution of electrical Engineers, 1999.

Reference Book:

1. E. W. Kimbark, "Direct Current Transmission", Vol.1, Wiley Inter science, 1971.

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<tr><td colspan="4">Electrical & Electronics Engineering</td></tr>
<tr><td>EEE721</td><td>Antennae & Wave Propagation</td><td>L</td><td>T</td></tr>
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Electrical & Electronics Engineering			
EEE722	**Smart Grid Technology**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Understand** features of Smart Grid in the context of Indian Grid
CO2	**Assess** the role of automation in Transmission/Distribution
CO3	**Apply** Evolutionary Algorithms for the Smart Grid/Distribution Generation.
CO4	**Understand** operation and importance of PMUs, PDCs, WAMS, Voltage and Frequency control in Micro Grids

CO's- PO's Mapping:
Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12
CO1	3	2	2	2	-	1	-	-	-	-	-	-
CO2	3	2	2	2	-	2	-	-	1	-	-	-
CO3	3	2	2	2	-	2	-	-	2	-	-	-
CO4	3	2	2	2	-	2	-	-	1	-	-	-
Avg.	**3**	**2**	**2**	**2**		**1.75**			**1**			

DETAILED SYLLABUS

Module I: (5 Lectures)
Introduction to Smart Grid, Architecture of Smart Grid System, Standards for Smart Grid System, Elements and Technologies of Smart Grid System.

Module II (14 Lectures)
Communication Technologies for Power System: Fiber Optical Networks, WAN base on Fiber Optical Networks, IP based Real Time data Transmission, Substation communication network, Zigbee. Information System for Control Centers (ICCS): ICCS Configuration, ICCS communication Network, ICCS Time Synchronization. E-Commerce of Electricity, GIS, GPS.

Module III (8 Lectures)
Integration, Control and Operation of Distributed Generation: Distributed Generation Technologies and its benefits, Distributed Generation Utilization Barriers, Distributed Generation integration to power grid.

Module IV: (12 Lectures)

Monitoring the smart grid: Load dispatch centers, wide-area monitoring system (WAMS), Phasor Measurement Unit(PMU), ;Smart sensors/telemetry, advanced metering infrastructure (AMI);smart metering; smart grid system monitoring; communication infrastructure and technologies; self-healing. Concept of Islanding.

Module V: **(3 Lectures)**

Micro grid: Integration of distributed energy sources; concept, operation, control and protection of Micro.

Text/Reference Books:

1. Smart power grids by A Keyhani, M Marwali.
2. Computer Relaying for Power Systems by Arun Phadke
3. Microgrids Architecture and control by Nikos Hatziargyriou
4. Renewable Energy Systems by Fang Lin Luo, Hong Ye
5. Voltage-sourced converters in power systems_ modeling, control, and applications by Amirnaser Yazdani, Reza Iravani"grid. Hybrid Power Systems: Integration of conventional and non-conventional energy sources.

Electrical & Electronics Engineering			
EEE723	**Electrical and Hybrid Vehicles**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students will be able to:

CO's	CO Description
CO1	**Demonstrate** the drive train and propulsion unit of hybrid vehicles and their performance
CO2	**Identify** the different possible ways of energy storage.
CO3	**Generalize** the different strategies related to energy management system.
CO4	**Design** the hybrid electric vehicle and battery electric vehicle.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	1	2	3	3	-	-	-	1	3
CO2	-	2	3	1	3	-	2	1	-	-	-	-
CO3	2	3	-	2	2	-	2	1	-	-	3	1
CO4	3	1	3	3	2	1	2	-	-	-	1	3
Total	**2.67**	**2**	**3**	**1.75**	**2.25**	**2**	**2.25**	**1**	**-**	**-**	**1.67**	**2.33**

DETAILED SYLLABUS

Module I: Introduction to Hybrid Electric Vehicles and Conventional Vehicles (3 Lectures)
Introduction to Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies; Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Module II: Hybrid Electric Drive-trains (6 Lectures)
Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.
Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive-train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module III: Electric Propulsion Unit (9 Lectures)

Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Module IV: Energy Storage (6 Lectures)

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices, Electrical overlay harness and communications.

Module V: Sizing the Drive System (5 Lectures)

Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology.

Module VI Energy Management Strategies (13 Lectures)

Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies, Rule and optimization based energy management strategies (EMS).

Case studies-Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Text Books:

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, , John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”, Springer, 2015.

Reference Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
2. T. Denton , “Electric and Hybrid Vehicles”, Routledge, 2016.

Electrical & Electronics Engineering			
EEE731	**Soft Optimization Techniques**	**L**	**T**
		3	**0**

Pre-requisite: None

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	Descriptions
CO1	**Understand** the concepts of population based optimization techniques.
CO2	**Evaluate** the importance of parameters in heuristic optimization techniques.
CO3	**Apply** for the solution of multi-objective optimization.

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

2. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	1	-	-	-	-	-	2
CO2	3	3	2	1	2	-	-	1	-	-	-	2
CO3	3	3	2	1	2	-	-	1	-	-	3	2
Avg.	**3**	**3**	**2**	**1**	**2**	**1**	**-**	**1**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

Module I: Genetic Algorithm and Particle Swarm Optimization (12 Lectures)

Genetic algorithms- Genetic Algorithm versus Conventional Optimization Techniques - Genetic representations and selection mechanisms; Genetic operators- different types of crossover and mutation operators -Bird flocking and Fish Schooling – anatomy of a particle- equations based on velocity and positions -PSO topologies - control parameters. Application to SINX maximization problem.

Module II: Ant Colony Optimization and Artificial Bee Colony Algorithms (10 Lectures)

Biological ant colony system - Artificial ants and assumptions - Stigmergic communications - Pheromone updating- local-global - Pheromone evaporation - ant colony system- ACO models-Touring ant colony system-max min ant system - Concept of elistic ants-Task partitioning in honey bees - Balancing foragers and receivers - Artificial bee colony (ABC) algorithms-binary ABC algorithms.

Module III: Shuffled Frog-Leaping Algorithm and Bat Optimization Algorithm (10 Lectures)

Bat Algorithm- Echolocation of bats- Behavior of microbats- Acoustics of Echolocation-Movement of Virtual Bats- Loudness and Pulse .

Emission- Shuffled frog algorithm-virtual population of frogs-comparison of memes and genes -memeplex formation- memeplex updation.

Module IV: Multi Objective Optimization **(4 Lectures)**
Application to multi-modal function optimization.Introduction to Multi- Objetive optimization-Concept of Pareto optimality.

Module V: Evolutionary Computing **(6 Lectures)**
Evolutionary Computing, Simulated Annealing, Random Search, Downhill Simplex Search.

Text Books/Reference:

1. Xin-She Yang, “Recent Advances in Swarm Intelligence and Evolutionary Computation,Springer International Publishing, Switzerland, 2015.
2. Kalyanmoy Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, 2001.
3. James Kennedy and Russel E Eberheart, Swarm Intelligence, The Morgan Kaufmann Series in Evolutionary Computation, 2001.
4. Eric Bonabeau, Marco Dorigo and Guy Theraulaz, Swarm Intelligence-From natural to Artificial Systems, Oxford university Press, 1999.
5. David Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Pearson Education, 2007.
6. Konstantinos E. Parsopoulos and Michael N. Vrahatis, Particle Swarm Optimization and Intelligence: Advances and Applications, Information science reference, IGI Global, 2010.
7. N P Padhy, Artificial Intelligence and Intelligent Systems, Oxford University Press, 2005.

Electrical & Electronics Engineering			
EEE732	**Illumination Technology**	**L**	**T**
		3	**0**

Course Outcomes:
After successful completion of the course, students should be able to:

COs	CO Description
CO1	**Evaluate** the characteristics of illumination sources/devices.
CO2	**Understand** and determine the performance of various lighting systems.
CO3	**Design** of lighting controls and management.
CO4	**Understand** the standards of lighting systems and commissioning.

CO's-PO's Mapping Matrix:
Enter correlation levels1, 2 or 3 as defined below-
1.Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	1	1	-	-	-	-	-	2
CO2	3	3	2	1	1	-	-	1	-	-	-	2
CO3	3	3	2	1	1	-	-	1	-	-	3	2
CO4	3	3	2	1	1	-		1	-	-	-	2
Avg.	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**1**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

Module I: Ballast based Systems (6Lectures)

Introduction - Magnetic and Electronic Ballast – Dimming Electronic Ballast for Fluorescent lamps - Lamp Ballast interactions – Electronic Ballast for HID Lamps - Pulse start metal halide system, Compact Fluorescent lamp.

Module II: Solid State Lamps (13 Lectures)

Introduction - Review of Light sources - white light generation techniques- Characterization of LEDs for illumination application. Power LEDs- High brightness LEDs- Electrical and optical properties – LED driver considerations.

Power management topologies- Thermal management considerations- Heat sink design- photometry and colorimetry - color issues of white LEDs- Dimming of LED sources -Designing usable lamp from white LEDs,- Luminaire design steps-SSL test standards. Dimming control scheme - Lighting controls for LED lamps.

Module III: Lighting Controls & Management (8 Lectures)

Introduction to lighting control – lighting control strategies - Energy Management strategies – Switching Control – sensor technology - occupancy sensors – PIR – Ultrasonic – location, coverage area & mounting configuration – special features –

Module IV: Applications of Sensors **(3 Lectures)**

Application. Photo sensors – spectral sensitivity – Photo sensor based control algorithms – Daylight-artificial light integrated schemes.

Module V: Commissioning of lighting controls **(10 Lectures)**

NASHRAE / IESNA standards & energy codes – international energy conservation code – compliance with controls Lighting Control Applications: Commercial lighting – stage and entertainment lighting – Architectural lighting – Residential Lighting Energy Management and building control systems.

Text Books/Reference:

1. Arturas Zukauskus, Michael S. Shur and Remis Gaska, "Introduction to solid state lighting", Wiley- Interscience, 2002.
2. E. Fred Schubert, "Light Emitting Diodes" (2nd edition), Cambridge University Press, 2006.
3. Craig DiLouie, Advanced Lighting Controls: Energy Saving Productivity, Technology & Applications, Fairmont Press, Inc., 2006.
4. Mohan, Undeland and Robbins, "Power Electronics: Converters, Applications and Design", John Wiley and Sons, 1989.
5. Steve Winder, "Power Supplies for LED Driving" Newnens Publication, 2008.
6. Robert S Simpson, Lighting Control: Technology and Applications, Focal Press, 2003.
7. IES Lighting Handbook, 10th Edition IESNA, 2011.

Electrical & Electronics Engineering			
EEE733	**Process Instrumentation and Control**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	**CO Description**
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	3	2	1	1	-	-	-	-	-	-	2
CO2	3	3	2	1	1	-	-	-	-	-	-	2
CO3	3	3	2	1	1	-	-	-	-	-	-	2
CO4	3	3	2	1	1	-		-	-	-	-	2
Avg.	**3**	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**2**

DETAILED SYLLABUS

MODULE I: Introduction **(7 Lectures)**

Special Characteristics of process systems: Large time constants, Interaction, Multistaging, Pure Lag; Control loops for simple systems: Dynamics and stability.

MODULE II: **(10 Lectures)**

Generation of control actions in electronic pneumatic controller. Tuning of controllers Zeigler Nichols and other techniques. Different control techniques and interaction of process parameters e.g. Feed forward,cascade, ratio, Override controls. Batch and continuous process controls. Multi variable control. Feed forward control schemes.

MODULE III: **(8 Lectures)**

Control valves, Valve positioners, Relief and safety valves, Relays,Volume boosters, Pneumatic transmitters for process variables.Various process schemes/ Unit operations and their control schemese.g. distillation columns , absorbers, Heat exchangers, Furnaces,Reactors, Mineral processing industries pH and blending processes.

MODULE IV: **(12 Lectures)**

Measurement, control and transmission of signals of process parameters like flow, pressure, level and temperature.

MODULE V: **(5 Lectures)**

Computer control of processes: Direct Digital Control, Supervisory Control and advanced control strategies.

Text/Reference Books:

1. Stephananopoulos G- Chemical Process control- An Introduction to theory and practice, PHI,1990
2. Luyben W L – Simulation and control for chemical engineers,1989, 2nd Edition, McGraw Hill,1989.

Electrical & Electronics Engineering			
EEE741	**High Power Converters**	**L**	**T**
		3	**0**

(This course is not offered to Electrical and Electronics Engg. students)

Prerequisite: Power Electronics

Course Outcomes:

After successful completion of course, the students will be able to:

COs	Description
CO 1	**Analyze** controlled rectifier circuits.
CO 2	**Explain** in basic operation and compare the performance of various power semiconductor devices and switching circuits.
CO3	**Design** and **analyze** power converter circuits and learn to select suitable power electronic devices and assessing the requirements of applications field.
CO 4	**Illustrate** the operation of line-commutated rectifiers–6 pulse and multi-pulse configurations.
CO 5	**Explain** the operation of PWM rectifiers–operation in rectification and regeneration modes and lagging, leading and unity power factor mode.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

3. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	1							2
CO2	3	3	2	2	1							2
CO3	3	3	2	2	1							2
CO4	3	3	2	1	2							2
CO5	3	3	2	1	2							2
Avg.	**3**	**3**	**2**	**1.6**	**1.4**							**2**

DETAILED SYLLBUS

Module I: Diode rectifiers with passive filtering **(6 Lectures)**

Half-wave diode rectifier with RL and RC loads; 1-phase full-wave diode rectifier with L, C and LC filter; 3-phase diode rectifier with L, C and LC filter; continuous and discontinuous conduction, input current wave shape, effect of source inductance; commutation overlap.

Module II: Thyristor rectifiers with passive filtering **(6 Lectures)**

Half-wave thyristor rectifier with RL and RC loads; 1-phase thyristor rectifier with L and LC filter; 3-phase thyristor rectifier with L and LC filter; continuous and discontinuous conduction, input current waveshape.

Module III: Multi-Pulse converter **(8Lectures)**

Review of transformer phase shifting, generation of 6-phase ac voltage from 3-phase ac, 6-pulse converter and 12-pulse converters with inductive loads, steady state analysis, commutation overlap, notches during commutation.

Module IV: Single-phase AC-DC single-switch boost converter (6 Lectures)

Review of dc-dc boost converter, power circuit of single-switch ac-dc converter, steady state analysis, unity power factor operation, closed-loop control structure.

Module V: AC-DC bidirectional boost converter (6 Lectures)

Review of 1-phase inverter and 3-phase inverter, power circuits of 1-phase and 3-phase ac-dc boost converter, steady state analysis, operation at leading, lagging and unity power factors. Rectification and regenerating modes. Phasor diagrams, closed-loop control structure.

Module VI: Isolated single-phase AC-DC flyback converter (10 Lectures)

DC-DC flyback converter, output voltage as a function of duty ratio and transformer turns ratio. Power circuit of ac-dc flyback converter, steady state analysis, unity power factor operation, closed loop control structure

Text / References Books:

1. G. De, "Principles of Thyristorised Converters", Oxford & IBH Publishing Co, 1988.
2. J.G. Kassakian, M. F. Schlecht and G. C. Verghese, "Principles of Power Electronics", Addison-Wesley, 1991.
3. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
4. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007.
5. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science &Business Media, 2001

Electrical & Electronics Engineering			
EEE742	**Digital Control Systems**	**L**	**T**
		3	**0**

Prerequisite: Control Systems

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	CO Description
CO1	**Evaluate** the output of a digital system for a given input.
CO2	**Describe** the dynamics of a Linear, Time Invariant systems through difference equations.
CO3	**Analyze** digital systems using the Z-transformation, state space methods.
CO4	**Design** digital controllers for physical systems.

CO's-PO's Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1	1	1	1					1
CO2	3	1	3	2	2							
CO3	3	2		2	2							
CO4	3	3	3	3	3		1					2
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1.5**

DETAILED SYLLABUS

Module I: Sampling and Reconstruction **(8 Lectures)**

Introduction, Examples of Data control systems, Sampler, Sampling Theorem, Signal Reconstruction-Digital to Analog conversion and Analog to Digital conversion, sample and hold operations.

Module II: The Z – Transforms **(9 Lectures)**

Introduction, Linear difference equations, pulse response, Z – transforms, Theorems of Z – Transforms, inverse Z-transforms, Z-Transform method for solving difference equations; Pulse transforms function.

Module III: State Space Analysis **(12 Lectures)**

State variables, State model for linear continuous-time system. Types of state models, Eigen value and Eigen vectors, Solution of state equation, State transition matrix and it's Properties, Methods for Computation of State Transition Matrix, State Space Representation of discrete time systems, Matrix solving discrete time state space equations, Discretization of continuous time state – space equations

Module IV: Controllability, Observability & Stability **(9 Lectures)**

Concepts of Controllability and Observability, Tests for controllability and Observability Duality between Controllability and Observability, Transfer matrix. Analysis of closed loop systems in the Z-Plane. Jury stability test – Stability Analysis by use of the Bilinear Transformation.

Module V: State Feedback Controller **(4 Lectures)**

Design of state feedback controller through pole placement – Necessary and sufficient conditions.

Text Books:

1. Discrete-Time Control systems – K. Ogata, Pearson Education/PHI, 2nd Edition
2. B. C Kuo, Digital Control Systems, 2nd Edition, Oxford University Press, Inc., 1992.

Reference Books:

1. F. Franklin, J.D. Powell, and M.L. Workman, Digital control of Dynamic Systems, Addison-Wesley Longman, Inc., Menlo Park, CA , 1998.
2. Digital Control and State Variable Methods by M.Gopal, TMH.

Electrical & Electronics Engineering			
EEE743	**Electrical Machine and Power Systems**	**L**	**T**
		3	**0**

Course Outcomes:

After successful completion of the course, students should be able to:

CO's	**CO Description**
CO1	**Understand** the construction and principle of operation of transformers, auto transformers, asynchronous and synchronous machines.
CO2	**Evaluate** performance characteristics of induction machine and synchronous machines.
CO3	**Analyze** the effects of excitation and mechanical input on the operation of synchronous machine.
CO4	**Understand** different elements and supply systems of power systems.
CO5	**Determine** the parameters of transmission lines

COs-POs Mapping Matrix:

Enter correlation levels1, 2 or 3 as defined below-

1. Slight (low) 2. Moderate (Medium) 3. Substantial (High)

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	1	1	1					1
CO2	3	1	3	2	2							1
CO3	3	2	3	2	2							1
CO4	3	3	3	3	3		1					1
CO5	3	2	3	2	2							1
Avg.	**3**	**2**	**3**	**2**	**2**	**1**	**1**					**1**

DETAILED SYLLABUS

Module I: Transformers **(8 Lectures)**

Constructional features, types, Special constructional features – cruciform and multiple stepped cores, cooling methodology, conservators, breather, Buchholz relay, voltage, current and impedance relationships, equivalent circuits and phasor diagrams at no load and full load conditions,voltage regulation, losses and efficiency, all day efficiency, auto transformer and equivalent circuit, parallel operation and load sharing.

Module II: Asynchronous Machines **(8 Lectures)**

General constructional features of poly phase asynchronous motors, concept of rotating magnetic field, principle of operation, phasor diagram, Equivalent circuit, torque and power equations, torque-slip characteristics, losses and efficiency.

Module III: Synchronous Machines **(9 Lectures)**

General constructional features, armature winding, emf equation, effect of distribution and pitch factor,flux and mmf relationship, phasor diagram, non-salient pole machine, equivalent circuit, determination of equivalent circuit parameters by open and short circuit tests, voltage regulation using synchronous impedance method, power angle characteristics.

Module IV: Introduction to Power Systems **(9 Lectures)**
Single line diagram of power system, brief description of power system elements, synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator. Supply System: different kinds of supply system and their comparison, choice of transmission voltage. Transmission Lines: configurations, types of conductors, resistance of line, skin effect.

Module V: Transmission Lines **(8 Lectures)**
Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit ,transmission lines, representation and performance of short, medium and long transmission lines, Ferranti effect, surge impedance loading.

Text/Reference Books:

1. Fitzgerald. A.E., Charles KingselyJr, Stephen D.Umans, 'Electric Machinery', Tata McGraw Hill, 2006.
2. M.G. Say, 'Performance and Design of Alternating Current Machines', CBS Publishers, New Delhi, 2008 Nagrath I. J and Kothari D.P. 'Electric Machines', Tata McGraw Hill Publishing company Ltd, 2010.
3. Power System Analysis, J. Grainger and W.D. Stevenson, TMH, 2006.
4. Electrical Power Systems, C. L.Wadhwa, New age international Ltd. Third Edition,2010
5. Electric Power Generation, Transmission & Distribution, S.N.Singh, PHI Learning.

PRODUCTION ENGINEERING

Production Engineering			
PE701	**Production Planning and Control**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1	**Introduction to Production Planning and Control:** Production system, type of manufacturing systems and their characteristics, objectives and functions of production planning and control	03
2	**Pre-planning:** Demand forecasting, common techniques of demand forecasting, estimating factors of production, product mix and batch size decisions, aggregate planning	06
3	**Production Planning:** Routing, Loading and scheduling with their different techniques, dispatching, Progress Report, Expediting and corrective measures	05
4	**Inventory Control:** Field and scope of inventory control, inventory types and classification, Inventory control models, static model, dynamic model both deterministic and stochastic,Economic lot size, reorder point and their application, ABC analysis, FSN analysis and VED analysis, Modern practice in purchasing and store keeping	08
5	**Material Requirement Planning & JIT:** Material requirement planning (MRP), Manufacturing Resource planning (MRP II). Japanese approach to inventory management: JIT, KANBAN	08
6	**Value Engineering:** Introduction, Different phase of value Engineering. Concept of productivity	06
7	**Aggregate Planning:** Introduction, Nature of Aggregate planning, Costs, problem structure, Methods of Aggregate planning, Introduction to Capacity planning	06
	Total	42

Suggested Books:

[1]. S.N Chary, Production and Operation Management, Tata McGraw Hill

[2]. Dr. K. C. Arora Production and Operation Management, Laxmi Publication Pvt. Ltd.

[3]. R. K. Garg & V. Sharma, Production planning and Control Management, Dhanpat Rai & C Sons

[4]. E.D. Scheele, W.L. Westerman and R.J. Wimment, Principles and Design of Production Control Systems

[5]. Production Control Engineering D. K. Corke, Hodder Arnold
[6]. Production Planning and Inventory Control- Seetharama L. Narasimhan, Dennis W. McLeavey, Peter J. Billington.

Production Engineering			
PE711	**Statistical Quality Control**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Introduction**: The meaning of quality and Quality improvement; Brief history of Quality methodology, Statistical methods for Quality Control and improvement; Total Quality management(quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement)	04
2.	**Methods and philosophy of SPC**: Chance and Assignable causes, Statistical basis of the control charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length - ARL)	06
3.	**Control Charts for Variables:** Control Charts for X-bar and R charts, Type I and Type II errors, the probability of Type II error, simple numerical problems.	08
4.	**Process Capability:** The foundation of process capability, Natural tolerance limits, C_p- process capability index, C_{pk}, P_p- process performance index, summary of process measures. Numerical problems.	06
5.	**Control Charts for Attributes:**Binomial distribution, Poisson Distribution (from the point of view of Quality Control), Control chart for fraction nonconforming, Control chart for number nonconforming, Control charts for nonconformities or defects, Control chart for number of nonconformities per unit, Numerical Problems	08
6.	**Lot by lot Acceptance Sampling for Attributes and CUSUM and EWMA control charts:** The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, Sequential sampling, AOQL, LTPD, OC curves, Cumulative sum control chart, Exponentially Weighted Moving Average control chart, Numerical Problems.	10
	Total	**42**

Suggested Books:

[1]. M. Mahajan., “Statistical Quality Control”, 5th Edition, Dhanpat Rai and co.

[2]. Eugen L. Grant, Richard S. Leavenworth “Statistical Quality Control” 6th edition,

McGraw Hill
[3]. Amitava Mitra, “Fundamentals of Quality Control and Improvement”, Wiley India
[4]. S.A.H Rizvi, Zahid A. Khan., “Quality Control (for engineers and managers)”,

Production Engineering			
PE712	**Total Quality Management**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Introduction to Quality Management** Evolution of Quality Management, Concepts of Product and Service Quality, Dimensions of Quality, Deming's, Juran's, Crosby's Quality Philosophy, Quality Cost	04
2.	**Process Quality Improvement** Introduction to Process Quality, Graphical and statistical techniques for Process Quality Improvement, Graphical tools for data representation, 7 QC tools, Sampling, sampling distribution, DMAIC process.	08
3.	Statistical Process control Control charts for variables, control charts for attributes, application of control charts.	08
4.	Process capability analysis, Measurement system analysis, Analysis of Variance (ANOVA), Design and Analysis of Experiment (DOE), Acceptance sampling plan.	12
5.	TQM, Leadership, Lean and JIT Quality Philosophy, Benchmarking, Process failure mode and effect analysis (PFMEA), Service Quality, Six sigma for Process Improvement, ISO 9001 and QS 9000, Quality Audit, Quality Circles.	06
6.	Quality Function Deployment, Robust Design and Taguchi Method. Design Failure Mode & Effect Analysis, Product Reliability Analysis of Six Sigma in Product Development.	04
	Total	**42**

Suggested Books:

[1]. Total Quality Management by Dale H. Besterfield, Pearson Publication

[2]. Principles of Total Quality Management by Vipin Mathur

[3]. Fundamentals of Quality Control and Management by Amitava Mitra, Wiley Publication

Production Engineering			
PE713	**Quality and Reliability Engineering**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

Sl. No.	Contents	Contact Hours
1	Control chart : Introduction to quality control, objectives, applications and cost consideration. Control charts, general theory of control charts, Control charts for variables and attributes, Theory and application of control charts for averages, ranges, standard deviation, fraction defective and number of defects, Process capability study, Interpretation of control chart. Acceptance sampling : Elementary concepts, sampling by attributes, single, double and multiple sampling plans, construction and use of o.c. curves, Sequential sampling techniques. Concept of quality circle. ISO - 9000 Quality systems. Total quality control-quality and competitiveness in a Global Market place, Establishing a customer focus. Employee involvement. Six sigma, Introduction to Taguchi methods.	**10**
2	Reliability concept, Failure-statistics: Failure density, Failure rate, Probability of failure, Mean failure rate, mean time to failure(MTTF), mean time between failure(MTBF).Graphical plots.	**6**
3	Hazard Models: Introduction, Constant Hazard, Linearly increasing Hazard, The weibull model. Distribution functions and Reliability analysis. Hazard Rate as Conditional Probability.	**6**
4	System Reliability: Introduction, Series configuration, Parallel configuration, Mixed configuration. Application to specific Hazard Models. Reliability analysis of (i) Complex systems and (ii)Systems not reducible to mixed Configuration. Mean time to failure of systems. Logic diagrams, Markov Models.	**6**
5	Reliability Improvement: Improvement of components, Redundancy (Element redundancy, Unit redundancy, Stand by redundancy), Optimization, Reliability Cost Trade-off.	**6**
6	Calculation of Reliability from: (i) Fault tree analysis (ii) Tie set and Cut-set methods (iii) by use of Boolean Algebra.	**4**
7	Maintainability and Availability: Introduction, Maintainability, System downtime, Availability, Inherent Availability, Achieved Availability, Operational Availability, Reliability and Maintainability Tradeoff.	**4**
	Total	**42**

Suggested Books:

[1]. Fundamentals of Quality Control and Improvement: Amitava Mitra, Wiley

[2]. Statistical Quality Control – Eugen L. Grant , Richard S. Leavenworth

[3]. Statistical Quality Control – M. Mahajan

[4]. Quality Control (For Engineers and Managers) – S.A.H. Rizvi, Zahid A. Khan, D.K. Singh, Gauhar Alam

[5]. Reliability Engineering – E. Balagurusamy

[6]. Reliability Engineering and Life Testing – V. N. A. Naikan

Production Engineering			
PE721	**Tool Design**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	Jigs & Fixtures: Principal of design and construction, Location and clamping	04
2.	Basic concept for design of turning, Milling, Drilling & Indexing Jigs and fixtures	08
3.	Classification of dies, components of dies assembly, Simple dies, compound dies, combination dies and progressive dies	08
4.	Punch and die clearance, centre of pressure, calculation of blank diameter	12
5.	Design of tools for the production of holes, surfaces of revolution, and flat surfaces like single point tools, form tools, drills, milling cutters	06
6.	Materials for cutting tools, cutting dies and forming dies, Economics of Tooling	04
	Total	**42**

Suggested Books:

[1]. Umesh Chandra & Surender Kumar, Production Engineering Design (Tool Design) Satya Prakashan, New Delhi.

[2]. C. Donaldson, Tool Design, G.H.Lecain and V.C.Goold, Tata McGraw Hill.

[3]. Osterguard E., Basic Die Making, Mc-Graw Hill Book Co.

Production Engineering			
PE722	**Advance Casting and Welding**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Gating system:** Elements of gating system**,** top and bottom getting system. Design of gating system ,Riser design-Caine method, modulus method, NRL method; time of pouring, casting yield	6
2.	**Meting and solidification of casting:** Melting and quality control of various steels and non-ferrous alloys - Nucleation and grain growth, solidification of pure metals, short and long freezing range alloys. Fluidity and its measurement	6
3.	**Special casting technique:** shell moulding, squeeze casting, vacuum die casting, counter-gravity flow-pressure casting, centrifugal casting, continuous casting & squeeze casting ,semisolid metal casting	5
4.	**Advance arc Welding process:** Plasma TIG, Hot wire TIG, cold metal transfer, Under water arc welding, Solid state welding; friction welding , Friction stir welding	5
5.	**Welding process used for special fabrication:** Thermit welding, Electroslag welding, electron beam welding, Laser beam welding, Ultrasonic Welding; special welding process (friction stir welding and hybrid (laser +GMAW/GTAW) process	7
6.	**Inspection and testing of welding**: Defects, Destructive tests – Non-destructive testing techniques – surface treatments-safety aspects in welding processes-	5
7.	**CAE of Welding And Casting:** Design of weldment, application of finite element method in welding – determination of distortion in weldments, modeling of temperature distribution – case studies. Design for casting, application of finite element method in casting-determination of hot spots, location of turbulence, and other defects, modeling of flow in molds, modeling of heat transfer in castings case studies	8
	Total	**42**

Suggested Books:

[1]. **P**.L.Jain “ Principles of foundry Technology” Tata Mc Graw Hill Publishers

[2]. Dr.R.S.Parmer “Welding processes and Technology” Khanna Publishers.

[3]. Howard B Cary, “ Modern Welding Technology” Prentice Hall, 2002

[4]. “Manufacturing & Technology: Foundry Forming and Welding”,P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.

[5]. H.S.Bawa “Manufacturing Technology-I” Tata Mc Graw Hill Publishers New Delhi, 2007.

[6]. S.V.Nadkarni, Modern Arc Welding Technology, Oxford & IBH Publishing Co. Pvt. Ltd.

Production Engineering			
PE723	Material Deformation Process	L	T
		3	0

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Basic Concepts** State of stress at a point, equilibrium equations, stress tensor, spherical tensor and deviator stress tensor, principal stress, deformation tensor	05
2.	**Theory of Plasticity** Engineering and true stress –strain, flow curve, idealized stress-strain model, plastic deformation equations, levy–mises equations, prandlt–reuss equations, strain hardening, strain rate and bauschinger effects	07
3.	**Flow Rule and Yield Criterion** Velocity field and strain rate, compatibility equation, von – mises and tresca yield criterion, biaxial and triaxial yield surfaces, experimental verification of yield criterion, lode–stress, parameter	07
4.	**Friction and Lubrication** Interfacial friction laws–Coulombs friction law, constant shear factor law, composite friction, law and hydrodynamic friction law, friction mechanism during plastic deformation, lubrication mechanisms–boundary, hydrodynamic and solid lubrication, metal working, lubricants–types and characteristic	10
5.	**Plain Strain Deformation Processes** Basic concepts of slip-line method, slab method (equilibrium technique) and energy method, (upper bound technique), analysis of following deformation processes, Forging of strip: pressure distribution and forging load Rolling of strip: pressure distribution, roll–separating force and driving torque	06
6.	**Axi-Symmetric Deformation Processes** Analysis of following deformation processes:-Forging of disc: pressure distribution and forging load Extrusion of cylindrical rod: extrusion load and frictional power loss Drawing of cylindrical wire: drawing load and maximum allowable reduction	07
	Total	**42**

Suggested Books:

[1]. Principle of Industrial Metal Working G.W. Rowe, Edward Arnold , London
[2]. Principles of Metal Working S. Kumar, IBH & Co., New Delhi
[3]. Metal Working Processes and Analysis B. Avitzur, McGraw Hill, USA Metal Working Processes and Analysis B. Avitzur, McGraw Hill, USA
[4]. Metal Working Processes and Analysis B. Avitzur, McGraw Hill, USA

Production Engineering			
PE731	**Supply Chain Management**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1	Introduction to Supply Chain Management: Concepts, Objectives, Information and Material flows in the Supply Chain, Supply Chain Planning, Supply Chain Decision Making, Managing uncertainties in Supply chain, Benefits of Supply Chain Management in Industry	4
2	Dynamics of SCM: Supply Chain Process Cycles, Supply Chain Integration, Bullwhip effect in Supply Chain, Information Systems and Processing in Supply Chain, Collaborative Planning Forecasting and Replenishment (CPFR), Inventory Planning and control	6
3	Information and Communication Technology used in Supply Chain: Need and Role of an Information System in SCM, Enterprise Resource Planning (ERP), Concept of SAP in Supply chain, Current Trends of use of IT in SCM, Use of IT enabled technologies / services in Logistical system	7
4	Supply Chain Management Practices: Bar-coding, Tierization of suppliers, Vendor Managed Inventory, Hub and Spoke concept, Dynamic pricing, Third Party Logistics (3 PL's) providers, Fourth Party Logistics (4 PL's) providers, Reverse Logistics, Green Logistics, Electronic Data Interface, Lean Operations	7
5	Procurement and Outsourcing Strategies: Make / In sourcing or Buy / Outsourcing Decisions, Green Purchasing, Strategic Outsourcing, Strategic partnership with the suppliers, Suppler Selection process, Supplier Rating and Control, Strategic Sourcing Decisions, Continuous Improvement of Suppliers, Quality Assurance Program of suppliers	8
6	Customer Relationship Management in Supply Chain: CRM, Strategic Partnership with the Customer, Linkage between CRM and SRM, Functional components of a CRM system, CRM Business cycle	5
7	Performance Benchmarking in SCM Implementation: Supply Chain Integration, Supply Chain Operations Reference (SCOR) Model, Supply Chain Performance Benchmarking	5
	Total	42

Suggested Books:

[1]. Chopra, Sunil and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, Prentice Hall of India.6th Edition

[2]. Sunil Sharma, Supply Chain Management - Concepts, Practices and Implementation, Oxford University Press
[3]. Mohanty R. P and S. G. Desmukh, Essentials of Supply Chain Management, Phoenix publishing
[4]. Ballou, Donald H. and S. Srivastava, Business Logistics / Supply Chain Management, Pearson Education, 5th Edition,
[5]. Simchi - Levi, D.P Kaminsky, Edith Simchi –Levi, Designing and Managing the supply Chain concepts, Strategies and Cases Tata McGraw – Hill, 3rd Edition,
[6]. Buffa, E. S. and Sarin, R. K., John Wiley & Sons Ltd , Modern Production / Operations Management, 8th Revised Edition,

Production Engineering			
PE732	**Enterprise Resource Planning**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**Enterprise:** An Overview: Business Functions and Business Processes, importance of Information: Characteristics of information; Types of information, Information System: Components of an information system; Different types of information systems; Management information system, Enterprise Resource Planning: Business modelling; Integrated data model	6s
2.	**Introduction to ERP:**Defining ERP, Origin and Need for an ERP System, Benefits of an ERP System, Reasons for the Growth of ERP Market, Reasons for the Failure of ERP Implementation: Roadmap for successful ERP implementation	7
3.	**ERP and Related Technologies:**Business Process Re-engineering, Management Information systems, Decision Support Systems, Executive Information Systems- Advantages of EIS; Disadvantages of EIS, Data Warehousing, Data Mining, On-Line Analytical Processing, Product Life Cycle Management, Supply Chain Management, ERP Security	7
4.	**ERP Implementation Life Cycle:**ERP Tools and Software, ERP Selection Methods and Criteria, ERP Selection Process, ERP Vendor Selection, ERP Implementation Lifecycle, Pros and cons of ERP implementation, Factors for the Success of an ERP Implementation	6
5.	**ERP Modules Structure**: Finance, Sales and Distribution, Manufacturing and Production Planning- Material and Capacity Planning; Shop Floor Control; Quality Management; JIT/Repetitive Manufacturing; Cost Management ; Engineering Data Management; Engineering Change Control ; Configuration Management ;Tooling, Human Resource, Plant Maintenance- Preventive Maintenance Control; Equipment Tracking; Component Tracking; Plant Maintenance Calibration Tracking; Plant Maintenance Warranty Claims Tracking, Quality Management Materials Management- Pre-purchasing; Purchasing; Vendor Evaluation; Inventory Management and Invoice Verification and Material Inspection	8
6.	**ERP – A Manufacturing Perspective:** Role of Enterprise Resource Planning (ERP) in manufacturing, Computer Aided Design/Computer Aided Manufacturing (CAD/CAM), Materials Requirement Planning (MRP)-Master Production Schedule (MPS);Bill of Material (BOM);Inventory Records; Closed Loop MRP; Manufacturing Resource Planning (MRP-II), Manufacturing and Production Planning Module of an ERP System , Distribution Requirements Planning (DRP), Just-in-Time(JIT) & KANBAN - Kanban; Benefits of JIT	8

		Total	**42**

Suggested Books:

[1]. Manufacturing Resource Planning (MRP II) with Introduction to ERP; SCM; an CRM by Khalid Sheikh, Publisher: McGraw-Hill

[2]. ERP and Supply Chain Management by Christian N. Madu, Publisher: CHI

[3]. Implementing SAP ERP Sales & Distribution by Glynn C. Williams, Publisher McGraw-Hill.

[4]. The Impact of Enterprise Systems on Corporate Performance: A study of ERP, SCM, and CRM System Implementations [An article from: Journal of Operations Management] by K.B. Hendricks; V.R. Singhal; and J.K. Stratman, Publisher: Elsevier.

Production Engineering			
PE733	**Management Information System**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	**The Meaning and Role of Management Information System**: Decision support system, System Approach, The system view of Business, MIS organization within the company. **Management Organizational Theory and the System Approach:** Development of organizational theory, Management and organizational behavior, Management, Information, and the system approach.	08
2.	**Computer System and M I S** : Data processing and the computer, operation of a manual information system, component of computer system/conversion of Manual to computer-based systems, The data bank concept, Computer-based applications. **Data Base Management**: The Business setting, Data base management system, Objective of a DBMS, Computer, Data base Technical overview.	08
3.	**Information System for Decision Making:** Evaluation of an information system, Basic information systems, Decision making and MIS, MIS as a technique for making programmed decisions, Decision Assisting Information Systems.	06
4.	**Strategic and Project Planning for M I S:** General Business planning, Appropriate MIS response, General MIS planning, Detailed MIS planning. **Conceptual System Design**: System objectives, Constraints, Information needs, Information sources, Alternative conceptual designs and selection, Documentation of the system concept, Conceptual design report.	08
5.	**Detailed System Design :** Aim of detailed design, Project management of MIS detailed design, Dominent and Trade-off criteria, Subsystem, Detailed operating subsystems and information flows, Degree of automation of operations; Inputs outputs and processing; system testing Software, hardware and tools; Documentation of detailed design.	08
6.	**Implementation Evaluation and Maintenance of MIS** : Implementation planning, Organize for implementation; Training of operating personnel, Development of forms for data collection and information, testing of system, cutover, Documentation of the system, Evaluation of MIS, Control and maintenance of the system.	06
	Total	**42**

Suggested Books:

[1]. Information system for modern management by Robert Murdick & James Claggett, PHI Publication

[2]. Management Information Systems by James A. O’Brien, George M. Marakas, McGraw Hill Education

[3]. Management Information System by Olson MIS- Rahul De, Wiley Publication

Production Engineering			
PE734	**Marketing Management**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S.No.	Contents	Contact Hours
1	Fundamentals of Marketing: Core concepts of marketing and Company orientation towards the market place, Market Oriented Strategic Planning: Defining the Mission, Defining SBUs, Business Portfolio Evaluation and assigning resources to SBUs, Scanning the Marketing Environment: Analyzing trends in the components of the company's Macro & Micro environment.	6
2	Market segmentation, targeting and positioning: Purpose of Segmentation, Bases of segmenting Consumer Markets - Demographic, Geographic, Psychographic & Behavioral, Evaluating & Selecting Market Segments, Dealing with competition: Identifying and analyzing competitors, Strategies for the Market leader, Follower, Challenger	8
3	Analyzing Consumer Markets: Consumer behavior- Factors affecting consumer behavior & consumer decision making process, Creating customer value, satisfaction & loyalty: Customer perceived value, customer satisfaction, measuring satisfaction, measuring customer life time value, CRM & building loyalty	6
4	Product Strategy: Classification of products, product levels, Analysis of product line & product mix, Product Life Cycle: Concept, Strategies for Introduction, Growth, Maturity & Decline Phase. Criticism of the Product Life Cycle.	5
5	Pricing Strategies: Selecting the pricing Objective, Determining demand, estimating costs, analyzing competitors, selecting a pricing method, initiating & responding to price changes, Integrated Marketing Communication: Meaning and Role of IMC, designing effective communication program, Meaning and role of the elements of communication mix, Leveraging Social Media for effective communication.	6
6	Distribution Strategies: Concept of Value Networks, Role of marketing channels. Channel design decisions, channel management decisions. Channel Integration through Vertical Marketing systems & Horizontal Marketing Systems, Retailing: Classification of Store Formats, Types of Retail Formats, Retail positioning, Store Location, Product assortment & Services, Price, promotion, Store Atmosphere	8

7	Managing services: Importance, Distinctive Characteristics, Green Marketing, Rural Marketing and Consumer Protection - Introduction and significance	3
	Total	42

Suggested Books:

[1]. Kotler, Keller, Koshy & Jha, Marketing Management A South Asian Perspective Prentice Hall/Pearson, Fourteenth Edition,

[2]. Rajan Saxena, Marketing Management, TMH, Fourth Edition,

[3]. Arun Kumar, N Meenakshi, Marketing Management, Vikas Publishing , 3rd Edition,

[4]. Bruce Walker & Stanton, Fundamentals of Marketing, McGraw Hill

[5]. W.D. Perraut & E.J. Mc Carthy, Basic Marketing, TMH

[6]. Russel S. Winner, Marketing Management , Pearson.

Production Engineering			
PE735	**Intelligent Manufacturing Systems**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	Basic concepts of Artificial intelligence and expert systems, System Components , System architecture and Data flow, System Operations	06
2.	Knowledge based systems, knowledge representation , knowledge acquisition and optimization, Knowledge based approaches to design mechanical parts and mechansims and design forautomated assembly	08
3.	Knowledge based system for material selection, Intelligent process planning system	06
4.	Intelligent system for equipment selection, Intelligent system for project management & factorymonitoring.	06
5.	Intelligent system for Scheduling in manufacturing , scheduling the shop floor , Diagnosis & troubleshooting	08
6.	The role of Artificial Intelligence in the factory of the future , Intelligent systems	08
	Total	**42**

Suggested Books:

[1]. Intelligent Manufacturing Systems, Andrew Kussiak, Prentice Hall
[2]. Introducing Artificial Intelligence, Simons, G.L, NCC Pub
[3]. Intelligent Scheduling,.by Monte Zweben, Morgan Kaufmann Publishers

Production Engineering			
PE741	**Finite Element Method**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1	Basic concepts: Variational and Residual methods-Introduction - Different approaches in Finite Element Method - Direct Stiffness approach, simple examples Variational approach, Elements of variational calculus – Euler's-Lagrange equation, Rayliegh Ritz method , Weighted Residual methods, Point Collation method, Sub domain Collation method, Galerkins method - Steps involved in FEM.	08
2	Elements and Interpolation Functions: Elements and coordinate system – Interpolation Polynomials - Linear elements Shape function - Analysis of simply supported beam - Element and Global matrices - Two dimensional elements, triangular and rectangular elements - Local and Natural Co-ordinate systems.	07
3	Finite Element Solution of Field Problems: Field problems – Finite element formation of field problems - Classification of partial differential equations - Quasiharmonic equation - Steady state problems - Eigen value problems - Propogation problems - Examples, Torsional problem – Fluid flow and Heat transfer problems - Acoustic vibrations – Application in manufacturing problems – metal cutting and metal forming.	07
4	Finite Element Solution of Structural Problems: Solid mechanic problems – Finite element formulation of solid mechanic problems - Axial force member - element matrices for axial force members - Truss element analysis of pinned truss - Two dimensional elasticity problems.	08
5	Higher Order Elements and Numerical Methods: Numerical method and computer implementation –Numerical method in FEM and Computer implementation. Evaluation of shape functions - One dimensional & triangular elements	07
6	Quadrilateral elements, Isoparametric elements - Numerical Integration, Gauss Legendre quadrature - Solution of finite element equations - Cholesky decomposition, Skyline storage - Computer implementation- Use of FEM software.	05
	Total	**42**

Suggested Books:

[1]. Larry J Segerlind ,“ Applied Finite Element Analysis”, John Wiley

[2]. Bathe, K.J., “Finite Element Procedures”, Prentice Hall

[3]. Huebner,K.H. and Thornton, E.A., “The Finite Element Method for Engineers”, John Wiley.

[4]. Reddy,J.N., “Introduction to Finite Element Method”, McGraw Hill,

[5]. S.S.Rao, “The Finite element method”, Elsevier.

[6]. Zienkiewich . O.C., and Taylor . R.L., “The Finite Element Method”, McGraw Hill

Production Engineering			
PE742	**Modern Optimization Technique**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	Dynamic Programming : Multistage Decision Processes, Concept of Suboptimization and Principle of Optimality,Computational Procedure in Dynamic Programming Continuous Dynamic Programming.	08
2.	Integer Programming: Gomory's Cutting Plane Method ,Integer Polynomial Programming, Branch and Bound Method,Sequential Linear Discrete Programming,Generalized Penalty Function Method	07
3.	Stochastic Programming:Random Variables and Probability Density Functions,Stochastic Linear Programming,Stochastic Nonlinear Programming	05
4.	Optimal Control and Optimality Criteria Methods:Calculus of Variations,Optimal Control Theory,Optimality Criteria Methods	05
5.	Modern Methods of Optimization:Genetic Algorithms,Particle Swarm Optimization,Optimization of Fuzzy Systems,Neural-Network-Based Optimization	10
6.	Practical Aspects of Optimization: Sensitivity of Optimum Solution to Problem Parameters,Multilevel Optimization,Multiobjective Optimization	07
	Total	**42**

Suggested Books:

[1]. Engineering Optimization: Theory and Practice, S.S. Rao ,New Age Inter. Pvt Ltd.,
[2]. Operation Research by Hamdy A. Taha, Pearson publication
[3]. Optimization for Engineering Design Algorithms and Examples, K. Deb, Prentice-Hall of India Pvt. Ltd
[4]. Modern heuristic optimization techniques, Kwang Y.Lee, Mohammed A.El Sharkawi John Wiley and Sons,
[5]. Dynamic Programming and Optimal Control, Dimitri P. Bertsekas,Athena Scientific
[6]. Prabhakar Pai, Operation Research, Oxford University Press.
[7]. Engineering Optimization, A.Ravindran, K.M.Ragsdell, G.V.Reklaitis, Wiley India Pvt. Ltd.

Production Engineering

PE743	Mechatronics	L	T
		3	0

DETAILED SYLLABUS

Sr. No.	Contents	Contact Hours
1.	Introduction: Definition of mechatronics, measurement system, control systems, microprocessor based controllers, mechatronics approach.	2
2.	Sensors and Transducers: Sensors and transducers, performance terminology, photoelectric transducers, flow transducers, optical sensors and transducers, semiconductor lasers, selection of sensors, mechanical / electrical switches, inputting data by switches.	7
3.	Actuators: Actuation systems, pneumatic and hydraulic systems, process control valves, rotary actuators, mechanical actuation systems, electrical actuation systems.	5
4.	Signal Conditioning: Signal conditioning, filtering digital signal, multiplexers, data acquisition, digital signal processing, pulse modulation, data presentation systems.	5
5.	Microprocessors and Microcontrollers: Microcomputer structure, microcontrollers, applications, programmable logic controllers.	8
6.	Modeling and System Response: Mathematical models, bond graph models, mechanical, electrical, hydraulic and thermal systems, dynamic response of systems, transfer function and frequency response, closed loop controllers.	7
7.	Design and Mechatronics: Input/output systems, computer based modular design, system validation, remote monitoring and control, designing, possible design solutions, detailed case studies of mechatronic systems used in photocopier, automobile, robots.	7
	Total	**42**

Suggested Books:

[1]. Bolton, W., "Mechatronics", Longman.
[2]. Alciatore, D. G. and Histrand, M. B., "Introduction to Mechatronics", Tata McGraw Hill
[3]. Shetty, D. and Richard, A.K., "Mechatronics System Design", PWS Pub. Boston
[4]. Mahalik, N., "Principles, Concept and Applications: Mechatronics", Tata McGraw.
[5]. Bishop, R.H. "Mechatronics Handbook", CRC Press.
[6]. Bolton, W., "Mechatronics: A Multidisciplinary Approach", 4th Ed., Prentice.
[7]. Merzouki R., Samantaray A. K., Pathak P.M., Bouamama B. Ould, Intelligent Mechatronic Systems: Modeling, Control and Diagnosis, Springer.

Production Engineering			
PE744	**Project Engineering**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

S. No.	Contents	Contact Hours
1.	The scope of project, characteristics of a project, stages of a project, Project constraints, Project Management structures, Responsibilities of project manager,	08
2.	Project productivity. The anatomy of a project. Environmental considerations in project evaluation.	07
3.	Main issues and secondary issues in feasibility study, Social cost benefit analysis, Commissioning, Evaluation of competing projects. Budgetary aspects and considerations of a project.	05
4.	Industrial/Engineering projects, R & D Projects, Turnkey projects, Network Modeling of a project, Deterministic & probabilistic activity networks, Line of Balance, Time-cost trade-off in a project, Mega projects.	05
5.	Project scheduling techniques, PERT, CPM Models.	08
6.	Project monitoring techniques, Performance and Cost Evaluation (PACE), Project Staffing Requirements, Resource leveling. Project Documentation, Computer Application in Project Engineering.	9
	Total	**42**

Suggested Books:

[1].Elements of Project Management, K. Nagarajan, New Age International
[2].Production and Operation Management, S.N Chary, Tata McGraw Hill
[3].Information Technology Project Management, Kathy Schwable, Cengage Learning Australia
[4].Guidelines for Project Evaluation, Pratha Dasgupta, Amartya Sen, & Stephen Marglin, United Nations,
[5].Strategic Project Management Made Simple: Practical Tools for Leaders and Teams,Terry Schmidt.
[6].Effective Project Management: Robert K. Wysocki ,Traditional, Agile, Extreme, 5th Edition.
[7].Project Engineering: The Essential Toolbox for Young Engineers, Frederick Plummer.
[8].Project Management Panneerselvam R, PHI Learning Pvt. Ltd.

CIVIL ENGINEERING

Civil Engineering			
CE701	Concrete Structure-II	**L**	**T**
		3	**0**

Pre-requisites: Strength of Materials.

Course Outcomes: At the end of the course, the students will be able to

CO1	Recapitulation of basic structural analysis, design philosophies viz working stress and limit state method.
CO2	Analysis and design of concrete structures such as water tanks, RC bridges, Silos and bunker, arches and shells.
CO3	Understanding of few practical aspects of design with an aim of future career possibilities.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Design of Residential Buildings: fundamentals of multi-storey buildings, analysis of various loads: gravity, wind, earthquake loads., method of substitute frames, design examples, bending moments in columns, analysis of multistory frames subjected to horizontal loads.	**12**
2.	Design of RCC water tanks: Uncracked structures and determination of basic parameters, Revision of working stress design philosophies. Introduction to water tanks and their classifications, Important IS codes and its provisions, Analysis and design of Circular water tanks with flexible base and restrained base. Analysis and design of Rectangular water tanks, Analysis of Overhead tanks, Intze tank- basic geometrical configurations; analysis methods; design of top domes, cylindrical walls, ring beam.	**12**
3.	Design of Silos and Bunkers: Introduction, difference between bunker and silo, design of square or rectangular bunkers, design of circular bunkers, design examples, silos for storage of cement,	**10**

	design examples.	
4.	Design of Simple Bridges: Bridges – basic definition, importance, classification., Site investigations for design of a bridge, Various loads and their combinations, Relevant IRC codes and its provisions, Introduction to RC bridge-, design of Culvertand T-beam bridge,.	**12**

Civil Engineering			
CE711	Hydraulic Structures	**L**	**T**
		3	**0**

Pre-requisites: WRE-I, WRE-II

Course Outcomes: At the end of the course, the students will be able to

CO1	Integrate the hydraulics and water resources background by involving the students in water structures design applications.
CO2	Encourage class discussions for formulating and solving multi-variable hydraulic design problems in an open-ended solution space.
CO3	To develop understanding of the basic principles and concepts of analysis and design of hydraulic structures.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Reservoir: Reservoir planning types of reservoirs elements of a Reservoir, mass curve and demand curve, yield of Reservoir, life of Reservoir.	**6**
2.	Types of dams and stability. Gravity dam, forces acting on gravity dam, load combination for stability analysis, elementary profile and practical profile, Foundation treatments, joint and Seal, galleries	**8**
3.	Arch dam: types of Arch dams, constant radium and constant Central angle, using thin and thick cylindrical theories, USSR guidelines for designing arch dam.	**8**
4.	Buttress: Types of buttress dam, design of flat slab buttress Dam, advantages and disadvantages of buttress dam.	**8**
5.	Embankment dams: Earth and rockfill Dam, types of embankment dam, causes of failure, design principles, method of	**8**

	construction, seepage through dams and foundation and remedial measurement.	
6.	Spillway and energy dissipation device: types of spillways, requirement, serviceability, design of straight drop and Ogee spillways, energy dissipation past spillways, types of stilling basin and design of stilling basin.	**8**

Civil Engineering			
CE712	Composite Materials	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to:

CO1	Explain the mechanical behavior of layered composites compared to isotropic materials.
CO2	Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.
CO3	Determine stresses and strains relation in composites materials.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	**Introduction:** Classifications of Engineering Materials, Concept of composite materials, Matrix materials, Functions of a Matrix, Desired Properties of a Matrix, Polymer Matrix (Thermosets and Thermoplastics), Metal matrix, Ceramic matrix, Carbon Matrix, Glass Matrix etc. Types of Reinforcements/Fibers: Role and Selection or reinforcement materials, Types of fibres, Glass fibers, Carbon fibers, Aramid fibers , Metal fibers, Alumina fibers, Boron Fibers, Silicon carbide fibers, Quartz and Silica fibers, Multiphase fibers, Whiskers, Flakes etc., Mechanical properties of fibres.	**14**
2.	**Various types of composites:** Classification based on Matrix Material: Organic Matrix composites, Polymer matrix composites (PMC), Carbon matrix Composites or Carbon-Carbon Composites, Metal matrix composites (MMC), Ceramic matrix composites (CMC); Classification based on reinforcements: Fiber Reinforced Composites, Fiber Reinforced Polymer (FRP) Composites, Laminar Composites, Particulate Composites, Comparison with Metals, Advantages & limitations of Composites.	**10**
3.	**Fabrication methods: Processing of Composite Materials:** Overall considerations, Autoclave curing, Other Manufacturing Processes like filament welding, compression molding, resin-	**8**

	transplant method, pultrusion, pre-peg layer, Fiber-only performs, Combined Fiber-Matrix performs, Manufacturing Techniques: Tooling and Specialty materials, Release agents, Peel plies, release films and fabrics, Bleeder and breather plies, bagging films.	
4.	Mechanical testing of composites, tensile testing, Compressive testing, Intra-laminar shear testing, Inter-laminar shear testing, Fracture testing etc.	**8**

Civil Engineering			
CE713	**Prestressed Concrete**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand the concepts of pre-stressing in concrete structures and identify the materials for pre-stressing.
CO2	Analyse a Pre-stressed Concrete section and Estimate losses of pre-stressing
CO3	Design pre-tensioned and post tensioned girders for flexure and shear

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Introduction: Fundamentals of prestressing - Classification and types of prestressing Concrete Strength and strain characteristics - Steel mechanical properties – Auxiliary Materials like duct formers.	**8**
2.	Prestressing Systems: Principles of pretensioning and post tensioning - study of common systems of prestressing for wires strands and bars and Losses of Prestress: Losses of prestress in pre tensioned and post tensioned members, I.S. code provisions.	**8**
3.	Analysis of Sections: In flexure, simple sections in flexure, kern distance - cable profile -limiting zones - composite sections cracking moment of rectangular sections.	**8**
4.	Design of Simply Supported Beams: Allowable stress as per I.S. 1343 - elastic design of rectangular and I-sections.	**8**
5.	Shear and Bond: Shear and bond is prestressed concrete beams - conventional design of shear reinforcement - Ultimate shear strength of a section - Prestress transfer in pretensioned beams-Principles of end block design.	**8**

Civil Engineering			
CE714	**Ground Water Hydrology**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	list and describe the properties of aquifers that control the movement and storage of groundwater
CO2	use Darcy's Law to explain the roles of aquifer properties and driving forces in governing the rate of groundwater flow
CO3	interpret the current and historical balance between groundwater recharge and water extraction from well hydrographs

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	INTRODUCTION: Ground water utilization & historical background, ground water in hydrologic cycle, ground water budget, ground water level fluctuations & environmental influence , occurrence and movement of ground water: Origin & age of ground water, rock properties affecting groundwater, groundwater column, zones of aeration & saturation, aquifers and their characteristics/classification, groundwater basins & springs, Darcy's Law, permeability & its determination, Dupuit assumptions, heterogeneity &anisotropy, Ground water flow rates & flow directions, general flow equations through porous media.	**10**
2.	ADVANCED WELL HYDRAULICS: steady/ unsteady, uniform/ radial flow to a well in a confined/ unconfined /leaky aquifer, well flow near aquifer boundaries/ for special conditions, partially penetrating/horizontal wells & multiple well systems, well completion/ development/ protection/ rehabilitation/ testing for yield	**8**
3.	POLLUTION AND QUALITY ANALYSIS OF GROUND	**8**

	WATER: Municipal /industrial /agricultural /miscellaneous sources & causes of pollution, attenuation/ underground distribution / potential evaluation of pollution, physical /chemical /biological analysis of ground water quality, criteria & measures of ground water quality, ground water salinity & samples, graphical representations of ground water quality.	
4.	SURFACE/ SUB-SURFACE INVESTIGATION OF GROUND WATER: Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction based methods for surface investigation of ground water, test drilling & ground water level measurement, sub-surface ground water investigation through geophysical / resistivity /spontaneous potential /radiation / temperature / caliper / fluid conductivity / fluid velocity /miscellaneous logging	**8**
5.	MODELING AND MANAGEMENT OF GROUND WATER: Ground water modeling through porous media /analog / electric analog / digital computer models, ground water basin management concept, hydrologic equilibrium equation, ground water basin investigations, data collection & field work, dynamic equilibrium in natural aquifers, management potential & safe yield of aquifers, stream-aquifer interaction.	**8**

Civil Engineering			
CE715	**Earthquake Engineering**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	To explain the concept of earthquakes and knowledge of earthquake engineering practices applied to Civil Engineering problems
CO2	To determine different design parameter under different degree of freedom.
CO3	To identify the remedial measures of earthquake disaster
CO4	Practice of Earthquake code and application

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Elements of Seismology, Definitions of Magnitude, Intensity, Epicenter, etc. General features of tectonic of seismic regions, Seismographs. Theory of Vibrations.	**8**
2.	Free vibrations of single degree, two degree and multiple degree freedom systems. Computation of dynamic response to time dependent forces. Vibration isolation. Vibration absorbers.	**8**
3.	Principles of Earthquake Resistant Design Response spectrum theory. Brief introduction to accelerographs and S.R.R.'s.	**8**
4.	Nature of dynamic loading resulting from earthquakes. Application of Response spectrum. Theory to a seismic design to structures. Resistance of structural elements and structures for dynamic loads, design criteria-strength and deflection. Ductility and absorption of energy.	**8**
5.	Dynamic Properties of Soils, Remedial measures and management of earthquake disaster, Introduction to Indian Standard Codes IS : 1893 – 1984 and IS: 4326 – 1993.	**8**

Civil Engineering			
CE721	**Construction Planning and Management**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	To describe different planning stages for any project.
CO2	To distinguish between CPM and PERT and its elements.
CO3	To create network diagram using CPM and PERT
CO4	To estimate earth work using Mass Haul diagram

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Management: Introduction, development of management and its recent trends, principle of management, function of management, administration of management and organization.	**6**
2.	Constructional planning: Need for construction planning, construction resources, stages in construction Job Lay-Out, preparation of construction schedule preparatory work for project, Inspection and quality control. Objective of C. P. M. and PERT, elements of network, network rules, constraints errors in network	**6**
3.	CPM: Critical path analysis, activity times and floats, optimization through CPM Technique, PERT: PERT and three Estimates, critical path and analysis of PERT network. Probability of completion of project, controlling and monitoring	**12**
4.	MASS HAUL DIAGRAM: Characteristics of mass Haul diagram, Earth work calculation by mass haul diagram, objective of motion study, objective/uses of time study, motion/time study procedure.	**6**

5.	SAFETY IN CONSTRUCTION: Hazards in construction projects, causes of accidents, costs of an accident, safety programme for construction, protective equipment, safety measures, construction element of a building.	**6**
6.	PREFABRICATION: Need for prefabrication, classification of prefabrication, scope of prefabrication in India, advantages and disadvantages of prefabrication design principle of prefabricate system.	**4**

Civil Engineering			
CE722	**Industrial Waste Treatment**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Ability to plan minimization of industrial wastes.
CO2	Ability to design facilities for the processing and reclamation of industrial waste water.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	INTRODUCTION: Types of industries and industrial pollution – Characteristics of industrial wastes – Population equivalent – Bioassay studies – effects of industrial effluents on streams, sewer, land, sewage treatment plants and human health Environmental legislations related to prevention and control of industrial effluents and hazardous wastes.	**8**
2.	CLEANER PRODUCTION: Waste management Approach – Waste Audit – Volume and strength reduction – Material and process modifications – Recycle, reuse and byproduct recovery – Applications.	**8**
3.	POLLUTION FROM MAJOR INDUSTRIES: Sources, Characteristics, waste treatment flow sheets for selected industries such as Textiles, Tanneries, Pharmaceuticals, Electroplating industries, Dairy, Sugar, Paper, distilleries, Steel plants, Refineries, fertilizer, thermal power plants – Wastewater reclamation concepts.	**9**
4.	TREATMENT TECHNOLOGIES: Equalisation – Neutralisation – Removal of suspended and dissolved organic solids – Chemical oxidation – Adsorption – Removal of dissolved inorganics – Combined treatment of industrial and municipal wastes – Residue management – Dewatering – Disposal.	**11**

Civil Engineering			
CE723	**Sustainable Construction Methods**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand rating systems and compares key features such as cost, ease of use, and building performance
CO2	Know rating systems in detail, including its evolution, objectives, criteria, levels of certification benefits,and shortcomings
CO3	Know a series of case studies representing diverse project types, sizes, certification levels, and climate regions
CO4	Know what are "lessons learned" of sustainable construction through case studies

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Introduction: Sustainability in the Built Environment, Environmental/Resources Issues & Industrial/Construction Metabolism.	**8**
2.	Environmental Economics and Life Cycle Costing, Life Cycle Assessment, Embodied Energy, Energy, and Materials.	**8**
3.	Building Assessment and Eco-labels, Sustainability Frameworks and Sustainable Communities and Sustainability Indicators.	**8**
4.	Energy Systems, Energy, Entropy, Energy Conservation, and Renewable Energy,Water Resources, Wastewater, and Storm-water and Urban Planning, Land Development, New Urbanism, and Landscaping.	**8**
5.	Design for the Environment, Ecological Principles, Passive Design, and Climatic Design and Construction Operations, Advanced Construction Waste Management and Demolition, Building Health, Building Commissioning and Facility Management, Industrial Ecology and Construction Ecology.	**8**

Civil Engineering			
CE724	**Elements of Fluivial Hydraulics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Understand rating systems and compares key features such as cost, ease of use, and building performance
CO2	Know rating systems in detail, including its evolution, objectives, criteria, levels of certification benefits,and shortcomings
CO3	Know a series of case studies representing diverse project types, sizes, certification levels, and climate regions
CO4	Know what are "lessons learned" of sustainable construction through case studies

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Introduction, Definition, Historical Development of Native Problem. Origin and Properties of sediment Introduction, Origin and Formation of sediment, Fundamental properties.	**8**
2.	Incipient motion Introduction, competent, life concept critical tractive Force, Critical attractive stress of cohesionless, cohesive material.	**8**
3.	Regime of flow :- Introduction, Description ripple dune, Antidune, Importance of regime flow prediction of regime flow.	**8**
4.	Bed load transport : Introduction, Mechanism,suspended saltation & total load transport.semi theoretical approach, Einstein's theory.	**8**
5.	Bed level variation in Alluvial channel Introduction, Mechanism, Aggredation, Degradation, scour, local scour, scour causes& protection.	**8**

Civil Engineering			
CE725	**Railway Engineering**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Explain Components of Railway Track, different Railway Gauges and design track Gradients as per given requirements.
CO2	Discuss various Types of Track Turnouts and describe purposes and facilities at Railway Stations.
CO3	Explain Interlocking and modern signal system and describe Surface Defects on Railway Track and Their Remedial Measures.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	**Introduction**: Alignment of Railway Lines Rails, Track Fittings and Track Stresses. Describe history and recent developments in railways. Explain Components of Railway Track, different Railway Gauges. Discuss requirements of an ideal alignment. Comprehend the Standard Rail Sections. Explain Causes and effects of Creep and Measures to Reduce Creep. Explain Fittings and Fastening and their Requirements. Discuss Forces Acting on Track and Coning of Wheels History of Indian Railways, Importance of Railways For Environment. Recent Developments. Role of Civil Engineers In Construction And Maintenance. Components of Railway Track .Definition of Railway Gauges, Types, Uniformity of Gauge. Different Gauges on Indian Railways,. Cross- Section of Permanent Way as Per IRS .Problems Caused By Change of Gauge. Basic Requirements and selection of An Ideal Alignment. Functions and Types Of Rails .Standard Rail Sections. Causes and Effects Of Creep, Measures To Reduce Creep. Fittings and Fastening and their requirements. Forces Acting On Track. Coning Of Wheels.	**8**

2.	**Sleeper & Geometric Design of Track:** Describe Functions & Requirements of sleepers. Explain Method of Fixing Rails with Prestressed Concrete and Wooden Sleepers. Explain the necessity and details of geometric design . Design track Gradients as per given requirements .Functions & Requirements of sleepers 2.2 Types and Spacing of Sleepers, 2.3 Method Of Fixing Rails With Pre-stressed Concrete And Wooden Sleepers, 2.4 Function and Specifications of Track Ballast 2.5 Necessity and Details of geometric design of track 2.6 Design of track Gradients, 2.7 Grade compensation on curves. 2.8 Curves and Super elevation.	**8**
3.	**Resistance to Traction, Points And Crossings**: 3a. Describe resistance to-friction 3b. Explain stress in rails 3c. Explain Necessity of Points & Crossing 3d. Draw Track Layouts And Sketches of Turn Out, 3e. Discuss various Types of Track Turnouts 3.1 Resistance to-friction, wave action, speed, track irregularity, wind, 3.2 Resistance to gradient, curvature, starting and accelerating. 3.3 Stress in rails, sleepers, ballast and formation 3.4 Necessity of Points & Crossing 3.5 Track Layouts And Sketches of Turn Out, 3.6 Types Of Crossing 3.7 Types of Track Turnouts.	**8**
4.	**Railway Stations and Yards**: 4a. Describe purposes and facilities at Railway Stations. 4b.Explain Station Yard 4.1. Purposes 4.2. Facilities Required at Railway Stations. 4.3. Requirements Of Station Yard, 4.4. Classification Of Railway Stations, 4.5. Types Of Yards.	**8**
5.	**Signaling And Interlocking**: 5a. Describe objectives of signaling 5b. Explain Interlocking and modern signal system 5.1 Objectives of signaling 5.2 Classification of signals 5.3 Types and working of Interlocking 5.4 Modern signal system.	**6**
6.	**Maintenance Of Railway Track:** 6a. Explain various types of railway track Maintenance 6b.Describe Surface Defects and Their Remedial Measures 6.1. Introduction of Maintenance Programme. 6.2. Monsoon, Pre-Monsoon & Post- Monsoon Maintenance. 6.3. Causes For Maintenance, 6.4. Routine Maintenance 6.5. Tools For Railway Track Maintenance &Their Functions. 6.6. Surface Defects And Their Remedial Measure.	**6**

Civil Engineering			
CE731	**Reliability Engineering**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Introduce concepts and methods in the field of reliability engineering and use of TQM (Total Quality Management) tools to measure and evaluate the quality of products.
CO2	Perform reliability analysis of a system and designing the same and apply the acquired knowledge in a practical operational problems or research projects.
CO3	Evaluate the use of reliability engineering for industrial activities.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	**Introduction:** Definitions and concepts, Reliability, Probability, Impossible and certain events. Failure-data and its Analysis, Hazard rate and Failure density, Reliability in terms of hazard rate, Failure density in other situations.	**10**
2.	**Hazard Models:** Type of distribution and standard deviation and variance, Expectations, Conditional probabilities.	**8**
3.	**System Reliability:** Series, Parallel and mixed configurations. Methods of solving Complex systems.	**8**
4.	**Reliability improvement:** Types of redundancies, Reliability allocation for a series of system, Optimization Reliability- cost trade-off.	**8**

Civil Engineering			
CE732	**Geographical Information System**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Describe the functional basis of a GIS AND appreciate the potential uses of GIS in ICM.
CO2	Consider the benefits and shortcomings of using GIS for ICM.
CO3	Outline the key data quality issues involved in using GIS AND develop a strategy to implement an effective GIS.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Basic concepts of GIS Introduction- Information Systems, spatial and non- spatial information, geographical concepts and terminology, Advantages of GIS. Basic components of GIS. Commercially available GIS hardware and software, organisation of Data in GIS.	**12**
2.	GIS Data: Input data-field data, statiatical data, Maps, Aerial photographs, Satellite data, points, lines and areas features, Vector and Raster data, Advantages and Disadvantages, Data entry through keyboard, digitizers and scanners, digital data. Pre-processing of data- Rectification and Registration. Interpolation techniques.	**12**
3.	Data management: Database Management System (DBMS). Various data models. Run length encoding, Quadtrees, Data Analysis - Data Layers, analysis of spatial and non-spatial data, Data overlay modelling, Data Presentation - Hardcopy devices, softcopy devices.	**8**
4.	Application of GIS.	**8**

Civil Engineering			
CE733	**Quality Control and Management**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Explain the different meanings of the quality concept and its influence.
CO2	Describe, distinguish and use the several techniques and quality management tools.
CO3	Explain and distinguish the Normalisation, homologation and certification activities.
CO4	Predict the errors in the measuring process, distinguishing its nature and the root causes.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Construction projects, Agencies involved in construction projects, mutual relationship, quality control at site, why and whose job is it.	**12**
2.	ISO / IS Requirements: IS 9000 (Parts 1 to 4), (Pt 1: 1994, Pt 2: 1993 Pt 3: 1994 Pt 4: 1993 for total quality management. ISO] 4000 – 988 for environment – impact of large construction projects.	**12**
3.	Quality control on construction projects, Inspection of reinforced concrete, masonry and steel works. testing techniques & quality audit reports.	**8**
4.	Statistical Analysis, Sampling frequencies, statistical & reliability analysis, optimum sample size.	**8**

Civil Engineering			
CE734	**Repairs & Rehabilitation of Structures**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Perform structural health monitoring AND Perform notable applications of structural health monitoring in civil applications
CO2	Diagnosis the damage of distress structures and Investigate the condition assessment of structures
CO3	Select the proper repair materials and its application and Select the method to Strengthen the distressed structures

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Maintenance and Repair Strategies Maintenance, Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance, Various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration.	**6**
2.	Strength and Durability Of Concrete- Quality assurance for concrete – Strength, Durability and Thermal properties, of concrete – Cracks, different types, causes – Effects due to climate, temperature, Sustained elevated temperature.	**6**
3.	Special Concretes- Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self-compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes.	**8**
4.	Corrosion – Effects of cover thickness; Corrosion monitoring, Corrosion protection techniques – Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic	**8**

	protection; Repair, Rehabilitation and Retrofitting of Structures.	
5.	Evaluation of root causes; Underpinning & shoring; some simple systems of rehabilitation of structures; Guniting, shotcreting; and Techniques for Repair and Protection Methods- Non-destructive Testing Techniques, Epoxy injection, Shoring, Underpinning.	**6**
6.	Non-Destructive testing systems; Use of external plates, carbon fibre wrapping and carbon composites in repairs. Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake – Demolition Techniques – Engineered demolition methods – Case studies.	**6**

*****Soft Skills and Interpersonal Communication (syllabus prepared and taught by Humanities Department)

Civil Engineering			
CE735	**Engineering Economics and Accountancy**	**L**	**T**
		3	**0**

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Engineering Economics: Introduction to Engineering Economics – Fundamental concepts – Time value of money – Cash flow and Time Diagrams – Choosing between alternative investment proposals.	**9**
2.	Methods of Economic analysis. The effect of borrowing on investment- Various concepts of National Income – Significance of National Income estimation and its limitations.	**9**
3.	Inflation –Definition – Process and Theories of Inflation and measures to control, New Economic Policy 1991 – Impact on industry.	**9**
4	Accountancy: Accounting Principles, Procedure – Double entry system – Journal – Ledger, Trail Balance – Cash Book – Preparation of Trading, Profit and Loss Account – Balance sheet.	**9**
5	Cost Accounting – Introduction – Classification of costs – Methods of costing – Techniques of costing – Cost sheet and preparation of cost sheet- Breakeven Analysis – Meaning and its application, Limitations.	**9**

Reading:

1. Engineering Economic Principles, Henry Malcom Stenar- McGraw Hill Pub.

2. “Modern Economic Theory”, Siltan Chand & Co.

3. Agrawal AN, “Indian Economy”, Dewett K.K., - Wiley Eastern Ltd, New Delhi.

4. “Accounting Part-I’, Jain and Narang - Kalyani Publishers.

5. “Cost Accounting”, Arora, M.N. - Vikas Publications.

Civil Engineering			
CE741	**Basics of Computational Hydraulics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Derive the governing equations of transients in pipes and channels
CO2	Apply method of characteristics and finite difference methods to solve unsteady flow problems in pipes and channels
CO3	Analyze transients in pumping and hydropower
CO4	Analyze dam break problem

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Introduction: Basic equations of fluid motion, heat and mass transfer, need for their numerical solution.	**12**
2.	Solution Techniques: Classification of governing equations-parabolic, elliptic and hyperbolic type, method of characteristics, explicit and implicit finite difference schemes – Crank Nicholson, Penceman-Rachford ADI, Leaffrom, Lax-Wendroff, Successive over-relaxation methods.	**12**
3.	Types of Problems: Analysis of water distribution networks, hydraulic transients in closed conducts, flood routing in stream using Saint-Venant equations, numerical solutions for one – dimensional convection and diffusion equation. Analysis of dam break problems. Positive and negative surge analysis, design and analysis of surge shocks.	**16**

Civil Engineering			
CE742	**Urban Hydrology and Hydraulics**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Analyze urban storm water systems, urban precipitation and storm water runoff.
CO2	Learn quantification of impacts of climate change on short duration high intensity rainfall in urban areas.
CO3	Case studies of several cities in India are dealt with, in the seminars presented by the students, and thus they get an exposure to a variety of urban flooding problems.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Review of basic hydrology; Strom water runoff generation; Return period; Hydrologic risk; Frequency analysis	**10**
2.	IDF relationships; Design storm; Open channel flow in urban watersheds; Interception storage, Infiltration, Depression storage	**10**
3.	Combined loss models; Estimation of runoff rates from urban watersheds; Flow routing; Storm water drainage structures	**10**
4.	Storm water detention; structural and non-structural control measures; Source control techniques; urban storm water models; introduction to urban groundwater systems.	**10**

Civil Engineering			
CE743	**Intelligent Transportation Systems**	**L**	**T**
		3	**0**

Course Outcomes: At the end of the course, the students will be able to

CO1	Differentiate different ITS user services
CO2	Select appropriate ITS technology depending upon site specific conditions
CO3	Design and implement ITS components

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Fundamentals of ITS: Definition of ITS, the historical context of ITS from both public policy and market economic perspectives, Types of ITS; Historical Background, Benefits of ITS.	**6**
2.	Sensor technologies and Data requirements of ITS: Importance of telecommunications in the ITS. Information Management, Traffic Management Centers (TMC).Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centers; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, video data collection.	**8**
3.	ITS User Needs and Services and Functional areas – Introduction, Advanced Traffic Management systems (ATMS), Advanced Traveler Information systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS), Advanced Rural Transportation systems (ARTS).	**8**
4.	ITS Architecture –Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods;	**8**

	Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning.	
5.	ITS applications: Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations and intermodal freight; public transportation applications; ITS and regional strategic transportation planning, including regional architectures: ITS and changing transportation institutions Automated Highway Systems- Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.	**10**

Civil Engineering			
CE744	**Structural geology**	**L**	**T**
		3	**0**

Pre-requisites:

Course Outcomes: At the end of the course, the students will be able to

CO1	Acquire knowledge on the geometry and type of structures present in earth.
CO2	Understand and describe the features formed in rocks when subjected to stress and impact of structural geology to active tectonic settings
CO3	Interpret graphs and models used in structural geology to understand and demonstratepoly phase deformations.

Course Articulation Matrix:

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

DETAILED SYLLABUS

MODULE	CONTENTS	Hrs
1.	Description, classification, and origin of earth structures. Ways in which the continental crust can deform; link scales of structure from the field, outcrops, handspecimen, thin section by integrating analytical techniques with practical examples.	**10**
2.	Theoretical and meso to micro-scale analysis of structures developed through a linked series of lectures and practical; practical 2D strain analysis; 3D strain concepts	**10**
3.	Incremental strain, kinematics and polyphase deformations; fold construction and classes; fault evolution and section balancing; fault rock microstructures;	**10**
4.	Fault and fold mechanics, current concepts in plate tectonics, cross-section construction techniques, structural interpretation of seismic data, structural styles in different tectonic settings (thrust and fold belts, rifts, strike and slip, gravity tectonics, inversion), structural geology of reservoir units.	**10**

Civil Engineering			
CE745	**Environmental, Health and Safety Management**	**L**	**T**
		3	**0**

MODULE	CONTENTS	Hrs
1.	Occupation, Safety And Management; Occupational Safety, Health and Environmental Safety, Management – Principles & practices, Role of Management in Industrial Safety, Organization Behaviaraion Human factors contributing to accident. Planning for Safety: Planning: Definition, purpose, nature, scope and procedure. Management by objectives and its role in Safety, Health and Management (SHE)	**8**
2.	Monitoring for Safety, Health & Environment: Occupational Safety, Health and Environment Management System, Bureau of Indian Standards on Safety and Health: 14489 – 1998 and 15001 – 2000, ILO and EPA Standards. Principles of Accident Prevention: Definition: Incident, accident, injury, dangerous, occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes etc.	**8**
3.	Education, Training and Employee Participation in Safety: Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs.	**8**
4	Competence Building Techniques (CBT), Concept for training, safety as an on-line function. Employee Participation: Purpose, areas of participation, methods, Role of trade union in Safety, Health and Environment Protection.	**8**
5	Management Information System: Sources of information on Safety, Health and Environment Protection. Compilation and collation of information, Analysis & use of modern methods of programming, storing and retrieval of MIS for Safety, Health and Environment. QCC HS Computer Software Application and Limitations.	**8**

Electronics & Communication Engineering

Electronics & Communication Engineering			
EC701	**Optical Fiber Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Identify and Develop the basic knowledge of different components of an Optical Fiber Communication theory.
CO2	Analyze the problems related to optical source, Fiber and Detector operational parameters.
CO3	Design and Investigate thecomplex problems related to high speed links, MUX, DEMUX, and different optical fiber link design parameters.
CO4	Use Modern Tool to analyze the concepts of WDM, Optical Amplifiers, Optical Switching and networking technology.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	2	-	-	-	-	-	-	-	-	2
CO2	1	3	-	-	1	-	-	-	-	-	-	1
CO3	1	-	3	2	-	-	-	-	-	-	-	1
CO4	-	-	1	1	3	-	-	-	-	-	-	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to optical fiber communication**: Principles and systems, Different types of fibers, SMF & MMF, Ray Theory analysis for step index fiber only. Fiber optic transmitters using LEDs and Laser diodes, Bias stabilization of LEDs and Lasers, Driver circuits for analog and digital modulation, Temperature stabilization of laser diodes, Modulation bandwidths of lasers and LEDs.	**8**
2	Fiber optic receivers using PIN and APD photodiodes, photo-diode amplifiers, SNR in PID and APD receivers, Receiver sensitivity, Eye diagram.	**8**
3	Coupling mechanisms of optical power from source to fiber and fiber to photo detector, Transmission characteristics of fibers and their effects on system performance, Selection of optical fiber types for short-haul, long-haul and high speed data links, optical power budget calculations of a fiber optic communication link.	**8**

4	Fiber optic interconnectivity devices for fiber optic communication links and networks: Optical isolators, polarizer, circulators, attenuators, Bragg grating filters, add/drop multiplexers, WDM MUX / DEMUX, fiber amplifiers, guided wave devices as external optical modulators.	**8**
5	Fiber optic analog modulation methods, Sub-carrier multiplexed analog communication principles, IM-DD systems, Fundamentals of optical coherent detection, Optical pulse format for digital communication systems, Performance of a 10 Mb/s digital fiber optic link and a 10 Gb/s data link, Effects of charp and line widths of lasers on system performance, Fiber optic networks for LAN, MAN and WAN – a brief study.	**8**

Text Books:

1. Optical fiber communications: principles and practice. Front Cover. John M. Senior.
2. “Cabling: The Complete Guide to Copper and Fiber-Optic Networking” by Andrew Oliviero and Bill Woodward.
3. “Fiber-Optic Transmission Networks: Efficient Design and Dynamic Operation (Signals and Communication Technology)” by Stephan Pachnicke.
4. “Fiber Optics Illustrated Dictionary (Advanced & Emerging Communications Technologies)” by J K Petersen.

Electronics & Communication Engineering			
EC711	**Mobile Communication**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand WLANs and their architecture
CO2	Design WAP pages using Wireless MarkUp language
CO3	Classify and distinguish different mobile communication generations and their architecture
CO4	To gain knowledge of different mobile transport layers

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	-	-	-	-	-	-	-	-	-
CO2	2	-	-	2	3	-	-	-	-	-	-	-
CO3	2	-	-	3	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**An Overview of Wireless Systems:** Introduction, Mobility versus portability, Mobile devices, Wireless communication and the layer model, First and Second Generation Cellular Systems, Cellular Communications from 1G to 3G Road Map for Higher Data Rate Capability in 3G, Wireless 4G Systems, Future Wireless Networks, Standardization Activities for Cellular Systems.	**8**
2	**Cellular System design concepts and fundamentals:** Frequency Reuse, Channel Assignment, Handoff Strategies, Interference and System Capacity, Trunking and Grade of service, Improving Coverage and Capacity in cellular systems. Mobile Radio Wave propagation, Large scale path loss and propagation models, Reflection, Diffraction, Scattering, Practical link budget design, Outdoor propagation models, Indoor propagation models	**8**
3	**Mobile Radio Wave propagation:** Small-Scale fading and multipath propagation, Rayleigh and Ricean Distributions, Multiple	**8**

	Access Techniques for Wireless Communications, FDMA, TDMA, Spread Spectrum multiple access, FHMA, CDMA, SDMA.	
4	**Multiple Access Techniques for Wireless Communications:** Packet radio, Pure ALOHA, Slotted ALOHA, CSMA, Reservation ALOHA, PRMA, Capacity of Cellular Systems, Wireless systems and standards, AMPS and ETACS, IS 54 and IS 136 GSM features, Architecture, Radio subsystems, Traffic channels, call processing.	**8**
5	**Wireless systems and standards:** CDMA features, Architecture, IS-95 Forward and reverse channels, power control, system capacity. Wireless Networking, WLAN, PAN, Mobile network layer, Mobile Transport layer, Wireless data services, Common channel signaling; Introduction to OFDM . **Wireless Networking:** Satellite data communication, cellular data communications, third generation UMTS system features, Wi MAX, RFID	**10**

Text Books:

1. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
2. Afif Osseiran, Jose.F.Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks", Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N. Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications.
5. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.

Electronics & Communication Engineering			
EC712	**Satellite Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Understand the orbital and functional principles of satellite communication systems
CO2	Architect, interpret, and select appropriate technologies for implementation of specified satellite communication systems.
CO3	Analyze and evaluate a satellite link and suggest enhancements to improve the link Performance.
CO4	Select an appropriate modulation, multiplexing, coding and multiple access schemes for a given satellite communication link.
CO5	Specify, design, prototype and test analog and digital satellite communication systems as per given specifications.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	2	1	2	1	-	-	-	2	2
CO2	1	-	-	1	2	2	2	-	-	-	2	2
CO3	-	-	-	-	2	2	1	-	-	-	2	2
CO4	1	-	-	-	3	2	1	-	-	-	2	2
CO5	1	1	-	-	3	2	1	-	-	-	2	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction:** Overview of Satellite Communications, GEO, MEO and LEO satellite systems, frequency bands Orbital Mechanics: Orbit Equations, Locating the satellite w.r.t. the earth, Orbital elements, look Angles, Orbital perturbation, Effects of earth's oblate ness ,moon and sun , Satellite eclipse, sun transit outage, Coverage angle, slant range, satellite launching.	**10**
2	**Satellite subsystems:** Attitude and Orbit Control System (AOCS), Telemetry, Tracking and Command System (TT&C), Power System, Satellite antennas, Communications subsystem, transponders.	**8**

3	**Satellite Link Design:** Basic transmission theory, System noise temperature and G/T ratio, CNR, CIR, ACI, IMI, down link design, up link design, System design examples.	**6**
4	**Modulation and Multiplexing:** FM with multiplexed telephone signals, Analog FM SCPC, PSK, QPSK, Multiple Access Schemes: FDM/FM/FDMA, TDMA, Frame structure, frame acquisition, synchronization, TDMA in VSAT network, On-board processing, CDMA, Spread spectrum transmission and reception, DS-SS CDMA capacity.	**8**
5	**Error Control for Digital Satellite Links:** Error control coding, Block codes, Convolution codes, Implementation of error detection on satellite links. **VSAT Systems:** Overview of VSAT systems, Network architectures, Access control, multiple access selection. **LEO Satellite systems:** Orbits, Coverage and frequency bands, off axis scanning, delay and throughput, NGSO constellation design, Problems.	**8**

Text Books:

1. Timothy Pratt, Charles Bostian Jermey Allnutt, Satellite Communications, John Wiley, Singapore, Second Edition, reprint 2013.
2. M. Richharaia, Satellite Communication Systems, BS Publishers, Second Edition, 2008.
3. TRI.T. HA, Digital Satellite Communications, McGraw-Hill, 2000.

Electronics & Communication Engineering			
EC713	**Nanotechnology and Application**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	**Understand the properties of Nano-materials and applications.**
CO2	**Apply chemical engineering principles to Nano-particle production.**
CO3	**Solve the quantum confinement equations.**
CO4	**Characterize Nano-materials.**
CO5	**Scale up the production Nanoparticles for Electronics and Chemical industries.**

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	-	-	-	-	-	-	-	-	2	-	-	3
CO3	3	-	-	-	-	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	2	-	-	3
CO5	-	-	-	-	-	-	-	-	-	-	2	3

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to Nanotechnology:** Introduction to nanotechnology and materials, Nanomaterials, Introduction to nano-sizes and properties comparison with the bulk materials, Different shapes and sizes and morphology.	**5**
2	**Fabrication of Nanomaterials:** Top Down Approach Grinding, Planetory milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Microemulsion Approach, Colloidal Nanoparticles Production, Sol Gel Methods, Sonochemical Approach, Microwave and Atomization, Gas phase Production Methods : Chemical Vapour Depositions. Kinetics at Nanoscale: Nucleation and growth of particles, Issues of Aggregation of Particles, Oswald Ripening, Stearic hindrance,	**10**

	Layers of surface charges, Zeta Potential and pH.	
3	**Carbon Nanomaterials:** Synthesis of carbon bucky-balls, List of stable carbon allotropes extended, fullerenes, metallofullerenes, solid C60, bucky onions, nanotubes, nanocones. **Quantum mechanics:** Quantum dots and its Importance, Pauli exclusion principle, Schrödinger's equation, Application of quantum Dots: quantum well, wire, dot, characteristics of quantum dots, Synthesis of quantum dots Semi-conductor quantum dots.	**7**
4	**Nanomaterials characterization:** Fractionation principles of Particle size measurements, Particle size and its distribution, XRD, Zeta potential, Electronic band structure Electron statistics Application, Optical transitions in solids, photonic crystals, Microscopies SEM, TEM, Atomic Forced Microscopy, Scanning and Tunneling Microscopy. **Applications:** Self-assembly and molecular manufacturing, Surfactant based system Colloidal system applications, Functional materials Applications, commercial processes of synthesis of nanomaterials, Nano inroganic materials of CaCO3 synthesis, Hybrid Waste Water Treatments systems, Electronic Nanodevices.	**10**
5	**Nanobiology:** Biological synthesis of nanoparticles and applications in drug delivery, Nanocontainers and Responsive Release of active agents, Layer by Layer assembly for nanospheres, Safety and health Issues of nano materials, Environmental Impacts, Case Study for Environmental and Societal Impacts.	**6**

Text books:

1) Kulkarni Sulabha K, Nanotechnology: Principles and Practices, Capital Publishing Company, 2007.
2) Stuart M. Lindsay, Introduction to Nanoscience, Oxford University Press, 2009.
3) Robert Kelsall, Ian Hamley, Mark Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
4) Gabor L. Hornyak , H.F. Tibbals , Joydeep Dutta , John J. Moore Introduction to Nanoscience and Nanotechnology CRC Press.
5) Davies, J.H. 'The Physics of Low Dimensional Semiconductors: An Introduction', Cambridge University Press, 1998.

Electronics & Communication Engineering			
EC721	**Antenna & Wave Propagation**	**L**	**T**
		3	**0**

Course Outcomes: After the completion of the course the student will be able to:

CO1	Understand the concept of radiation through mathematical formulation
CO2	Plot the characteristics of wire and aperture antennas
CO3	Develop the performance characteristics of array antennas
CO4	Measure the antenna parameters
CO5	Apply the concept of antenna in mobile communication

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	2	-	2	-	-	-	-	-	-	-	-	-
CO3	-	2	-	2	-	-	-	-	-	-	-	-
CO4	-	-	3	3	2	-	-	-	-	-	-	-
CO5	3	2	-	2	3	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course Content	No. of Lecture
1	**Antenna Fundamentals:** Introduction to antennas & its significance, Scalar electric potential, vector magnetic potential, radiation from an alternating current element, Induction field, radiation field, power radiated by a current element, Definition of electric dipole, radiation by a half wave dipole. Power by a half wave dipole & its radiation resistance, Radiation from a quarter wave monopole Power radiation and radiation resistance of dipole & monopole, Radiation resistance of aerials and loop, problems Isotropic radiator, network theorem, application of network theorem to antennas.	8
2	**Antenna Parameters:** Radiation pattern, power pattern, field pattern Radiation intensity, Antenna impedance, mutual impedance, gain and directivity, bandwidth, Polarization, efficiency, effective length, area or aperture, scattering loss, Collecting aperture, physical aperture, relation between large aperture and gain Effective aperture of a small elementary dipole, half wave antenna, effective length, front to back ratio, Antenna beam	9

	width and side lobes. Friss Transmission formula, Radar range equation**.**	
3	**Design of Arrays:** N-element linear array- broadside array, End fire array, multiplication of patterns Effect of earth on vertical pattern mutual impedance effects, Binomial arrays, problem solving.	**6**
4	**Practical antennas:** VLF, LF, MF transmitting antennas, resonant & non resonant antennas, V antenna, travelling wave antenna, Rhombic antenna, VHF &UHF antennas, horn antenna Folded dipole & Yagi-Uda antenna, Parabolic reflector antenna,, Corner reflector, Parabolic reflector antenna, Micro strip Antennas**.**	**8**
5	**Antenna impedance measurements:** Radiation pattern measurements Measurement of antenna beam width and gain, Polarization measurements. Measurement of radiation resistance. **Wave Propagation:** Types of wave propagation, space wave propagation and line of sight distance for flat and curved surfaces.	**10**

Text Books:

1. E.C. Jordan & K.G. Balmain, Electromagnetic waves & Radiating Systems, PHI, 2007.
2. Antenna Theory: Analysis and Design, Constantine A. Balanis, John Wiley & Sons, 3rd Ed., 2009.
3. David K. Cheng, “Field and Wave Electromagnetics”, Pearson, 2e, 2014.
4. John D. Kraus, Antennas, 2nd Edition, McGraw Hill, 1988.
5. R.E. Collins, Antennas and Radio Propagation, Singapore: McGraw Hill, 1985.
6. David M. Pozar, “Microwave Engineering”, Wiley, 4e, 2012.
7. Ahmed El Zooghby, ‘Smart Antenna Engineering’, ARTECH HOUSE, INC, 2005.
8. Frank B. Gross, ‘Smart antenna with MATLAB’, Second Edition, McGraw-Hill, 2015.

Electronics & Communication Engineering			
EC722	**RF IC Design**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Ability to design a system, component, or process, and synthesise solutions to achieve desired needs.
CO2	Perform calculation related to modulation and detection
CO3	Design of Critical Components in CMOS RF-IC Design.
CO4	Design of CMOS Low-Noise Amplifier and Mixer
CO5	Perform small signal conversion gain simulation

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	3	2	3	-	-	-	-	-	-	-	-
CO4	1	2	2	2	-	-	-	-	-	-	-	-
CO5	-	1	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to RF and Wireless Technology:** Complexity comparison, Design bottle necks, Applications, Analog and digital systems, Choice of Technology. **Basic Concepts in RF design:** Nonlinearity and time variance, ISI, Random process and noise, sensitivity and dynamic range, passive impedance transformation.	**10**
2	**Multiple Access:** Techniques and wireless standards, mobile RF communication, FDMA, TDMA, CDMA, Wireless standards.	**8**
3	**Transceiver Architectures:** General considerations, receiver architecture, Transmitter Architecture, transceiver performance tests, case studies.	**7**
4	**Amplifiers, Mixers and Oscillators:** LNAs, down conversion mixers, Cascaded Stages, oscillators, Frequency synthesizers.	**7**

5	**Power Amplifiers:** General considerations, linear and nonlinear Pas, classification, High Frequency power amplifier, large signal impedance matching, linearization techniques.	**8**

Text Books:

1. Razavi Behzad, RF Microelectronics, Prentice-Hall, 1998
2. Couch L W, Digital and Analog Communication Systems, Pearson/Prentice-Hall, c2007.
3. Behzad Razavi, Design of Analog CMOS Integrated Circuits, McGraw-Hill, 2001.
4. Leung Bosco, VLSI for Wireless Communication, Prentice Hall, 2002

Electronics & Communication Engineering			
EC723	**Real Time Embedded System**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Illustrate different types of embedded system and present its mathematical model under time Constraint.
CO2	Design methodologies for real time system and its application.
CO3	To understand RTOS and distinguishes between GPOS and RTOS.
CO4	To work on real time language.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	3	2	-	-	-	-	-	-	-
CO2	1		3	2	-	-	-	-	-	-	-	-
CO3	2	1	-	3	-	-	-	-	-	-	-	-
CO4	-	-	2	2	3	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	Introduction-defining Real time systems, Embedded Real Time Systems, Special Characteristics of real time systems, a brief evolutionary history. Hardware Architectures of Real Time systems	**12**
2	Software architectures (concepts of interrupt driven activation, need for real time monitor, pseudo parallelism), meeting of dead-lines & real time constraints.	**5**
3	Overview of WARD & MELLOR Methodology: Ward & Mellor Life Cycle, the essential model step, the implementation model, real time extensions of DFD.	**10**
4	Real time languages: overview of ADA/Java Extension	**4**
5	Real time Operating Systems, System Development Methodologies.	**6**

Text Books:

1. Introduction to Embedded Systems -Shibu K.V, McGraw Hill

2. Embedded Systems Design –Santanu Chattopadhyay, PHI, 2013.
3. Embedded System Design -Frank Vahid, Tony Givargis, John Wiley.
4. Embedded/Real-Time Systems: Concepts Design and Programming, K.V.K.K. Prasad Dreamtech, 2005.
5. Embedded Systems –Lyla, Pearson, 2013.
6. An Embedded Software Primer -David E. Simon, Pearson Education.

Electronics & Communication Engineering			
EC731	**Internet of Things**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Understand IOT design requirements
CO2	Compare various technologies and protocols
CO3	Study storage and intelligent analytics
CO4	Application of IOT in smart cities
CO5	Design and experiment various use cases

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	-	2	-	-	-	-	-	-	-	-	-	-
CO3	-	3	2	3	-	-	-	-	-	-	-	-
CO4	1	2	2	2	-	-	-	-	-	-	-	-
CO5	-	1	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course Content	No. of Lecture
1	**Introduction to IOT:** IoT and the connected world, Architecture of IoT, Security issues, Opportunities for IoT. **The Web of Things:** Linked data, Enterprise data, Importance of security, privacy, and authenticity, Industry standards, Web of Things layer as the driver for IoT systems.	**8**
2	**Lessons from the Internet:** Relevance of internet to network of things, network management, security, mobility and longevity.	**5**
3	**Technologies:** Wireless protocols, Connectivity options. **Data storage and analysis:** Managing high rate sensor data, Processing data streams, Data consistency in an intermittently connected or disconnected environment, Identifying outliers and anomalies.	**10**
4	**Use cases:** Smart Buildings, Smart health, Home automation, Location tracking.	**6**
5	**Smart Cities:** Collection of information including opportunistic sensing, crowd sensing, and adhoc sensing Response of the system including analytics and optimization, distributed action, people as intelligent actuators, the risk for cyber-attacks in centralized and distributed systems	**10**

Text Books:

1. Designing the Internet of Things, by Adrian McEwen, Hakim Cassimally Wiley 2013.
2. Enterprise IoT Naveen Balani Create Space Independent Publishing Platform 2016.

Electronics & Communication Engineering			
EC731	**VLSI Design***	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	APPLY the knowledge of semiconductor to review MOSFET characteristics, small geometry effects and scaling.
CO2	DEVELOP voltage, current sources and amplifiers and Operational amplifier made by CMOS.
CO3	CONSTRUCT switched capacitor filters, ADC, DAC and interconnects
CO4	ANALYZE CMOS Inverter, Dynamic CMOS, Pass transistor and transmission gates
CO5	DESIGN CMOS combinational, sequential circuits and memories

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	3	1	-	-	-	-	-	-	1
CO2	3	3	3	3	3	-	-	-	-	-	-	1
CO3	3	3	3	3	3	-	-	-	-	-	-	1
CO4	3	3	3	3	3	-	-	-	-	-	-	1
CO5	3	3	3	3	3	-	-	-	-	-	-	1

DETAILED SYLLABUS

Module	Content	No. of Lectures
1	**Introduction:** Review of MOSFET characteristics, scaling and small-geometry effects, and MOSFET capacitances. MOS resistor, MOS current source, current mirror circuits. MOS voltage source, linear voltage and current converters.	**6**

2	**CMOS operational amplifier (OPAMP) design:** Differential amplifier, level shifter, source follower, output stage voltage and power amplifiers. Cascode OP-AMP. Compensation techniques. **Analog Filters:** Switched capacitor (SC) fundamentals, first order SC circuits, second-order SC circuits and cascade design. Analog to digital and digital to analog converters, speed of conversion and over sampling issues. **VLSI Interconnects:** Distributed RC model, transmission line model. Future inter connect technologies.	**14**
3	**Digital VLSI Circuit Design:** MOS inverters, CMOS inverter, state characteristics, switching characteristics, power dissipation issues. **CMOS logic gates:** NAND, NOR, XOR, CMOS logic design of half and full adders. CMOS transmission gates, pseudo-nMOS, domino logic gates.	**9**
4	**Sequential MOS Logic Circuits:** The SR latch circuit, clocked latch and flip-flop, CMOS D-latch and edge-triggered circuits, Schmitt trigger circuit, Comparator. **Dynamic Logic Circuits:** Pass transistor logic, synchronous dynamic circuit techniques.	**8**
5	**Semiconductor Memories:** ROM circuits, SRAM circuits, DRAM circuits, drivers and buffers, Buffer scaling and design issues	**5**

Text Books:

1. Sung-Mo Kang, Yusuf Leblebici Chulwoo kim, Digital Integrated Circuits: Analysis and Design, 4th Edition, McGraw Hill Education, 2016.
2. Behzad Razavi, Design of Analog CMOS Integrated Circuits, 2nd Edition, McGraw Hill Education, 2016.
3. Jan M RABAEY, Digital Integrated Circuits, 2nd Edition, Pearson Education, 2003.
4. Neil H.E. Weste and David Harris, CMOS VLSI Design: A circuits and systems perspective,
   4th Edition, Pearson Education, 2015.

Electronics & Communication Engineering			
EC733	**5G Communication**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	Learn 5G technology & its features.
CO2	Learn the Key RF, PHY, MAC, and air interface changes required to support 5G.
CO3	Understand the Radio technology that enables devices to communicate directly with each other without any additional network infrastructure.
CO4	Evaluate implementation options for 5G.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	2	2
CO2	-	3	-	-	-	-	-	-	-	-	2	2
CO3	2	2	-	-	-	-	-	-	-	-	2	2
CO4	2	-	-	-	1	-	-	-	-	-	2	2

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Overview of 5G Broadband Wireless Communications:** Evaluation of mobile technologies 1G to 4G (LTE, LTEA, LTEA Pro), An Overview of 5G requirements, Regulations for 5G, Spectrum Analysis and Sharing for 5G. **5G wireless Propagation Channels**: Channel modeling requirements, propagation scenarios and challenges in the 5G modeling.	**8**
2	**5G Wireless System Architecture**: Basic Radio Accesses Network (RAN) architecture, High level requirements for the 5G Technology, Functional Architecture and flexibility–integration of LTE, LTEA and new air-interface to fulfill 5G requirements, Enhanced multi RAT coordination towards 5G, Physical Architecture and Deployment, Deployment enablers, flexible function placement in 5G deployments.	**9**
3	**Transmission and Design Techniques for 5G:** Basic requirements of transmission over 5G, Modulation Techniques – Orthogonal frequency division multiplexing (OFDM), generalized frequency division multiplexing (GFDM), filter bank multi-carriers (FBMC) and universal filtered multi-carrier (UFMC), Multiple Accesses Techniques– orthogonal frequency division multiple accesses (OFDMA), Generalized	**9**

	frequency division multiple accesses (GFDMA).	
4	**Non-orthogonal multiple accesses (NOMA):** Device-to-device (D2D) and machine-to-machine (M2M) type communications–Extension of 4G D2D standardization to 5G, radio resource management for mobile broadband D2D, multi-hop and multi-operator D2D communications, Millimeter-wave Communications, spectrum regulations, deployment scenarios, beam-forming, physical layer techniques, interference and mobility management, Massive MIMO.	**8**
5	**MAC Layer for 5G:** Overview of Wireless MAC Protocols and its Characteristics, Case Study, Implementation and Analysis of MAC Protocols in Lab View/MATLAB.	**6**

Text Books:

1. Martin Sauter "From GSM From GSM to LTE–Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband", Wiley-Blackwell.
2. Afif Osseiran, Jose. F. Monserrat, Patrick Marsch, "Fundamentals of 5G Mobile Networks", Cambridge University Press.
3. Athanasios G.Kanatos, Konstantina S.Nikita, Panagiotis Mathiopoulos, "New Directions in Wireless Communication Systems from Mobile to 5G", CRC Press.
4. Theodore S.Rappaport, Robert W.Heath, Robert C.Danials, James N.Murdock "Millimeter Wave Wireless Communications", Prentice Hall Communications.
5. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", John Wiley & Sons.

Electronics & Communication Engineering			
EC741	**Low Power VLSI Circuits**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Identify the sources of power consumption in a given VLSI Circuit
CO2	Analyze and estimate dynamic, leakage power components in a DSM VLSI circuit
CO3	Choose SRAMs/ DRAMs for Low power applications
CO4	Design low power arithmetic circuits and systems
CO5	Decide at which level of abstraction it is advantageous to implement low power techniques in a VLSI system design

Mapping of Course Outcomes with Program Outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	-	-	-	-	-	-	-	-	-
CO2	1	2	-	-	-	-	-	-	-	-	-	-
CO3	1	3	-	3	-	-	-	-	-	-	-	-
CO4	1	2	-	2	-	-	-	-	-	-	-	-
CO5	1	1	-	-	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction:** Sources of Power Dissipation, Static Power Dissipation, Active Power Dissipation, Circuit Techniques for Leakage Power Reduction.	8
2	**Adders:** Standard Adder Cells, CMOS Adders Architectures, Low Voltage Low Power Design Techniques, Current Mode Adders.	8
3	**Multipliers:** Types Of Multiplier Architectures; Braun, Booth Multipliers and their performance comparison, Low Voltage Low Power Design Techniques.	10
4	**Memories:** Sources of power dissipation in SRAMs, Low power SRAM circuit techniques, Sources of power dissipation in DRAMs, Low power DRAM circuit techniques.	10
5	**Wires:** Increased delays of wires, new materials for wires and dielectrics, Basic background on testing, Low power and safely operating circuits, Case study–A Low power subsystem design.	8

Text Books:

1. Kiat Seng Yeo and Kaushik Roy, Low- Voltage, Low-Power VLSI Subsystemss, Edition 2009, Tata Mc Graw Hill .
2. Soudris D, Piguet C and Goutis C, Designing CMOS Circuits for Low Power, Kluwer Academic Publishers, 2002.
3. Jan Rabaey, Low Power Design Essentials, Springer.

Electronics & Communication Engineering			
EC742	**Biomedical Instrumentation**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student will be able to:

CO1	UNDERSTAND the origin of bio-potentials, anatomy and their physical significance
CO2	ANALYZE ECG, EEG and EMG signals and respiratory system measurement
CO3	ANALYZE medical imaging systems
CO4	DESIGN Therapeutic and prosthetic devices.
CO5	APPLY Medical application of LASER and safety measures of instruments.

Mapping of Course Outcomes with Program Outcomes:

Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	-	-	-	3
CO2	3	-	-	-	3	-	-	-	-	-	-	3
CO3	3	-	-	-	3	-	-	-	-	-	-	3
CO4	-	-	-	-	-	-	-	-	-	-	-	3
CO5	2	-	-	-	3	-	-	-	-	-	-	3

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Basic Medical Instrumentation System**: Static and dynamic characteristics of medical instruments, Bio-signals and characteristics. Problems encountered with measurements from human beings. **Bio-Potential Electrodes and Physiological Transducers:** Electrode potential, Electrode equivalent circuit, Types of Electrodes-Surface Electrodes, Needle Electrodes, Micro Electrodes. Pressure transducers, Transducers for body temperature measurement.	**14**
2	Electrical Conduction system of the heart, Block diagram Of Electrocardiograph, ECG leads, Einthoven triangle, ECG amplifier, EEG 10-20 lead system, Specifications and Interpretation of ECG, EEG, EMG.	**8**

3	**Blood flow meters:** Electromagnetic blood flow meter, Ultrasonic Doppler blood flow meter. Blood pressure measurement- Ultrasonic blood pressure monitoring. **Physiological Assist Devices & Therapeutic Equipment:** Pacemakers, External & internal, Defibrillators, External & internal, Hemodialysis machine.	**10**
4	Spirometry, Pnemuotachograph, Ventilators Monitoring Equipment: Arrhythmia Monitor, Foetal Monitor, and Incubator. **Medical Imaging Equipment:** X-ray generation, X-ray tube, X-ray machine, Computed Tomography (CT), Ultrasound Imaging system.	**10**
5	Electric shock hazards, Leakage currents, Test instruments for checking safety parameters of biomedical equipments.	**8**

Text Books:

1. L. A. Geddes and Wiley, Principles of Biomedical Instrumentation L. E. Baker (2nd Ed.)
2. L. Cromwell, Biomedical Instrumentation and Measurements, Prentice Hall.
3. John G. Webster (Ed.), Medical Instrumentation – Application and Design, 3rd Edition, John Wiley & Sons Inc.
4. Handbook of Biomedical Instrumentation by R. S. Khandpur, Tata McGraw Hill.
5. Introduction to Biomedical Technology by J. J. Karr & J. M. Brown, Pearson Publication.
6. Medical Instrumentation Application and Design by J. G. Webster, Wiley Publication.

Electronics & Communication Engineering			
EC743	**MEMS Technology**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	Understanding of MEMS and Microfabrication.
CO2	Understanding of MEMS materials.
CO3	Application of Sensing and Actuation.
CO4	Understanding of Micromachining.
CO5	Understanding of Optical MEMS.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	-	1	-	-	-	-	-	-	-	-
CO2	-	3	-	1	-	-	-	-	-	-	-	-
CO3	-	3	-	3	-	-	-	-	-	-	-	-
CO4	1	2	-	2	-	-	-	-	-	-	-	-
CO5	-	1	-	-1	-	-	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**Introduction to MEMS and Microfabrication:** History of MEMS Development, Characteristics of MEMS-miniaturization–microelectronics integration-Mass fabrication with precision. Micro fabrication-microelectronics fabrication process-silicon based MEMS processes-new material and fabrication processing-points of consideration for processing.	**14**
2	**Electrical and Mechanical Properties of MEMS Materials:** Conductivity of semiconductors, crystal plane and orientation, stress and stain–definition– relationship between tensile stress and stain-mechanical properties of silicon and thin films, Flexural beam bending analysis under single loading condition- Types of beam- deflection of beam-longitudinal stain under pure bending spring constant, torsional deflection, intrinsic stress, resonance and quality factor.	**8**

3	**Sensing and Actuation:** Electrostatic sensing and actuation-parallel plate capacitor–Application-Inertial, pressure and tactile sensor parallel plate actuator-comb drive. Thermal sensing and Actuations-thermal sensors-Actuators-Applications-Inertial, Flow and Infrared sensors. Piezo resistive sensors- piezo resistive sensor material- stress in flexural cantilever and membrane-Application-Inertial, pressure, flow and tactile sensor. Piezoelectric sensing and actuation- piezoelectric material properties-quartz-PZT-PVDF–ZnO Application-Inertial, Acoustic, tactile, flow-surface elastic waves. Magnetic actuation- Micro magnetic actuation principle- deposition of magnetic materials-Design and fabrication of magnetic coil.	**10**
4	**Bulk and Surface Micromachining:** Anisotropic wet etching, Dry etching of silicon, deep reactive ion etching (DRIE), and Isotropic wet etching, Basic surface micromachining process- structural and sacrificial material, stiction and antistiction methods, Foundry process.	**10**
5	**Polymer and Optical MEMS:** Polymers in MEMS- polymide-SU-8 liquid; crystal polymer (LCP)-PDMS-PMMA-Parylene-Flurocorbon, Application-Acceleration, pressure, flow and tactile sensors. Optical MEMS-passive MEMS, optical components-lenses-mirrors-Actuation for active optical MEMS.	**8**

Text Books:

1) Foundation of MEMS, Chang Liu, Prentice Hall.
2) Microsystem Design, Stephen D. Senturia, Springer.
3) Analysis and Design Principles of MEMS Devices, Minhang Bao, Elsevier.

Electronics & Communication Engineering			
EC744	**Smart Antenna**	**L**	**T**
		3	**0**

Course Outcomes: After completion of the course student must be able to:

CO1	To Familiarize with smart and adaptive antennas.
CO2	To study about the different adaptive algorithms for the antenna.
CO3	Understanding the concept of direction of arrival and angle of arrival.
CO4	To analyze the effect of mutual coupling and to study the space time.

Mapping of Course Outcomes with Program Outcomes:

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	-	-	-	3	-	-	-	-	-	-
CO2	3	-	-	-	3	-	3	-	-	-	-	-
CO3	3	2	-	-	2	-	2	-	-	-	-	-
CO4	2	1	-	-	1	3	-	-	-	-	-	-

DETAILED SYLLABUS

Module	Course content	No. of Lectures
1	**INTRODUCTION:** Introduction to Smart Antennas, Architecture of a Smart Antenna System: Transmitter and Receiver, Smart Antenna Configurations: Switched and Fixed Beam Antennas, Adaptive Antenna Approach, Types of Smart Antennas, Benefits and Drawbacks of Smart Antennas, Applications of Smart Antennas.	**8**
2	**FIXED BEAM SMART ANTENNA SYSTEMS:** Introduction, Conventional Sectorization, Antenna Arrays Fundamentals: Linear Arrays, Array. Weighting, Circular Arrays, Rectangular Planar Arrays, Fixed Side lobe Canceling, Retro directive Arrays, Beamforming, Adaptive Arrays, Butler Matrix, Spatial Filtering with Beam formers, Switched Beam Systems, Multiple Fixed Beam System.	**8**
3	**ADAPTIVE ARRAY SYSTEMS:** Uplink Processing: Diversity Techniques, Angle Diversity, Maximum Ratio Combining, Adaptive Beam forming, Fixed Multiple Beams versus Adaptive Beam forming. Downlink Processing: Transmit Diversity Concepts, Downlink Beam forming, Spatial Signature Based Beam forming, and DOA-Based Beam forming.	**9**

4	**ANGLE-OF-ARRIVAL ESTIMATION:** Fundamentals of Matrix Algebra, Array Correlation Matrix, AOA Estimation Methods: Bartlett AOA Estimate, Capon AOA Estimate, Linear Prediction AOA Estimate, Maximum Entropy AOA Estimate, Pisarenko Harmonic Decomposition AOA Estimate, Min-Norm AOA Estimate, MUSIC AOA Estimate, ESPRIT AOA Estimate.	**9**
5	**MOBILE STATIONS' SMART ANTENNAS:** Introduction, Multiple-Antenna MS Design, RAKE Receiver Size, Mutual Coupling Effects, Dual Antenna Performance Improvements, Downlink Capacity Gains, Principles of MIMO systems: SISO, SIMO, MISO,MIMO.	**8**

Text Books:

1. Ahmed El Zooghby, 'Smart Antenna Engineering', ARTECH HOUSE, INC, 2005.
2. Frank B. Gross, 'Smart antenna with MATLAB', Second Edition, McGraw-Hill, 2015.

Mining Engineering

Mining Engineering			
MN701	**Mine Legislation & Safety Engineering**	**L**	**T**
		3	**0**

Course objective:

Introduce students to the different laws of Indian Mining industry. To categorize, analyze and develop capability by measure actions to prevent and mitigate mine accidents. To ameliorate different past and recent case studies dealing with mine hazards and accidents. Course aims for the students to identify and evaluate any real-life scenario of mine disasters henceforth, also comprehend and absorb inherent knowledge of mitigation strategies to achieve minimal casualties within the mines.

DETAILED SYLLABUS

Module-1: Statutory laws: Statutory law regarding development and conservation of minerals, Mines and mineral (regulation and development) act 1957.

Module-2: Mineral concession rules: Procedure for obtaining mineral concession, Mineral concession rules 1960, Mineral concession and development rules 1958.

Module-3: Regulation and Development: Coal mines (regulation and development) act 1974, Mines and mineral (regulation and development) act 1957, Mines act 1952.

Module-4: Mines Regulations: Coal mines regulations 1957, Metal liferous mines regulation 1961, Mine rules: Coal mines rescue rules, Crèche rules, Electricity act and rules pertaining to mining.

Module-5: Safety in Mining: Safety organization, Role of management, Supervisors and workers, Pit safety committees, Workmen's Inspector role, Role of safety officers.

Module-6: Accidents in Mining: Classification of accidents, Statistics, causes and prevention of accidents, Accidents rate in Indian mines, Accident enquiries and reports. Mine Fires; Surface and underground mine fire -causes and prevention, causes and nature of spontaneous heating. Dealing with the underground fire. Sealed off Area and Reopening: the study of atmosphere behind sealed off area. Factors, conditions, danger and safety measure for reopening. Methods of firefighting, firefighting-organization, and Rescue work related to connection with mine fires.

Inundations and Related Rescue Operations: Rescue work pertaining with connection with mine fires Causes and protective measures for inundations. Precautions to be taken while approaching the old- working design construction of water dams. Dewatering and recovery of waterlogged working and water danger plan, Rescue work related to mine inundations. Fire damp explosions, causes, preventive measures, Coal dust explosions, causes, preventive measures, Rescue work related to mine explosions.

Module-7: Health and disease in Mining: Health of workmen, Occupational disease in mining, International labour organization and its model code in the field of safety and accident prevention, Airborne Dust: Dust production, Assessment and control of mine dust and associated hazards.

Module-8: Management, relation and welfare in Mining: Principles of management and organization, Industrial relations, Welfare organization, Development of safety consciousness; Interest, publicity and propaganda for safety; Audio-visual aids, Safety drives campaigns. Different types of rescue equipment. Use of organization for rescue work, Disaster management plan of mines.

Course outcomes

To develop an understanding of the principles and concepts of law underpinning mining and energy law in India, including the following:

1. The development of mining legislation in India, including issues of constitutional law and international law.
2. The regulation of onshore and offshore mineral and petroleum exploration and production.
3. Judicial arrangements and appeals, in particular the jurisdiction of the Warden's Court.
4. The relationship between mining and indigenous peoples, including Native Title law;
5. Environmental controls over mining and energy production, including mining in protected areas such as national parks and reserves;
6. The regulation of the Indian electricity industry.
7. After completion of the course students will be able to find and explain the various kinds of the disasters which takes place within underground mines and opencast mines.
8. Able to summarize the categories hazards due to fire, inundation, dust and explosions.
9. Able to recall and identify various causes, factors and mitigation strategies associated with the above risks.
10. Able to demonstrate, distinguish and perform various rescue operations, apparatus their specification, and workings in case of any mishap in the mines.
11. Able to recall and relate main provisions, regulations and rules laid down by the statutory bodies in the country concerning the safety of mine workers.

Reference/text books:

1. Banerjee S. P., "Prevention combating Mine Fires", Lovely Prakashan, Dhanbad, India.
2. The coal mines regulations – CMR 2017.

3. The mines rule Coal mines pithead bath rules, Mineral concession rules Mines and minerals (development and regulation) act, The metalliferous mines regulations, Mines Act - 1952
4. Banerjee S.P. (2003); "Mine Ventilation"; Lovely Prakashan, Dhanbad, India.
5. Deshmukh, D. J. (2008); "Elements of Mining Technology, Vol. II"; Denett& Co., Nagpur, India.
6. Hartman, H. L., Mutmansky, J. M. & Wang, Y. J. (1982); "Mine Ventilation and Air Conditioning"; John Wiley & Sons, New York.
7. Karmakar, N. C. (2001); "Handbook of gas testing"; Lovely Prakashan, Dhanbad, India.
8. Le Roux, W. L. (1972); Mine Ventilation Notes for Beginners"; The Mine Ventilation Society of South Africa.
9. McPherson, M. J. (1993); Subsurface Ventilation and Environmental Engineering"; Chapman & Hall, London.
10. Misra G.B. (1986); "Mine Environment and Ventilation"; Oxford University Press, Calcutta, India.
11. Ramlu, M. A. (1991); "Mine fires, Explosions, Rescue, Recovery and Inundations"; Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Vutukuri, V. S. & Lama, R. D. (1986); "Environmental Engineering in Mines"; Cambridge University Press, Cambridge.
13. Kejriwal, B.K," A Survey ofAccidents, Their Causes &Prevention''.
14. Kaku L.C, "Fire in Coal Mine", LovelyPrakashan, Dhanbad, India.
15. GhatakS., "Mine Ventilation. 1 & Vol. 2, LovelyPrakashan, Dhanbad, India.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							3				
CO2		3		2		3	2		2	3	3	3
CO3				2	3			3				
CO4			2			2	3		3	1	2	2
Avg.	3	3	2	2	3	2.5	2.5	3	2.5	2	2.5	2.5

Mining Engineering			
MN711	**Applied Rock Mechanics**	**L**	**T**
		3	**0**

Course Objectives:

The course is designed to provide a better understanding of the applied aspects of rock mechanics in mining, design and stability analysis of underground excavations including pillar design, design of protective pillar, support design and reinforcement requirement, mechanics of surface subsidence and slope stability in surface mines which depicts bench slope and waste dump slope stability analysis.

Course Outcome:

After completion of the course, students will be able to:

1. Understand the stability of rock structure, support and reinforcement requirement in underground excavation.
2. Understand the subsidence impacts and mechanics, caving mechanism and rock burst and bump in underground structure.
3. Understand the blasting mechanics which include tensile cracking and blastability of rocks.
4. Understanding on the stability aspects of rock slopes.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							3				
CO2		3		2		2	3		2	3	2	3
CO3	2			2	3			3			2	2
CO4			2			2	2		3	2	2	
Avg.	2	3	2	2	3	2	2.5	3	2.5	2.5	2	2.5

DETAILED SYLLABUS

Module 1. Design and stability of underground structures in rock:Intact rock and rock mass classification systems, methods for design and stability analysis of underground excavations, design of single and multiple openings in massive, stratified and jointed rock mass, mine pillars and their classification, pillar stresses, pillar design, stability analysis of pillars, design of protective pillar

Module 2. Design of support and reinforcement for underground excavation: Types& classification of support and reinforcement systems, support and reinforcement requirement – influencing parameters, estimation and selection, support and reinforcement principle, method of design

Module 3. Subsidence:Causes and impacts of subsidence, mechanics of surface subsidence, discontinuous andcontinuous subsidence, monitoring, prediction, control and management of subsidence.

Module 4. Caving of overlying rock mass:Rock caving in underground mining, mechanics of rock caving, assessment of cavability, induced caving methods. Rockburst and Coal Bumps: Phenomenology of rock bursts, prediction and control of rock bursts, coal bumps and gas outbursts.

Module 5. Mechanics of Blasting: Mechanics of blasting, tensile cracking and blastability of rocks.

Module 6. Slope stability in surface mines: Types of mine slope including waste dumps, common modes of slope failure, factors influencing slope stability, slope stability assessment techniques, stability analysis, measures to enhance slope stability, monitoring of slopes.

Text/Reference Books:

1. Rock Mechanics for underground mining, third edition B. H. G. Brady, E. T. Brown
2. Engineering rock mechanics, Vol. I & II, John A. Hudson and John P. Harrison
3. Engineering rock mass classification, Z.T Bieniawski.
4. Rock Slopes: Design, Excavation, Stabilization, Hoek Y Bray
5. Fundamental and Applied Rock Mechanics, D. Deb, A.K. Verma
6. Rock Blasting, P. Pal Roy

Mining Engineering			
MN712	**Numerical Methods in Geomechanics**	**L**	**T**
		3	**0**

Course objectives:

This course starts with Principle of continuum mechanics and Numerical Methods. It will elaborate the different numerical methods for Mathematical Modelling and need of Numerical Modelling in designing excavation by analysing stresses around the excavation. The course will also explain different Numerical Techniques such FDM, FEM, BEM and introduction to some software's based on these techniques.

The objective of this course are to:

- Introduce students to application of Numerical Methods in Mathematical Modelling
- Introduce students to practical application of Numerical Simulation in civil and mining industry
- Introduce students to different Numerical Techniques and software's based on this.

Course outcomes

Upon successful completion of this course, the student will be able to:

Knowledge based

- Understand different Numerical Methods.
- Identify and apply different Numerical Methods in different kind of Modelling
- Understand working of different FEM/ FDM/ BEM based software's

Skills

- Analyse and evaluate different kind of Numerical Techniques (FEM) for different conditions
- Can use different software's for designing Civil and Mining structures
  Able to write some programmes for various applications in Civil and Mining Industry

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					2		2			3	

CO2		3		2			3	2	3	2		2
CO3				2	3	2		2			3	
CO4			2				2		3	2		2
Avg.	3	3	2	2	3	2	2.5	2	3	2	3	2

DETAILED SYLLABUS

Module-1: Introduction:Principle of continuum mechanics, Numerical Methodsin general, Solutionof Equations by Iteration, Interpolation.

Module-2: Numerical Integration and Differentiation**:** Numerical Integration and Differentiation

Module-3: Numerical Methods in Linear Algebra:Linear systems: Gauss Elimination, Solution byIteration.

Module-4: Numerical Modelling:Need for numerical modelling in design of excavation in mines,domain and boundary conditions and its application in Mathematical Modelling.

Module-5: Finite Element Method:Basic principle, assembling elements to form a structuralstiffness matrix, imposing boundary conditions, solving structural equations using plane truss, elements on assumed displacements, constant strain triangle, iso-parametric formulation.

Module-6: Finite Difference Method:Basic principle, explicit finite difference method, finitedifference equation, solution stability.

Module-7: Boundary Element Method:Basic principle, introductory ideas of its application inmining excavations.

Text/Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th edition; John wiley& sons, Part E (Numerical Methods)

2. Debasis Deb, Finite Element Method: Concept and Applications in Geomechanics; Prentice Hall of India

3. J. B. Martins, Numerical Methods in Geomechanics; Springer
4. G. Swoboda, Numerical Methods in Geomechanics, 6th edition; CRC Press
5. http://vle.du.ac.in/course/view.php?id=562

Mining Engineering			
MN713	**GEO-Statistics**	**L**	**T**
		3	**0**

Course Objectives:

The course is designed to provide a better understanding to use the statistical tool in mining industries. It will give the idea of interpretation of reserve estimation using three-dimensional modelling software.

Course Outcome:

After completion of the course, students will be able to:

1. Understand use of statistics tools to use in mining fields.
2. Know reserve estimation methods using statistics tool.
3. Understand and interpret the 3 – D model of reserve.
4. Understand the use of mine modelling software like Surpac, Minex.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					2			2			
CO2		3		2			3	3		3	2	3
CO3				2	3	2			2			
CO4			2				3	2		3	3	2
Avg.	3	3	2	2	3	2	3	2.5	2	3	2.5	2.5

DETAILED SYLLABUS

Module 1: Geo - statistics: Introduction, Concept.

Module 2: Basics of Probability and Statistics: Mean, Median, Mode, Probability Distribution (normal & log normal), Variance, Cumulative frequency and Cumulative probability.

Module 3. Mineral Inventory: Prospecting, exploration, method to quantify the size, shape & distribution of the ore reserve. Ore reserve calculation

Module 4. Extension method and application of classical statistics: Regionalized variables, variogram and semi – variogram modelling, regularization, auxiliary functions.

Module 5. Kriging: Introduction, concept of development, types of kriging, linear kriging methodology, and their application in mining industries, common problems associated with the use of kriging.

Module 6. Geo - statistics for quality control: Basis of non-parametric geo - statistics and indicator kriging. Introduction to SURPAC, STATISTICA, SPSS/SYSTAC software.

Text/Reference Books:

1. Open Pit Mine Planning and Design, Two Volume Set, Second Edition by William A. Hustrulid (Author), Mark Kuchta (Author)
2. Mining Geostatistics by A. G Journel& Ch. J. Huijbregts.
3. Advanced Geostatistics in the Mining Industry: Proceedings of the NATO Advanced Study Institute held at the Istituto di Geologia Applicata of the 13–25 October 1975 (Nato Science Series C:) Paperback – Import, 26 Mar 2012 by M. Guarascio (Editor), C.J. Huybrechts (Editor), M. David (Editor).
4. Geostatistics, Rendu J.M
5. Surface Mining, Kennedy Wiley

Mining Engineering			
MN714	**Instrumentation in Rock Mechanics**	**L**	**T**
		3	**0**

Course Outcome:

The course is designed to provide a better understanding to evaluate use of instrumentation in mining and civil engineering projects. Strata control instrumentation and monitoring aims at evaluation and monitoring the trends of changing rock mechanical parameters, namely, dilation, load, convergence, stress and axial loading etc., during mining so that rock mechanical un-eventualities are apprehended well before for effective corrective measures. Host rock geometry in coal mining is represented by stratified rock masses of relative weaker strength. Such stratifications are compound and unite in their virgin state before any kind of mining. Dilation / bed separation causes change in stress from its in-situ state, which in turn is propagated in the rocks around. Such induced effect of stress can be revealed in the workings with the help of instrumentation, aiding apprehension of strata movement and subsequent assessments.

Course Outcomes:

After completion of the course, students will be able to:

1. Understand use of instrumentation of in rock mechanics.
2. Know Causes and impacts of rock failure, rock strength and stresses induced in rocks.
3. Understand the time dependent deformation in rock structure.
4. Understand the effect of water on rock structure and their stability.
5. Understand the dynamic characteristics of rock and rock mass.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3					3		3		3		3
CO2		3		2			2		2		2	
CO3				2	3	2		2		3		3
CO4			2				2		2		3	
Avg.	3	3	2	2	3		2	2.5	2	3	2.5	3

DETAILED SYLLABUS

Module 1: Load and Pressure Measuring Instruments: Load cells, pressure measuring instruments – stress capsules, stress meters, borehole pressure cells and flat jacks. Strain gauges and transducers, readout units, sensors, transmitters and data acquisition systems.

Module 2: Deformation and Strain Measuring Instruments: Convergence meters, convergence recorders, tape extensometers, bore hole deformation gauge, multipoint borehole extensometers and bore hole camera.

Module 3: Testing Equipment: UTM, MTS and acoustic emission equipment. Rock bolt pull tester. Monitoring and interpretation of the data.

Module 4: Soil Mechanics: Instrumentation for shear strength and bearing capacity of soils.

Module 5: Applications: Mining and Civil Engineering applications.

Text/Reference Books:

1. Rock mechanics instrumentation for mine design by U.S. Dept. of the Interior, Bureau of Mines, 1973.
2. Fundamental and Applied Rock Mechanics, D. Deb, A.K. Verma
3. Fundamental and Rock Mechanics, B. K. Shrivastava, A. Jaiswal

Mining Engineering			
MN721	**Mine Planning and Design**	**L**	**T**
		3	**0**

Course Objectives:

The course is designed to provide a better understanding of planning and design stage, for opening of the mine. This subject focuses on understanding the complete mining context and characteristics of the deposit, and of recognizing and addressing the specific constraints of each project in order to select the appropriate mining method and a robust mine plan.

Course Outcome:

After completion of the course, students will be able to:

1. Prepare the conceptual note, mine planning report, feasibility report and mine closure report.
2. Evaluate economic reserve estimation for ore and sedimentary deposit
3. Understand the choice of technology deploy in the mine
4. Understand the optimum location of mine entries
5. Understand the selection of equipment, size of the mine and mine life.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				2		3	2		2		3
CO2		3	2	2		3			3		3	
CO3	2			2	3		2	2		2		
CO4		2	2			3		2	2		3	3
Avg.	2	2.5	2	2	2.5	3	2.5	2	2.5	2	3	3

DETAILED SYLLABUS

Module 1: Introduction to Mine Planning: Principle of the planning, short range and long-range planning, role of planning in mining ventures.

Module 2: Reserve Estimation: Ore reserve estimation, economic block model.

Module 3: Mine Planning Input: Geological, mineralogical, structural, economical, environmental and technical inputs.

Module 4: Mine Life: Determination of optimum output, life of a mine and size of mine field based on economic consideration, Taylor’s mine life rule, ultimate pit configuration.

Module 5: Mine Entry: Optimum location of mine entries, theoretical considerations of opening and development of mine field.

Module 6: Production Planning and Scheduling**:** Production planning and scheduling, mine equipment planning, estimation of their numbers, infrastructure planning.

Module 7: Mine Closure: Mine Closure-ongoing and final report preparation

Module 8: Mine Planning Report**:** Feasibility report and project report - contents and preparation

Text/Reference Books:

1. Principles of Mine Planning, Jayant Bhattacharjee
2. Open Pit Mine Planning and Design, 3rd Edition, 2013 Vol. I & II, William A. Hustrulid, MarkKuchta, Randall K. Martin
3. SME Mining Engineering Handbook, Third Edition, 2011Vol. I & II, Peter Darling
4. Mine Planning and Equipment Selection 2001: Proceedings of the Tenth International Symposium on Mine Planning and Equipment Selection, New Delhi, India, November 19-21, 2001, Raj K. Singhal, Bhaskar P. Singh
5. Underground Winning of Coal, 1992, T.N. Singh
6. GEOVIA SURPAC, Tutorials for ore deposit
7. GEOVIA MINEX, Tutorials for sedimentary deposit

Mining Engineering			
MN722	**Mine Closure**	**L**	**T**
		3	**0**

Course objectives:

The course objectifies to ensure long term physical, chemical and biological stability of the site to minimize potential environmental and health risk.

Goals and Outcomes:

This course provides the necessary and legal aspects of mine closure to comply with uninterrupted mining process. It gives special focus on the preparation of mine closure plan on elemental basis. With this course, the students will be able to:

- Know the insight into mine closure plan
- Prepare a mine closure plan
- Know the various legal aspects related with mine closure plan

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3						3			3		
CO2		3		2		3		3	2		2	3
CO3				2	3					3		
CO4			2			2	2	2	2		3	3
Avg.	3	3	2	2	3	2.5	2.5	2.5	2	3	2.5	3

DETAILED SYLLABUS

Module-1: Mine closure planning: importance, methodology, statutes concerning mine closure.

Module-2: Principles, planning, financial provisions, implementation, standards for closure criteria, systems approach for mine closure.

Module-3: Various legal aspectsof mine closure planning, its advantages and amendments. Guidelines from ministry of environment and forest.

Module-4: Mine closure plan, guidelinesfor preparation of mine closure plan.

Module-5: Standards of Mine Closure in Indian Mines, components, process, monitoring rules.

Text/reference books:

1. Guide for mine closure planning, Sánchez, L.E.; Silva-Sánchez, S.S.; Neri, A.C, Brasília, 2014, IBRAM – Brazilian Mining Association.
2. Mine Closure - A. Robertson & S. Shaw
3. Mineral Conservation and Development Rules, 2017, Indian Bureau of Mines
4. Guidelines for preparation of Mine Closure Plan, Ministry of Coal, GOI

Mining Engineering			
MN723	**Mine Reclamation and Rehabilitation**	**L**	**T**
		3	**0**

Course objectives:

The role of reclamation and closure in any mineral exploration project can be regarded as the final chapter in the life of that project. When the exploration project develops further into a feasibility study or a full-scale mining operation, however, then the reclamation process undertaken at the exploration stage becomes the first step in the final rehabilitation of the mine. There are many definitions used in describing reclamation and closure. These include: Decommissioning. This is the transitional period between the cessation of operations and the final closure of that operation. Reclamation. This refers to the physical aspects of earth moving, regrading and revegetation. Rehabilitation.

Goals and outcomes:

This course provides the basis for estimating the financial liability associated with a mining project. The objective of rehabilitating a typical exploration site is to minimize long-term environmental liability by maintaining geotechnical stability, restoring native ecosystems, striving to achieve a more beneficial land use, etc. Provide ideas and process about closing a mine, how to do reclamation and necessity of reclamation. The students will be able to:

- Understand the post mining liabilities associated with mines.
- Know the technical aspects to mitigate the adverse impacts.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2				2		3			2		3
CO2		3	2	2		2		2	3		3	
CO3	3			2	3		3			3		3
CO4		2	2			2		2	1		2	
Avg.	2.5	2.5	2	2	2.5	2	3	2	2	2.5	2.5	3

DETAILED SYLLABUS

Module-1: Economical and technical aspects of reclamation of mined out land.

Module-2: Reclamation Methods: Back filling, outside dumps and their stability.

Module-3: Top soil handling, assessment of soil productivity potential, re-vegetation, factors for plant Growth, parameters for soil quality and their importance.

Module-4: Reclamation plan and land use plan, general requirements of protection of hydrologic balance.

Module-5: Erosion of soil: types of erosion, estimation of top soil erosion, Landscaping of disturbed and, estimation of reclamation cost and benefits, use of reclaimed land and structures.

Module-6: Mine Closure Planning: Importance, methodology, statutes concerning mine closure, Land reclamation as post mining operation, Statutes concerning reclamation of mined out area. Mine rehabilitation: Planning, Principles of Rehabilitation, Standard Rehabilitation, Monitoring, Maintenance and Relinquishment of Restored Mines.

Text/reference books:

1. Surface Mining Technology, S.K. Das
2. Elements of Mining Technology Vol I, D.J. Deshmukh
3. Bio-Geotechnologies for Mine Site Rehabilitation, M.N.V. Prasad, Paulo Jorge deCampos Favas, Subodh Kumar Maiti
4. Spoil to Soil: Mine Site Rehabilitation and Revegetation. 1st Edition, by N.S. Bolan,M.B. Kirkham, Y.S. Ok
5. Mine rehabilitation: A Handbook for the Coal Mining Industry – 1984, J. C. Hannan

Mining Engineering			
MN724	**Sustainable Mining Practices**	**L**	**T**
		3	**0**

Course objectives:

The Strategy for incorporating involved in extracting non-renewable resources have come under increasing pressure to embed the concept of sustainability into strategic decision-making processes and operations. In addition to these considerations, responsible corporations have been able to move towards sustainability by developing a range of appropriate stewardship initiatives. Economic development, environmental impact and social responsibilities must be well managed, and productive relationships must exist between government, non-government organisations, industry and stakeholders.

Goals and outcomes:

This course provides the inside into the less know environment impacts related with coal preparation plants and throw the light into regulatory frameworks related with these plants.
The students will be able to understand the:

- Environmental problems associated with the coal preparation plants.
- The mitigating measures associated with those issues.
- Regulatory frameworks associated with those issues.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3							2				2
CO2		3	2	2		2	3		3	2	3	
CO3	2			3	3							3
CO4			2			2	2	2	2	2	1	
Avg.	2.5	3	2	2.5	3	2	2.5	2	2.5	2	2	2.5

DETAILED SYLLABUS

Module-1: Coal preparation and washing: The Needs of Coal Preparation, Coal preparation process –physical, chemical or mechanical processes

Module-2: Coal dust generation: Sources, characterization, ill effects, measurement, monitoring, standards, mitigating measures

Module-3: Air pollution: Sources, characterization, ill effects, measurement, monitoring, standards, mitigating measures.

Module-4: Water pollution: Sources, ill effects, water quality parameters–physico-chemical, biological and bacteriological. Water quality criteria, standards, monitoring and mitigating measures. Heavy metal pollution and its abatement; Surface water pollution – detection and management.

Module-5: Environmental Impact Assessment: Methods of EIA and their applicability.

Module-6: Environmental Management Plan: Structure and preparation of EMP, Environmental Laws

Text/reference books:

1. Elements of Fuel technology, Godfrey Wilfred Himus, Leonard Hill Limited. 1958.

2. Fuels: Solid, liquid and gaseous fuels, J. Brame and King, Kessinger Publishing, LLC, 2007.

3. Coal, Oil Shale, Natural Bitumen, Heavy Oil and Peat - Volume I, Gao Jinsheng - 2009

4. Coal, Oil Shale, Natural Bitumen, Heavy Oil and Peat - Volume II, Gao Jinsheng - 2009

Mining Engineering			
MN731	**Mine Economics and Resource Management**	**L**	**T**
		3	**0**

Course Objective:

This course examines the economic factors affecting the mining cycle; it consists of mineral economics, exploration of the global resource market, performing project economic evaluations. Assessing and estimating the resource and reserve estimation techniques of coal and metal liferous deposits. Learners should be able to skim the roadmap regarding resource management and planning by focusing on the cost efficiency at every mining process and developing decision making based on costs.

Course outcomes:

Upon the successful completion of the course, the students would be able to:

- Analyze and construct essential and relevant economic forecasts and financing plans throughout the mine life cycle.
- Assemble cash flow information and able to evaluate and determine the economic feasibility of the mine project.
- Able to recognize and interpret the sustainability perspective related to the mineral industry.
- Assess the project's impact on the economy of the country and, apply and improve economic criteria to real life decision making.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2							2		2		2
CO2		3		2		3	2		3		3	
CO3	2			2	3			2		2		
CO4			2			2	2		2		2	3
Avg.	2	3	2	2	3	2.5	2	2	2.5	2	2.5	2.5

DETAILED SYLLABUS

Module1: Mineral Sampling: Definition, purpose, and classes of samples, Chip, Grab, Groove, Bore hole, Dump, Alluvial & Bulk sampling. Development & stope sampling, Samples size reduction techniques. Errors in sampling- its minimization.

Module 2: Geo-Statistics: Use of statistical techniques in mine sampling. Reliability of samplingresults. Calculation of average assay, width and tonnage of mineral deposits, Introductory principles of Geo-statistics.

Module 3: Mineral resource: Mineral reserve estimations - various categories. Mine Valuation: Depreciation. Amortization of capital. Theory of mine valuation- its purpose, Factors affecting the value of a mine.

Module 4: cash flow evaluation: Hoskold, Morkill and other classical methods for mine valuation. Pay back method and Discount cash flow (DCF) methods of project evaluation (NPV & IRR).

Module5: Financial Management: Mine accounts, mining costs, cost categorization, break even analysis, balance sheet, profit and loss accounts, mine budgeting.

Module 6: Management Techniques: Elements of Management function, Project management, Organizational structures in mines.

Module7: Application of operation research techniques in mining PERT, CPM and Linear Programming methods with special reference to mining industry.

Reference/text books:

1. Sharma N.L, “Mineral Economics”.
2. Rubawsky “Mineral Economics”, Elsevier Science Pub.
3. Deshmukh R.T “Mineral Economics”, Meera Publication, Nagpur.
4. Chatterjee K.K “Mineral Economics”, Willey Eastern.
5. Misra G.B- “Mineral Economics”.
6. Mineral Economics Sinha & Roy
7. Mine Valuation, Baxter, Addition Wesley
8. Mine Economics & Strategy, Runge, SME, USA

Mining Engineering			
MN732	**Mine Management**	**L**	**T**
		3	**0**

Course Objectives:

This course introduces Objective of mine management, characteristics of minerals and coal, crushing methods, separation methods, methods of concentration, fields of application and limitations.

Course Outcomes:

1. Recognize and appreciate the holistic nature of the mine management process
2. Identify the key stakeholders in a mining project and their respective needs.
3. Demonstrate an awareness of management theory and processes.
4. Recognize the factors that motivate people's behaviour in the mine working environment.
5. Apply the principal performance measures used in mine management.
6. Demonstrate an awareness of mining law (safety, mining leases etc).
7. Recognize and appraise the factors contributing to safety & risk management issues in specific mining-related processes.
8. Investigate the causes and consequences of mining-related serious incidents and propose risk management strategies
9. Demonstrate an awareness of contractor management (vs owner-operated).
10. Assess and understand the economic conditions in which the mining industry operates

CO-PO Mapping:

COs/POs		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3						3					
CO2			3		2		3		2	3	2	3	3
CO3		2			2	3		2					
CO4				2			2		2	2	2	2	
Avg.		2.5	3	2	2	3	2.5	2.5	2	2.5	2	2.5	3

DETAILED SYLLABUS

Module 1: Introduction: Evolution of management; theory and practice; principles of scientific management; elements of management function; planning; organization and control; structure and design of organization for mining enterprises.

Module 2: Personal Management: Selection; training and development of human resources formining enterprises; leadership; study of traditional leader behaviour; autocratic; democratic and Laissez-Faire behaviour;

Module 3: Production Management: Determination of norms and standards of operations by work study; analysis of mine capacities and capability; production planning; scheduling and control; short term and long-term planning; productivity; concepts and measurements; application of Ergonomics in mine operation.

Module 4: Financial Management: Capital budgeting; techniques for mining project; project evaluation; payback period and IRR; methods of cost analysis and cost control; breakeven charts; working capital management.

Module 5: Materials Management: ABC Analysis, Inventory Management; Purchase policies, P and Q system, inventory control, Review period, lead time.

Module 6: Behavioural Sciences for Management: Conflict management; conflict in organization; sources of conflict; dealing with conflict; organizing for conflict resolution; conflict and growth; Individual motivation; two-way personal communication.

Module 7: Maintenance Management: Definition, Classifying Reliability, Types of Maintenance; Break-down, scheduled, preventive, predictive, protective and lean maintenance.

Module 8: Marketing Management: Strategic planning & marketing management processes, marketing environment, marketing information systems, market management and forecasting; New product development processes.

Text/Reference Books:

1. I M Pandey, Financial Management, Vikash Publishing House Pvt. Ltd., New Delhi
2. P. Gopalakrishnan & M. Sundaresam, Materials Management- An Integrate Approach, Prentice Hall India Pvt. Ltd., New Delhi
3. SC Saksena, Business Administration and Management, Sahitya Bhawan, Agra.
4. P. Kstler, Marketing Management, Prentice Hall India Pvt. Ltd. New Delhi
5. M. Telsang, Industrial Engineering and Production Management, S. Chand & Co. Ltd., New Delhi

6. Lee &Dobbler, Purchasing and Materials Management, Tata Mc-Grand Hill Publishing Co. Ltd. New Delhi

Mining Engineering			
MN741	**Remote Sensing & Geographical Information System**	**L**	**T**
		3	**0**

Course Objectives:

Remote Sensing and GIS is a relatively young scientific discipline and is an area of emerging technology which has witnessed phenomenal growth over last three decades. In the recent past, there has been tremendous development in the field of Remote Sensing data collection, analysis and utilization. The science of Remote Sensing is no more an art of Map making from satellite image. The digital data handling led to the development of GIS (Geographical Information System) followed by another innovation of GPS (Global Positing System). Remote Sensing coupled with GIS and GPS techniques has dramatically enhanced human capability for resources exploration, mapping and monitoring on local and global scale.The application of Remote Sensing techniques and Geographical Information System(GIS) in various activities including resources evaluation, environmental monitoring and Landuse/Landcover mapping etc, have grown considerably during the last three decades and Remote Sensing data products are being increasingly used for plan information at all levels. An essentials pre-requisite to partaking in these opportunities is the building of various indigenous capacities for the development and utilization of space science and technology. This has led to a spurt in the demand for qualified manpower.

This course is designed to address the following:

- Understanding the Geo-informatics approach
- Teach fundamental principles involved in RS and GIS
- Understand the Fundamentals of Remote Sensing Products
- Know the Indian Remote Sensing Program
- Role of Remote Sensing for various surveys and information extraction
- Know about different software available in RS and GIS
- Learn fundamental procedures in RS and GIS
- Teach data integration and defining problems in digital format

Course outcomes

Upon successful completion of this course, the student will be able to:

Knowledge based

- Know Understand the remote sensing process;
- Understand digital data in different and their formats

- Know about National and International RS Programs
- Know about various satellites and images
- Know about changing field practices in Survey
- Know how to generate different types of digital data
- Know about Application areas

Skills

Use operations of RS & GIS to:

- Geotechnical investigations (soil studies, dam site studies)
- Water resources management
- Environmental studies (EIA and Land Use Land cover studies)
- Transportation planning, Urban Planning, E-Governance.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3		2		3		3	3	3	2	3
CO3				2	3							3
CO4			2			2		2	1	3	3	
Avg.	3	3	2	2	3	2.5		2.5	2	3	2.5	3

DETAILED SYLLABUS

Module 1: Definition & Scope of Remote Sensing: Electromagnetic energy & spectrum, Atmospheric windows. Remote Sensing Systems, Sensors & Scanners, Resolution of sensors, Multispectral, thermal & Radar data. Radiometers, spectral Signatures.

Module 2: Elements of Remote Sensing Systems: Terrestrial, airborne &spaceborneplatforms, sunsynchronous & Geostationary satellites. Various earth resources satellites, Indian Remote Sensing Programs.

Module 3: Remote Sensing Data products & their types: Analogue & Digital data Formats,errors.

Module 4: Interpretation Techniques: Elements & Methods of interpretation, Reliefdisplacement and vertical exaggeration, Photogrammetric determination of elevation from Remote Sensing Data.

Module 5: Digital Image Processing: Image rectification & restoration, imageenhancements, image classification; supervised & unsupervised, accuracy assessments.

Module 6: Geographical Information Systems: Raster & Vector Data, Components of GIS, concepts & basic characteristics of Vectorization, topology generation, attribute data attachment, editing and analysis. Buffer, Overlay and Interpolation techniques. Managing networks in GIS.

Module 7: Global Positioning Systems:Types and method, Applications:Integrated approach of RS & GIS application; Geotechnicalinvestigations (soil studies, dam site studies), water resources management, environmental studies (EIA and Land Use Land cover studies), transportation planning, Urban Planning, E-Governance.

Text/Reference Books:

1. M. Anji Reddy BS Publications Remote Sensing and Geographical Information Systems Third Edition.

2. C.P LO Albert KW Yeung, Concepts and techniques of Geographic Information Systems Pritince Hall of India 2002.

3. John R Jensen Remote Sensing of the Environment an Earth Resource Perspective Pearson Education 2006.

4. Geographic Information System and Environment Modelling Keith C. Clerk, Bradley O Parks, Michel P Crane Pritince Hall of India 2002.

5. Bhatta Remote Sensing and GIS Oxford University Press First Edition.Surveying (Vol – 1,2 & 3), by B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain – Laxmi Publications (P) Ltd., New Delhi.

Mining Engineering			
MN741	**Social-Environmetal Impact of Opencast Mines**	**L**	**T**
		3	**0**

Course objective:

This course outlines various factors which effects the ecological and societal imbalance, repercussions due to mega open cast mining projects. Following course summarizes those environmental and social issues that formed the basis for the Mining and Critical Ecosystems framework. Environmental and social impacts are divided into waste management issues, impacts to biodiversity and habitat, indirect impacts, and poverty alleviation and wealth distribution.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2		3	2	2		2		3	2		3	3
CO3	2			2	3							
CO4		2	2					2	2		2	
Avg.	2	2.5	2	2	3	2		2.5	2		2.5	3

Detailed Syllabus

Module-1: Introduction: History of environmental problems in mines and present environmental scenario. Techno-economics of environmental management.

Module-2: Environmental Parameters and Standards: Baseline data. Impact of mining activities on environmental parameters. Mitigating measures, monitoring and control. National and international standards and regulations. ISO principles and series

Module-3: Environmental Standards: National and International standards of various environmental parameters.

Module-4: Environmental Impact Assessment (EIA): Framework for EIA, screening, scoping and baseline studies. EIA methodologies and their applicability, Environmental Impact Indices, uncertainties in EIA.

Module-5: Environmental Management Plan (EMP):Scope, structure and legislative requirements. Preparation of EMP

Module-6: Land Acquisition & Revenue: Concepts, Related laws and regulations. Corporate Social Responsibility: Concepts and principles. Mine closure**:** Concepts and principles. Environmental administration: Laws related to mining environment.

References:

1. Environmental Legislation in India, Region Asia.
2. Pollution control acts, rules and notifications issued thereunder, CPCB-India Environmental Law of India, S.K. Choudhury, Oxford & IBH Publishers.
3. Handbook of Environmental laws, Acts, Guidelines, Compliances & Standards Policy, Trivedy, BS Publishers.
4. Environmental Impact Assessment -Larry, W. Canter (2nd ed), McGraw Hill Inc. Singapore, 1996.
5. Strategic Environmental Assessment – Riki Therirvel, E. Wilson, S. Thompson, D. Heaney, D. Pritchard. Earth scan, London, 1992.
6. Environmental Impact Assessment-Cutting edge for the 21st century - Alan Gilpin, CUP, London, 1994.
7. Environmental Impact Assessment-Theory & Practice - Peter Wathern, Unwin Hynman, Sydney, 1988.
8. Renewable Energy Environment and Development-Maheswar Dayal Konark Pub. Pvt. Ltd. 1998.

Mining Engineering			
MN743	**Sustainable Energy Resources**	**L**	**T**
		3	**0**

Course objectives:

The course should enable the students to:

1. Understand the various forms of conventional energy resources.
2. Learn the present energy scenario and the need for energy conservation
3. Explain the concept of various forms of renewable energy
4. Outline division aspects and utilization of renewable energy sources for both domestics and industrial application
5. Analyse the environmental aspects of renewable energy resources.

Goals and Outcomes:

This course gives a flavour of sustainable sources of energy to the students. This covers generation, design, efficiency and characteristics of various sustainable energy sources including wind, hydro and tidal systems. Student should be able to

- Analyze solar radiation data, extra-terrestrial radiation, radiation on earth's surface.
- Design solar thermal collections.
- Design solar photo voltaic systems.
- Develop maximum power point techniques in solar PV and wind.
- Explain wind energy conversion systems, Betz coefficient, tip speed ratio.

CO-PO Mapping:

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3											
CO2		3		2		3	3	2	3	2	3	3
CO3				2	3							
CO4			2			2		2	2	2	2	
Avg.	3	3	2	2	3	2.5	3	2	2.5	2	2.5	3

DETAILED SYLLABUS

Module-1: Wind Energy Conversion: Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics. Site

Selection Criteria: Advantages, Limitations, Wind Rose Diagram, Indian Wind Energy Data, Organizations like C-WET etc., Wind Energy Conversion System, Design, Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandtl's tip loss correction.

Module-2: Design of Wind Turbine: Wind turbine design considerations; Methodology; Theoretical simulation of wind turbine characteristics; Test methods. Wind Energy Application - Wind pumps: Performance analysis, design concept and testing; Principle of WEG; Stand alone, grid connected and hybrid applications of WECS; Economics of wind energy utilization; Wind energy in India; Case studies.

Module-3: Small Hydropower Systems: Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps and turbine; Selection and design criteria of pumps and turbines; Site selection and civil works.

Module-4: Speed and voltage regulation: Investment issues load management and tariff collection; Distribution and marketing issues: case studies; Potential of small hydro power in India. SHP: Renovation and Modernization, Testing Methods

Module-5: OTEC-Tidal Energy: Geothermal, MHD, Thermionic- Thermoelectric energy conversion system, Fuel Cells, Batteries, Micro Alge, Biodiesel from Alge.

Text/reference books:

1. G L Johnson, Wind Energy Systems, Prentice Hall Inc, New Jersey, 1985.
2. David A. Spera, (Editor) Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, American Society of Mechanical Engineers; (1994)
3. Erich Hau, Wind Turbines: Fundamentals, Technologies, Application and Economics, Springer Verlag; (2000)
4. Paul Gipe, Karen Perez, Wind Energy Basics: A Guide to Small and Micro Wind Systems, Chelsea Green Publishing Company; (1999)
5. J. F. Manwell, J. G. McGowan, A. L. Rogers, Wind Energy Explained, John Wiley & Sons; 1st edition (2002)

MN744	OPENCAST MINING MACHINERY	3L-0T-0P	3 CREDITS

Course Objective:
To give an overall idea about the various heavy-duty machines employed in mines and their structure and applications.

Syllabus
Module 1: Introduction to Surface mining equipment. Hydraulic Transmission system, Suspension System, Tyres, Wheels and Axle assembly, Braking and Steering system, Under Carriage unit of Crawler mounted machine; Hydraulic systems used in Heavy Earth Moving Equipment.
Module 2: Classification of equipment; system with different combination of excavator and transport equipment. Applicability of different surface mining equipment, Mechanics of rock cutting / loading by excavator
bucket.
Module 3: Prime movers used in surface mining equipment: Turbo-charged diesel engine, construction, operation and maintenance of its subsystems, trouble shooting of the engine.
Module 4: Classification, construction, operation and maintenance of various sub-systems of Shovel, Dragline, Bucket wheel excavator, Scraper, Surface Miner, Dumper, Dozer, Ripper, Grader, Loader, Compactor, Drills and Highwall miner Construction and Operations of subsystems of HEMM.
Module 5: Drilling Machine: Classification, construction, operation and maintenance of Rotary Blast Hole Drill, Jack Hammer Drill, DTH Drill; Drill Bits and Tubes / Rods, Drilling fluids., Construction and Operation of Exploratory drilling.
Module 6: Recent trends and development of surface mining equipment: Automation and control in HEMM. Selection criteria of open cast mining equipment. Safety aspects related to open cast mining equipment: Fire protection system used in HEMM.

Outcome Assessment Strategies:
• Individual, small group and full class discussions may be used as part of student assessment. Homework assignments, tutorials, surprise tests, mid semester examination and end semester examination will be used to assess outcomes.
• Specific details of the assessment procedure will be given the first week of class. In general, student assessment would depend on class attendance, input and feedback during the lecture and problem-solving sessions, homework, and written examinations.

Course Outcome:
Students will have a brief idea about
CO1. The various systems and functioning of the heavy-duty machineries in terms of hydraulic circuits being employed
CO2. The transmission systems.

COs/POs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	3	3	1	3	2	2	3
CO2	3	3	2	2	3	2	3	1	3	1	2	3

References/Books:

1. Recent Development of Heavy earth Moving machineries – A. De, Lovely Prakashan
2. Moving the Earth – Nicholes
3. On and with the Earth – J. Singh
4. Drilling Technology Handbook– C. P. Chugh

DEPARTMENT OF METALLURGICAL ENGINEERING

BIT, SINDRI, DHANBAD

7th Semester Course Structure

Sl. No.	Course No.	Subject	L	T	P	Credit
1.	ML701N	Foundry Technology (Professional Core Course)	3	0	0	3
2.		**Professional Elective – V (Any One of the Following)**				
I.	ML703N	Advances in Steel Making	3	0	0	3
II.	ML705N	Non Destructive Testing	3	0	0	3
III.	ML707N	Light Metal Alloys Steels	3	0	0	3
IV	ML709N	Special Steels and Cast Irons	3	0	0	3
V	ML711N	Non Metallic Materials	3	0	0	3
3.		**Professional Elective – VI (Any One of the Following)**				
I.		Principles of Management	3	0	0	3
II.	ML713N	Alloys Steels and High Temperature Alloys	3	0	0	3
III.	ML715N	High Temperature Materials	3	0	0	3
IV.	ML717N	Computer applications in materials and Engineering	3	0	0	3
V.	ML719N	Physical Chemistry of Iron and Steel Making	3	0	0	3
4.		**Open Elective – IV (Any One of the Following)**				
I.	ML721N	Composite Materials	3	0	0	3
II.	ML723N	Advanced Engineering Materials	3	0	0	3
III.	ML725N	Emerging Materials	3	0	0	3
IV.		Industrial Automation and Control	3	0	0	3
V.		Engineering Economics and Management	3	0	0	3
5.		**Open Elective – V (Any One of the Following)**				
I.	ML727N	Nano Materials	3	0	0	3
II.	ML729N	Nanostructured Materials	3	0	0	3
III.		Industrial Management	3	0	0	3
IV.		Industrial Safety and Hazards	3	0	0	3

I	ML702N	Foundry Lab.	0	0	3	1
II	ML704N	PROJECT - I	0	0	4	2
3.	IA701N	Internship Assessment	0	0	2	2
					Total Credit	**20**

Program Outcomes:

PO1	Apply knowledge of mathematics and science, with fundamentals of Metallurgical engineering to be able to solve complex engineering problems related to program.
PO2	Analyze problems of metallurgical engineering including thermodynamics of materials, physical metallurgy, Iron and steel making, and foundry technology to formulate design
PO3	Design, implement, and evaluate metallurgical aspects and processes considering public health, safety, cultural, societal and environmental issues.
PO4	Design and conduct experiments using domain knowledge and analyze data to arrive at valid conclusions.
PO5	Apply current techniques, skills, knowledge and computer based methods & tools to develop metallurgical systems.
PO6	Analyze the local and global impact of modern technologies on individual organizations, society and culture.
PO7	Apply knowledge of contemporary issues to investigate and solve problems with a concern for sustainability and ecofriendly environment.
PO8	Exhibit responsibility in professional, ethical, legal, security and social issues.
PO9	Function effectively in teams, in diverse and multidisciplinary areas to accomplish common goals.
PO10	Communicate effectively in diverse groups and exhibit leadership qualities.
PO11	Apply management principles to manage projects in multidisciplinary environment.
PO12	Pursue life-long learning as a means to enhance knowledge and skills.

7th Semester Syllabus/Course Content

Metallurgical Engineering			
Code: ML701	Foundry Technology	**L**	**T**
		3	**0**

Objectives of the course:

- To study the science and engineering of casting.
- To study the various processing techniques.
- Analyze the causes of various foundry related defects and their remedies.

Course Outcomes:

After completing this course the student have:

CO1	Knowledge of technical procedures of making castings
CO2	The ability to analyze defects, microstructure and phases in castings
CO3	The ability to perform computational analysis of castings

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	3	3	1	1	-	-	-	-	-	-	1	-

Detailed contents

Module 1: Pattern Making: Various pattern materials, allowances and types of patterns. (3 Hours)

Module 2: Molding and Core making: Principle ingredients of molding and core sand, their characteristics.Various types of binders and additives to molding, Sand Conditioning, Various sand control tests.Machine molding, high pressure molding, Sand molding processes based on Sodium Silicate, Organic Binders and other special molding processes.Shell molding and its full details. (12 Hours)

Module 3: Design of gating and risering of cast pertaining to iron and steel and non-ferrous casting. Different methods of casting such as die casting, centrifugal casting, rheo casting. (5 Hours)

Module 4: Various types of melting furnaces used in foundries such as Cupola, Electric Furnace, Induction Furnace. Melting of Cast Iron, Steel, Non-Ferrous Metals and Alloys. (8 Hours)

Module 5: Casting defects, their causes and remedies. Metallurgical inspection and quality control in foundries. (6 Hours)

Module 6: Consideration of environment, safety, energy optimization, and productivity associated with the above mentioned topics. Use of CAD CAM in foundries. (6 Hours)

Text / Reference Books:

1. Principles of Foundry Technology, P. Jain, McGraw Hill, 2017
2. Foundry Technology, Peter Beeley, 2nd Edition, Butterworth-Heinemann
3. Introduction to Foundry Technology, M. Lal, Khanna Publications
4. Foundry Technology, O. P. Khanna, DhanpatRai Publications
5. Materials and Processes in Manufacturing, E.P. DeGamo, Black and Kohser.

Metallurgical Engineering			
Code: ML703	Advances in Steel Making	**L**	**T**
		3	**0**

Course Objective:

To study and learn steel making process and also studied the advances on steel making.

Course outcomes:

1. Understand the Importance & Mechanisms of Reactions in Steel Making.
2. Explain secondary steel making Processes & its significance.
3. Identify the inclusion types & Methods of Preventions.
4. Understands the Merit & Demerits of Ingot Castings & Continuous castings

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	-
CO 3	3	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	3	1	1	-	-	-	-	-	-	-	-

5.

Course Content:

Module 1: Secondary steel making process: Introduction, process, variation, stirring techniques, synthetic slag refining with stirring and perrin process. (7 Hours)

Module 2: Classification and propertied of alloy steel, raw materials for alloy steel making. Manufacturing of alloy steel like stainless steel, Hadfield steel and high speed steel. (7 Hours)

Module 3: Development in stainless steel making, Rust less process, Ajax process, Tendum furnace process, continuous steel making process,Spray steel making process, IRSID, SIP process, EOF process and dual hearth furnace process. (7 Hours)

Module 4: Decarburization Techniques: AOD and VOD process,CLU process and MRP process.Injection metallurgy: Plunging technique, power injection, Wire Feeding, their economic analysis. (7 Hours)

Module 5: Remelting Process: Vacuum Arc Remelting and Electro slag remelting process. Teeming methods: Direct pouring, Tundish teeming and bottom teeming. (7 Hours)

Module 6: Vacuum treatment of liquid steel: Principles, vacuum raising equipments, degassing process: ladle degassing and stream degassing, Present scenario in India and abroad. (7 Hours)

Text / Reference Books:

1. Iron Making and Steel Making: Theory and Practice, Author: Ahindra Ghosh, Amit Chatterjee, Publisher: PHI Learning Pvt. Ltd.
2. An Introduction to Steel Making, Author: Tupkary R.H. Publisher: Khanna Publishers

3. Steel Making Publisher: Kudrin V. Mir Publisher

Metallurgical Engineering			
Code: ML705	NON DESTRUCTIVE TESTING	**L**	**T**
		3	**0**

Course Objective:

To study the different nondestructive testing techniques of materials components and their specific applications.

Course Outcomes:

CO1	Understand the basics of materials joining, processes related to joining, welding defects and remedies
CO2	Understand welding metallurgy, and weldability characteristics.
CO3	Practice and analyze the various NDT techniques
CO4	Selection of NDT and understand their capabilities

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	3	3	1	1	-	-	-	-	-	-	1	-
CO 4	-	3	1	1	-	-	-	-	-	-	-	-

Course Content:

Module 1: Visual examination, Basic principles of liquid penetrant testing and Magnetic particle testing. (6 Hours)

Module 2: Radiography - basic principle, electromagnetic radiation sources, radiographic imaging, inspection techniques, applications, limitations and safety. (6 Hours)

Module 3: Eddy current testing - principle, application, limitation. (6 Hours)

Module 4: Ultrasonic testing - basic properties of sound beam, transducers, inspection methods, flaw characterization technique, immersion testing, advantage, limitations; acoustic emission testing. (6 Hours)

Module 5: Leak testing, Holography and Thermography - principles, procedures and applications, Comparison and selection of NDT methods; defects in casting, forging, rolling and others. (6 Hours)

Text / Reference Books:

1. Baldevraj, Jayakumar T., Thavasimuthu M., „Practical Non-Destructive Testing", Narosa Publishing, 1997

2. Suryanarayana, „Testing of Metallic Materials", Prentice Hall India, 1979

Metallurgical Engineering			
Code: ML707	LIGHT METAL ALLOYS	**L**	**T**
		3	**0**

Course Objectives:

Upon Successful completion of this course, each student should be able to:

- To understand various light metal alloys and their applications.
- To know principles of casting these alloys.
- To know various mechanical processing techniques.
- To understand failure analysis of these alloys.

Course Outcomes:

CO1	1. Understand the different light metal alloys and their specific applications.
CO2	2. To understand the melting ad casting characteristics of an alloys.
CO3	3. Understand the physical metallurgy of light metal alloys.
CO4	4. Understand the defects and failure analysis of light metal components

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	3	1	1	1	-	-	-	-	-	-	1	-

CO 4	-	2	1	1	-	-	-	-	-	-	-	-

Course Content:

Module 1: Classification of light metal alloys, their properties, importance of strength / wt. ratio in engineering applications. Detailed engineering applications, Indian / International specifications. (8 hours)

Module 2: Melting methodology of light metal alloys used of melting / refining flows.
Casting characteristics of light metal alloys (Ag, Mg, Te alloys). (8 hours)

Module 3: Light metal alloys foundry practices, master alloy used in melting.
Physical metallurgy of light metals alloys, rolling, sheet metal working, extrusion etc.
Special Alloys: Duralumin, Al-Li, Mg-Li alloys - production and processing techniques & applications. (8 hours)

Module 4: Titanium alloys: Alloying elements and their effects, types of alloys, their processing, heat treatment, properties and selection. (8 hours)

Module 5: Strategic applications of light metal alloys, air craft industries. Functional considerations. Defects analysis in cast and rolled products. Failure analysis of light metal alloys components. (8 hours)

Text / Reference Books:

1. Raudebaugh R.J.; Non-ferrous Physical Metallurgy; Pitmavi Publishing Corpn., 1952.
2. Polmear I.J.; Light Alloys (3rd Edition); Arnold, 1995.
3. Bickert C.M.; Light Metals; Minerals Metals & Materials Society, 1990.
4. Brooks C.R.; Heat Treatment Processing & Structure Properties of Non Ferrous Alloys; ASM, 1984.

Metallurgical Engineering			
Code: ML709	SPECIAL STEELS AND CAST IRONS	**L**	**T**
		3	**0**

Course objective:

To know different types of steel and Cast-iron.

Course Outcome:

CO1	Represent the problems in developing high strength steels
CO2	Understand the basic concepts of special steels with regard to their manufacturing, processing, heat treatments and micro-structural evaluation.
CO3	Classify dual phase steels, TRIP steels, maraging steels and stainless steels
CO4	Understand the principles of micro-alloying and thermo-mechanical processing
CO5	Analyze the problems associated with heat treatment of tool steels and ultrafine grained steels.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	2	2	1	-	-	-	-	-	-	-	-
CO 3	3	1	1	1	-	-	-	-	-	-	1	-
CO 4	-	3	1	1	-	-	-	-	-	-	-	-

Course Content:

Module1: Definition of high strength steels, problems in developing high strength steels; discussion on fracture toughness; HSLA steels, principle of microalloying and thermomechanical processing; importance of fine grained steels. (8 Hours)

Module 2: Phase diagrams, composition, properties and applications of ferritic, austenitic, martensitic, duplex and precipitation hardenable stainless steels. (8 Hours)

Module 3: Dual phase steels, TRIP steels, maraging steels, metallurgical advantages, heat treatment, properties and applications. (8 Hours)

Module 4: Tool steels; classification, composition, and application, constitution diagram of high speed steels, special problems in heat treatment of tool steels. (8 Hours)

Module 5: Types of cast irons - grey, SG, white, malleable; austempered ductile iron; alloy cast irons, Ni hard, high silicon cast irons, heat resistant cast irons- high chrome cast iron- structure, property and engineering applications. (8 Hours)

Text / Reference Books:

1. *Leslie W. C., „The Physical Metallurgy of Steels", McGraw Hill, 1982*

2. Pickering P. B., „Physical Metallurgy and the Design of Steels", Applied Science Publishers, 1983

Metallurgical Engineering			
Code: ML711	Non Metallic Materials	**L**	**T**
		3	**0**

Objectives of the course

- To introduce the student to the range of non-metallic materials available for engineering.
- To get an exposure to the techniques associated with the synthesis, processing andcharacterization of these materials and to make them aware of the applications wherethese materials are preferred.

Course Outcomes

After completing this course the student can:

CO1	List the prominent non-metallic materials available for engineering applications
CO2	Indicate the uses for which these materials are preferred
CO3	Indicate the structure property relations in these materials
CO4	Indicate the synthesis and processing steps associated with these materials

Detailed contents

Synthesis, processing, structure, properties, characterization, applications, failure modes and deterioration mechanisms of the following will be studied

Module 1: Polymers (10 Hours)
Module 2: Ceramics (10 Hours)
Module 3: Glasses (2 Hours)
Module 4: Composites (12 Hours)
Module 5: Textiles (2 Hours)
Module 6: Adhesives (2 Hours)
Module 7: Foams (2 Hours)

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	2	1	1	-	-	1	-	-	-	-	-

Text / Reference Books:

1. Textbook of Polymer Science; Fred W. Billmeyer, Wiley 2007
2. Introduction to Ceramics; Kingery, Bowen, Uhlman. Wiley India Pvt Limited, 2012

Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012

Metallurgical Engineering			
Code:	Principles of Management	**L**	**T**
		3	**0**

Objectives:

To understand the principles of management and their application to the functioning of an organization.

Course Outcomes:

CO1	Understand the meaning of management and science
CO2	Nature and purpose of Planning, types of Planning
CO3	Upon completion of this course, the students will get a clear understanding of management functions in an organization

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	-	2	1	1	-	-	1	-	-	-	-	-

Contents:

Module 1: Definition of management, science or art, manager vs entrepreneur; Types of managers-managerial roles and skills; Evolution of management- scientific, human relations, system and contingency approaches; Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises; Organization culture and environment; Current trends and issues in management. (8 hours)

Module 2: Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies, Strategic Management, Planning Tools and Techniques, Decision making steps & processes. (8 hours)

Module 3: Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning, Recruitment selection, Training & Development, Performance Management, Career planning and Management. (8 hours)

Module 4: Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment, leadership, types & theories of leadership, effective communication. (8 hours)

Module 5: Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting. (8 hours)

Text / Reference Books:

1. Robins S.P. and Couiter M., Management, Prentice Hall India, 10th ed., 2009.
2. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
3. Tripathy PC & Reddy PN, Principles of Management, Tata McGraw Hill, 1999.

Metallurgical Engineering			
Code: ML713	ALLOY STEELS & HIGH TEMPERATURE ALLOYS	**L**	**T**
		3	**0**

Course Objectives:

- To make the candidate understand effect of various alloying elements in steel
- To make the candidate understand various kind of specifications and heat treatments of different alloy steels

Course outcomes:

CO1	Understand the different types of steels and effects of their alloying components.
CO2	Studied the structural steels and their applications
CO3	Applications of different heat treatments and their effects in their microstructure.
CO4	Studied of light metal alloys applications.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-

Module 1: Classification of Alloy Steels depending on alloying content, effect of alloying elements on the constitution, structure and properties of steels, ferrite former and carbide former, alloy cast irons.

Module 2: Studies of low alloy structural steels, High strength low alloy steels, Dual phase steels, General Engineering Steels, Medium alloy and high alloy tool steels such as HCHC, HSS etc.

Module 3: Corrosion resistant stainless steels, processing and heat treatment of Hadfield's Mn Steel, spring steel, electrical sheet steels, steels for magnetic application, Maraging steel, Ausformed steel and TRIP Steels.

Module 4: Heat treatment equipment's, techniques employed for low, medium and high alloy steels with special emphasis on high speed tool steel, stainless steel, spring steels, alloy cast iron, Various specification viz. AISI, BSS, DIN & IS for alloy steels and alloy cast iron.

Module 5: Heat resistant alloys - general properties, metallurgical structure, processing, applications and limitations, super base alloys- Ni-base alloys, Co-base alloys, Fe-base alloys, Ni-Fe base alloys. Titanium alloys for high temperature aeronautical applications, their processing, properties, and selection.

Text / Reference Books:

1. Roberts G.A.; Tools Steels; American Society of Metals, 1980.
2. Clark, Varney W.R.; Metallurgy for Engineers; East West Press, 1962.
3. Peter Payson; The Metallurgy of Tools Steels; John Wiley & Sons, 1962.
4. ASM Handbook –Vol.1 (10th Edition); ASM International, 1995.

Metallurgical Engineering			
Code: ML715	High Temperature Materials	**L**	**T**
		3	**0**

Course Objective:

To study the high temperature materials and their mechanical properties.

Course Outcomes:

CO1	Select materials for various temperature ranges
CO2	Develop materials for high temperature applications
CO3	Interpret the influence of creep, thermal fatigue, oxidation, high temperature corrosion, erosion and ageing on materials
CO4	Analyze life of creep resistant steels, superalloys, ceramics and polymers at elevated temperature
CO5	List the usage of high strength steels and spring steels

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	-
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-
CO 5	1	-	1	2	-	-	1	-	1	-	-	1

Detailed syllabus

Module 1: Introduction and Elevated temperature characteristics of engineering materials. Corrosion at elevated temperatures. High temperature creep, thermal and thermomechanical fatigue of structural alloys. Elevated temperature crack growth and creep-fatigue interaction. (8 hours)
Module 2: Elevated temperature mechanical characteristics of carbon alloy steels and Stainless steels. Elevated temperature corrosion properties of carbon alloy steels and Stainless steels. Elevated temperature mechanical and corrosion properties of high alloy cast steels. (5 hours)
Module 3: Super-alloys: their processing, high temperature mechanical properties, corrosion behavior, microstructural degradation behavior of super alloys. Titanium and titanium alloys. Nickel alloys. Refractory metals, alloys and Structural inter-metallic. Ceramics for applications in refractory technology. (13 hours)
Module 4: Oxidation resistant coatings. Thermal barrier coatings. High temperature polymers. Carbon - carbon composites. Ceramic Matrix composites for refractory applications. Thermal barriers in space vehicles and satellites. (11 hours)
Module 5: Materials for in extreme environments: Case studies for applications in industry, defense and nuclear applications. (5 hours)

Text / Reference Books:

1. Evans, R.W and Wilshire, B. Creep of Metals and Alloys. Institute of Metals, 1985, London.
2. J. R. Davis, ASM Specialty Hand Book: Heat – Resistant Materials, ASM, 1997.

Metallurgical Engineering			
Code: ML717	Computer Applications in Materials and Engineering	**L**	**T**
		3	**0**

Objectives of the course

This course introduces computational methods in the domain of metallurgical and materials engineering. At the end of the course the student should be able to

Course Outcomes:

CO1	Analyze a metallurgical problem to create a well posed numerical problem
CO2	Identify initial and boundary conditions of a problem relevant to materials domain
CO3	Propose a solution procedure for a numerical problem in the domain of materials engineering
CO4	Demonstrate ability to quantify a materials engineering problem through numerical analysis

Detailed syllabus:

Module 1: Computer Basics and programming, Techniques in Computer simulation. (10hours)
Module 2: Finite Element Analysis, Monte-Carlo Methods, Mathematical Modelling of Physical Concepts. Atomic level design of materials based on the first-principles simulation techniques. (10hours)
Module 3:CALPHAD, Microstructure Modelling, Process Modelling. (10hours)
Module 4: Integrated Selection of Materials and Processes, Calculation of materials properties starting from microscopic theories. (10hours)

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-

Text / Reference Books:

1. R J Arsenault, J R Beeler Jr, D M Easterling (Eds): Computer Simulation in Materials Science, ASM International, 1986.
2. K. Ohno, K. Esfarjani, and Y. Kawazoe : Computational Materials Science - From Ab Initio to Monte Carlo Methods, Springer, 1999.
3. Wolfram Hergert, Arthur Ernst, Markus Dane: Computational Materials Science – From Basic Principles to Materials Properties, Springer, 2004.

Mapping of course outcomes with program outcomes

Metallurgical Engineering			
Code: ML719	PHYSICAL CHEMISTRY OF IRON AND STEEL MAKING	**L**	**T**
		3	**0**

Course Objective:

1. To import the knowledge of reactions taking place during iron and steel making
2. To develop the skill of analysis of the reasons of not producing quality steel
3. To make inclusion free quality steel products

Course Outcomes

At the end of this course, the students would be able to:

CO1	Understand the quality production of Iron and steel.
CO2	Make clean steel products through conventional and continuous casting.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	1	2	-	-	1	-	-	-	-	-

Course Content:

Module 1: Liquid properties : Surface Tension, Viscosities of liquid metals, Diffusion in metals and alloys, Physico-chemical properties of molten gasses, slag and matte, surface tension and transport properties. (8 hours)

Module 2: Reaction in iron making, kinetics of reduction of ores, pellets and sinter. Slag-Metal reaction of S-Si in Blast furnace. (8 hours)

Module 3: Reaction in Steel Making: Slag –metal reaction in Hearth process. Gas/Slag/Metal Reactions in Pneumatic and Oxygen steel making process. (8 hours)

Module 4: Discussions of Phosphorous and Carbon reactions and their interdependence. (8 hours)

Module 5: Deoxidation Theory and Practice: Ladle treatment of steel like gas purging, vacuum treatment and Ladle furnace. Reaction during solidification of steel in Moulds and /or during continuous casting. (8 hours)

Text / Reference Books:

1.An Introduction to the Physical Chemistry of Iron & Steel Making

Book by Robert George Ward.

2.Physical chemistry of iron and steel manufacture by Bodsworth C.

Metallurgical Engineering			
Code: ML721	Composite Materials	**L**	**T**
		3	**0**

Objectives of the course

- To obtain knowledge on classification, processing, characterization and applicationsof composite materials.
- To obtain knowledge on mechanical properties and failure mechanisms of compositesunder loading conditions for engineering applications

Course Outcomes:

After completing this course, students will have:

CO1	Knowledge on classification, processing, characterization and applications of various composite materials
CO2	Ability to arrive at different deformation and failure mechanisms of composite materials under different loading conditions in engineering applications

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	1	2	1	1	-	-	-	-	-	-	1	-
CO 2	-	1	1	2	-	-	1	-	-	-	-	-

Detailed contents

Module 1: Introduction: Definition, history, characteristics, classifications, advantages and limitations, industrial scenario and applications. (2 hours)

Module 2: Material and microstructural parameters of composites. Unidirectional-fibre composites: Fibre characteristics. Longitudinal strength and modulus of composites, minimum and critical fibre volume fractions, factors affecting strength. Transverse strength and modulus. (8 hours)

Module 3: Failure modes. Single and multiple fractures. Short-fibre composites: Stress transfer, critical fibre length. Modulus and strength. Whiskers and whisker reinforced composites. (6 hours)
Module 4: Particulate composites: Large-particle composites and dispersion-strengthened composites. Cermets. Zirconia toughened ceramics. Interface: Interface characteristics and their effects on adhesive, frictional and mechanical bonding mechanisms. Coupling agents and their role on the properties composites. Interface coatings. (10 hours)
Module 5: Properties of composites: Static mechanical properties, fatigue, impact and creep properties, fracture behaviour and damage tolerance. (10 hours)
Module 6: Advanced composites: Nano composites, hybrid composites, sandwich composites, in-situ composites, smart composites, self-healing composites, and carbon-carbon composites (4 hours).

Text / Reference Books:

1. Composite Materials: Science and Engineering; Krishan K. Chawla, Springer, 2012

Metallurgical Engineering			
Code: ML723	ADVANCED ENGINEERING MATERIALS	**L**	**T**
		3	**0**

Course Objective:

To study the metallurgy and properties of advanced engineering materials. To learn the advanced material processing to their specific applications.

Course outcomes:

CO1	Study the several advanced engineering materials
CO2	Understand the microstructure and metallurgy of advanced engineering materials.
CO3	To study the processing of advanced engineering materials.
CO4	Learn different processing techniques

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-

Course Content:

Module 1: Electronic Polymers, Organic electronics, Melanin, Organic semiconductor, Printed electronics, Organic LED. Nanostructures, Nanomaterials, Nanocomposites. (7 hours)
Module 2: Biomaterials: Metallic biomaterials like 316L stainless steel, Co-Cr Alloys, Titanium Ti6Al4V, Ceramic biomaterials like Alumina, Zirconia, Carbon Hydroxyapatite, Polymeric biomaterials like Ultra high molecular weight polyethylene, Polyurethane. (7 hours)
Module 3: Smart Materials: Piezoelectric materials, Shape memory alloys and shape memory polymers. High Performance Alloys, Nickel super alloys, Ti alloys, Al-Li alloys, Hastelloy, Inconel, Monel, Nitronic, Cobalt based alloys and commercially available pure nickel alloys. (7 hours)
Module 4: Functional and Engineering Ceramics: diverse applications as cutting tools, mobile phone microwave devices, polycrystalline diamond and fuel cells. (7 hours)
Module 5: Hybrid Materials: Design, Synthesis and Properties of hybrid materials created by blending disparate materials such as plastics with metals. (7 hours)
Module 6: Processing of Advanced Materials, Superplastic, spray forming, rapid solidification. Materials selection and design. (7 hours)

Text / Reference Books:

1. Overview Leonard V. Interrante, Mark J. Hampden-Smith Wiley, *Chemistry of Advanced Materials*, An -VCH; 1st edition (1997)
ISBN-10: 0471185906 ISBN-13: 978-0471185901.
2. R E Smallman, A. H. W. Ngan, Butterworth-Heinemann, *Physical Metallurgy and Advanced Materials*, Seventh Edition, 2007,
ISBN: 0750669063.

Supplementary Reading:

1. M. Meyers, M Sarikaya, R. Ritchie, Elsevier, *Nano and Microstructural Design of Advanced Materials 2003*, ISBN-13: 978-0-08-
044373-7, ISBN-10: 0-08-044373-7.

Metallurgical Engineering			
Code: ML725	**EMERGING MATERIALS**	**L**	**T**
		3	**0**

Course objective:

To define new engineering materials and apply for multi-functional areas.

Course outcomes:

Upon completion of the course, the student will be able to:

CO1	Describe various processing techniques of different engineering materials.
CO2	Analyse the Phase diagram and Microstructure using Microscope for different type of Stainless steel materials.
CO3	Select the material for Biological, Nuclear, Space and Cryogenic service applications.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	1
CO 3	-	1	1	2	-	-	1	-	-	-	-	-

Course content:

Module 1: Techniques of rapid solidification. Production of metallic glasses, atomic arrangement, comparison with crystalline alloys - mechanical, electrical, magnetic, superconducting and chemical properties and applications. (10 hours)

Module 2: Phase diagrams of ferritic, martensitic and austenitic stainless steels, duplex stainless steels, precipitation hardenable stainless steels, mechanical and metallurgical properties of stainless steels, HSLA steels, micro-alloyed steels Aluminium alloys, magnesium alloys and titanium alloys; metallurgical aspects, mechanical properties and applications. (10 hours)

Module 3: Development of super alloys-iron base, nickel base and cobalt base - properties and their applications; materials for cryogenic service, materials in nuclear field, materials used in space. (10 hours)

Module 4: Carbonaceous materials - including nano tubes and fullerenes; shape memory alloys, functionally gradient materials, high temperature super conductors - bio materials. (10 hours)

Text / Reference Books:

1. Sukh Dev Sehgal, Lindberg R.A., „Materials, their Nature, Properties and Fabrication", S Chand, 1973

2. Polmear I. J. „Light alloys: Metallurgy of Light Metals", 3rd Edition, Arnold, 1995

Metallurgical Engineering			
Code:	Engineering Economics and Management	**L**	**T**
		3	**0**

Course Objective:
To study the engineering economics and management of an organization.

Course Outcomes:

CO1	Understand the engineering economics and their basic fundamentals
CO2	Understand the accounts, and costing.
CO3	Understand the Industrial management
CO4	Learn the optimization techniques.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	-	-	-	-
CO 3	1	2	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	1

Course Content:
Module 1: Simple and Compound Interest, annuities and depreciation: cause and methods, comparison of alternative and replacement studies (i) equivalent annual cost method (ii) present worth method (iii) rate of return method. (7 hours)

Module 2: Accounting: Double entry book keeping, journal, ledgers, manufacturing account: profit and loss accounts, balance sheet. (7 hours)

Module 3: Costing: Cost and cost accounting, elements, break even analysis, determining selling price and profitability, over-head cost allocation, costing system, job costing, unit costing, process costing, operation costing department cost, cost control: actual and standard cost, budget and budgetary sheet. (7 hours)

Module 4: Management and Organization: Principle of management, elements of management, planning, organizing direction and control, Organization structure and charts, line, staff functional and committee organization. (7 hours)

Module 5: Industrial Management: Industrial ownership LP proprietorship, partnership, Joint Stock Company and cooperative societies, site selection, plant layout: process oriented product oriented layouts, line balancing. Production Materials Management: Production types: job order, batch and mass production, inspection and quality control, inventory control, economic order quality. (7 hours)

Module 6: Optimization Techniques: Linear programming: graphical method, analytical method of solution (two variables), CPM and PERT. Personal Management: Functions: manpower planning, recruitment, selection, training, promotion, discipline, welfare, job evaluation, merit rating, wages and incentives. Marketing research and sales forecasting, sales management, advertisement and sales promotion. (7 hours)

Text / Reference Books:

- 1. O. P. Khanna, *Industrial Engineering and Management*, Khanna publishers, New Delhi.
- 2. Dr. K. C. Arora, *TQM and ISO 14000*, S. K. Kataria & Sons, New Delhi.

Metallurgical Engineering			
Code: ML727	Nano materials	**L**	**T**
		3	**0**

Objectives of the course

To recognize the differences between nano-materials and conventional materials and to become familiar with a wide range of nano-materials, their synthesis, characterization, properties and applications.

Course Outcomes:

After completing this course, the student should be able to:

CO1	Indicate the differences between nano-materials and conventional materials
CO2	Indicate how specific synthesis techniques can result in nano-materials
CO3	Give examples of specific nano-materials and explain the scientific reasons for the properties displayed by them
CO4	Describe how specific characterization techniques can be used to analyze nano-materials

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	2	-	-	-	-	-	-	1	-
CO 4	-	2	1	2	-	-	1	-	-	-	-	-

Detailed contents

Module 1: History of nanomaterials (2 Hours)
Module 2: Discussion of the Feynman talk “There is plenty of room at the bottom” (4 Hours)
Module 3: Synthesis routes for nano and ultra-fine grained materials: bottom up and top down approaches (2 Hours)
Module 4: Specific synthesis routes such as vapor deposition, sol-gel, rapid solidification

processing, high energy ball milling, cryo rolling, and equal channel angular extrusion (6 Hours)

Module 5: Thermodynamics of nanomaterials (3 hours)

Module 6: Mechanical property aspects of nano-materials, inverse Hall-Petch relationship (2 Hours)

Module 7: Specific nano materials and their applications such as:

Carbon nano-structures (Nano-tubes, nano-horns, graphene, buckyballs etc.) (6 Hours)

Semiconducting nano-materials – Quantum confinement, Quantum wells, quantum wires and quantum dots. (3 Hours)

Magnetic nanomaterials – super paramagnetism (2 hours),

Ferroelectric, nano ceramics (2 Hours)

Super-plasticity (2 Hours)

Nano-composites (2 Hours)

Module 8: Characterization techniques from the perspective of nanomaterials (4 Hours).

Text / Reference Books:

Introduction to Nanomaterials, Charles Poole and Frank Owens, Wiley 2007.

Metallurgical Engineering			
Code: ML729	NANOSTRUCTURED MATERIALS	**L**	**T**
		3	**0**

Course Objective:

To develop an understanding of the basic knowledge of Metallurgical and Materials Engineering and gain knowledge on overview of developments in the field of materials over periods; to become familiar with the metals and materials industry

Course Outcomes:

CO1	Define engineering materials technology and understand each stage of the materials cycle, material selection criteria
CO2	Understand the impact of Metallurgical and Materials Engineering solutions in a global, economic, environmental, and societal context
CO3	Become familiar with the science behind the development of metals and materials
CO4	Become familiar with current trends / developments and the prevailing industrial scenario in metals and materials

1.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	1	-	-	-	-	1	-	1	-
CO 4	-	2	1	2	-	-	1	-	-	-	-	-

Course Content

Module 1: Introduction: Types of nanomaterials, Emergence and challenges in nanotechnology. (4 Hours)

Module 2: Synthesis routes for nanomaterials: Bottom-up and top-down approaches, Solid, Liquid, Gas phase synthesis, Hybrid Phase synthesis. (9 Hours)

Module 3: Synthesis of bulk Nanostructured materials: Approaches and challenges. Properties of nanomaterials: Stability of nanomaterials, Mechanical properties, Optical, Electrical and Magnetic properties, nano-diffusion. (8 Hours)

Module 4: Characterization of nanomaterial: Structural characterization by XRD, SEM, TEM, SPM, Chemical characterization by spectroscopy techniques, characterization of mechanical properties by Nano indentation, hot compression testing, Fracture analysis. (10 Hours)

Module 5: Application of nanomaterials: Electronics and optoelectronics applications, Nanobots, Biological applications, Catalytic applications, Quantum devices, Application of carbon nanotubes, Nanofluids. Future of Nanotechnology. (11 Hours)

Text / Reference Books:

1. Yuri Gagotsi (Ed.), Taylor and Francis, *Nanomaterails Handbook*, 2006.
2. G. Cao, *Nanostructures and Nanomaterials*, Imperial College Press, 2006.

Supplementary Reading:

1. R. D. Booker and E. Boyden, *Nanotechnology for Dummies*, Dummies Publishing, 2005.
2. C. Deere and M. Llano, *Nanostructures*, Springer, 2004.
3. C. P Poole and F. T. Owe, *Introduction to Nanotechnology*, Willey Press, 2003.

Metallurgical Engineering			
Code:	Industrial Management	**L**	**T**
		3	**0**

Course Objective:

To study the management in organisation, work study, inventory, and quality management.

Course Outcomes:

CO1	To understand the role of management in organisation.
CO2	To study the evolution and structure of industry.
CO3	To study the marketing management and understand the work study.
CO4	To study the inventor and quality management.

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	3	2	1	-	-	-	-	-	-	-	1
CO 3	1	2	1	1	-	-	1	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	-

Detailed syllabus

Module 1: Introduction: Overview of the course, Examination and Evaluation patterns; Nature, significance and role of management in organizations. (7 Hours)
Module 2: Evolution of Industry and Principles of management: Evolution of industry and professional management; Functions of management; Organization structures; Hawthorne Experiments and informal organizational structures; Motivational theories and leadership styles. (7 Hours)
Module 3: Marketing Management: Marketing management process; 4P's of marketing mix; Target marketing; Product life cycle and marketing strategies. (7 Hours)
Module 4: Work Study: Productivity and its role in the economy; Techniques for improving productivity; Method study; Principles of motion economy; Stop watch time study; Work sampling. (7 Hours)
Module 5: Quality Management: Dimensions of quality; Process control charts; Acceptance sampling; Taguchi's Quality Philosophy; Quality function deployment; Introduction to TQM. (7 Hours)
Module 6: Inventory Management: Purpose of inventories; Inventory costs; ABC classification; Economic Order Quantity (EOQ); P and Q systems of inventory control. (7 Hours)

Text / Reference Books:

1. Koontz H and Weihrich H, Essentials of Management, 7th Ed., McGraw-Hill, New York 2007.
2. Kotler P, Marketing Management, 13th Ed., Prentice Hall of India/Pearson, New Delhi 2009.
3. Chase, Shankar, Jacobs and Aquilano, Operations and Supply Management, 12th Ed., Tata McGraw Hill, New Delhi 2010.

Metallurgical Engineering			
Code:	Industrial Safety and Hazards	**L**	**T**
		3	**0**

Course Objective:

To study the different accident and their safety measures

Course Outcomes:

CO1	To understand the different accident cases and safety program
CO2	To understand the industrial hygiene
CO3	To study toxic release and their prevention measures
CO4	To estimate the risk assessment

Mapping of course outcomes with program outcomes

Course Outcome s	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 1 0	PO 1 1	PO 1 2
CO 1	2	-	-	-	-	1	2	1	-	-	-	-
CO 2	-	1	2	1	-	-	-	-	1	-	-	-
CO 3	1	3	1	1	-	-	-	-	-	-	1	-
CO 4	-	1	1	2	-	-	1	-	-	-	-	1

Detailed syllabus:

Module 1: Introduction-Safety Programs, Engineering Ethics, Accident and Loss Statistics, Acceptable Risk, Public Perceptions, the Nature of the Accident Process, Inherent Safety. (7 Hours)
Module 2: Industrial Hygiene- Anticipation and Identification, Hygiene Evaluation, Hygiene Control. (7 Hours)
Module 3: Toxic Release and Dispersion Models- Parameters Affecting Dispersion, Neutrally Buoyant Dispersion Models, Dense Gas Dispersion, Toxic Effect Criteria, Effect of Release Momentum and Buoyancy, Release Mitigation. . (8 Hours)
Module 4: Fires and Explosions- The Fire Triangle, Distinction between Fires and Explosions, Flammability Characteristics of Liquids and Vapors, Limiting Oxygen Concentration and Inerting, Flammability Diagram. . (8 Hours)
Module 5: Hazards Identification- Process Hazards Checklists, Hazards Surveys, Hazards and Operability Studies, Safety Reviews. . (7 Hours)
Module 6: Risk Assessment- Review of Probability Theory, Event Trees, Fault Trees. **Safety Procedures**: Process Safety Hierarchy, Managing Safety, Best Practices, Procedures—Operating, Procedures—Permits, Procedures—Safety Reviews and Accident Investigations. . (6 Hours)

Text / Reference Books:

1. D. A. Crowl and J.F. Louvar, Chemical Process Safety (Fundamentals with Applications), Prentice Hall,2011.

2. R.K. Sinnott, Coulson & Richardson's Chemical Engineering, Vol. 6, Elsevier India, 2006

DEPARTMENT OF METALLURGICAL ENGINEERING

BIT, SINDRI, DHANBAD

8th Semester Course Structure

Course Objective:

- To evaluate the ability of an would be B.Tech graduate in the area for which he/she has been exposed/learnt during his/her study upto 7th semester.
- To observe his/her capability to find out the solution of a problem by making the model, analysing the situation and formulating the theories and practicals performed till date in the form of a project.

Sl. No.	Course No.	Subject	L	T	P	Credit
1.	ML802N	PROJECT-II	0	0	17	8
		Comprehensive viva	0	0	3	0
TOTAL CREDITS (5th Semester to 8th Semester)						**70**

Course Outcomes:

- After completing the project work in real sense of its meaning, students can be relied to work on certain industrial projects.

*****Students must give presentation each month in the department and In-house project presentation will be every week.

Computer Science & Engineering and Information Technology					
Code: CS701	**Artificial Intelligence**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOME

CO.1: Discuss basic concepts of Artificial Intelligence, AI(Artificial Intelligence) principles, AI Task domains and application.
CO.2: Explain various searching techniques, constraint satisfaction problem, game playing techniques and **Apply** these techniques in applications which involve perception, reasoning and learning.
CO.3: Explain various searching techniques, constraint satisfaction problem, game playing techniques and **Apply** these techniques in applications which involve perception, reasoning and learning.
CO.4: Explain working of uncertainty management, decision making and learning methods.
CO.5: Apply different knowledge representation, reasoning, and learning techniques to real-world problems.

CO-PO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO.1	3	-	-	-	-	-	-	-	-	-	-	3
CO.2	3	2	2	2	-	-	-	-	-	-	-	-
CO.3	3	2	2	2	-	-	-	-	-	-	-	-
CO.4	3	-	-	-	-	-	-	-	-	-	-	2
CO.5	-	2	2	2	-	-	-	-	-	-	-	-

**3: high, 2: moderate, 1 low*

MODULE 1:

Introduction
Overview of AI, Problems of AI, AI techniques, Problem Solving, Problem Space and Search, Defining the problem as state space search, Problem characteristics; Tic,Tac,Toe Problem
AI languages
Basic knowledge of AI programming languages like Prolog and Lisp .

MODULE 2:

Basic Search Techniques

Solving Problems by searching; Uniform search strategies; Breadth first search, depth first search, depth limited search, bidirectional search, Best First search, comparing search strategies in terms of complexity.

MODULE 3:

Special Search Techniques

Heuristic Search, greedy best,first search, A* search; Hill climbing search, Simulated Annealing search; Genetic Algorithm; Constraint Satisfaction Problems; Adversarial search, Games, Optimal decisions and strategies in games, Minimax search, Alpha,beta pruning.

Symbolic Logic

Syntax and semantics for propositional logic, Syntax and semantics of FOPL, Properties of WFF, Clausal form, Unification, Resolution.

MODULE 4:

Reasoning Under Inconsistencies and Uncertainties :

Non,monotonic reasoning, Truth Maintainace System, Default Reasoning & closed world assumption, Predicate completion and circumscription, Fuzzy Logic.

Probabilistic Reasoning

Bayesian probabilistic inference, Representation of knowledge in uncertain domain, Semantics of Bayesian networks, Dempster, Shafer theory.

MODULE 5:

Structured Knowledge

Associative networks, Conceptual graphs, Frames structures.

Expert Systems

Rule based systems, Non production systems : decision tree architectures, black board system architecture, neural network architecture.

Learning

Types of learning, general learning model, Learning by induction; generalization, specialization, example of inductive learner.

Text book:

1. Elaine Rich, Kevin Knight and Shivashankar B Nair, “Artificial Intelligence”, Mc Graw Hill Publication, 2009.
2. Dan W. Patterson, “Introduction to Artificial Intelligence and Expert System”, Pearson Publication,2015.

References:

1. Saroj Kaushik, “Artificial Intelligence”, Cengage Learning, 2011.

Computer Science & Engineering and Information Technology					
Code: CS711	**Machine Learning**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcome: At the completion of the course a student will be able to –

1. Discuss fundamental of machine learning, design and its application.
2. Differentiate various learning approaches, and to interpret the concepts of different learning.
3. Illustrate and apply clustering algorithms and identify its applicability in real life problems.
4. Discuss basics of neural network and its different model.
5. Describe different optimizations algorithm.

CO-PO Mapping-

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	1	2							
CO2	3	2	3	1					1			2
CO3	3	3	2	2	1							
CO4	3	2	2		2							
CO5	2	2	3	1	2							

MODULE 1: What is Machine learning, Basic principal, Utility of ML Well defined learning system, Designing learning system, Challenges in ML, Application of ML.

MODULE 2: Linear Regression (with one variable and multiple variables), Gradient Descent, Classification (Logistic Regression, Over fitting, Regularization, Support Vector Machines), Decision Trees and issue in decision tree, Bayesian Learning – Bayes Theorem, Concept Learning, Bayes Optimal Classifier, Naïve Bayes Classifier, Bayesian Belief Networks, EM Algorithm.

MODULE 3:

Clustering (K-means, Hierarchical, etc.), Dimensionality reduction, Principal Component Analysis, Anomaly detection, Feasibility of learning, Reinforcement learning.

MODULE 4:

Artificial Neural Networks, Artificial Perceptron's, Gradient Descent and The Delta Rule, Adaline, Multilayer Networks, Back-propagation Rule back-propagation Algorithm-Convergence.

MODULE 5:

Evolutionary algorithm, Genetic Algorithms – An Illustrative Example, Hypothesis Space Search, Genetic Programming, Swarm intelligence algorithm.

Text Book:

1. Understanding Machine Learning. Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press.

2. Tom Mitchell. Machine Learning (McGraw Hill)

3. Artificial Neural Network, B. Yegnanarayana, PHI, 2005

Reference Book:

1. Christopher M. Bishop. Pattern Recognition and Machine Learning (Springer)

Computer Science & Engineering and Information Technology					
Code: CS712	**MULTIMEDIA SYSTEMS AND APPLICATIONS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcome:

After Completion of this course, the students will be able to:

1. Developed understanding of technical aspect of Multimedia Systems.
2. Understand various file formats for audio, video and text media.
3. Develop various Multimedia Systems applicable in real time.
4. Design interactive multimedia software.
5. Apply various networking protocols for multimedia applications.
6. To evaluate multimedia application for its optimum performance.

Syllabus:

MODULE 1:

Introduction to Multimedia System: Architecture and components, Multimedia distributed processing model, Synchronization, Orchestration and Quality of Service (QOS) architecture.

MODULE 2:

Audio and Speech: Data acquisition, Sampling and Quantization, Human Speech production mechanism, Digital model of speech production, Analysis and synthesis, Psycho-acoustics, low bit rate speech compression, MPEG audio compression.

MODULE 3:

Images and Video: Image acquisition and representation, Composite video signal NTSC, PAL and SECAM video standards, Bilevel image compression standards: ITU (formerly CCITT) Group III and IV standards, JPEG image compression standards, MPEG video compression standards.

MODULE 4:

Multimedia Communication: Fundamentals of data communication and networking, Bandwidth requirements of different media, Real time constraints: Audio latency, Video data rate, multimedia over LAN and WAN, Multimedia conferencing.

MODULE 5:

Multimedia Information Systems: Operating system support for continuous media applications: limitations is usual OS, New OS support, Media stream protocol, file system support for continuous media, data models for multimedia and hypermedia information, content based retrieval of unstructured data.

Text / Reference Books

1. Ralf Steinmetz and Klara Nahrstedt, Multimedia Systems, Springer.
2. J. D. Gibson, Multimedia Communications: Directions and Innovations, Springer.
3. K. Sayood, Introduction to Data Compression, Morgan-Kaufmann.
4. A. Puri and T. Chen, Multimedia Systems, Standards, and Networks, Marcel Dekker.
5. Iain E.G. Richardson, H.264 and MPEG-4 Video Compression, John Wiley.
6. Borivoje Furht, Handbook of Multimedia Computing, CRC Press.

Computer Science & Engineering and Information Technology					
Code: IT721	**Data Mining and Data Warehousing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes

1. Establish the relation between data warehousing and data mining.
2. Able to comprehend multi-dimensional structure of data model.
3. Able to identify the need for analysis of large, complex, information-rich data sets.
4. Identify the goals and primary tasks of the data mining process.
5. Recognize the iterative character of a data process and specify its basic steps.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	1	2	3	2	-	-	-	-	-	1	-	-
CO 2												
CO3	3	3	1	-	3	3	3	2	3	-	-	2
CO4	2	3	2	-	-	-	-	-	-	-	-	1
CO5	1	2	3	-	-	-	-	-	-	-	-	-

Syllabus

MODULE 1:

Introduction :

Data warehousing-definitions and characteristics, Multi-dimensional data model, Warehouse schema.

Data Marts : Data marts, types of data marts, loading a data mart, metadata, data model. Maintenance, nature of data, software components; external data, reference data, performance issues, monitoring requirements and security in a data mart.

MODULE 2:

Online Analytical Processing: OLTP and OLAP systems, Data Modeling, LAP tools, State of the market, Arbor Essbase web, Microstrategy DSS web, Brio Technology, star schema for multi dimensional view, snowflake schema, OLAP tools.

MODULE 3:

Developing a Data Warehousing : Building of a Data Warehousing, Architectural strategies & organizational issues, design considerations, data content, distribution of data, Tools for Data Warehousing.

MODULE 4:

Data Mining : Definitions; KDD (Knowledge Discovery database) versus Data Mining; DBMS versus Data Mining, Data Mining Techniques; Issues and challenges; Applications of Data Warehousing & Data mining in Government.

Association Rules: Apriori algorithms. Partition algorithm, Dynamic itemset counting algorithm, FP- tree growth algorithm, Generalized association rule.

MODULE 5:

Clustering Techniques :Clustering paradigm, Partition algorithms, CLARA, CLARANS, Hierarchical clustering, DBSCAN, BIRCH, CURE; Categorical Clustering, STIRR, ROCK, CACTUS.

Decision Trees : Tree construction principle, Best split, Splitting indices, Splitting criteria, Decision tree construction with presorting.

MODULE 6:

Web Mining: Web content Mining; Web structure Mining; Web usage Mining; Text mining.

MODULE 7:

Temporal and Spatial Data Mining: Basic concepts of temporal data mining, The GSP algorithm, SPADE, SPIRIT, WUM.

Books

1. Data Warehousing, Reema Thareja
2. Data mining - Concepts & Techniques, Jiawei Han, Micheline Kamber, Morgan Kaufmann ,2nd Ed.2006.
3. Oracle 8i Data Warehousing, Michale Corey, Michale Abbey, Tata McGraw Hill
4. Fundamentals of Database Systems, Navathe and Elmasry, Addison Wesley, 2000
5. Data Mining, Arun Pujari Orient Longman, 2003

Computer Science & Engineering and Information Technology					
Code: IT722	**INFORMATION SECURITY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes: At the end of the course the student will be able to:

CO1	Recognize propensity of errors and remedies in processes involving information technology
CO2	Consummate knowledge of risk and controls in IT operation in industry
CO3	Determine IT security guidelines for various type of industries
CO4	Evaluate asset safeguarding, data integrity, system effectiveness and system efficiency.
CO5	Understand software security auditing including database security audit, network security audit and micro-computer security audit.

Mapping of course outcomes with program outcomes

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**
CO1		2		3		1		2	
CO2		2		3		1		2	
CO3		2		3		1		2	
CO4		2		3		1		2	
CO5		2		3		1		2	

Detailed syllabus:

Module1

Computer Auditing- System Access control, Data Access Control, Security Administration, System Design.

Module 2

Hardware Security Controls - The Total System Needs Securing, Levels of Hardware Controls, Operating System Controls , Access Controls, General-Purpose Operating Systems Security , Sources of Additional Information

Module 3

Software Controls - Software Security and Controls, Types of Software Intrusions, Configuration Management , Modularity and Encapsulation, Protecting Information, Selecting Security Software, Analysis of Software Products Database Security - Introduction to Databases, Security Requirements of Databases, Designing Database Security.

Module 4:

Methods of Protection, Security of Multilevel Databases,The Future of Databases. Network and Telecommunication Security - Telecommunications and Networks, Security Considerations, Cases in Point, Special Communications, Security Considerations.

Module 5:

Microcomputer Security - Microcomputer Problems and Solutions , The Microcomputer Environment , Security of Microcomputers, Internal Data Security, The Threats to Micros, Developing a Micro Security Plan, Establishing a Micro-to-Mainframe Link , Portable Microcomputer Security , Password Protection, Security of Special Micro Applications.

Reading:

1. Deborah Russell, *Computer Security Basics*, O'Reilly & Associate, 1991.
2. Karen A. Forcht, *Computer Security Management*, Boyd & Fraser Publishing Co., 1994.
3. Donald A. Watne, Peter B.B. Turney, *Auditing EDP Systems*, 2nd Edition, PH 1990

Computer Science & Engineering and Information Technology					
Code: CS721	**Natural Language Processing**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

Students will be able to

1. Understand approaches to syntax and semantics in NLP.
2. Understand approaches to discourse, generation, dialogue and summarization within NLP.
3. Understand current methods for statistical approaches to machine translation.
4. Understand machine learning techniques used in NLP, including hidden Markov models and probabilistic context-free grammars
5. Understand clustering and unsupervised methods, log-linear and discriminative models, and the EM algorithm as applied within NLP

Module-I

Introduction to Natural Language Processing (NLP). Sound: Biology of Speech Processing; Place and Manner of Articulation; Word Boundary Detection; Argmax based computations; HMM and Speech Recognition.

Module-II

Words and Word Forms: Morphology fundamentals; Morphological Diversity of Indian Languages; Morphology Paradigms; Finite State Machine Based Morphology; Automatic Morphology Learning; Shallow Parsing; Named Entities; Maximum Entropy Models; Random Fields.

Module-III

Structures: Theories of Parsing, Parsing Algorithms; Robust and Scalable Parsing on Noisy Text as in Web documents; Hybrid of Rule Based and Probabilistic Parsing; Scope Ambiguity and Attachment Ambiguity resolution.

Module-IV

Meaning: Lexical Knowledge Networks, Wordnet Theory; Indian Language Wordnets and Multilingual Dictionaries; Semantic Roles; Word Sense Disambiguation; WSD and Multilinguality; Metaphors; Co-references.

Module-V

Web 2.0 Applications: Sentiment Analysis; Named Entity Recognition; Text Entailment; Robust and Scalable Machine Translation; Question Answering in Multilingual Setting; Cross Lingual Information Retrieval (CLIR).

Text Books:

1. Dan Jurafsky and James Martin, “Speech and Language Processing”, 2nd Edition, Prentice Hall, 2008.
2. Andrew Radford, Martin Atkinson, David Britain, Harald Clahsen and Andrew Spencer, “Linguistics: An Introduction”, Cambridge University Press, 2009.

Reference Books:

a. Chris Manning and Hinrich Schütze, “Foundations of Statistical Natural Language Processing”, MIT Press. Cambridge, 1999.
b. Allen James, “Natural Language Understanding”, 2nd edition, Benjamin Cumming, 1995.
c. Eugene Charniack, “Statistical Language Learning”, MIT Press, 1993.
d. Steven Bird, “Natural Language Processing with Python”, 1st Edition, O'Reilly, 2009.
e. Jacob Perkins, “Python Text Processing with NLTK 2.0 Cookbook”, Packt Publishing, 2010.

Computer Science & Engineering and Information Technology					
Code: CS732	**Values and Ethics in Profession**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

CO1 Identify the effects of technological growth on the society and the limited natural resources.

CO2 Identify the essence of sustainable development, and will be able to apply approaches to handle energy crisis and environment protection.

CO3 Analyze the impact of technology transfer and the problems of man machine interaction for the human operators in engineering projects and industries.

CO4 Apply industrial standards, code of ethics and role of professional ethics in engineering field.

CO5 Assess the possible values crisis at different levels and the way out with the help of the constitution and moral, and ethical values.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
IT6105.1	-	-	2	-	-	2	3	-	-	-	-	-
IT6105.2	-	-	3	-	-	-	3	-	-	-	-	-
IT6105.3	-	-	1	-	2	-	2	2	-	-	-	-
IT6105.4	-	-	3	-	2	3	-	3	-	-	-	-
IT6105.5	-	-	1	-	2	3	-	3	-	-	-	-
Average			2		1.2	1.6	1.6	1.6				

#3 highly, #2 moderate and #1 low

Module-1

Science, Technology and Engineering as Knowledge and as Social and Professional Activities, Effects of Technological Growth: Rapid Technological growth and depletion of resources. Reports of the Club of Rome. Limits of growth; sustainable development, Energy Crisis; Renewable Energy Resources.

Module-2

Environmental degradation and pollution. Eco-friendly Technologies. Environmental Regulations. Environmental Ethics, Appropriate Technology Movement of Schumacher: later developments

Module-3

Technology and developing nations. Problems of Technology transfer. Technology assessment, impact analysis. Human Operator in Engineering projects and industries. Problems of man machine interaction. Impact of assembly line and automation. Human centered Technology.

Module-4

Ethics of Profession

Engineering profession: Ethical issues in engineering practice. Conflicts between business demands and professional ideals. Social and ethical responsibilities of Technologists. Codes of professional ethics. Whistle blowing and beyond. Case studies.

Module-5

Profession and Human Values

Value Crisis in contemporary society, Nature of values: Value Spectrum of a 'good' life, Psychological values: Integrated personality; mental health, Societal values: The modern search for a 'good' society, justice, democracy, secularism, rule of law; values in Indian Constitution, Aesthetic values: Perception and enjoyment of beauty, simplicity, clarity - Moral and ethical values: Nature of moral judgments; canons of ethics; ethics of virtue; ethics of duty; ethics of responsibility.

Suggested Text Books:

1. Stephen H Unger, Controlling Technology: Ethics and the Responsible Engineers, John Wiley & Sons, New York 1994 (2nd Edition)
2. Deborah Johnson, Ethical Issues in Engineering, Prentice Hall, Englewood Cliffs, New Jersey 1991.
3. A N Tripathi, Human values in the Engineering Profession, Monograph published by IIM, Calcutta 1996.

Suggested Reference Books:

1. Mike Martin and Ronald Schinzinger, "Ethics in Engineering", McGraw-Hill, New York, 2005.
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics Concepts and Cases", Thompson Learning, 2000.
3. Govindarajan M, Natarajan S., Senthil Kumar V. S., "Engineering Ethics", Prentice Hall of India, New Delhi 2004.
4. Charles D Fledderman, Engineering Ethics", Prentice Hall, New Mexico, 1999.
5. Edmund G Seebauer and Robert L Barry, Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
6. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, 2003.

Computer Science & Engineering and Information Technology					
Code: IT701	Software Engineering	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes:

- Ability to identify the minimum requirements for the development of application.
- Ability to develop, maintain, efficient, reliable and cost effective software solutions
- Ability to critically thinking and evaluate assumptions and arguments**.**

MODULE- I: Introduction to Software Engineering:The evolving role of software, Changing Nature of Software, legacy software, Software myths. A Generic view of process: Software engineering- A layered technology, a process framework, The Capability Maturity Model Integration (CMMI).

MODULE 2: Process patterns, process assessment, personal and team process models. Process models: The waterfall model, Incremental process models, Evolutionary process models, Specialized process models, The Unified process.

MODULE 3: Software Requirements:Functional and non-functional requirements, User requirements, System requirements, Interface specification, the software requirements document. Requirements engineering process: Feasibility studies, Requirements elicitation and analysis.

MODULE 4

Requirements validation, Requirements management. System models: Context Models, Behavioral models, Data models, Object models, structured methods.

MODULE 5: Design Engineering:Design process and Design quality, Design concepts, the design model, pattern based software design. Creating an architectural design: software architecture, Data design, Architectural styles and patterns, Architectural Design, assessing alternative architectural designs, mapping data flow into a software architecture. Modeling component-level design: Designing class-based components, conducting component-level design, object constraint language, designing conventional components. Performing User interface design: Golden rules, User interface analysis, and design, interface analysis, interface design steps, Design evaluation.

TEXT BOOKS:

- Software engineering A practitioner’s Approach, Roger S Pressman, sixth edition McGraw Hill International Edition.
- Software Engineering, Ian Sommerville, seventh edition, Pearson education.

REFERENCE BOOKS:

- Software Engineering, A Precise Approach, Pankaj Jalote, Wiley India, 2010.
- Software Engineering : A Primer, Waman S Jawadekar, Tata McGraw-Hill, 2008
- Fundamentals of Software Engineering, Rajib Mall, PHI, 2005
- Software Engineering, Principles and Practices, Deepak Jain, Oxford University Press.
- Software Engineering1: Abstraction and modeling, Diner Bjorner, Springer International edition, 2006.
- Software Engineering2: Specification of systems and languages, Diner Bjorner, Springer International edition 2006.
- Software Engineering Foundations, Yingxu Wang, Auerbach Publications, 2008.
- Software Engineering Principles and Practice, Hans Van Vliet, 3rd edition, John Wiley &Sons Ltd.
- Software Engineering 3: Domains, Requirements, and Software Design, D. Bjorner, Springer International Edition.
- Introduction to Software Engineering, R. J. Leach, CRC Press.

Computer Science & Engineering and Information Technology					
Code: CS741	**CRYPTOGRAPHY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcome:

.1 Explain the basics of network security and compare various encryption techniques.

.2 Summarize the functionality of public key cryptography

.3 Apply various message authentication functions and secure algorithms

.4 Demonstrate different types of security systems and describe different levels of security and services.

CO-PO Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
IT6103.1	-	-	-	-	2	-	-	-	-	1	-	1
IT6103.2	-	2	-	-	2	-	-	-	-	-	-	-
IT6103.3	3	2	-	-	2	1	-	-	-	-	1	-
IT6103.4	-	3	1	-	-	2	-	3	-	-	-	-
Average	0.75	1.75	0.25	0	1.5	0.75	0	0.75	0	0.25	0.25	0.25

Course Description:

MODULE 1:

Conventional Encryption and Message Confidentiality: Conventional Encryption Principles, Conventional Encryption Algorithms, Location of Encryption Devices, Key Distribution

MODULE 2:

Public key cryptography and Message Authentication: Approaches to Message Authentication, SHA-1, MD5, Public key cryptography Principles, RSA, Digital Signatures, Key Management

MODULE 3:

Network Security Applications: Kerberos Motivation, Kerberos version 4, PGP Notation, PGP Operational Description

MODULE 4:

IP Security: IP Security Overview, IP Security Architecture, Authentication Header

Web Security: Web Security Threats, Web Traffic Security Approaches, Overview of Secure Socket Layer and Transport Layer Security, Overview of Secure Electronic Transaction

MODULE 5:

Intruders and Viruses: Intruders, Intrusion Techniques, Password Protection, Password selection Strategies, Intrusion Detection, Malicious Programs**,** Nature of viruses, Types of viruses, Macro viruses, Antivirus Approaches

Firewalls: Firewall characteristics, Types of Firewalls, Firewall configuration

Suggested Text Books:

1. **"Cryptography and Network Security Principles and Practices", Fourth Edition, William Stallings. Publisher: Prentice Hall**
2. **"Cryptography And Network Security", McGraw Hill, Behrouz A *Forouzan***

<table>
<tr><td colspan="6">Computer Science & Engineering and Information Technology</td></tr>
<tr><td>Code: IT742</td><td>Knowledge Driven Development (KDD)</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td colspan="2"></td><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

Course objective:

Managing knowledge in a software project is a challenge. Waterfall methodology places emphasis on exhaustive documentation, which is difficult to be kept updated with the dynamics project delivery environment. Agile relies mostly on user stories and acceptance criteria for knowledge management which is flexible but may not be exhaustive.

KDD digitises the knowledge currently contained in the project documents into a specified number of building blocks represented in inventory relationship format. For the implementation aspects, it follows Agile way of working. By digitising knowledge, KDD brings in the next level of maturity in the project delivery that takes it closer to effective implementation of digital transformation programmes using enablers such as Machine Learning, Artificial Intelligence, Data Analytics, Cloud.

Course outcome:

After completing this course, students will acquire:

1. A general understanding of how IT projects are delivered by IT companies.
2. Details of a new project delivery methodology (Knowledge driven development – KDD) based on digitisation of project knowledge.
3. How KDD may assist Waterfall, Agile and DevOps methodologies.
4. The potential contribution of KDD in the current wave of digitisation that industry is undergoing.
5. Application of KDD in digitising domain knowledge and enterprise knowledge.

Course syllabus:

MODULE 1: Project delivery and supporting methodologies (4 hrs)

- IT Industry from technology and domain perspective
- Information technology – a knowledge-based industry
- IT project delivery – An introduction
- IT project delivery methodology landscape

MODULE 2 : Project delivery pain areas and the way forward (4 hrs)

- IT project failures
- Project delivery pain areas
- Project knowledge
-

MODULE 3. Project knowledge model – context and definition (5 hrs)

- Traditional project knowledge management
- Project delivery activities and project knowledge
- Project knowledge model – Definition
- Project knowledge model – An example

MODULE 4: Extending project knowledge model to cover end to end project delivery – KDD (10 hrs)

- KDD focus area and core value
- End to end project delivery using quality gate
- Tracking project delivery quality through Key process indicators (KPI)
- Fitment for different types of Domains and Projects
- KDD Differentiator
- Contrasting KDD with Agile and Waterfall methodologies

MODULE 5: KDD Compliance with standards of project delivery (10 hrs)

- Quality assurance framework
- Project management framework
- Service management framework
- Enterprise architecture framework
- Test management framework
- Addressing contemporary concerns of project delivery
- Assisting Waterfall, Agile and DevOps
- Positioning of KDD in the digital era

6. Global relevance of KDD (8 hrs)

- KDD and generic knowledge management framework
- Examples of generic knowledge management framework
- Generic knowledge management framework – its potential usage in skill development
- Towards another ontology framework

Recommended text-book:

Knowledge Driven Development – Bridging Waterfall and Agile Methodologies, Published jointly by Cambridge University Press and IISc Press.

References:

1. Agile Manifesto: http://agilemanifesto.org/

2. Scrum guide: https://www.scrumalliance.org/learn-about-scrum/the-scrum-guide

Computer Science & Engineering and Information Technology					
Code: PECV1	**Data Warehousing and Data Mining**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Course Outcomes

1. Establish the relation between data warehousing and data mining.
2. Able to comprehend multi-dimensional structure of data model.
3. Able to identify the need for analysis of large, complex, information-rich data sets.
4. Identify the goals and primary tasks of the data mining process.
5. Recognize the iterative character of a data process and specify its basic steps.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	P10	P11	P12
CO1	1	2	3	2	-	-	-	-	-	1	-	-
CO 2												
CO3	3	3	1	-	3	3	3	2	3	-	-	2
CO4	2	3	2	-	-	-	-	-	-	-	-	1
CO5	1	2	3	-	-	-	-	-	-	-	-	-

Syllabus

MODULE 1:

Introduction :

Data warehousing-definitions and characteristics, Multi-dimensional data model, Warehouse schema.

Data Marts : Data marts, types of data marts, loading a data mart, metadata, data model. Maintenance, nature of data, software components; external data, reference data, performance issues, monitoring requirements and security in a data mart.

MODULE 2:

Online Analytical Processing: OLTP and OLAP systems, Data Modeling, LAP tools, State of the market, Arbor Essbase web, Microstrategy DSS web, Brio Technology, star schema for multi dimensional view, snowflake schema, OLAP tools.

MODULE 3:

Developing a Data Warehousing : Building of a Data Warehousing, Architectural strategies & organizational issues, design considerations, data content, distribution of data, Tools for Data Warehousing.

MODULE 4:

Data Mining : Definitions; KDD (Knowledge Discovery database) versus Data Mining; DBMS versus Data Mining, Data Mining Techniques; Issues and challenges; Applications of Data Warehousing & Data mining in Government.

Association Rules: Apriori algorithms. Partition algorithm, Dynamic itemset counting algorithm, FP- tree growth algorithm, Generalized association rule.

MODULE 5:

Clustering Techniques :Clustering paradigm, Partition algorithms, CLARA, CLARANS, Hierarchical clustering, DBSCAN, BIRCH, CURE; Categorical Clustering, STIRR, ROCK, CACTUS.

Decision Trees : Tree construction principle, Best split, Splitting indices, Splitting criteria, Decision tree construction with presorting.

MODULE 6:

Web Mining: Web content Mining; Web structure Mining; Web usage Mining; Text mining.

MODULE 7:

Temporal and Spatial Data Mining: Basic concepts of temporal data mining, The GSP algorithm, SPADE, SPIRIT, WUM.

Books

1. Data Warehousing, Reema Thareja
2. Data mining - Concepts & Techniques, Jiawei Han, Micheline Kamber, Morgan Kaufmann ,2nd Ed.2006.
3. Oracle 8i Data Warehousing, Michale Corey, Michale Abbey, Tata McGraw Hill
4. Fundamentals of Database Systems, Navathe and Elmasry, Addison Wesley, 2000
5. Data Mining, Arun Pujari Orient Longman, 2003

Computer Science & Engineering			
CS733	**Data Mining**	**L**	**T**
		3	**0**

Course Outcomes

The students shall able to:

CO1.**Analyze** different data models used in data warehouse.
CO2. **Apply** different preprocessing techniques for different attributes.
CO3. **Determine** frequent item set using association rules.
CO4**. Apply** different classification techniques to classify the given data set.
CO5. **Analyze** different clustering techniques.

CO-PO mapping

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2			1	1	1					
CO2	3	2	2		1	1		1				1
CO3	3	2	2		1			1	1			
CO4	3	2	2		1		1		1			
CO5	3	2	2		1		1	1	1		1	1
	3	2	2		1	1	1	1	1		1	1

Module - 1

Data warehousing and online analytical processing: Data warehousing: Basic concepts, Data warehouse modeling: Data cube and OLAP, Data warehouse design and usage, Data warehouse implementation, Data generalization by attribute-oriented induction.

Module – 2

Introduction and Data Preprocessing :Why data mining, What is data mining, What kinds of data can be mined, What kinds of patterns can be mined, Which Technologies Are used, Which kinds of Applications are targeted, Major issues in data mining .Data Preprocessing: An overview, Data cleaning, Data integration, Data reduction, Data transformation and data discretization.

Module – 3

Classification: Basic Concepts: Basic Concepts, Decision tree induction, Bays Classification Methods, Rule-Based classification, Model evaluation and selection, Techniques to improve classification accuracy.

Module– 4

Mining Frequent Patterns, Associations, and Correlations: Basic Concepts and Methods: Basic Concepts, Frequent Itemset Mining Methods, Which Patterns Are Interesting?—Pattern Evaluation Methods, Pattern Mining in Multilevel, Multidimensional Space, Constraint-Based Frequent Pattern Mining.

Module – 5

Cluster Analysis: Basic concepts and methods: Cluster Analysis, Partitioning methods, Hierarchical Methods, Density-based methods, Grid-Based Methods, Evaluation of clustering.

Text Book:

1. Jiawei Han, Micheline Kamber, Jian Pei: Data Mining Concepts and Techniques, ELSEVIER (MK) 3rd edition 2012.

Reference Books:

1.Arun K Pujari: Data Mining Techniques 2nd Edition, Universities Press, 2009.
2. Jiawei Han and Micheline Kamber: Data Mining - Concepts and Techniques, 2nd Edition, Morgan Kaufmann Publisher, 2006.
3.Alex Berson and Stephen J. Smith: Data Warehousing, Data Mining, and OLAP Computing, Mc GrawHill Publisher, 1997.
4. Insight into Data Mining – Theory and Practice – K.P.Soman, Shyam Diwakar, V.Ajay, PHI, 2006.

Computer Science & Engineering			
CS713	**Human Computer Interaction**	L	T
		3	0

COURSE OUTCOMES

CO. 1: Explain the capabilities of both humans and computers from the viewpoint of human information processing.
CO. 2: Understand the design technologies for individuals and persons with disabilities
CO. 3: Analyze and Design real time application in mobile HCI and Web Interface.
CO. 4: Describe typical human–computer interaction (HCI) models and styles, as well as various historic HCI paradigms.

Module I : FOUNDATIONS OF HCI

The Human: I/O channels – Memory – Reasoning and problem solving; The computer: Devices – Memory – processing and networks; Interaction: Models – frameworks – Ergonomics – styles – elements – interactivity- Paradigms.

Module II : DESIGN & SOFTWARE PROCESS

Interactive Design basics – process – scenarios – navigation – screen design – Iteration and prototyping. HCI in software process – software life cycle – usability engineering – Prototyping in practice – design rationale. Design rules – principles, standards, guidelines, rules. Evaluation Techniques – Universal Design.

Module III : MODELS AND THEORIES

Cognitive models –Socio-Organizational issues and stake holder requirements – Communication and collaboration models-Hypertext, Multimedia and WWW.

Module IV : MOBILE HCI

Mobile Ecosystem: Platforms, Application frameworks- Types of Mobile Applications: Widgets, Applications, Games- Mobile Information Architecture, Mobile 2.0, Mobile Design: Elements of Mobile Design, Tools.

Module V : WEB INTERFACE DESIGN

Designing Web Interfaces – Drag & Drop, Direct Selection, Contextual Tools, Overlays, Inlays and Virtual Pages, Process Flow. Case Studies.

TEXT BOOKS:

- Alan Dix, Janet Finlay, Gregory Abowd, Russell Beale, "Human Computer Interaction", 3rd Edition, Pearson Education, 2004 (UNIT I , II & III)
- Brian Fling, "Mobile Design and Development", First Edition , O‟Reilly Media Inc., 2009 (UNIT –IV)
- Bill Scott and Theresa Neil, "Designing Web Interfaces", First Edition, O‟Reilly, 2009.(UNIT-V)

INFORMATION SECURITY 3 – 0 – 0 3

Course Outcomes: At the end of the course the student will be able to:

CO1	Recognize propensity of errors and remedies in processes involving information technology
CO2	Consummate knowledge of risk and controls in IT operation in industry
CO3	Determine IT security guidelines for various type of industries
CO4	Evaluate asset safeguarding, data integrity, system effectiveness and system efficiency.
CO5	Understand software security auditing including database security audit, network security audit and micro-computer security audit.

Mapping of course outcomes with program outcomes

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1		2		3		1		2	
CO2		2		3		1		2	
CO3		2		3		1		2	
CO4		2		3		1		2	
CO5		2		3		1		2	

Detailed syllabus:

Module1

Computer Auditing- System Access control, Data Access Control, Security Administration, System Design.

Module 2

Hardware Security Controls - The Total System Needs Securing, Levels of Hardware Controls, Operating System Controls , Access Controls, General-Purpose Operating Systems Security , Sources of Additional Information

Module 3

Software Controls - Software Security and Controls, Types of Software Intrusions, Configuration Management , Modularity and Encapsulation, Protecting Information, Selecting Security Software, Analysis of Software Products Database Security - Introduction to Databases, Security Requirements of Databases, Designing Database Security, Methods of Protection, Security of Multilevel Databases,The Future of Databases. Network and Telecommunication Security - Telecommunications and Networks, Security Considerations, Cases in Point, Special Communications, Security Considerations.

Module 4

Microcomputer Security - Microcomputer Problems and Solutions , The Microcomputer Environment , Security of Microcomputers, Internal Data Security, The Threats to Micros, Developing a Micro Security Plan, Establishing a Micro-to-Mainframe Link , Portable Microcomputer Security , Password Protection, Security of Special Micro Applications.

Reading:

1. Deborah Russell, *Computer Security Basics*, O'Reilly & Associate, 1991.
2. Karen A. Forcht, *Computer Security Management*, Boyd & Fraser Publishing Co., 1994.
3. Donald A. Watne, Peter B.B. Turney, *Auditing EDP Systems*, 2nd Edition, PH 1990