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B.I.T. SINDRI, DHANBAD, JHARKHAND

(Higher Technical and Skill Development, Govt. of Jharkhand)

INDUSTRIAL.LY

Newsletter- Department of Production Engineering

(NBA Accredited Programme)

2020-21

CII Confederation of Indian Industry | AMSI Additive Manufacturing Society of India | NBA National Board of Accreditation

FROM THE DIRECTOR'S DESK

DR. D.K. SINGH

I am exhilarated to present before you this laudable departmental newsletter of the Department of Production Engineering. This newsletter delineates the details of this dynamic and flourishing department of the institution.

The Department of Production Engineering, first in Asia, was started in the year 1955. The department has established links with the industries, R&D organizations, consultancy organizations and academic institutes in the region in furtherance of the cause of manufacturing engineering. The main objective of the department is integration of technology with management planning and controlling the design, development and operation of manufacturing system in accordance with recent technology.

BIT Sindri, the premiere institute of the state, has also received worldwide acclaim for imparting efficacious technical knowledge and creating the perfect blend of academic brilliance and technical prowess. The institute has made rapid strides in the path of progress and endeavours to cater to the present day needs of technical education. Recently, our faculty members added another jewel to the crown of the institute by bagging 21 projects under CRS scheme by the AICTE. May all the students prove to be valuable assets for the state and the nation and play pioneering roles in the process of their development.

FROM THE HOD'S DESK

DR. PRAKASH KUMAR

In 1955, BIT Sindri was the first to start 'The Department of Production Engineering' in Asia, an integrated B.Tech course comprising of manufacturing technology, engineering science and management science. In these 65 years, ever since it was started, our department has been consistently able to build connections with R&D organizations, consultancy corporations, several well-driven industries, and academic institutions across boundaries. The goal has always been to teach students about the smoothest, most judicial, and most economical way of production.

Production engineering encircles the application of castings, machining and joining processes, metal cutting and tool design, metrology, automation, machining and others. Well-equipped laboratories are our support system. They ensure that we deliver the best. Our collaboration with SIEMENS has paved a way to 3D printing, Advanced Manufacturing lab, Robotics Lab, Paint Shop, CNC Lathe, and several other advances, for students to learn and apply. Our department is supplemented with well qualified professors and highly cooperative staff.

Besides the lucrative academics, our students are constantly involved in research, trainings, seminars, webinars, various projects on design development and operation of manufacturing systems, which in turn ensures their all-inclusive growth. The well-built alumni base in itself validates the department's efficiency. I am delighted to present our yearly wrap up newsletter "INDUSTRIAL.LY", with an underlying desire to let people see through us and acknowledge our work.

DEPARTMENT OF PRODUCTION ENGINEERING

The Department of Production Engineering, first in Asia, was started in the year 1955. The department has established links with the industries, R&D organizations, consultancy organizations and academic institutes in the region in furtherance of the cause of manufacturing engineering. The faculty members are also actively engaged in the R & D and have large number of publications.

The main objective of Production Engineering is integration of technology with management in planning and controlling the design, development and operation of manufacturing system in accordance with recent technology. The students are trained through the program and will be well equipped with quantitative techniques of management decisions coupled with the knowledge of recent & newly developed technology, computer applications, so that they will be capable for significant contribution to industries, business and Govt. organization at all levels of decision making.

VISION

To Become a Centre of Repute Striving Continuously Towards Providing Quality Education, Research and innovation in the Field of Production and Industrial Management.

MISSION

- To provide quality education at both undergraduate and post graduate levels.
- To produce engineering graduates to meet the demands of industries and R&D organizations.
- To emphasize on integrating manufacturing technology with industrial management.
- To impart latest technological knowledge to students by continuous development of curricula and faculty.
- To contribute to the country and the society at large by enhancing the interaction between academia and industries.

PROGRAM EDUCATIONAL OBJECTIVES

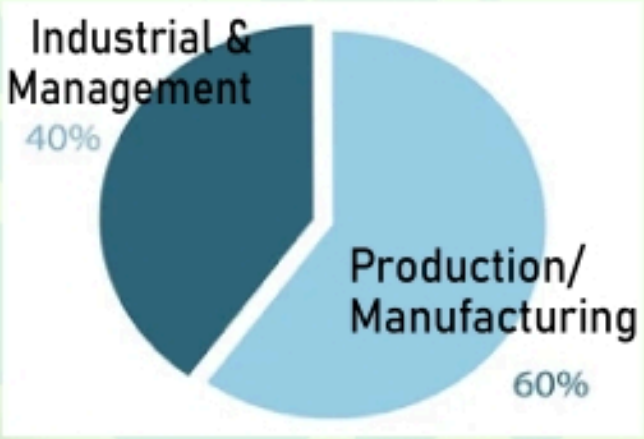
- **PE01:** To comprehend the fundamentals of production and industrial engineering to solve engineering problems.
- **PE02:** To produce skilled and competent graduates capable of facing the challenges of real business world and engineering practices.
- **PE03:** To facilitate the acquisition of essential skills such as: analysis, synthesis, problem solving and critical thinking to industrial problems.
- **PE04:** To develop an attitude for continuous learning and aspiration to excel in all endeavour.
- **PE05:** To improve interpersonal skill, team spirit and employability while believing on the ethical values.

PROGRAM SPECIFIC OBJECTIVES

- **PS01:** Graduates will be able to apply knowledge of manufacturing science and industrial engineering concepts for product, design and development.
- **PS01:** Graduates will be able to apply knowledge of manufacturing science and industrial engineering concepts for product, design and development.
- **PS03:** Graduates will be able to implement modern tools and techniques of manufacturing and industrial management to meet the challenges of real business world.

COURSE CURRICULUM/STRUCTURE

- Production Engineering is a combination of manufacturing technology with management science.
- Course deals with integrated design and efficient planning of the entire manufacturing system, which is becoming increasingly complex with the emergence of sophisticated, production methods and control systems.



INDUSTRIAL ENGG.

- Industrial Org. & Mgmt.
- Work Study & Ergonomics
- Operations Research
- Engg. Economics
- Project Engg.
- Value Engg.
- Plant Engg.
- Management Information System (MIS)
- Prod. Planning & control
- Quality & Reliability Engg.
- Maintenance Tech. & Safety Engg.

PRODUCTION/MFG. ENGG

- Casting
- Welding
- Metrology
- Metal Cutting
- Metal Forming
- Material Science
- Automation & Robotics
- Non Traditional Machining

DESIGN

- MD
- TOM
- MOS
- CAD/CAM
- Engg. Mechanics

THERMAL

- Thermodynamics
- I.C Engine

FLUID

- Fluid Mechanics
- Fluid Machinery

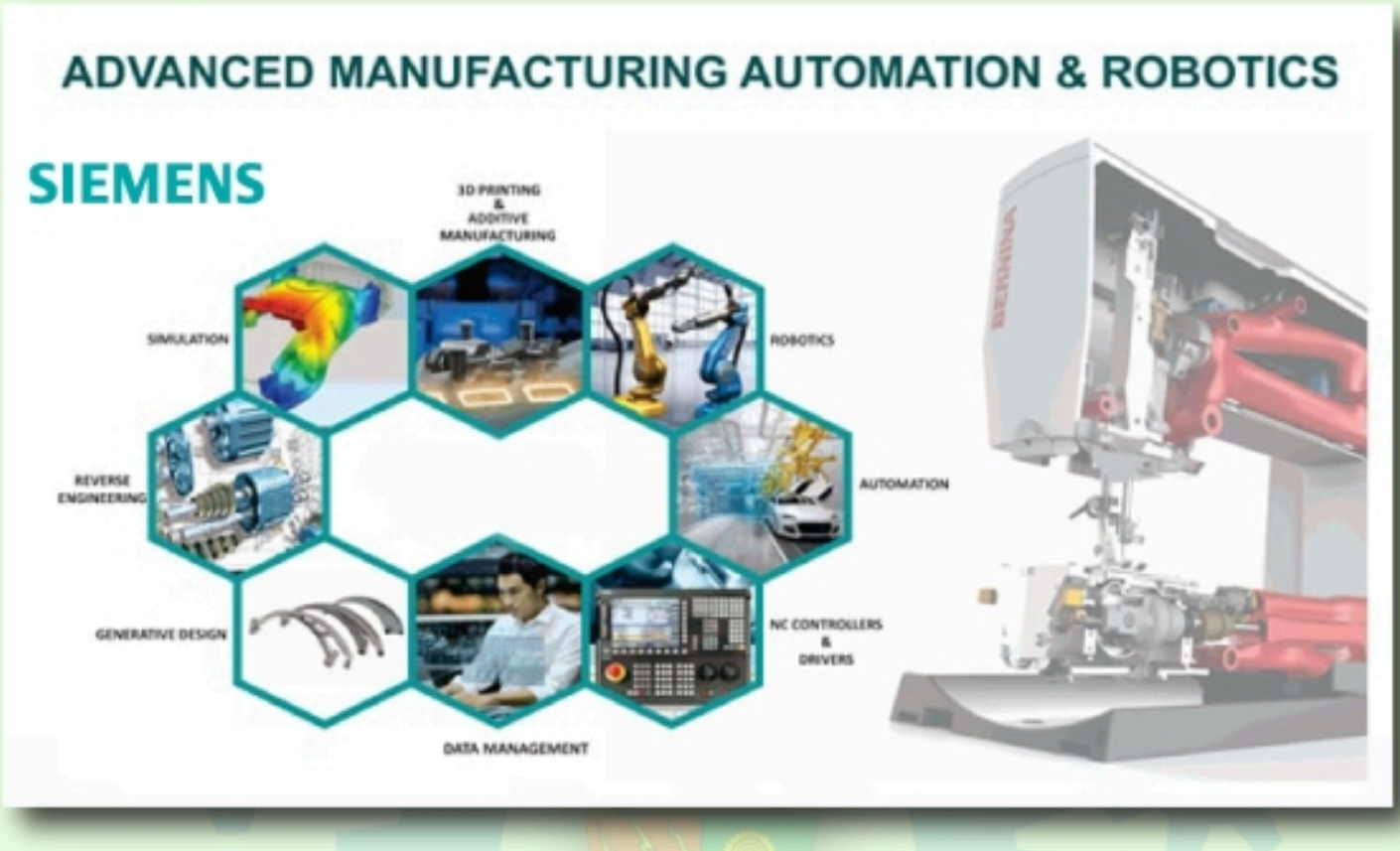
LABS/WORKSHOPS FACILITIES

The department houses over 25 different lab facilities that are equipped with the cutting-edge technology and encompasses all aspects of mechanical engineering.

- Metrology Lab
- TMCF Lab
- Ergonomics and Work Study Lab
- Welding Lab
- Production Workshop
- Tool Designing Lab
- Computer Lab (Set up by Siemens)
- CAD/CAM Lab (Set up by Siemens)
- FMS & Robotics Lab (Set up by Siemens)
- Mechanics Lab (Mechanical Engg. Dept.)

- Material Testing Lab (Mechanical Engg. Dept.)
- MOS (Mechanical Engg. Dept.)
- KOM Lab (Mechanical Engineering Dept.)
- Flui d Mechanics Lab (Mechanical Engg. Dept.)

SIEMENS, CENTRE OF EXCELLENCE



The Siemens CoE in Manufacturing, established in 2018 at B.I.T. Sindri , operates with a primary focus of creating a robust technical education eco system through its experience in industrial products and services. There are 12 sophisticated Laboratories for Design and Validation, Advanced Manufacturing, Test and Optimization , Automation, Electrical and Energy savings, Process Instrumentation, Mechatronics, CNC Machines, CNC Controller, Robotics, Rapid Prototyping and Internet of Things which provides opportunity for promising innovations. This multi faceted unique centre offers skill development courses, Internships, Research and Development assistance and Industrial consultancy services across various sectors.

COURSES UNDER CENTRE OF EXCELLENCE

Centre of Excellence (COE) is a body that provides high quality training in specific sectors with special focus on emerging technologies. It develops association between academic and industry for the benefit of skill deve lopment sector. The following relevant courses offered by COE (SIEMENS LAB.)

- NX Essential
- NX Synchronous And Advanced Modelling
- Advanced Simulation Processes And Solution
- CNC Turning
- CNC Milling
- ROBCAD Basic
- ROBCAD Advanced
- Rapid Prototyping (3D Printing)
- Basic & Advanced Robotics (Material Handling Robot, Arc Welding Robot, Spot Welding Robot)
- Vibration Measurement and Analysis
- Experimental Model Testing and Analysis

START-UP CELL

In nature every seed needs the right environment to germinate and grow. It needs proper conditions, nourishment sunlight to grow from a tiny seed to a majestic tree. In the same way every idea needs to be nurtured in the right environment to flourish and become what it can. Therefore, to provide the required conditions for the growth and development of every innovation our college has a startup cell headed by the HOD of the department of Production Engineering **Dr. Prakash Kumar**. The cell works to give wings to the new and innovative ideas of the students of BIT Sindri. It was founded in the year 2018 under the guidance of our honorable director Dr. D.K Singh and patronage of the government of Jharkhand. The start-up cell not only helps in the development but also provides initial financial backbone to the budding idea.

It paves the road from the conception to its transformation into an actual entity by providing support throughout the gruesome journey. There are many activities for the development of the student which are organized by the cell like- Workshop for the start-up activities and preparation of mini action plan to make them aware of the policies of the government of India; Entrepreneur's meet to motivate students and create dynamic, vibrant ecosystem; Motivational talks to fill young mind with enthusiasm; Hackathon and several competitions at inter and intra college levels. Our start-up cell also has a exclusive Incubation center where great minds come together to help transcend ideas into reality.

ACTIVITIES OF START UP CELL

S.No.	Event Type	Period	Topic
01	Webinar	11th Aug 2020	"Design Thinking and Artificial Intelligence"
02	Webinar	13th Aug 2020	"e-Commerce AI enabled solutions through Government e- Marketplace (GeM)"
03	Online course	10th Aug 2020 to 02nd Nov 2020	"Introduction to Entrepreneurship"
04	Webinar	27th Nov 2020	"Social Entrepreneurship"
05	Online Session	12th Dec 2020	Idea pitching Session
06	Hackathon	23rd Dec 2020 to 24th Dec 2020	The National Hardware Hackathon 2020
07	Online Session	03 Jan 2021	Start-up awareness Programme or Start-up Induction for B. Tech Batch of 2020
08	Workshop	22nd may 2021 to 24th may 2021	"project management"

Startups of our Department

Sl. No.	Name	Department	Start-up Company	Start-up Name	Start-up initiated year	Summary
1	Priyatosh Dwivedi	Production Engg.	Enmest Tradecom Pvt. Ltd	Enmest tradecom	2018	Enmest Tradecom Pvt. Ltd is a trading company dealing in International marketing.
2	Mr. Vikash Kumar Prajapati	Production Engg.	Putoos Graphics Pvt. Ltd	My Resolve	2018	My Resolve is customize bracelet making company
3	Mr. Vikash Kumar Prajapati	Production Engg.	Putoos Graphics Pvt. Ltd	Bulk Mock Up	2017	New Automation Tool for Entrepreneurs Selling T-shirts, Phone Cases, Canvas, or any other POD Products
4	Mr. Vikash Kumar Prajapati	Production Engg.	Putoos Graphics Pvt. Ltd	Putoos Graphics	2016	E-Commerce Image Editing Agency

INCUBATION CENTRE

Our premier college Birsa Institute of Technology has kick started an incubation center which is one of a kind in the entire region of Jharkhand. It was inaugurated in the year 2017 December in collaboration with Atal Bihari Vajpayee innovation lab in Ranchi under the leadership of our Head of Department of Production engineering **Dr. Prakash Kumar** and under the guidance of our honorable director **Dr D.K. Singh**. The mission is to provide an amb ient atmosphere to the students, a space to facilitate their idea and to nurture them. The incubation center will allow the students to make a prototype of their product. This facility is not only restricted to the students of BIT Sindri but students from across Jharkhand are also welcome. It is a magnificent lab of 2,500 sq ft with state of the art facilities including WiFi and 3D printers inside the IT building of our prestigious college. The prime goal of the incubation center is to provide support and assistance to the innovators both technically and financially. It serves the purpose of reducing the time from the conception of the idea to its transformation into a marketable entity. It provides funding up to 10 lakhs to the groups developing prototypes of the selected projects. Besides mentoring students on startup ideas, the cell also organizes various programs at regular intervals such as entrepreneurial conclave hosted in 2018 and many more such events.

CLUBS AND SOCIETIES

- **AIESEC**, with its motto, "Activating Youth leadership since 1948 is the world's largest youth run organisation It provides an opportunity to live a shared responsibility for the world by sending it's student members for foreign internship in countries like Ukraine, Malaysia, Egypt andVietnam.

- **Arts Club** is one of the oldest Students Cultural Society at BIT Sindri. It has a long rich tradition of Art and Culture. It provides a platform to Bitians to exhibit their hidden talents.Arts Club is quite popular in BIT due to its popular stage shows and cultural programs. It not only helps in preserving our rich art and cultural heritage, but entertains BIT during the hard and busy academic life.

- **BIT Cultural Society** is one of its own kinds, which exclusively focus on the rich cultural heritage of Jharkhand. It provides a platform to showcase the variety of cultural wealth that long lived in Jharkhand.

- **ECO CLUB** is an environment cum socio-cultural club of BIT Sindri. Main agenda of the club is to spread awareness among the people and to build a sustainable environment for living. The club runs plantation drive round the year. SMRITI TARU and GREEN MARATHON are its two main events.

- **Electrical Engineering Society-** The EES was formed in the 1970s to bridge the gap between teachers and students. Rewinding to the golden days, the ELECTRICAL ENGINEERING SOCIETY (EES) is ready to revamp, which retraces it's rooted in the 1970s. The society works towards achieving the overall objective of enhancing the knowledge and awareness in the field of Electrical Engineering through research & project based activities, meetings, discussions, and quizzes, build proper communication among the members of the Department of Electrical Engineering, develop leadership and initiative, strengthening alumni contact, and to inculcate a sense of responsibility amongst the members of the Association.

▪ **Gandhi Rachnatmak Samiti** was established on 2nd October in 1969,on the occasion of Gandhi Jayanti by the Director and professors of B.I.T Sindri. Since then this club works on the ideology of Mahatma Gandhi in the direction of mutual benefit of the society.In the present scenario,it has evolved into a Social-cum-Technical-cum-Cultural-cum-Political club. It is the oldest clubs of B.I.T Sindri and owns a separate library under its belt.

▪ **Hackathon and Coding Club, BIT Sindri** is the official coding club of the college. It was started in 2018 to improve the coding culture of the institute and help the students to start and excel in coding activities. The team has grown considerably in the past years and has helped many students in coding. HnCC has also organised a national level hackathon "Hackatron", many coding contests, and community events by calling various speakers.

▪ **IETE** provides leadership in Scientific and Technical areas of direct importance to the national development and economy. Government of India has recognized IETE as a Scientific and Industrial Research Organization (SIRO) and also notified as an educational Institution of national eminence. The objectives of IETE focus on advancing electrotechnology. The IETE conducts and sponsors technical meetings, conferences, symposia, and exhibitions all over India, publishes technical journals and provides continuing education as well as career advancement opportunities to its members.

▪ **ISTE** Students' Chapter B.I.T Sindri is a technical club in B.I.T Sindri. With the motto of technical development, ISTE Students' Chapter focuses on the personality devlopment and enhancement of technical skills of students in B.I.T Sindri. ISTE Students' Chapter B.I.T Sindri conducts many events , seminars , guest lectures , workshops throughout the year and last but not the least ISTE organizes the official techfest "TRIVENI" where budding engineers from different colleges participate to prove their might.

▪ **LEO CLUB of BIT Sindri**: LEO stands for LEADERSHIP EXPERIENCE OPPORTUNITY. LEO Club is the youth wing of LIONS International. Its objective is to provide citizen of the world for development and contribution, both individually and collectively as responsible member of local, national and International community. The club holds an august position in the campus and is best known for its energetic and versatile members who are endowed with austeridiocyncrasy and burnished personality under the guidance of Prof Dr. Amar kumar. LEO Club is a socio-cultural club. On the cultural front,it organizes Fresher Of the Year Contest and BITAANSH, which are the most awaited events of the college and on social front, it organizes book- drive and blood donation camps.

▪ **Literary Society** is the cultural-cum-literary club of the college. Literary Society stands as a platform for students to express their opinions and thoughts about various aspects. The club works for the overall development of the students through various activities conducted. Development of speaking, reading and listening skills among the students, which in turn help in personality development, has always been the idea behind the establishment of the club.

▪ **Model Club** is an attempt to manifest the technical mindset, personality development and success stories of this premier technical institution of Jharkhand. This club is the only technical club established by the BIT administration in the year 1976 with the leadership of wing commander Gyaneshwar Singh and his able team for conducting technical activities for the young technocrats of BIT Sindri. After its establishment, the club has always been on an ascent to scaling new heights every year by organizing various technical events. Since then, Model Club is an organization that is inherently associated with diffusion of science and technology in would-be technocrats..

▪ **Mechanical Engineering Society** of BIT Sindri provides the industrial exposure to find real-world applications of concepts, and at the same time also provides a platform to showcase and enhance the management skills of its members. The Mechanical Engineering Society aims to bring holistic development of students by gentle manifestation of the mind, and thereby the development of placement scenario. It is working to provide all-around development of the department in the field of research and training. It bridges the gap between department and industry and thereby ushering in the new era of the essence. It is to establish a strong foundation between the alumni and the department for all-around holistic development.

▪ **Painting Wing-** Engineers at BIT Sindri have got several platforms and mediums to exhibit their art, creativity and talent. Painting Wing is one of such platforms. It is a group of young painting artists among BIT students. Painting wing organizes exhibitions, Rangoli competitions, T-shirt painting competitions, Pottery painting competitions etc.

▪ **Photographic Club** is a platform that helps students to exhibit their art, creativity and talent. The members of the club manifest their creativity via shooting through camera. Photographic Club is a group of young photographers among BIT students. At photographic club, they share their common hobby and interest. Here they can learn fundamentals of professional and art of photography.

▪ **PRAYAAS INDIA** is a Non-Governmental Organization providing free and high-quality education to underprivileged children living in slums and villages near college campus. The whole management of the organization is handled by college students. Presently more than 800 children are getting free education. Apart from two-hours evening classes, meritorious students of Prayaas India are admitted in good private schools for formal education. Prayaas is a charitable organization in the service of underprivileged and poor children.

▪ **Rotaract Club of Sindri** is the youth wing of Rotary International aimed at organizing various socio-cultural events and developing managerial skills. The moto of the club is to provide an opportunity for young men and women to enhance the knowledge and skills that will assist them in personal development, to address the physical and social needs of their communities, and to promote better relations between all people worldwide through a framework of friendship and service.

▪ **SAE India** is an affiliate society of SAE international, Registered as an Indian non profit engineering and scientific society dedicated to the advancement of mobility practitioners, SAEINDIA comprises members who are individuals from the mobility community, which includes engineers, executives from industry, government officials, academics and students. Events- BAJA SAE INDIA, SUPRA SAE INDIA, EFFI CYCLE, AERO DESIGN and ECO KART

▪ **Sarjana**, derived from the Sanskrit word "Srijan" meaning "to create", describes the college representative magazine of BIT Sindri. Being the Editorial Board and the Student Media Body of the college, it provides all the stakeholders of BIT an opportunity to display their skills and talent through its various platforms. It covers the various events and happenings on the campus and keeps the student fraternity updated with the current activities.

▪ **Sports club** of BIT Sindri ensures the physical well being of Bitians. It accomodates profilic range of co-curricular activities as part of our daily routine. The prestigious club was established in late 80's. The Sports club of BIT Sindri focuses on how to promote and develop interest in a particular Sport or physical activities. Sports build a spirit of healthy rivalry, true sportsmanship and personality development in everyone whether it's a casual face-off between friends, intra-college championship or inter-college tournaments on a grand scale. Students of BIT sindri have proved their worth in sports time and again.

TRAINING AND PLACEMENT CELL

The Department of Training and Placement is the marketing division of the institute. Over the years, the department acting as an interface between institute and companies, has maintained symbiotic, vibrant and purposeful relationship with industries across the countries. Here are the TAP Coordinators of our branch from the year 2K20-21.

ARON JOHN LAKRA
Production Engineering
2K17

AYUSH KUMAR
Production Engineering
2K17

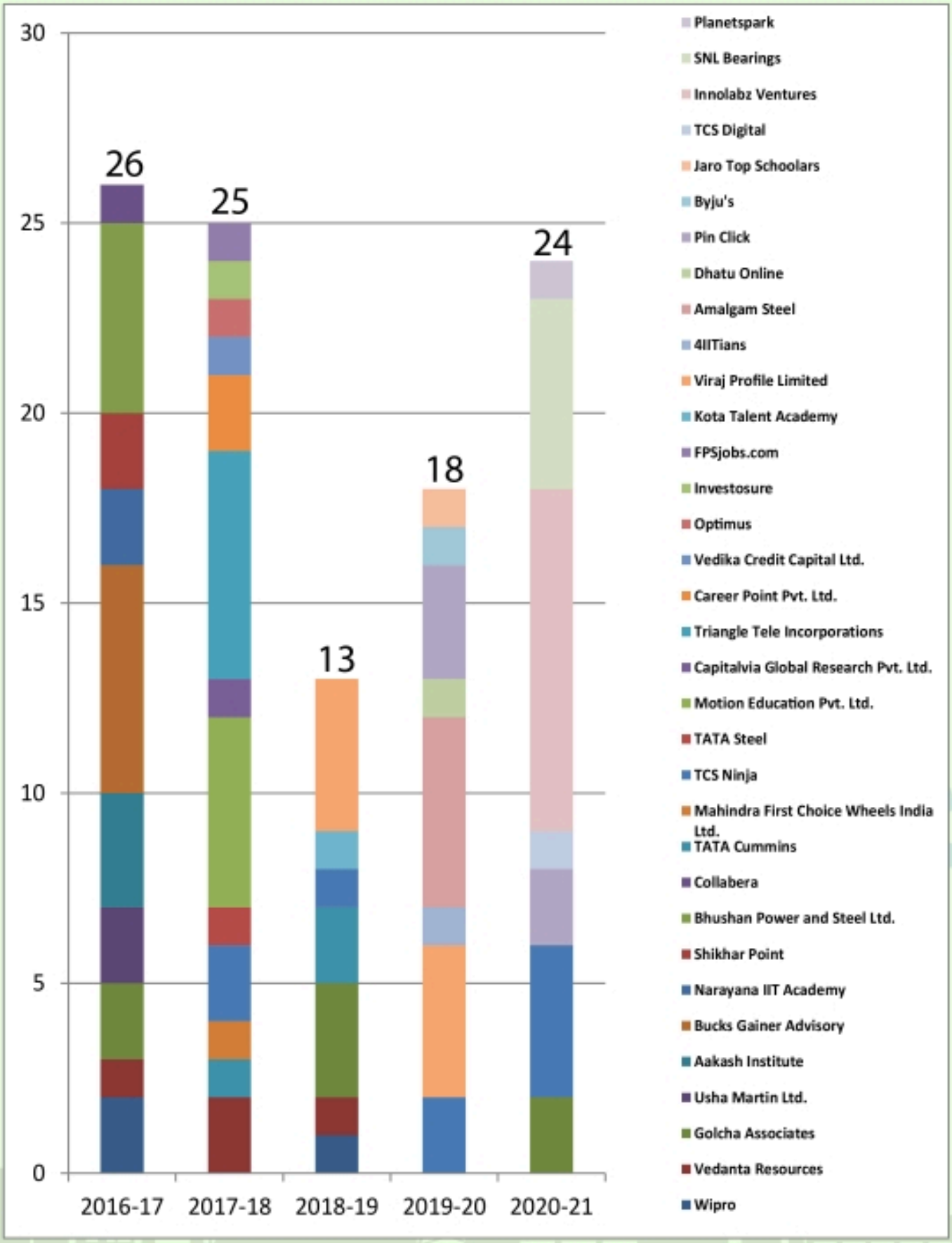
RIYA KUMARI
Production Engineering
2K17

SUNNY KESHRI
Production Engineering
2K17

PLACEMENT RECORD
(Session 2017-21)

NAMES	FIRM NAME
Arkodeep Mukherjee	TCS Ninja
Kunal Kumar	TCS Ninja
Saurav Kumar	TCS Ninja
Shubham Kumar	TCS Ninja
Yogesh Kumar	TCS Digital
Ayush Kumar	PlanetSpark
Alka Tirkey	Innolabz Ventures
Aashish Kumar	Innolabz Ventures
Sunny Keshri	Innolabz Ventures
Shubham Raj	Innolabz Ventures
Hemsagar Hembrom	Innolabz Ventures
Varun Vohra	Innolabz Ventures
Aron John Lakra	Innolabz Ventures
Ankit Kumar Rajak	Innolabz Ventures
Deepak Kumar Dubey	Innolabz Ventures
Ayush Kumar	SNL Bearings
Sunny Keshri	SNL Bearings
Kalisharan Kr Yadav	SNL Bearings
Shashi Bhushan Biruli	SNL Bearings
Shubham Sinha	SNL Bearings
Riya Kumari	Viraj Profiles Ltd.
Shalini Singh	Viraj Profiles Ltd.
Aron John Lakra	Usha Martin
Banti Kumar Singh	Usha Martin

PLACEMENT DETAILS



ACHIEVEMENTS OF THE DEPARTMENT

1. In the 2nd edition of Innovative Product Design and Intelligent Manufacturing Systems, paper titled as "MCDM Optimization of Characteristics in Resistance Spot Welding for Dissimilar Materials Utilizing Advanced Hybrid Taguchi Method Coupled CoCoSo, EDAS and WAPAS Method" authored by **Dr. Surya Narayan Panda** and his team mates, got selected as Most Distinguished Paper at the national conference, held on 12th and 13th February 2021, jointly organized by Dept. Of Industrial Design and Dept. Of Mechanical Engg. Of NIT, Rourkela.

2. In an inaugural virtual conference of Innovative Manufacturing, Mechatronics & Materials Forum 2020 (iM3F 2020) organised by the Faculty of Manufacturing and Mechatronic Engineering Technology, Universiti Malaysia Pahang (UMP), on 06th August 2020, paper titled as "Development of self-lubricating ceramic composite and evaluation of mechanical and tribological properties" authored by **Mr. Anand Kumar** and his team mates, got certificate of recognition.

3. **Dr. Prakash Kumar** acted as a Coordinator in the webinar on Quality Concepts (QC, Kaizen, 5S, SPC & Six Sigma) organized by Department of Production Engineering, BIT Sindri in collaboration with QCFI, Rourkela Chapter from 5th June 2020 to 9th June 2020.

4. **Dr. Prakash Kumar** acted as a Chairperson and Chief Key Note Speaker in the 2nd edition of International Webinar/FDP on Blockchain Technology and Management in Covid-19, organized by Department of Master of Business Administration and Internal Quality Assurance Cell (IQAC) GGSESTC, Bokaro Steel City and in Association with Block Chain and Block Edu, Kolkata India.

5. In the last year Production Engineering Department has successfully organized series of webinars and workshops on variety of industrial topics, in order to keep the students updated and industrial trends and newfangled concepts of the industry.

6. **Dr. Surya Narayan Panda** has been reviewer for journal "Mechanism and Machine Theory-Elsevier".

7. **Dr. Sumanta Mukherjee** has presented an invited lecture on 3D Printing of Assistive Devices at IIT Kharagpur.

8. **Dr. Surya Narayan Panda** has been invited as keynote speaker in "Advances in Mechanical Engineering" at GCE, Keonjhar, Odisha.

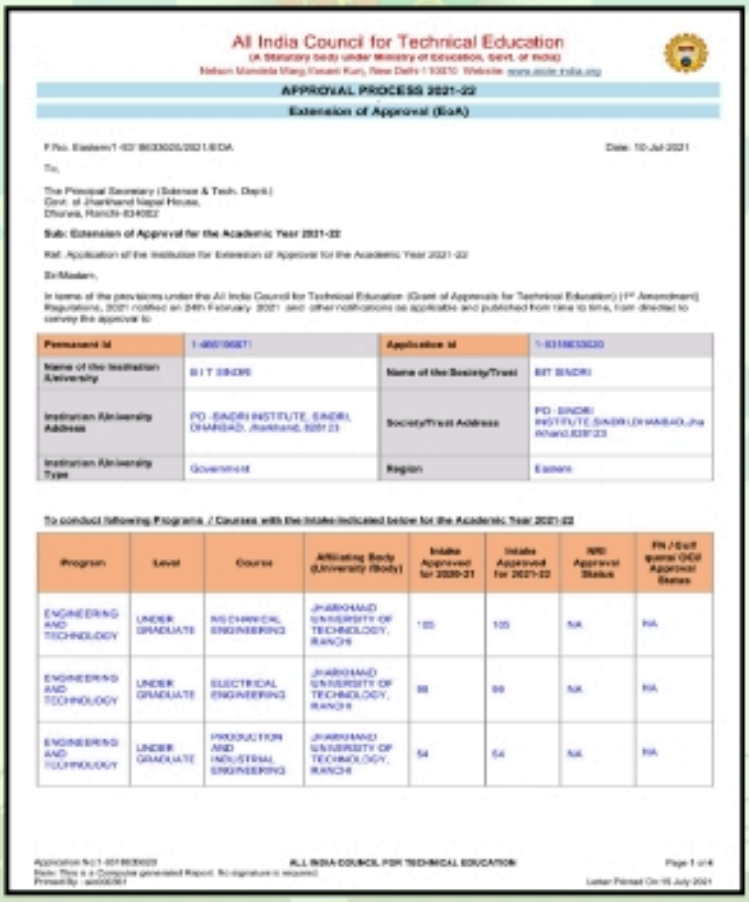
9. Under the able guidance of Director **Dr. D.K. Singh sir**, and respected HOD **Dr. Prakash kumar**, the NBA team accredited the Production engineering department with its validity extending till the academic year 2022- 2023 i.e. upto 30-06-2023.

PREFERMENT

The ongoing pandemic couldn't dampen our spirits and our department continued on its quest to reach some glorious milestones.

It was only due to the consistent and tireless efforts of our HOD, Dr. Prakash Kumar and our dedicated faculty that after a long-winded procedure the name of the branch got changed from "Production Engineering" to "**Production and Industrial Engineering**". This would surely benefit the students of our branch in availing different opportunities during placement interviews of reputed organizations. It would also be beneficial for students aspiring for higher education in esteemed institutions of the nation as well as abroad.

The department would continue to strive for the betterment of its students and to add more precious jewels to the crown of BIT Sindri.



All India Council for Technical Education

(A Statutory body under Ministry of Education, Govt. of India)

Nelson Mandela Marg,Vasant Kunj, New Delhi-110070 Website: www.aicte-india.org

APPROVAL PROCESS 2021-22

Extension of Approval (EoA)

F.No. Eastern/1-/EOA/2021 Date: 10-Jul-2021

To,

The Principal Secretary (Science & Tech. Dept.)
Govt. of Jharkhand Nepal House,
Dhurwa, Ranchi-834002

Sub: Extension of Approval for the Academic Year 2021-22

Ref: Application of the Institution for Extension of Approval for the Academic Year 2021-22

Sir/Madam,

In terms of the provisions under the All India Council for Technical Education (Grant of Approvals for Technical Education) (1st Amendment) Regulations, 2021 notified on 24th February 2021 and other notifications as applicable and published from time to time, I am directed to convey the approval to

Permanent Id	1-4807/0871	**Application Id**	1-8318633820
Name of the Institution /University	B I T SINDRI	**Name of the Society/Trust**	BIT SINDRI
Institution /University Address	PO -SINDRI INSTITUTE, SINDRI, DHANBAD, Jharkhand, 828123	**Society/Trust Address**	PO - SINDRI INSTITUTE,SINDRI,DHANBAD,Jharkhand,828123
Institution /University Type	Government	**Region**	Eastern

To conduct following Programs / Courses with the Intake indicated below for the Academic Year 2021-22

Program	Level	Course	Affiliating Body (University /Body)	Intake Approved for 2020-21	Intake Approved for 2021-22	NRI Approval Status	FN / Gulf quota/ OCI/ Approval Status
ENGINEERING AND TECHNOLOGY	UNDER GRADUATE	MECHANICAL ENGINEERING	JHARKHAND UNIVERSITY OF TECHNOLOGY, RANCHI	120	120	NA	NA
ENGINEERING AND TECHNOLOGY	UNDER GRADUATE	ELECTRICAL ENGINEERING	JHARKHAND UNIVERSITY OF TECHNOLOGY, RANCHI	60	60	NA	NA
ENGINEERING AND TECHNOLOGY	UNDER GRADUATE	PRODUCTION AND INDUSTRIAL ENGINEERING	JHARKHAND UNIVERSITY OF TECHNOLOGY, RANCHI	54	54	NA	NA

Application No:1-8318633820 ALL INDIA COUNCIL FOR TECHNICAL EDUCATION Page 1 of 4

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Printed By : ad00081 Letter Printed On:15 July 2021

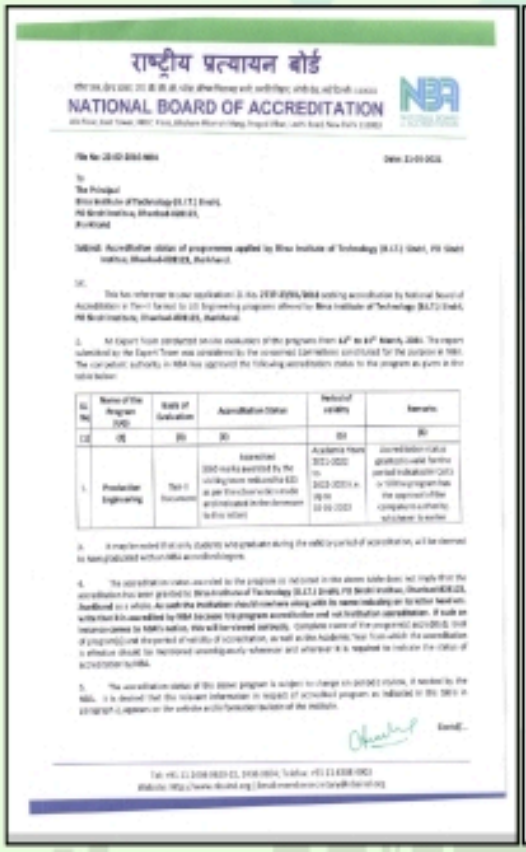
NBA ACCREDITATION

The entire world was taken aback by the emergence of the novel corona virus, COVID-19. With an unprecedented rate of spread, this virus put the world to a halt and made the mighty nations make some calculated and significant choices. BIT SINDRI was also affected by the nation-wide impact of virus and had to make unforeseen changes in its mode of functioning. However, despite its constraints and limitations, the Institute joined hands with the nation in withstanding the crisis through various techniques and modifications in its respective departments. The Production engineering department instrumentalised its labs, knowledge and various trainings to orient itself as an asset in tackling this major crisis.

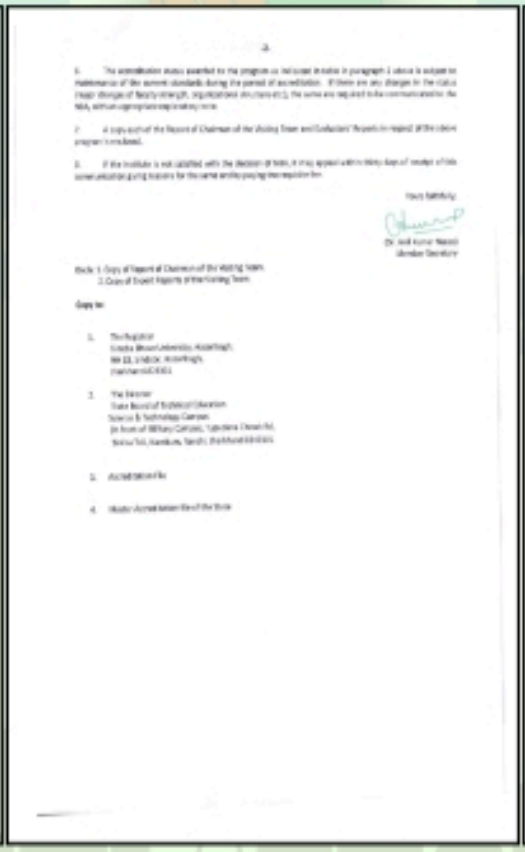
An expert team conducted on- site evaluation of the programs from 12th to 14th March 2021. The report submitted by the Expert team was considered by the concerned committees constituted for NBA.

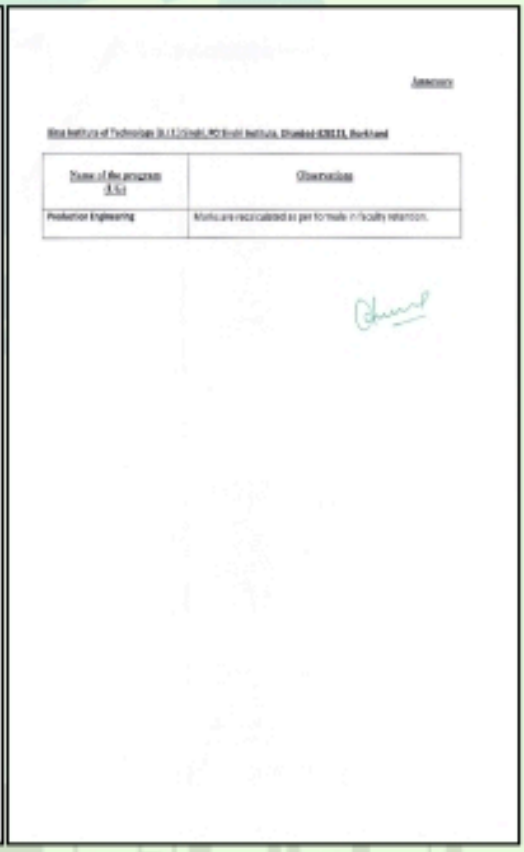
As we all know that 'success is the sum total of small efforts, repeated day in - day out' , it proved to be very very apt for the department. Under the able guidance of Director **Dr. D.K. Singh**, and respected HOD **Dr. Prakash kumar**, the NBA team accredited the Production engineering department with its validity extending till the academic year 2022- 2023 i.e. upto 30-06-2023 .

With its consistent efforts, highly determined faculty and diligent students the department aims to land off at a yet higher range in terms of technological development, R&D and placement records.


राष्ट्रीय प्रत्यायन बोर्ड

NATIONAL BOARD OF ACCREDITATION





SEMINARS, WORKSHOPS, AND FDP ORGANIZED

In order to keep the students updated with the latest industrial trends and newfangled concepts of the industry, a series of webinars were conducted by the department. The talks were focused on contemporary topics like Quality Concepts, Design Thinking and Industry Focused AI, e-Commerce Solutions through Government e-Marketplace (GeM), IoT and Its Application in Process Industries, Operations and Scheduling Aspect of Flexible Manufacturing System (FMS) and Open-Die Forging of Metal Matrix Composites: FEM Simulation Analysis.

With the aim to equip the minds of students with qualities like critical questioning, innovation, service and continuous improvement, BIT Sindri in collaboration with Alumni Association of North America (BITSAANA) organized Online Sessions on "Entrepreneurship" by Prof. Rajen Jaswa, Serial Entrepreneur & Adjunct Professor of IIT Bombay. Continuing with the endeavor to get the students acquainted with the intricate and subtle concepts of entrepreneurship, Production Engineering Department and Entrepreneurial Cell, BIT Sindri in association with IIT Bombay launched a Structured Course: Introduction to Entrepreneurship. This was followed by another structured course: Technical Venture Creation.

Of late, an online workshop on Project Management was conducted by Production Engineering Department & E-Cell of BIT Sindri in collaboration with Alumni Association of North America (BITSAANA)

More of such events would be conducted by the department in the near future, so that students are not deprived of the opportunity to interact with leading academicians and industry experts due to the prevelant pandemic situation.

SEMINARS, WORKSHOPS, AND FDP ORGANIZED

S.No.	National or International	Department	Workshop/ Seminar/ FDP	Period	Topic
01.	National	**Department of Production Engineering, BIT Sindri** in Collaboration with QCFI, Rourkela Chapter	Webinar	5th June 2020 to 9th June 2020	Webinar on "Quality Concepts (QC, Kaizen, 5S, SPC & Six Sigma)"
02.	National	**Production Engineering Department and Entrepreneurial Cell, BIT Sindri**	Webinar	11th August 2020	Webinar on "Design Thinking and Industry Focused AI"
03.	National	**Production Engineering Department and Entrepreneurial Cell, BIT Sindri**	Webinar	13th August 2020	Webinar on "e-Commerce Solutions through Government e-Marketplace (GeM)"
04.	National	**Production Engineering Department, BIT Sindri**	Webinar	20th August 2020	Webinar on "IoT and Its Application in Process Industries"
05.	National	**Production Engineering Department, BIT Sindri**	Webinar	7th September 2020	Webinar on "Operations and Scheduling Aspect of Flexible Manufacturing System (FMS)"
06.	National	**Production Engineering Department, BIT Sindri**	Webinar	12th September 2020	Webinar on "Open-Die Forging of Metal Matrix Composites: FEM Simulation Analysis "
07.	National	**IIT Bombay in association with Production Engineering Department and Entrepreneurial Cell, BIT Sindri**	Structured Course of IIT Bombay	10th August 2020 to 2nd November 2020	Structured Course: Introduction to Entrepreneurship (ENT 201/603)

08.	National	**IIT Bombay in association with Production Engineering Department and Entrepreneurial Cell, BIT Sindri**	Structured Course of IIT Bombay	11th Jan 2021 to 30th April 2021	Structured Course: Technical Venture Creation (ENT 208/602)
09.	International	**Production Engineering Department & E-Cell of BIT Sindri and in collaboration with Alumni Association of North America (BITSAANA)**	Workshop	22nd to 24th May 2021	Online Workshop on Project Management
10.	National	**Production Engineering Department, BIT Sindri**	Workshop	5th to 9th July 2021	e-Workshop on "Emerging Manufacturing Technologies & Strategies (EMTS-2021)"
11.	National	**Production Engineering Department and Start-up Cell (IIC 3.0), BIT Sindri**	Webinar	16th July 2021	Webinar on "Electric Vehicles- Automotive trends in transformation from ICE car towards electrical"

RESEARCH PROJECTS UNDERGOING

S. No.	Professor	Research Topic
01	Mr. Mukesh Chandra	Design & Development of a Proof-of-Concept Model of a Doubly Curved Membrane based Space Structure
02	Dr. Sumanta Mukherjee	Development of 3D Printed User- specific Assistive Devices for Persons with Disabilities in India
03	Dr. Surya Narayan Panda	Investigation to fatigue and vibration characteristics of Rolling Element Bearing
04	Mr. Kashif Hasan Kazmi	Optimization Technique for smooth supply chains of medical equipment and essential medicine during COVID-19 pandemic

TECHNICAL REPORT

Model Based Fuzzy Logic Approach for Optimal Maintenance of Mine Hydraulic Excavators

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Professor & Head,
Production Engineering Department
BIT Sindri

Abstract: Diagnostic problems in mining equipment are considered as ill-structured problems for which effective algorithmic results are not possible due to lack of unknown nature of failures. The effectiveness of detecting faults lies in the ability to extrapolate using a variety of information source and knowledge pool, connecting between different structures to reach the appropriate solutions. Most of the maintenance models focus on equipment failure in terms of sudden stoppage. Majority of the maintenance optimization models are, in general, considers a fixed value of the cost of breakdown maintenance. But, the cost of breakdown maintenance not only includes down time losses and repair/replacement cost, but may also include various indirect cost. Early detection of failure modes represents the most effective way to reduce the chances of equipment failure but the existing Indian scenario in terms of machine maintenance reveals the predominance of breakdown maintenance culture in the coal mining industries in particular and industries involving heavy duty earth moving machinery in general. Many researchers worked in the area of cost optimization in mining operation through artificial intelligence technique. Advanced fault diagnosis methods have also been used in various research works such as model-based approaches, knowledge based approaches, qualitative simulation, neural network, genetic algorithm and classical multivariate statistical techniques. Although, extensive data base are available regarding maintenance and its methodology but no suitable maintenance methodology is yet available for specific mining machinery including excavators. The purpose of this paper is to develop a strategy for maintenance of various heavy duty earth moving mining excavators. These excavators are finding increasing applications in mining operations. The maintenance system is used to assess the potential failure and give a probable solution. This paper aims to develop a fuzzy logic based inference system that diagnose the fault causes quickly and displays measures to correct them.

I. INTRODUCTION :

The existing Indian scenario in terms of machine maintenance reveals the predominance of breakdown maintenance culture in the coal industries in particular and industries involving heavy earth moving machinery in general. Considering the high capital cost and limited life of the main excavators, breakdown maintenance is not a right approach wherein a machine is attended for maintenance only after a component or a sub system breaks. For complex configuration of mining excavator, there are various types and different forms of failure. It is difficult to precisely diagnose various faults using a single demarcation process, because of their complex structure (such as mechanical, hydraulic, electrical and electronic subsystems) and having strong interaction and juncture. For the development Fuzzy System, the standardization of the failure codes were classified. The critical components were identified. Analyses were done through of the failure history analysis, maintenance manuals, and the expert knowledge. The rule

base (fuzzy logic based inference system) has been constructed in order to develop decision support system to operational maintainability.

II. MAINTENANCE OPTIMIZATION MODELS (FOR FUZZY LOGIC BASED INFERENCE SYSTEM)

A. Model No 1. (For type "0" maintenance strategy)

a. Introduction

In order to reduce the number of breakdowns, periodically inspection of equipment and rectification of any minor defects, which is eventually cause complete breakdown, can be done. These inspection cost money in terms of materials, wages, and loss of production due to scheduled downtime.

Therefore, it is to determine an inspection policy which will give the resulting output such that the profit per unit time from the equipment is maximized over a long period.

b. Construction of Model – Assumptions

- Equipment failure occurs according to the negative exponential distribution with mean time to failure (MTTF) – $1/\lambda$, where λ is mean arrival rate of failure.
- Repair times are negative exponentially distributed with mean time $1/\mu$.
- Inspection times are negative exponentially distributed with mean time 1/I, and number of inspection would be n.
- V is the profit value if there are no downtime losses.
- The average cost of repair per uninterrupted unit of time R
- The breakdown rate of the equipment λ is a function of n, the frequency of inspection. That is the breakdowns can be reduced by number of inspection, therefore, $\lambda = \lambda(n)$
- $\lambda(0)$ = breakdown rate if no inspection are made.
- $\lambda(1)$ = breakdown rate if one (1) inspection is made.
- The objective is to choose n in order to maximize the expected profit per unit time from operating the equipment.

$$P(n) = V - [V \times (\lambda(n) / \mu)] - [V \times (n/i)] - R[\lambda(n)/\mu] - I(n/i)$$

The above equation is the objective function of this model.

B. Model No 2. (For Type "1" Maintenance Strategy)

a. Introduction

When production equipment fails or it's overhauled, the cost that the company pays may be classified in two categories. In first category, we consider the intervention cost which includes labour and materials. In second category, it is included downtime costs, such as reconfiguring alternative production lines, using less efficient methods, reduced product quality, lost raw material, and so on. Quantifying intervention costs is quite easier. On the other hand, non intervention cost is difficult to measure because it included downtime cost. The sum of both intervention and non intervention define the global cost, which is a very critical indicator to measure the maintenance management strategies.

b. Construction of Model – Assumptions

The following assumptions are made:

1. Corrective actions are minimal.
2. Preventive actions are applied at equal time intervals Ts.
3. Opportunistic maintenance practices may be disregarded due to lack of scale economies with grouped maintenance actions.
4. Life cycle duration is equivalent to an integer n, where n is the number of periods between two overhauls. That is T1 = nTs. Consequently, there are n-1 overhauls during a lifecycle.
5. Intervention costs depend on the time interval required to perform the activities. They correspond to piecewise linear functions. Each segment is determined by T'_{rj}

and costs $C^l_{i,j}$ and $C^r_{i,j}$ on the left and right side of segment of j.

1. Overall replacement cost corresponds to $C_{R;g} = C_{R;l} + C_{R;d}$
2. The objective is to minimize the expected overall cost in order to determine the overhaul frequency and routine maintenance time. The choice is justified as it is the only one that specially measures the effects of downtime costs.

Another objective for similar problem includes, among others:

To maximize availability: this criterion is applicable when downtime costs are much larger than direct costs. It pertains while considering major critical components/equipment.

To minimize intervention costs: once availability is modelled, intervention costs are estimated for fixing a budget. This condition does not take into account the nonintervention costs. In order to this, it is necessary to add a minimum availability constraint specifically. This would be achieved imposing a minimum availability constraint.

Setting up overall cost rate as prime objective comes from the identification of non-intervention costs, which may be difficult to estimate. The amount of information needed to use this objective is much larger than using others. Acquiring the required data from the system of information could be costly and difficult too. The expected global cost per unit time for this model may be expressed as follows:

$$c_g(T_s, T_o, T_r, n) = [n_r(nT_s)(C_{c,d}+C_{c,i})+(n-1)(C_{o,d}+C_{o,i})+C_{R,g}]/ nT_s$$

The above equation is the objective function of this model.

C. Model No-3 (For Type "2" Maintenance Strategy)

Reliability is an index representing the system performance. For a system, the reliability normally reduces depending on the increase in service time of the system. To maintain the expected performance of a system, taking correct maintenance during its entire life cycle is necessary. Corrective maintenance (CM) is usually categorized into minimal repair (1C) and corrective replacement (2C). 1C maintenance makes no change in system time and restores the system reliability to it had failed. 2C maintenance renews the system time to zero to the new reliability curve of the system. Preventive maintenance activities are also grouped into simple preventive maintenance (1P) and preventive replacement (2P). 1P maintenance, like lubricating, cleaning, calibrating, tightening, simple repair etc., changes the reliability of the system to its newer state. 2P maintenance means corrective replacement policy to renew the reliability curve to new one, but occurs in the system state. 2P action is taken after a several time of 1P action. While planning the preventive maintenance policy, frequently it is faced the problem in determining the right conditions for preventive maintenance or preventive replacement. To solve the problem, the unit cost life of system is used as an index for deciding the combination of activities at each preventive maintenance stage. Preventive maintenance scheduling is the next stage if the maximum unit cost life of the system at this stage is smaller than its discarded life.

$$B_{mj} = [l_p + T_{j+1}] / [C_{jo} + C_{rj} + C_{rn}]$$

For evaluating the unit-cost life of the system, the maintenance cost and the extended life of the system need to be investigated. Considering the corrective maintenance cost in the j-th PM stage, C_{rj} is defined as

$$C_{rj} = C_o \left(\int_{tj-1}^{tj} \lambda(t)dt + \Sigma_{i=1}^{n} \int_{tj-1}^{tj} h_{ij}(t)dt\right)$$

The above equation is the objective function of this model.

III. CRITICALITY ANALYSIS AND MAINTENANCE STRATEGY FOR FUZZIFICATION

A. Criticality Analysis of Equipment:

a. Safety
b. Machine importance for the process
c. Maintenance costs
d. Failure frequency
e. Downtime length
f. Access difficulty

B. Weight values assigned to the relevant parameters

considered in FMECA analysis – Weight of parameter

a. Safety – 1.5
b. Machine importance for the process – 3
c. Maintenance costs – 2
d. Failure frequency – 1.5
e. Downtime length – 1
f. Access difficulty & operating condition – 1

The factors taken into account are grouped together in following criticality index (C.I), C.I = (S x Weight Value of Safety) + (IP x Weight value of machine importance) + (MC x Weight value of maintenance costs) + (FF X Weight value of failure frequency) + (DL x Weight Value of downtime length) + (AD x Weight Value of access difficulty).

Where S = safety, IP = importance of machine for the process, MC = maintenance costs, FF = failure frequency, DL = downtime length, AD = machine access difficulty A rational qualification of six factors has been defined and based on a set of tables. In exacting, every applicable factor is divided into several classes that are assigned a different score (in the range from 1 to 100) to take account the different criticality levels.

Scale:

(This parameter is subjective type and the ratings were done
after consulting different experts):-

C. Analysis is done on the basis of available data from Z-AXIS 470 H Log Book for the period of 01/04/2012 to 31/03/2013(After commissioning of the equipment in Year March 2007)

Table: Criticality Index for Various Components of Excavators Z-AXIS 470 H

Type of components	Parameters of criticality						Criticality index
	S	IP	M	FF	DL	AD	
Engine	50	25	25	30	60	20	325
Hydraulic	50	25	40	50	60	20	385
Electrical	70	60	35	70	60	20	600
Track & Suspension	50	25	35	35	60	20	352.5
Hydraulic	50	30	40	50	60	20	400
Engine	50	25	20	25	60	20	307.5
Hydraulic	50	25	35	35	60	20	352.5
Electrical	70	60	35	70	70	30	620
Transmission	70	60	35	70	90	20	630
Hydraulic	50	25	20	35	60	20	322.5
Engine	50	25	40	50	60	20	385
Electrical	50	25	35	50	70	30	395
Hydraulic	50	25	40	50	60	20	385
Track & Suspension	25	35	30	35	35	50	340
Hydraulic	30	35	40	60	35	50	405
Transmission	25	35	40	40	35	50	367.5
Electrical	30	65	70	10	90	60	565

IV. METHODOLOGY OF OPTIMIZATION

A. Reliability Function

R(t) = 1-F(t);

F(t) = 1-exp(-xt); (for negative exponential distribution of failure) Where R(t)- Reliability function

F(t) – Probability density function of failure.

X – Failure rate at time t.

B. Sample Calculation:-

The failure rate of hydraulic System at 2400 hours is 1. Therefore F(t) at 2400 hours = 1 – exp(-1) = 0.64

R (t) at 2400 hours = 1- 0.64 = 0.36

Table: Reliability R(t) of components at different stages

Components	Cumulative working hours				
	300	600	900	1200	2400
Hydraulic Sys.	0.9	0.9	0.81	0.74	0.32
Electrical Sys.	0.9	0.8	0.74	0.30	0.13
Engine Sys.	0.9	0.9	0.88	0.70	0.52
Track	0.9	0.9	0.80	0.76	0.55
Transmission System	0.9	0.9	0.85	0.80	0.65

C. Objective function:-

$B = \Sigma^{n}_{j=1} Cr_{x\, r(t)} + \Sigma^{n}_{j=1} Cf1_{x\, \{1-r(t)\}}$

Where, B – Total probabilistic cost of repair

Cr – Repair cost

Cf –Failure cost (including cost due to loss of production hours)

n- No. of components

r (t) – Reliability of component after a certain stage

r (t) – R(t) + n1m1(0.995 – R(t) + n2m2(0.995 – R(t) (Initial reliability is taken as 0.995)

Where, n1 – No. of "1" maintenance done m1 – improvement factor for"1" type of maintenance

n2- No of "2" type of maintenance done "0" type of maintenance – cleaning, checking, inspection etc

"1" type of maintenance – Greasing, oil changing, oiling, small repairing, replacement of hoses seals etc

"2" type of maintenance- overhauling or major repairing of components.

Reliability predicted based on the past data between (2011- 15) based on experimental results.

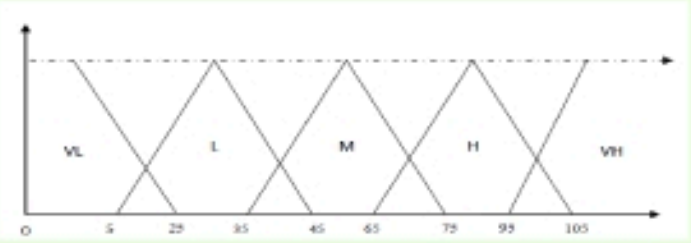
Components	Cumulative Working Hours				
	300	600	900	1200	2400
Hydraulic	95	92	81	74	32
Electrical	92	81	74	30	13

Failure frequency percentage based on past data in different cumulative working standards.

Components	Cumulative Working Hours				
	300	600	900	1200	2400
Hydraulic	8	12	16	28	73
Electrical	12	20	32	52	96

V. A FUZZY APPROACH FOR DIFFERENT TYPES OF EXCAVATOR USED TO INTERPRET THE MAINTAINABILITY POLICIES REQUIRED

After the calculation of reliability percentage and the failure frequency we are implementing fuzzy sets to identify maintainability required in terms of terms of very low, low, medium, high and very high sets.



Here fuzzy controller is used maintain the maintainability into the system. The system consists of two inputs, namely reliability and failure frequency and one output namely maintainability control as illustrated in figure below:

VI. FUZZIFICATION OF INPUTS

For fuzzification of inputs, that is to compute the membership function for the antecedents are as below:

Degree of Membership Function It is calculated by finding out the slope and delta values of each operation whichever needed on the respective fuzzy sets as represented in the figure above:

Therefore, Delta 1 = X - Point 1 & Delta 2 = Point 2 – X

Also if delta 1 ≤ 0 or delta 2 ≤ 0, then degree of membership function is zero else, Degree of membership function =

$$\min \begin{pmatrix} Delta\ 1 * slope\ 1 \\ Delta\ 2 * slope\ 2 \\ max \end{pmatrix}$$

Calculation of degree of membership functions

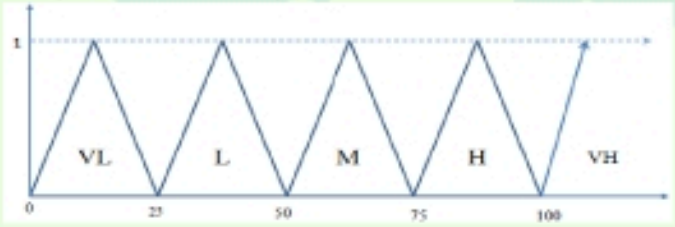
We have calculated degree of membership function for each condition in different working hours with reference to the reliability percentage and percentage of failure frequency individually for both hydraulic system and electric system.

An illustration for hydraulic system calculation of membership function for reliability percentage in different working hours

Delta 1 = 95- 65 = 30
Delta 2 = 105-95 = 0
Slope 1 = 1/40
Slope 2 = 1/40
Degree of membership function,

$$(\mu_{300\,95}) = \min\begin{pmatrix}30 * 1/40\\ 10 * 1/40\\ 1\end{pmatrix}$$

Therefore, μ30095 = 0.25
Similarly, μ60092 = 0.375, μ90081 = 0.4, μ 120074 = 0.025, μ240032 = 0.325
Again calculating degree of membership function for percentage of failure frequency in different working hours μ3008 = 0.075, μ 60012 = 0.175, μ90016 = 0.275, μ120028 = 0.425, μ240073 = 0.375
Again, for electrical system calculation of membership function for reliability percentage in different working hours μ 30092 = 0.375, μ60081 = 0.4, μ90074 = 0.025, μ 120030 = 0.375, μ240013 = 0.2
Again calculating degree of membership function for percentage of failure frequency in different working hours μ30012 = 0.175, μ 60020 = 0.375, μ90032 = 0.325, μ120052 = 0.425, μ240096 = 0.225
As the membership function is calculated we must have to develop some fuzzy rules to strength the output values based on our results. Therefore considering an output of fuzzy sets in our approach as below:



VII. DEVELOPMENT OF FUZZY RULES:

Rule1: If reliability is VL and failure frequency is VL then maintainability policy is VL
Rule2: If reliability is VL and failure frequency is L then maintainability policy is VL
Rule3: If reliability is VL and failure frequency is M then maintainability policy is VL
Rule4: If reliability is VL and failure frequency is H thenmaintainability policy is VL.
Rule5: If reliability is VL and failure frequency is VH then maintainability policy is VL
Rule6: If reliability is L and failure frequency is VL then maintainability policy is VL
Rule7: If reliability is L and failure frequency is L then maintainability policy is VL
Rule8: If reliability is L and failure frequency is M then maintainability policy is VL
Rule9: If reliability is L and failure frequency is H then maintainability policy is VL
Rule10: If reliability is L and failure frequency is VH then maintainability policy is VL
Rule11: If reliability is M and failure frequency is VL then maintainability policy is VL
Rule12: If reliability is M and failure frequency is L then maintainability policy is VL
Rule13: If reliability is M and failure frequency is M then maintainability policy is VL
Rule14: If reliability is M and failure frequency is H then maintainability policy is VL
Rule15: If reliability is M and failure frequency is VH then maintainability policy is VL
Rule16: If reliability is H and failure frequency is VL then maintainability policy is VL
Rule17: If reliability is H and failure frequency is L then maintainability policy is VL
Rule18: If reliability is H and failure frequency is M then maintainability policy is VL
Rule19: If reliability is H and failure frequency is H then maintainability policy is VL
Rule20: If reliability is H and failure frequency is VH then maintainability policy is VL
Rule21:If reliability is VH & failure frequency is VL then maintainability policy is VL
Rule22: If reliability is VH & failure frequency is L then maintainability policy is VL
Rule23:If reliability is VH & failure frequency is M then maintainability policy is VL
Rule24: If reliability is VH & failure frequency is H then maintainability policy is VL
Rule25: If reliability is VH & failure frequency is VH then maintainability policy is VL
Now, based on the rules earlier, the rule strength using fuzzy membership value of both systems are illustrated as below:

A. For Hydraulic System
- Min (0.25, 0.075) = 0.075
- Min (0.375, 0.175) = 0.175
- Min (0.4, 0.275) = 0.275

- Min (0.025, 0.425) = 0.025
- Min (0.325, 0.375) = 0.325

B. For Electrical System:

- Min (0.375, 0.175) = 0.175
- Min (0.4, 0.325) = 0.325
- Min (0.025, 0.325) = 0.025
- Min (0.375, 0.425) = 0.375
- Min (0.2, 0.225) = 0.2

From the above fuzzified values we can able to determine the type of maintenance polices to be implemented in each scenario

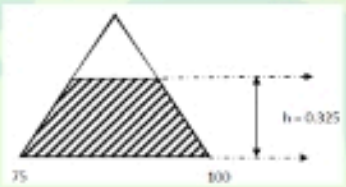
0 – 0.199 – Type 0 Maintenance needed
0.2 – 0.299 – Type 1 Maintenance needed
0.3 – 0.5 Type 2 Maintenance needed

From the above values it is clear that in hydraulic system at critical point (0.325) type 2maintenance is required and also at electrical system at critical point (0.375) type2 maintenance is needed. Therefore, need of defuzzification arises to find out the actual maintenance needed at those critical situation to run the system smoothly.

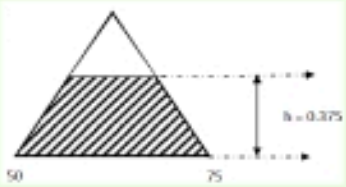
VIII. DEFUZZIFICATION APPROACH FOR MAINTAINABILITY POLICES TO BE IMPLEMENTED

The centre of gravity method applied to defuzzify the output. Initially, the centroids are computed for each of the competing output membership function. Then the new output membership area is determined by shortening the height of the membership value on Y–axis as dictated by rule strength value. Finally, the centre of gravity (C.G) is computed using the weighted average of X – axis with the newly computed output areas, the latter serving as weights.

For hydraulic system:
Rule strength applied to determine output = 0.325 Shaded area = ½ *(25+16.875)*0.325 = 6.80



For Electrical System:
Rule strength applied to determine output = 0.375 Shaded area = ½*(25+15.625)*0.375 = 7.61



IX. CONCLUSIONS

The overall cost against the idle hours of the main excavators become prohibitive both in terms of direct cost as well as indirect cost due to loss of production and productivity. So, it is imperative to have some well researched maintenance methodologies with efficient solutions which will maintain the ill structured symptoms of failures through constant monitoring of the machines health and performance to keep it at the desired or standardized availability/ reliability level. Initially reliability and failure frequency of each category of components are considered. But, based on criticality analysis, electrical and hydraulic components are found to be more impact stirring, leading to the failure of the system. Therefore, these two components are considered for fuzzification. Based on the reliability and the failure frequency data, fuzzy sets are implemented to identify the need of maintenance policies at different conditions. Fuzzy logic has been used to make inferences, based on the acquired information (real time data) and the knowledge base, which further helps to decide the suitable maintenance strategies in different situations. Fuzzy rules have been developed to identify the critical position and maintenance policy needed at different situation. However, defuzzification approach is considered to support the actual maintenance strategy to function uninterruptedly and to perform at their optimum level.

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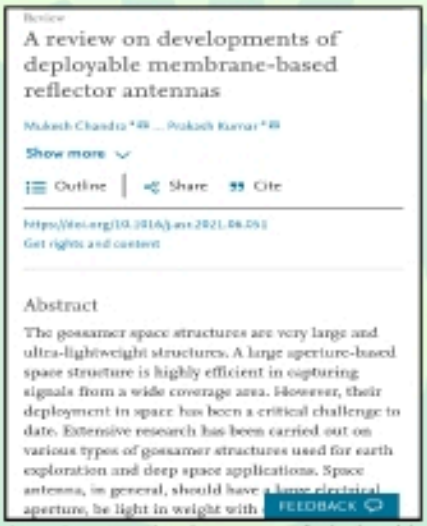

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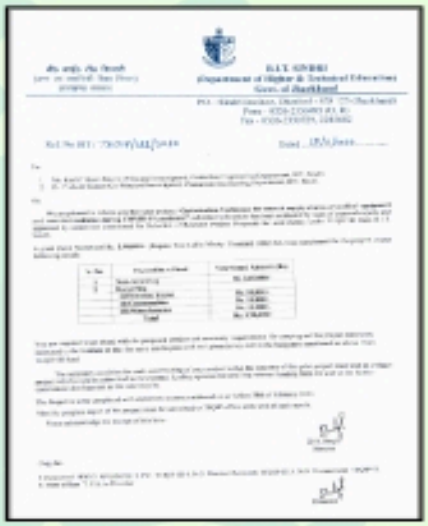

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PUBLICATION IN SCI AND SCOPUS

Sl. No.	Authors	Title	Journal	Year	Vol	Year	Pages	DOI/URL
1	Sumanta Mukherjee,Santanu Dhara, Partha Saha	Enhanced corrosion, tribocorrosion resistance and controllable osteogenic potential of stem cells on micro-rippled Ti6Al4V surfaces produced by pulsed laser remelting	Journal of Manufacturing Processes	2021	65	2021	119-133	10.1016/j.jmapro.2021.03.023
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3	Md. Mofeed Alam, Abhishek Kumar Jha, Sumanta Mukherjee, Surya narayan Panda, and Shitanshu S. Chakraborty	A Review on Friction Stir Welding—A Green Manufacturing Technology	Lecture Notes in Mechanical Engineering	2021		2021	869-880	https://doi.org/10.1007/978-981-15-9505-9_76
4	Dilip Kumar Bagal. Abhishek Barua. Siddharth Jeet. Antarjyami Giri. Ajit Kumar Patlanaik, and Surya Narayan Panda	Scope of Using Photovoltaic Cell to Power Electrical Units of Air-Conditioned Linke Hofmann Busch (LHB) Coaches Used in Indian Railways	Lecture Notes in Mechanical Engineering	2021		2021	405-414	https://doi.org/10.1007/978-981-15-6360-7_37

5	Tanmay, Mukesh Chandra, Sumit Sharma & Sudhansu Sekhar Panda	Study of Mechanical and Metallurgical Properties of Cold and Hot Reciprocating Wire TIG Welding on AISI 1035 Carbon Steel	Journal of The Institution of Engineers (India): Series D	2021		2021	159–166	https://doi.org/10.1007/s40033-021-00249-2
6	Simeon A., Nitesh Kumar, Samik Dutta, Naresh C. Murmu and Mukesh Chandra	A Critical Review on the Trends Toward Effective Online Monitoring of Defects in Friction Stir Welding of Aluminum Alloys	Lecture Notes in Mechanical Engineering	2021		2021		https://doi.org/10.1007/978-981-15-9505-9_75
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8.	Surya Narayan Panda, Ajit Kumar Pattanaik, Pradip Kumar Sahu, Prakash Kumar and Bijay Kumar Khamari	Process Parameter Optimization in EDM: A Multi-objective Approach using Metaheuristic	Lecture Notes in Mechanical Engineering	2020		2020	193-201	http://doi.org/10/1007/978-981-15-1307-7_21

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10	Dilip Kumar Bagal, Ajit Kumar Pattanaik, Dulu Patnaik, Abhishek Barua, Siddharth Jeet and Surya Narayan Panda	Multi-objective Optimization and Experimental Investigation of CNC Oxy-Fuel Gas Cutting Parameters Using Taguchi Coupled Data Envelopment Analysis	Lecture Notes in Intelligent Transportation and Infrastructure	2020		2020	75-83	https://doi.org/10.1007/978-981-32-9971-9_9
11	Surya Narayan Panda, Dilip Kumar Bagal, Ajit kumar Pattanaik, Dulu Patnaik, Abhishek Barua, Siddharth Jeel, Biswajit Parida and Bibekananda Naik	Comparative Evaluation for Studying the Parametric Influences on Quality of Electrode Using Taguchi Method Coupled with MOORA, DFA, and TOPSIS Method for Electrochemical Machining.	Lecture Notes in Intelligent Transportation and Infrastructure	2020		2020	115-129	https://doi.org/10.1007/978-981-32-9971-9_13
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16	Sayan Atta, Kisor Kumar Sahu, Anand Kumar, Dr. Nilrudra Mandal	Development of Self-lubricating Ceramic Composite and Evaluation of Mechanical and Tribological Properties	Lecture notes in Mechanical Engineering	2020	565			https://doi.org/10.1007/978-981-15-9505-9_51
17	Mukesh Chandra, Prakash Kumar, Satish Kumar,Somnath Chattopadhyaya, Sayan Chatterjee	A review on developments of deployable membrane-based reflector antennas	Advances in Space Research	2021		2021		https://doi.org/10.1016/j.asr.2021.06.051

OUR SPECIALITIES AND UNIQUENESS

- This is the only branch which includes Engineering & Management both and Production Engineering is not much different From Mechanical Engineering.

- Production engineers deal with everything starting from procurement of raw materials to the processes involv ed till the final product reaches market.

- The students here possess good intellectual caliber, scientific ability and a strong perseverance to compete. The scoring system has whetted each and every student to near perfection, preparing them to face real wo rld problems confidently.

- Our students have a wide knowledge of engineering practices and are aware of the management challenges related to production. In addition, many have substantial industrial experience.

- In addition to scientific and engineering skills, our graduates have been moulded into well rounded personalities, given their exposure to team work on projects, presentation and communication skills and active participation in extracurricular activities.

- In order to pace up with fast changing world, curriculum is kept up to date by incorporating the inputs from leading academia and industries. Regular talks by people from academia and industries are scheduled to expose the students to the evolving technology.

- We are confident that our students and graduates can make a positive impact on your organization.

- Equipped with the knowledge of equipment maintenance, system design, output maximization, troubleshooting, production testing and production planning, we are sure our students will create an impact in this domain of engineering.

- The especially designed Siemens courses and software training ensure that our students are proficient with cutting edge technology. This is pivotal to reducing the gap between design and manufacturing, one of the objectives of concurrent engineering.

- Our students possess the aptitude and the skills to deal with different manufacturing technologies and production design principles with an elaborative study about their working, construction and maintenance as well as design metrics that can be used in order to create the better quality products at a lower cost and in a more effective way so that productivity as well as efficiency of the entire system can be increased.

- Our students can use the tools of data science, computer simulation along with extensive mathematical tools for modeling such as mathematical optimization and queueing theory, and computational methods for system analysis, evaluation and optimization.

- Our students are well-versed in traditional roles of this engineering discipline like planning the layouts of factories and designing assembly lines and other manufacturing paradigms.

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ABHISHEK MAZUMDAR
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ANANT SAURABH
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TATA Technologies

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TATA Motors

ANIL KUMAR SAHANI
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