AUTONOMOUS

SYLLABUS

VII & VIII Semesters

B.E. in Mechanical Engineering

2023

MITE

Invent Solutions

MANGALORE INSTITUTE OF
TECHNOLOGY & ENGINEERING

MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING

(A Unit of Rajalaxmi Education Trust®, Mangalore)
Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE, New Delhi
Accredited by NAAC with A+ Grade & ISO 9001:2015 Certified Institution

Institute Vision

*"To attain perfection in providing **Globally Competitive Quality Education** to all our Students and also benefit the global community by using our strength in **Research and Development**"*

Institute Mission

"*To establish world class educational institutions in their respective domains, which shall be C**enters of Excellence** in their stated and implied sense. To achieve this objective we dedicate ourselves to meet the challenges of becoming **Visionary and Realistic**, **Sensitive and Demanding**, **Innovative and Practical,** Theoretical **and Pragmatic;** ALL at the same time"*

Department Vision

To provide globally competitive Mechanical Engineering education and advance research that drives sustainable technological solutions for society

Department Mission

- *To deliver quality Mechanical Engineering education through innovative pedagogy, hands-on learning, and industry collaboration, nurturing globally competent engineers with professional ethics and problem-solving skills*

- *To promote research, innovation, and lifelong learning in Mechanical Engineering, fostering sustainable technological solutions that address societal and industrial challenges*

Program Educational Objectives (PEOs)

After successful completion of the program, the graduates will be

- *Demonstrate technical competence in core and emerging areas of Mechanical Engineering, applying scientific and practical knowledge to solve real-world problems*
- *Pursue innovation, research, and entrepreneurial ventures, adapting to evolving technological trends through lifelong learning*
- *Uphold ethical and professional standards, practice social responsibility, and contribute to sustainable development, both individually and in collaborative settings*
- *Exhibit leadership, effective communication, and interpersonal skills required to thrive in multidisciplinary and multicultural environments*

Program Specific Outcomes (PSOs)

At the end of the program, Mechanical Engineering graduates will be

1. *Proficient in applying core Mechanical Engineering principles and inter-disciplinary knowledge to design, analyze, manage and select suitable manufacturing processes for the efficient production of mechanical systems*
2. *Competent in analyzing and operating thermal and fluid systems, including HVAC, power generation and electric vehicles, with an emphasis on energy efficiency and environmental sustainability*

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LIST OF COURSES

VII/VIII Semester Courses			
Sl. No.	**Course Code**	**Course Title**	**Sem**
PROFESSIONAL CORE COURSES			
1	23MEPC401	Smart Manufacturing	VII
2	23MEPC402	Electric and Hybrid Vehicles	VII
PROFESSIONAL ELECTIVE COURSES			
3	23MEPE411	Supply Chain Management	VII
4	23MEPE412	Non Traditional Machining	VII
5	23MEPE413	Composites and Nano-Composite Materials	VII
6	23MEPE42X	MOOCs (NPTEL/SWAYAM)	VIII
OPEN ELECTIVE COURSES			
7	23MEOE411	3D Printing	VII
8	23MEOE412	Energy Efficient and Sustainable Engineering	VII
9	23MEOE413	Optimization Techniques	VII
SKILL ENHANCEMENT COURSES			
10	23MESE409	Project Phase -II	VII
11	23MESE431	Internship	VIII
12	23MESE432	Publication / Patenting	VIII
HUMANITIES & SOCIAL SCIENCE COURSE			
13	23HMCC421	Constitution of India & Professional Ethics	VII

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VII Semester (2023 Scheme): Mechanical Engineering

Sl. No.	Course Code	Course Title	Category	Teaching Dept.	Teaching Hours /Week			Examination (Marks)			Duration of Exam (SEE) in Hrs	Credits
					L	T	P	CIE	SEE	Total		
1	23MEPC401	Smart Manufacturing	Professional Core Course	ME	3	0	2	50	50	100	3	4
2	23MEPC402	Electric and Hybrid Vehicles	Professional Core Course	ME	3	0	2	50	50	100	3	4
3	23MEPE41X	Professional Elective –III*	Discipline Specific Electives	ME	3	0	0	50	50	100	3	3
4	23MEOE41X	Open Elective –III**	Open Electives	ME	3	0	0	50	50	100	3	3
5	23MESE409	Project Phase -II	Skill Enhancement	ME	-	-	12	100	100	200	3	6
6	23HMCC421	Constitution of India & Professional Ethics	Humanities & Social Sciences	Humanities/ Any dept.	1	0	0	100	-	100	-	1
											Total Credits	**21**

***Professional Elective Course -III**

Sl. No.	Course Code	Course Title
1	23MEPE411	Supply Chain Management
2	23MEPE412	Non Traditional Machining
3	23MEPE413	Composites and Nano-Composite Materials

****Open Elective Course-III**

Sl. No.	Course Code	Course Title
1	23MEOE411	3D Printing
2	23MEOE412	Energy Efficient and Sustainable Engineering
3	23MEOE413	Optimization Techniques

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VIII Semester (2023 Scheme): Mechanical Engineering

Sl. No.	Course Code	Course Title	Category	Teaching Dept.	Teaching Hours /Week			Examination (Marks)			Duration of Exam (SEE) in Hrs	Credits
					L	T	P	CIE	SEE	Total		
1	23MEPE42X	MOOCs* (NPTEL/SWAYAM) 8/12 WEEKS	Professional Elective	ME	-	-	-	-	-	100	-	2
2	23MESE431	Internship	Skill Enhancement	ME	-			100	100	200	3	12
3	23MESE432	Publication / Patenting	Skill Enhancement	ME	-	-	-	100	-	100	-	2
										Total Credits		**16**

*** Massive Open Online Courses (MOOCs) -** Identified by the BoS of the department

Guidelines for MOOCs

To promote self-paced, flexible, and industry-relevant learning, a Two-Credit Online professional elective course is introduced in the VIII semester curriculum for all Bachelor of Engineering (B.E.) programs. Students are required to complete an approved online course as per the following guidelines:

1. **Registration and Course Completion:**
   Students must complete any one of the *Board of Studies (BOS)* approved online courses by registering for an 8-week or 12-week course offered through recognized platforms such as NPTEL or SWAYAM. Registration can be done during semester VI or semester VII.

2. **Credit Conversion:**
   The score obtained in the proctored examination conducted by the respective online platform shall be formally converted into course credits as per institute norms.

3. Provision for students failing to clear the Online Course

If a student fails to successfully complete the selected online course within two consecutive attempts before the commencement of Semester VIII, they must register for an elective course offered by the respective department. This elective will be delivered in online mode by the department.

4. Assessment Pattern for the alternate elective:

a. All assignments for the alternate elective course must be submitted online.
b. The Continuous Internal Evaluation (CIE) and the Semester End Examination (SEE) shall be conducted in offline mode.
c. Students must physically appear for these examinations at the institute.

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VII & VIII Semester

Smart Manufacturing			
Semester	**VII**	CIE Marks	**50**
Course Code	**23MEPC401**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:2**	Exam Hrs	**3**
Total Hrs	**40+24**	Credits	**4**

Course Objectives: This course is designed to

1. Impart the knowledge of evolution, fundamental principles, and key enablers of the Fourth Industrial Revolution
2. Provide knowledge of AI-driven methods and applications specifically tailored for industrial automation and problem-solving
3. Familiarize with computational tools used for predictive maintenance, process improvement, and real-time factory intelligence
4. Develop proficiency in additive and computer-integrated manufacturing technologies
5. Familiarize digital twins and eco-friendly practices to ensure sustainable operations in smart factories

Module 1: Introduction to Smart Manufacturing	**No. of Hrs: 8**

Overview of manufacturing evolution from Industry 1.0 to 4.0, Design principles and benefits of Industry 4.0, Integration of Industry 4.0 and manufacturing systems, Impact of Industry 4.0 technologies on sustainable manufacturing, Barriers to adoption of Industry 4.0, Introduction to smart manufacturing, Benefits of the adoption of smart manufacturing in large and small or medium enterprises, Impact of smart manufacturing on sustainable development, Transition to smart manufacturing, Intelligent automation systems, Industrial Internet of Things (IIoT): Reference architecture, implementation strategy, benefits & challenges, application domains

Textbook 1: Chapter 1 - 1.2, 1.4
Chapter 2 - 2.5,2.9
Chapter 3 - 3.1, 3.2, 3.4, 3.5, 3.6

Module 2: Industrial AI	**No. of Hrs: 8**

The need for industrial artificial intelligence (AI), Difference between industrial AI and AI, Basic problems in an industry, Basic methods of problem-solving using AI, AI technologies suitable for industry, Potential applications of AI in industry – predictive maintenance, virtual metrology, energy optimization, defect detection, and material sorting based on machine vision

Introduction Machine learning: introduction to supervised and unsupervised learning. Data acquisition in industrial environments, Introduction to machine vision for manufacturing inspection and quality monitoring

Textbook 2: Chapter 2 - 2.1, 2.2, 2.3,2.4, 2.6, 2.7
Textbook 2: Chapter 4 -4.2

Module 3: Predictive analytics	**No. of Hrs: 8**
Predictive analytics for smart manufacturing systems, four enabling technologies, Analytical technologies – data preprocessing, feature engineering, and data-driven analytics, Platform technologies, Operations technologies – PLM, MES, Challenges for AI in manufacturing operations Introduction to Cyber-Physical Systems (CPS), Introduction to predictive maintenance and condition monitoring in manufacturing systems Textbook 3: Chapter 8 - 8.1, 8.2,8.2.2, 8.2.3,8.2.4, 8.4	
Module 4: Additive and Computer-Integrated Manufacturing Systems	**No. of Hrs: 8**
Computer-Aided Design Technology, Printing Technologies, Programmable Logic Controller, Materials, Computer Numerically Controlled Machining, Turn mill center, Multiple axis turning center, Vertical turning center, Use of Layers, Classification of AM Processes, 3D printing Technologies - SLS, LBPF, LOM, DED Textbook 4: Chapters 2 -2.3, 2.4, 2.5, 2.6	
Module 5: Digital Twins and Green Manufacturing Systems	**No. of Hrs: 8**
Digital twins for advanced manufacturing, Elements of a digital twin, Case studies Green Manufacturing (GM), Needs of Industry 4.0 for nurturing environment sustainability, Industry 4.0 Components and Tools for Advancing GM, Functions of Industry 4.0 for GM, Future Implications, Possibilities and benefits of integrating GM and Industry 4.0, Introduction to life cycle assessment (LCA), Energy-efficient manufacturing practices and waste reduction in production systems Textbook 2: Chapter 6 - 6.1, 6.3 Textbook 5: Chapter 1 - 1.1.1, 1.2, 1.3, 1.6 Chapter 10 - 10.5	
Lab Components:	**No. of Hrs: 24**
1. CNC Turning Programming using G & M Codes 2. CNC Milling Programming using G & M Codes 3. CNC Drilling and Canned Cycles Programming 4. CNC Threading using G & M Codes 5. CNC Turning Program Generation using CAPS TURN 6. CNC Milling Program Generation using CAPS MILL 7. 3D Model Creation and Slicing of 3D Models for Additive Manufacturing 8. 3D Printing of mechanical components (two exercises)	

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

1. Articulate Industry 4.0 evolution, principles, integration, smart manufacturing concepts, sustainability impact, and adoption challenges
2. Describe the need, scope, methods, challenges, and key applications of AI in industries
3. Explain predictive analytics, manufacturing platforms, operations systems, and AI challenges
4. Develop 3D printing components and CNC programs using G & M codes
5. Describe CNC, PLC, AM process, digital twins and green manufacturing technologies for sustainable and efficient production systems

Textbooks:

1. Wankhede, V. A., Vimal, K. E. K., & Sahlot, P, "Industry 4.0 for Manufacturing Systems: Concepts, Technologies, and Applications", 1st Edition, CRC Press, 2025
2. Jay Lee, "Industrial AI - Applications with sustainable performance", 1st Edition, Springer Singapore, 2020.
3. Soroush, M., Baldea, M., & Edgar, T. F., "Smart manufacturing: Concepts and methods", Elsevier, 2020.
4. Gibson, I., Rosen, D., Stucker, B., Khorasani, M., Rosen, D., Stucker, B., & Khorasani, M., "Additive manufacturing technologies", Springer, 2021.
5. Parihar, R. S., & Jain, N., "Green Manufacturing for Industry 4.0: Building a Sustainable Future with Smart Technology", CRC Press, 2024.

Reference Books:

1. Shyam Varan Nath, Ann Dunkin, Mahesh Chowdhary, Nital Patel, "Industrial Digital Transformation", 1st Edition, Packt Publishing Limited, 2020
2. Zude Zhou, Shane Xie, Dejun Chen, "Fundamentals of Digital Manufacturing Science", Springer, 2012

Web links:

1. Industry 4.0: Managing The Digital Transformation, Prof. Murli Dhar Agrawal, IIT Bombay: https://onlinecourses.nptel.ac.in/noc26_ge04/preview
2. Digital Manufacturing and Technologies, IITM Pravartak/L&T EduTech : https://digitalskills.iitmpravartak.org.in/course_details.php?courseID=203
3. Introduction to Industry 4.0 and Industrial Internet of Things, Prof. Sudip Misra, IIT Kharagpur. : https://nptel.ac.in/courses/106105195
4. Metal Additive Manufacturing, Prof. J. Ramkumar, Prof. Amandeep Singh Oberoi, IIT Kanpur. URL:https://onlinecourses.nptel.ac.in/noc24_me130/preview

Electric and Hybrid Vehicles			
Semester	**VII**	CIE Marks	**50**
Course Code	**23MEPC402**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:2**	Exam Hrs	**3**
Total Hrs	**40+24**	Credits	**4**

Course Objectives: This course is designed to

1. Introduce the fundamentals of Electric Vehicles (EVs) and Hybrid Vehicles (HVs), their architectures, energy flow patterns, and global trends in EV adoption
2. Impart the concepts of energy storage and conversion systems including batteries, ultra-capacitors, fuel cells, and associated power management strategies
3. Familiarize electric machines and drive systems used in EV/HV applications, along with performance characteristics and control requirements
4. Familiarize EV/HV system design considerations, vehicle dynamics, charging architectures, standards, and safety requirements

Module 1: Introduction to Electric Vehicle & Hybrid Vehicle	**No. of Hrs: 8 + 6**

Configurations of Electric Vehicles, Performance of Electric Vehicles, Traction Motor Characteristics, Tractive Effort and Transmission Requirement, Energy Consumption

Hybrid Electric Vehicles-Concept of Hybrid Electric Drivetrains, Architectures of Hybrid Electric Drive trains, Hybrid Electric Drive trains- Series, parallel-Torque Coupling, speed coupling

Laboratory Components:

1. Tractive Effort calculation for Electric Vehicle using Simulink & Simscape
2. Series Hybrid Electric Vehicle Simulation using Simulink & Simscape

Textbook 1 : 5.1, 5.2, 5.2.1, 5.2.2, 5.4, 6.1, 6.2, 6.2.2

Module 2: Vehicle Dynamics and Automotive Transmission Systems	**No. of Hrs: 8 + 6**

General Description of Vehicle Movement , Vehicle Resistance-Rolling Resistance , Aerodynamic Drag, Grading Resistance; Dynamic Equation, Power Train Tractive Effort, Vehicle Performance- Maximum Speed of a Vehicle, Grade ability, Acceleration Performance

Transmission Characteristics, Torque converter, Manual Gear Transmission (MT) , Automatic Transmission, Continuously Variable Transmission, Dedicated Hybrid Transmission (DHT) with Cruise control

Laboratory Components:

1. Vehicle Resistance Force Analysis using Simulink & Simscape
2. Vehicle Acceleration Simulation using Simulink & Simscape

Textbook 1 : 2.1, 2.2, 2.3, 2.5, 2.6, 4.2, 4.3, 4.4, 4.5, 4.7

Module 3: Battery Technology and Energy Storage Characteristics	**No. of Hrs: 8+4**

Battery Parameters-Cell and Battery Voltages, Charge Capacity, Energy Stored, Specific Energy, Energy Density, Specific Power, Energy Efficiency, Self-discharge Rates, Battery Geometry, Battery Life and Number of Deep Cycles. Working principle and applications : Lead Acid Batteries, Lithium Batteries, Metal–Air Batteries- Aluminium–Air Battery, Zinc–Air Battery

Laboratory Component:
Battery State of Charge (SOC) Simulation using Simulink & Simscape

Textbook 2 : 3.2, 3.3, 3.6, 3.7

Module 4: Hybrid Energy Storage Technologies	**No. of Hrs: 8+4**

Batteries in Hybrid Vehicles-Introduction, IC/Battery Electric Hybrids, Battery/Battery Electric Hybrids, Combinations using Flywheels. Battery Modelling-Battery Equivalent Circuit, Modelling Battery Capacity, Simulating a Battery at a Set Power, Calculating the Peukert Coefficient, Battery Sizing, Super capacitors, Battery Charging-Battery Chargers, Charge Equalisation, Thermal Management System

Laboratory Component:
Battery Equivalent Circuit Model using Simulink & Simscape

Textbook 2 : 3.11, 3.12, 3.8.1, 3.9

Module 5: Electric Propulsion Systems	**No. of Hrs: 8+4**

DC Motor Drives-Principle of Operation and Performance, Combined Armature Voltage and Field Control. Induction Motor Drives- Basic Operation Principles of Induction Motors, Steady-State Performance, Constant Volt/Hertz Control, Power Electronic Control

Permanent Magnetic BLDC Motor Drives- Basic Principles, Construction and Classification, Properties of PM Materials, Performance Analysis and Control of BLDC Machines

Laboratory Component:
DC Motor Speed Characteristics using Simulink & Simscape

Textbook 1 : 7.1, 7.1.1 to 7.1.3, 7.2 to 7.2.4, 7.3.1-7.3.3, 7.3.4

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

1. Articulate the operating principles and configurations of electric and hybrid vehicles and their impact on vehicle performance and energy consumption
2. Apply vehicle dynamic equations and drivetrain principles to evaluate tractive effort, transmission characteristics, and vehicle performance parameters
3. Articulate battery parameters, working principles, and applications of various batteries, along with battery modelling, sizing, and charging methods used in electric and hybrid vehicles
4. Apply battery parameters to determine the performance, efficiency, and suitability of batteries for electric and hybrid vehicle applications
5. Articulate the operating principles, control methods, and performance characteristics of motor drives
6. Demonstrate the modeling and analysis of key components and performance characteristics of electric and hybrid vehicle systems using simulation tools

Textbooks:

1. Mehrdad Ehsani, Yimin Gao, Stefano Longo, Kambiz Ebrahimi "Modern Electric, Hybrid Electric and fuel cell vehicles", 3rd Edition, CRC press Taylor & Francis Group, 2018.
2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 2nd Edition, John Wiley and Sons, 2012.

Reference books:

1. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", CRC Press, 2009.
2. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 2nd Edition, CRC Press, 2011.

Web links:

1. Introduction to Hybrid and Electric Vehicles, by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati. URL: https://nptel.ac.in/courses/108/103/108103009/
2. Electric Vehicles, by Prof. Amitkumar Jain, IIT Delhi. URL: https://nptel.ac.in/courses/108/102/108102121/

Supply Chain Management			
Semester	**VII**	CIE Marks	**50**
Course Code	**23MEPE411**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Objectives: This course is designed to

1. Impart a foundational understanding of Supply Chain Management (SCM) concepts relevant to industries
2. Provide knowledge of supply chain responsiveness, efficiency, and performance
3. Impart the concepts of tools and techniques for managing materials flow
4. Impart concepts of network design and configure efficient & resilient manufacturing supply chain networks
5. Familiarize with emerging trends, digital transformations, and evolving roles in modern supply chains

Module 1: Fundamentals of Supply Chain & its Industrial Importance	**No. of Hrs: 8**

Introduction, evolution of Supply Chain Management (SCM), key concepts in SCM, objectives, decisions in SC, importance of SC, enablers of supply chain performance, SC performance in India: challenges in maintaining SC in India, SC challenges for the Indian FMCG sector

Textbook 1: Chapter 1
Textbook 2: Chapter 1

Module 2: Supply Chain Strategy, Performance Measures & Forecasting	**No. of Hrs: 9**

Competitive and SC strategies, customer service & cost trade-offs: order delivery lead time, SC responsiveness, delivery reliability, product variety; SC performance measures, linking SC & business performance, enhancing SC performance, make vs. buy, material requirement planning, role of forecasting, qualitative & quantitative forecasting methods, time-series forecasting models

Textbook 1: Chapters 2, 3, 7
Textbook 2: Chapter 2

Module 3: Inventory & Logistics Management	**No. of Hrs: 8**

Types of inventory: cycle, safety, anticipation, pipeline; inventory related costs, managing cycle, safety & seasonal stock, drivers of transportation decisions, modes of transportation, devising a strategy for transportation, vehicles scheduling, transportation cost in E-retailing, introduction to ERP, importance of ERP software in industries

Textbook 1: Chapter 4, 5

Module 4: Network Design, Integration & Outsourcing Strategies	**No. of Hrs: 9**
Network operations planning: costs, network optimization - cost minimization & profit maximization model, internal integration: centralized, decentralized, hybrid; external integration: increase in demand volatility, impact of buyer & supplier practices, Bullwhip effect, distortions, & remedial strategies, SC external integration: Industry level initiatives-vendor-managed inventory (VMI), efficient customer response, collaborative planning forecasting and replenishment (CPFR), role of IT in transaction execution, collaboration and coordination, risk management in global SC Textbook 1: Chapters 6, 8,9 Textbook 2: Chapter 6	
Module 5: Future Trends in Supply Chain	**No. of Hrs: 8**
Introduction - Agile supply chain configuration design, SC for high demand uncertainty environment: forecast updating, responsive SC; law of demand & optimal pricing decision, revenue management under uncertain demand & limited-capacity situations, sustainable SCM: Factors, challenges of green supply chain initiatives, Re- process, environmental & social responsibility, evolution of AI in SCM, key AI technologies, AI's impacts on business, AI's potentials & limitations. Textbook 1: Chapters 12, 13, 14 Textbook 3: Chapter 2	

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

1. Articulate the influence of supply chains on overall manufacturing performance
2. Describe the supply chain strategies, forecasting practices, inventory policies, and logistics decisions that support effective manufacturing operations
3. Apply forecasting techniques, inventory models, and logistics planning methods to make suitable supply chain decisions
4. Articulate the role of network design, integration, outsourcing, future trends and sustainability initiatives in strengthening collaboration and flexibility in modern supply chains
5. Apply network design principles, integration mechanisms, and risk-mitigation approaches to make effective supply chain decisions

Textbooks:

1. Janat Shah, "Supply Chain Management Text and Cases", 2nd Edition, Pearson Education, 2016
2. Sunil Chopra and Peter Meindl, "Supply Chain Management-Strategy Planning and Operation", 7th Edition, Pearson Education, 2019
3. Dean H. Stanton, "The AI Revolution: Transforming Supply Chain Management", 1st Edition, August 2025

Reference Books:

1. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, "Designing and Managing the Supply Chain: Concepts, Strategies, and Cases", 3rd Edition, Tata McGraw-Hill, 2007
2. Ballou Ronald H, "Business Logistics and Supply Chain Management", 5th Edition, Pearson Education, 2003
3. Michael H. Hugos, "Essentials of Supply Chain Management", 1st Edition, Wiley, 2003

Web links:

1. Modelling and Analysis for Supply Chain Management: https://onlinecourses.nptel.ac.in/noc21_mg45/preview
2. Operations and Supply Chain Management: https://nptel.ac.in/courses/110106045
3. Management of Inventory Systems: https://nptel.ac.in/courses/110105095

Non-Traditional Machining			
Semester	**VII**	CIE Marks	**50**
Course Code	**23MEPE412**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Objectives: This course is designed to

1. Impart the knowledge of fundamental needs, scope and classification of Non-Traditional Machining (NTM) processes
2. Familiarize with the ultrasonic, jet, beam, chemical and discharge machining working principles, equipment details, and process mechanisms of NTM

Module 1: Introduction and Ultrasonic Machining	**No. of Hrs: 8**

Introduction to Non-traditional machining (NTM), Need, Comparison between traditional and non-traditional machining, general classification of NTM processes, classification based on nature of energy employed in machining, selection of NTM processes, advantages, limitations and applications, hybrid processes

Ultrasonic Machining (USM): Equipment & process, Operation, applications, advantages and limitations

Textbook 3 : Chapter 1, 2

Module 2: Jet Machining & Nano Finishing	**No. of Hrs: 9**

Abrasive Jet Machining (AJM), Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations

Nano finishing-Abrasive Flow: Principle, materials used, process parameters and applications, Magnetorheological Finishing and Magnetic Abrasive Finishing

Textbook 3 : Chapter 2, Textbook 3: Chapter 2.3, 7.4.4, 7.4.5

Module 3: Chemical Machining Processes	**No. of Hrs: 8**

Electrochemical Machining (ECM): Introduction, principle, chemistry, process characteristics, process parameters, tooling, applications, advantages, and disadvantages

Electrochemical Grinding- working principle, material removal, surface finish, advantages and applications

Chemical Machining (CHM): Elements of the process, Types of chemical machining process, Process characteristics, advantages, limitations and applications

Textbook 3 : Chapter 3

Module 4: Discharge & Arc Machining	**No. of Hrs: 9**

Electrical Discharge Machining (EDM): Introduction, mechanism of metal removal, EDM equipment, EDM process parameters, advantages, limitations

Plasma Arc Machining (PAM): Introduction, non-thermal generation of plasma, equipment, mechanism of metal removal, Plasma torch, process parameters, process characteristics., applications, advantages and limitations

Textbook 3 : Chapter 4

Module 5: Beam Machining	**No. of Hrs: 8**

Laser Beam Machining (LBM): Introduction, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations

Electron Beam Machining (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations

Textbook 3 : Chapter 4

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

1. Articulate the need for non-traditional machining, classification, and the working principles, equipment, and applications of Ultrasonic Machining (USM), Abrasive Jet Machining (AJM), Water Jet Machining (WJM) and nano-finishing operations
2. Apply the operating parameters of USM, AJM, & WJM to determine machining outcomes
3. Enunciate the principles, process mechanisms, and equipment, of Electrochemical Machining (ECM), Chemical Machining (CHM), Electrical Discharge Machining (EDM), and Plasma Arc Machining (PAM), including their applications, advantages, and limitations
4. Apply principles of operating and process parameters of ECM, CHM, EDM, and PAM to determine their influence on material removal rate, and process efficiency for a given machining task
5. Articulate the principles, beam generation methods, equipment, and mechanisms of metal removal in LBM and EBM

Textbooks:

1. H. Youssef and H. El-Hofy, "Non-Traditional and Advanced machining Technologies", CRC Press, Taylor & Francis group, 2021
2. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001
3. P.C Pandey and H S Shah, "Modern Machining Process", 1st edition, McGraw Hill Education India Pvt. Ltd. 2000

Reference Books:

1. Vijay K Jain, "Advanced Machining Processes", 6th reprint,Allied Publishers Pvt. Ltd., 2007
2. Dr. Amitabha Bhattacharyya, New Technology, The Institute of Engineers (India), 2000
3. Aditya, Modern Machining process, 2002

Web links:

1. Electric Discharge Machining, http://vlabs.iitkgp.ac.in/vamm/exp1/index.html#, IIT Kharagpur

2. Prof. Shantanu Bhattacharya, Advanced Machining Processes, https://nptel.ac.in/courses/112104425, IIT Kanpur

Composites and Nano-Composite Materials			
Semester	**VII**	CIE Marks	**50**
Course Code	**23MEPE413**	SEE Marks	**50**
Teaching Hrs/Week (L:T:P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Objectives: This course is designed to

1. Impart knowledge on classification, applications and manufacturing methods of composite materials
2. Provide knowledge of micromechanics relations to evaluate the elastic properties of the fiber-reinforced composites
3. Familiarize the concept of dimensionality & morphology of nanomaterials and carbon-based nanocomposites
4. Impart the knowledge of microscopic imaging techniques for nanomaterials characterization

Module 1: Fundamentals of Composite Materials	**No. of Hrs: 7**

Introduction, classification of composites, particulate composites, fiber reinforced composites, laminated composites, polymer, metal and ceramic matrix composites, fiber types: glass, carbon, organic, ceramic and metallic fibers, continuous and discontinuous fibers, advantages, heat treatment on metal matrix composites, limitations and applications of composites

Textbook 2: 15.1 – 15.6, 15.14 – 15.16, Textbook 3: 2.2.1, 2.2.3, 2.2.5, 2.2.7, 2.2.9, 2.4.1.

Module 2: Manufacturing Methods for Composites	**No. of Hrs: 8**

Stir casting, spray deposition, powder metallurgy, injection moulding, hand and prepreg lay-ups, bag moulding, autoclave, compression moulding, vacuum-assisted resin transfer moulding, pultrusion and filament winding

Textbook 2: 15.9.1, 15.9.2, 15.10.2, Textbook 3: 3.1 – 3.5, 3.7– 3.9.

Module 3: Micromechanics of Fiber Reinforced Composites	**No. of Hrs: 9**

Volume & mass fractions, Categories of composite material: heterogeneous, anisotropic, orthotropic & isotropic materials, longitudinal & transverse modulus, in-plane Poisson's ratio, longitudinal tensile strength

Textbook 3: 4.1.1, 4.1.3 – 4.1.7, 4.2.1 – 4.2.3, 4.4.1

Module 4: Nanomaterials	**No. of Hrs: 9**

Introduction, dimensionality, morphology of nanostructured materials, inorganic nanomaterials: nanometals and alloys, colloidal metal nanoparticles, non-oxide inorganic nanomaterials, nano clusters, carbon-based nanomaterials: fullerene, carbon nanotubes (CNTs), graphene, carbon nanofibers, organic nanomaterials: polymeric nanoparticles, dendrimers, nanocellulose, self-assembled and supramolecular nanomaterials

Textbook 1: 2.1, 2.1.1, 2.1.2, 2.2.1, 2.2.2, 2.2.4, 2.3.1 to 2.3.4, 2.4.1 to 2.4.3, 2.6.

Module 5: Nanocomposites and Characterization of Nanomaterials	**No. of Hrs: 9**

Nanocomposites, Ceramic Matrix Nanocomposites (CMNCs), Metal Matrix Nanocomposites (MMNCs), Polymer Matrix Nanocomposites (PMNCs), nano coatings, functional nano coatings, protective nano coatings, smart nano coatings

Characterization of nanomaterials: microscopic imaging techniques: electron microscopy, Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM)

Textbook 1: 2.7, 2.7.1, 2.7.2, 2.7.3, 2.8, 2.8.1, 2.8.2, 2.8.3, 5.1, 5.2, 5.2.1, 5.2.2.

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

1. Articulate the classification, constituents of composites, types of fibers, manufacturing methods, elastic properties and applications of the composite materials
2. Apply micromechanics principles to determine volume and mass fractions, elastic moduli, in-plane Poisson's ratio, and longitudinal tensile strength of fiber reinforced composites
3. Articulate the fundamental concepts of nanomaterials, structure, types & applications of nanocomposites, principles of microscopic imaging techniques for characterization
4. Apply the principles of composite manufacturing methods to build and test composite materials

Textbooks:

1. Kumar, Narendra, and Sunita Kumbhat., "Concise concepts of nanoscience and nanomaterials", 1st Edition, scientific publishers, 2018
2. Parashivamurthy, K. I. "Material Science and Metallurgy", 1st Edition, Pearson Education India, 2012
3. Barbero, Ever J., "Introduction to composite materials design", 2nd Edition CRC press, 2010

Reference Books:

1. Rao, MS Ramachandra, and Shubra Singh, "Nanoscience and nanotechnology: Fundamentals to Frontiers", 1st Edition, Wiley, 2017
2. Murty, Budaraju S. "Textbook of nanoscience and nanotechnology", 1st Edition, Springer Science & Business Media, 2013

Web links:

1. Manufacturing of Composites, NPTEL Course, https://www.youtube.com/live/VIyjDg_2KlQ?si=0NJYZifQQ6BF2TgZ
2. Nanocomposites, NPTEL Course, https://youtu.be/t-pVi3IMdOk?si=4rzAggRTI2hRpz9f
3. Mechanics of Fiber Reinforced Polymer Composite Structures, NPTEL Course, https://youtube.com/playlist?list=PLwdnzlV3ogoVE2AIC-G4Uew8XsaINwJGo&si=hF06uMz1upZmsb4y

3D Printing			
Semester	**VII**	CIE Marks	**50**
Course Code	**23MEOE411**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**03**
Total Hrs	**42**	Credits	**03**

Course Objectives: This course is designed to

1. Provide knowledge of concepts and evolution of 3D Printing systems with 3D Printing process chains, design, materials, and classification
2. Familiarize various 3D Printing processes and process parameters calculation
3. Familiarize process selection guidelines, software tools, post-processing, multi-material 3D Printing, and industrial applications

Module 1: Fundamentals of 3D Printing and Process Chain	**No. of Hrs: 8**

Introduction, Generic AM process, rapid prototyping, benefits of 3D Printing, reverse engineering technology, classification, metals systems, hybrid systems

3D Printing Process chain: Introduction, steps in 3D Printing, design for 3D Printing

Textbook 1: 1.1, 1.3, 1.4.4, 1.4.5, 1.5, 1.7.1, 2.6, 2.7, 2.8, 3.1, 3.2, 3.7

Module 2: Photo polymerization, Fusion Deposition and Extrusion Methods	**No. of Hrs: 9**

Photo polymerization: Introduction, UV Curable Photopolymers, Stereolithography: process, machines, Micro Stereolithography, Mask Projection SL Technology, Benefits, Drawbacks, and Applications, Calculation of build parameters, material consumption, and part cost

Fusion deposition: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanisms, Electron Beam melting (EBM), Benefits, Drawbacks, and Applications

Extrusion: Principle, Materials, Benefits, Drawbacks, and Applications

Textbook 1: 4.1, 4.4.1, 4.4.2, 4.7, 4.8.1, 5.1, 5.2, 5.3, 5.6.3, 6.2, 6.5, 6.6

Module 3: Lamination, Beam Deposition and Direct Write Methods	**No. of Hrs: 8**

Lamination method: Laminated Object Manufacturing (LOM), Adhesive Bonding, Thermal bonding, Ultrasonic Consolidation process, LOM and UC applications

Beam Deposition method: Introduction, beam deposition process, material delivery, BD systems, process parameters, benefits and drawbacks

Direct Write Technologies: Ink based, laser transfer, thermal spray

Textbook 1: 8.1, 8.2, 8.4, 9.1, 9.2, 9.4, 9.5, 9.8, 10.3, 10.4, 10.5

Module 4: Process Selection and Post Processing	**No. of Hrs: 9**
Process Selection: Introduction, challenges of selection, production planning and control. STL file: Introduction, format, creation from CAD system, issues with STL files, STL file manipulation **Post Processing:** Support material removal, surface texture improvements, property enhancement techniques: thermal and non thermal Calculation of layer thickness, number of layers, exposure time per layer, total build time, resin consumption, machine operating cost, and total part cost Textbook 1: 12.1, 12.3, 12.5, 13.2.1, 13.2.2, 13.3, 13.4, 16.1, 16.2, 16.6, 16.7	
Module 5: Multi Materials 3D printing and Applications	**No. of Hrs: 8**
Introduction, multiple material approaches: discrete, porous and blended multiple material processes **3D Printing Applications:** Aerospace, defense, automobile, and biomedical sectors Textbook 1: 17.1-17.5	

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

1. Articulate the principles, processes, classification, and process chain of 3D Printing along with its applications
2. Articulate the principles and applications of major 3D Printing processes, including process selection and post-processing
3. Apply stereolithography (SLA) principles to calculate build parameters, material consumption, and part cost
4. Articulate multi-material 3D Printing and applications in aerospace, defense, automotive, and biomedical sector
5. Apply FDM additive manufacturing principles to design, slice, fabricate, and evaluate a PLA component, and estimate build parameters, material consumption, and part cost

Textbooks:

1. I. Gibson, D. W. Rosen, B. Stucker, "Additive Manufacturing Technologies", 1st Edition, Springer, 2010

Reference Books:

1. Hari Prasad, A.V. Suresh, "Additive Manufacturing Technology", 1st Edition, Cengage Learning, 2019
2. T.S. Srivatsan, T.S. Sudarshan, "Additive Manufacturing: Innovations, Advances, and Applications", CRC Press, Taylor & Francis Group, LLC, 2016
3. Amit Bandyopadhyay, Susmita Bose, "Additive Manufacturing", CRC Press, Taylor & Francis Group, 2019

Web links:

1. NPTEL Video Lectures – 3D Printing and Design for Educators, Dr. Sharad K. Pradhan, NITTTR, Bhopal. URL: https://onlinecourses.swayam2.ac.in/ntr26_ed01/preview
2. NPTEL Video Lectures – Metal Additive Manufacturing, Prof. J. Ramkumar, Prof. Amandeep Singh Oberoi, IIT Kanpur. URL: https://onlinecourses.nptel.ac.in/noc24_me130/preview
3. NPTEL Video Lectures – Navigating the Latest Trends in Additive Manufacturing Landscape, Prof. Alankar, Ms. Akshatha Hulmani Dayananda, IIT Bombay, Wipro 3D. URL: https://onlinecourses.nptel.ac.in/noc26_me08/preview

Energy Efficient and Sustainable Engineering			
Semester	**VII**	CIE Marks	**50**
Course Code	**23MEOE412**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**03**
Total Hrs	**42**	Credits	**03**

Course Objectives: This course is designed to

1. Provide an understanding of energy efficiency, sustainability, and climate impact
2. Impart knowledge of energy-efficient design practices in buildings and systems
3. Provide knowledge of selecting energy-efficient equipment using technical and economic criteria
4. Impart knowledge of sustainable operation and maintenance strategies using digital tools
5. Familiarize the energy auditing techniques and economic evaluation of Energy Conservation Measures

Module 1: Introduction	**No. of Hrs: 09**

Energy Scenario: Global and Indian energy scenario, energy resources classification, sector-wise energy consumption, energy demand growth, energy security challenges

Energy Efficiency & Conservation: Scope, difference between efficiency and conservation, barriers to implementation, demand-side management

Sustainability Principles & Sustainable Development Goals (SDG): Concept of sustainable development, triple bottom line, overview of SDGs with emphasis on SDG 7, 9, 11, 12, and 13

Energy–Environment–Economy Nexus: Linkage between energy use, economic growth, environmental degradation, decarbonization pathways

Carbon Footprint & Climate Impact: Greenhouse gases, global warming potential, emission scopes, basic methodology of carbon footprint estimation

Energy Performance Indicators: Concept, baseline establishment, normalization, examples from industry and buildings

Module 2: Energy Efficient Design Practices	**No. of Hrs: 08**
Design for Energy Efficiency & Sustainability: Integrated design approach, sustainable materials, embodied energy **Passive Design Strategies**: Building orientation, natural ventilation, daylighting, shading devices, thermal mass. **Active Design Strategies:** High-efficiency electrical and mechanical systems, automation **Energy-Efficient Lighting & HVAC Design**: Lighting systems and controls, HVAC system selection, Coefficient Of Performance (COP), Energy Efficiency Ratio, load estimation	
Module 3: Selection of Energy-Efficient Equipment & Systems	**No. of Hrs: 08**
Energy-Efficient Motors: Motor losses, efficiency classes, IE standards, selection methodology **Variable Frequency Drives (VFDs):** Principle of operation, applications, energy-saving potential **Renewable Energy Systems Integration:** Solar PV, solar thermal, wind systems, grid integration **Life Cycle Cost (LCC) Analysis:** Initial, operating and maintenance costs, replacement cost, numerical examples	
Module 4: Sustainable Operation	**No. of Hrs: 08**
Energy-Efficient Operational Strategies: Best operating practices, load management, energy control **Performance Monitoring & Benchmarking**: Key Performance Indicators, internal and external benchmarking **Energy Management Systems (EMS):** Structure, components, data acquisition and reporting **Digital Tools & IoT in O&M:** Smart sensors, energy meters, IoT platforms, AI applications	

Module 5: Energy Audit and Assessment	**No. of Hrs: 09**

Energy Audit Concepts & Types: Need, scope, benefits, preliminary and detailed audits

Energy Audit Methodology & Instrumentation: Data collection, measurements, audit instruments

Identification of Energy Conservation Measures (ECMs): Electrical, thermal, and operational ECMs

Economic Evaluation: Simple payback period, Net Present Value (NPV), Internal Rate of Return (IRR)

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

1. Articulate the global and Indian energy scenario, sustainability principles, carbon footprint fundamentals, and energy performance indicators
2. Describe energy-efficient and sustainable building design principles and the role of energy-efficient equipment, and basic life-cycle cost considerations
3. Articulate energy-efficient operation strategies, performance monitoring and energy management systems, and the fundamentals of energy audits, energy conservation measures
4. Apply the life cycle costing and economic evaluation methods to assess the performance of the engineering systems

Textbooks:

1. Wayne C. Turner & Steve Doty , "Energy Management Handbook", CRC Press,2006
2. John Randolph & Gilbert Masters , "Energy for Sustainability", Island Press,2008
3. Lal Jayamaha, "Energy-Efficient Building Systems", McGraw Hill,2006

Reference Books:

1. Capehart, Turner & Kennedy, "Guide to Energy Management", Fairmont Press,2012
2. Stephen Peake, "Renewable Energy: Power for a Sustainable Future", Oxford University Press,2018
3. Jerry Yudelson, "World's Greenest Buildings", Routledge Press,2013

Web links:

1. Energy Resources, Economics, and Sustainability, Prof. Pratham Arora, IIT Roorkee. URL: https://onlinecourses.nptel.ac.in/noc26_hs115/preview
2. Sustainable Energy Technology, Prof. Sayak B Banerjee, IIT Hyderabad. URL- https://onlinecourses.nptel.ac.in/noc23_me138/preview

Optimization Techniques			
Semester	**VII**	CIE Marks	**50**
Course Code	**23MEOE413**	SEE Marks	**50**
Teaching Hrs/Week (L: T: P)	**3:0:0**	Exam Hrs	**3**
Total Hrs	**42**	Credits	**3**

Course Objectives: This course is designed to

1. Impart knowledge of modeling techniques for effective decision-making
2. Familiarize the concepts of linear programming, transportation, assignment, and sequencing
3. Introduce game theory concepts for strategic decision making
4. Provide knowledge of Project Evaluation and Review Techniques (PERT) and Critical Path Method (CPM) for project planning and scheduling

Module 1: Linear Programming Problem	**No. of Hrs: 8**

Introduction to optimization techniques: characteristics, Phases, and Applications.
Linear programming (LP): LP problem formulation, graphical methods, Simplex method, and Big- M method
Textbook 1: 2.2, 2.8, 3.3, 4.3

Module 2: Transportation and Assignment Problem	**No. of Hrs: 10**

Introduction, types of transportation problems, methods of finding initial solution: North-West Corner, Least Cost, Vogel's Approximation, test for optimality
Assignment Problem: Hungarian method, unbalanced assignment, travelling salesman problem
Textbook 1: 9.3, 9.4, 9.5, 10.3.1, 10.4.3, 10.6

Module 3: Sequencing Problems	**No. of Hrs: 7**

Introduction, Johnson's procedure, processing n - jobs through two machines, three machines, and m - machines, processing two jobs through m machines

Textbook 1:20.2, 20.3, 20.4, 20.5, 20.6

Module 4: Theory of Games	**No. of Hrs: 7**

Introduction, two-person zero-sum games, pure strategies: minimax and maximin principles, mixed strategies: games without saddle point, principles of dominance, games without saddle point: algebraic method, graphical method

Textbook 1: 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.6.1, 12.6.4

Module 5: Project Management: PERT and CPM	**No. of Hrs: 10**

Introduction, difference between PERT and CPM, PERT/CPM network components and precedence relationships, rules for AOA network construction, errors and dummies in network, guidelines for network construction, Fulkerson's rule for numbering the events, network construction with examples, critical path analysis with examples, project scheduling with uncertain activity times with examples

Textbook 1: 13.2, 13.4, 13.5, 13,6

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

1. Articulate the fundamental concepts and methodologies of optimization techniques, including linear programming, transportation, assignment & sequencing problems, game theory, and project management techniques
2. Formulate Linear Programming Problems and find an optimal solution
3. Solve transportation, assignment, and sequencing problems using optimization techniques
4. Solve game theory problems using principles for strategic decision-making
5. Apply PERT and CPM techniques to plan, schedule, and determine critical paths & project completion time

Textbooks:

1. J K Sharma, "Operations Research Theory and Applications", 6th Edition, Laxmi Publications Pvt. Ltd., 2017

Reference Books:

1. R. Panneerselvam, "Operations Research", 2nd Edition, PHI Learning, 2009
2. P K Gupta and D S Hira, "Operations Research", 7th Edition, Chand Publications, New Delhi, 2014
3. S.D. Sharma, "Operations Research Theory, Methods & Applications", 1st Edition, Kedarnath Ramanath & Co, 2024
4. Hillier and Lieberman, "Introduction to Operations Research", 8th Edition, McGraw-Hill, 2024

Web links:

1. Operations research: https://nptel.ac.in/courses/111107128
2. Introduction to Operations Research: https://nptel.ac.in/courses/110106062
3. Introduction to Project Management (Unit 11): https://nptel.ac.in/courses/110107141

Project Phase – II			
Semester	**VII**	CIE Marks	**100**
Course Code	**23MESE409**	SEE Marks	**100**
Hrs/Week (L: T: P)	**0:0:12**	Exam Hrs	**3**
		Credits	**6**

Objectives: This course is designed to

1. Enable students to execute, validate, and communicate the engineering solution to the identified problem conceptualized in Project Phase – I
2. Motivate students to extend their project work toward research publications, patent filing, funding proposals, or technology transfer, where applicable

General Guidelines for CIE procedure:

1. The Department project coordinator will take the responsibility of monitoring all the activities related to the project execution.
2. The HOD shall constitute project evaluation/review committee(s) & the composition shall be as follows:
    a. HOD or one of the HODs in case of an interdisciplinary project, shall be the Chairman of the committee
    b. Project Coordinator shall be member - Convener
    c. Project guide shall be the member
    d. One/Two senior faculty members nominated by the HOD (may be from different departments in case of an interdisciplinary project jointly nominated by the HODs)
3. Project teams must implement the problem identified using the proposed methodology through systematic experimentation and/or simulation leading to a functional solution or validated outcome in consultation with their project guide.
4. Each project team shall maintain a project diary and record their project progress at regular interval of time. This shall carry signature of the students and the project guide.
5. Marks may be equally or proportionally distributed among team members based on contribution assessed by the guide and committee.
6. A student shall obtain minimum of 40% of the total CIE marks to gain eligibility for SEE

General Guidelines for SEE procedure:

1. The Department project coordinator will take the responsibility of all the requirements for successful conduction of the SEE.
2. SEE for project work will be conducted by two examiners (one internal examiner and the other an external examiner) appointed by the Controller of Examinations.
3. Project teams must present their projects that have been executed and completed with a functional solution or validated outcome during the SEE.

4. Each project team shall bring to the SEE a project report that shall carry signature of the students, project guide, HOD and the Principal. Plagiarism, data fabrication, or copying of work will result in stringent disciplinary action and /or penalties. (Note: Any disciplinary actions or penalties will be as per institutional policy.)
5. Marks may be equally or proportionally distributed among team members based on contribution assessed by the examiners.
6. A student shall obtain minimum of 40% of the total SEE marks to pass this course.

Deliverables:

1. Comprehensive Project Report comprising of:
    - Abstract
    - Introduction
    - Literature Survey
    - Problem Definition
    - Proposed Methodology
    - Design
    - Implementation
    - Results and discussion
    - References
    - Appendices

   The project report shall be prepared in the prescribed format provided by the institute.
2. A plagiarism report shall be obtained from the Department of Library. Acceptable similarity threshold is generally below 20%, and hence, the plagiarized content shall not exceed 20%. Similarity above 20% will require resubmission after proper revisions.

Review and Evaluation for CIE:

1. There shall be two reviews and a presentation. Total of 100 CIE marks is distributed as follows:

Review - 1	
Phase wise execution of proposed solution	20 Marks
Use of modern tools for proposed solution	10 Marks
Contribution as an individual and team member	10 Marks
Total	**40 Marks**
Review - 2	
Complete Implementation and Demonstration of Modules	15 Marks
Report Quality & Formatting	15 Marks
Total	**30 Marks**

Presentation	
Presentation	20 Marks
Team work	10 Marks
Total	**30 Marks**
Grand Total	**100 Marks**

2. First review shall be conducted after one month from the start of the semester.
3. Every department shall develop rubrics to assess performance of the students based on the above given parameters.

Evaluation for SEE:

1. There shall be a presentation for SEE. Total of 100 SEE marks is distributed as follows:

SEE	
Execution of proposed solution	40 Marks
Evaluation of Project Report	30 Marks
Project presentation & Question and Answer	30 Marks
Total	**100 Marks**

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

1. Execute the problem identified using the methodology proposed through systematic design, development, experimentation, and/or simulation, leading to a functional solution or validated outcome
2. Translate theoretical concepts into practical implementation while considering constraints such as feasibility, cost, sustainability, safety, ethics, and societal relevance
3. Exhibit the resourcefulness to act independently as well as collaboratively within a team in overcoming technical challenges encountered during project execution
4. Plan tasks effectively, manage time and resources, meet defined milestones, and adhere to deadlines, reflecting professional engineering practice
5. Prepare a comprehensive project report that clearly documents design decisions, implementation details, experimental results, analysis, and conclusions using standard technical writing practices
6. Confidently present the project work through reviews, demonstrations, seminars, and viva-voce examinations, addressing questions from peers, faculty, and examiners

Constitution of India & Professional Ethics			
Semester	**VII**	CIE Marks	**100**
Course Code	**23HMCC421**	SEE Marks	**-**
Teaching Hrs/Week (L: T: P)	**1:0:0**	Exam Hrs	**-**
Total Hrs	**13**	Credits	**1**

Course Objectives: This course is designed to

1. Introduce the foundational principles and features of the Indian Constitution
2. Familiarize the Fundamental Rights and Directive Principles
3. Provide an understanding of Union and State government policies and Electoral Process
4. Develop awareness on Sustainable development goals, energy conservation and climate change
5. Inculcate Ethical responsibilities and Code of Conduct

Module 1: Introduction to the Indian Constitution	**No. of Hrs: 2**

Definition and Significance of the Constitution, Making of the Constitution, Constituent Assembly, Preamble, Salient features of the Indian Constitution, Amendments, Schedules and Citizenship

Module 2: Fundamental Rights and Duties	**No. of Hrs: 4**

Fundamental Rights: Right to Equality, Right to Freedom, Right to Life & Personal Liberty, Right against Arbitrary arrest and Preventive Detention, Right against Exploitation, Right to Religion, Cultural & Educational Rights and Right to Constitutional Remedies, Restrictions and Limitations, Directive Principles of State Policy and its relevance in the society, Fundamental Duties of Citizens

Module 3: Union and State Government Structure	**No. of Hrs: 3**

Union Govt: Union Legislature- Parliament-Lok Sabha and Rajya Sabha, Sessions of Parliament, Parliamentary System, Parliamentary Committees, Important Parliamentary Terminologies.

Union Executive– President, Prime Minister, Union Cabinet, Union Council of Ministers

Union Judiciary-Supreme Court of India, Judicial Review and Judicial Activism

State Govt: State Legislature- State Legislative Assembly, State Legislative council,

State Executive- Governor, Chief Minister, State Cabinet, State Council of Ministers,

State Judiciary- High Court and Subordinate Courts

Elections: Election Commission of India, Process and Laws

Emergency Provisions

Module 4: Ethics and Sustainable Development	**No. of Hrs: 2**

Ethics: Values and types, Honesty, Trust, Integrity and Reliability in Engineering, Sustainable development goals, energy conservation, sustainable developments, Environmental Ethics: climate change and ethical responsibility

Module 5: Professional Ethics for Engineers	**No. of Hrs: 2**
Scope & Aims, Code of Ethics, Professional responsibility, Accountability, Research Ethics, Clash of Ethics (example with respect to technology), Conflicts of Interest, Risks, Safety, Liability and Corporate Social Responsibility	

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

1. State the preamble and the basic features of the Indian Constitution
2. Explain the Fundamental Rights, Directive Principles of State Policy and their relevance in contemporary Indian society
3. Compare the functioning of the Union and State legislature, Executive and Judiciary
4. Classify Ethical, Virtues and explain sustainable development goals and climate change
5. Outline the Aims, Code of Ethics, and principles of Corporate Social Responsibility

Textbooks:

1. Raja Ram, M., Constitution of India & Professional Ethics, 3rd Edition, New Age International Publishers, 2015
2. Dr. Tharanath, Santhosh Prabhu & Suma Suresh Kogilgeri, Constitution of India & Professional Ethics, Pristine Publishing House, 2018
3. Sharma Brij Kishore, Introduction to the Constitution of India, 8th Edition, PHI Learning Pvt. Ltd., 2011
4. Charles E Harris, Michael S. Pritchard & Michael J. Rabins, Engineering Ethics: Concepts and Cases, 1st Edition, IEEE / Cengage, 2018
5. Iqbal, Jaquir, SDG – Sustainable Urban Development: Challenges, Achievements & Opportunities, 1st Edition, Global Vision Publishing House, 2013

Web links:

1. Making of the Indian Constitution - https://www.youtube.com/watch?v=Z5nQ4xea9ts
2. Parts, Articles and Schedules of the Indian Constitution - https://www.youtube.com/shorts/TJRdYarLPYI
3. The Indian Constitution - https://www.youtube.com/watch?v=vXvlSXlmkyM
4. Professional Engineering Ethics - https://www.youtube.com/watch?v=SVz6Q7EoBJM
5. Sustainable Development Goals- https://www.youtube.com/watch?v=qAIolKgDPrA

Internship			
Semester	**VIII**	CIE Marks	**100**
Course Code	**23MESE431**	SEE Marks	**100**
Hrs /Week (L: T: P)	-	Exam Hrs	**03**
Total Hrs	-	Credit	**12**

Objectives: This course is designed to

1. Bridge the gap between academic learning and real-world engineering practice
2. Provide hands-on experience in industry, research and incubation environments
3. Develop technical, analytical, and professional skills
4. Expose students to organizational structure, workflow, and workplace ethics
5. Enhance employability, innovation, and lifelong learning capabilities

Preamble:

Internship refers to the position of a student as trainee or a temporary (or unconfirmed) employee, who works in an organization, with or without pay/stipend, in order to gain work experience or satisfy requirements for a qualification. It is a structured, supervised professional experience in an industry, research organization, or incubation centers.

Internships play a vital role in bridging the gap between theoretical education and professional practice. In general, engineering internships serve as a crucial component of professional education by providing experiential learning, industry readiness, and holistic skill development, ultimately producing competent engineers or entrepreneurs. Apart from these, it develops professional ethics, work culture awareness and communication skills.

Types of Internships:

Following are the types of internships:

i. **Industry Internship:** Carried out in the engineering industry, companies, manufacturing units, startups, business, IT industry. The topic involved may be technical, managerial, production-related tasks, live projects, or innovative activities.

ii. **Research Internship:** Carried out at universities, research labs, or R&D departments or organizations. The internship involves literature review, data analysis, and experimental work leading to publications, prototypes, technical reports or innovations. The research internship may induce students to plan for higher studies or academic careers.

iii. **Entrepreneurship Internship:** Undertaken in association with start-ups, or entrepreneurship cells or launching own idea in Preincubation/Incubation centers. The internship offers exposure to business planning, prototype, product development, and promotes innovation, risk-taking, and entrepreneurial mindset.

iv. **Post-Placement Internship:** Refers to the internship offered to students after they receive a confirmed job offer (placement) from a company, but before formally joining as full-time employees. This internship (on-site, virtual, or hybrid) ensures that students are groomed to be professionally ready, technically competent, and culturally aligned with the organization even before official induction.

General Guidelines:

1. The official engagement period of 15-week for students selected/recruited by the company/ organization only at their premises under the supervision of the company, shall only be considered as an internship.
2. The period of training and working of students who have been recruited as employees by organizations at the beginning of the 4th year of the program, shall also be treated as an internship.
3. The assigned faculty mentor/coordinator/guide should monitor the student's progress, and document offer letters, training reports, attendance, and evaluations for awarding academic credits.
4. All students undergoing an internship, should adhere to all the guidelines, reporting protocols, and evaluation procedures prescribed by the Institution and the company.
5. Students must submit the certificate of completion of an internship with the period of internship clearly mentioned, from the respective company/organization.

Procedure for CIE:

1. The Department Internship coordinator identified by the HOD will take the responsibility of monitoring all the activities related to the Internship.
2. The HOD shall constitute Internal Internship evaluation/review committee & the composition shall be as follows:
    a. HOD shall be the Chairman of the committee
    b. Internship Coordinator shall be member – Convener
    c. Internal Internship Guide shall be member
    d. Two senior faculty members nominated by the HOD shall be the members
3. The External Internship evaluation/review committee shall be composed of industry supervisor/external guide. For evaluation, the industry supervisor/external guide may join the review in online mode.
4. The internal evaluation shall be conducted by the departmental review committee based on the student's internship progress, documentation, and presentation which will comprise the student's daily report, focusing on the regularity, completeness, and clarity of the internship logbook/diary; the deliverables and outcomes, considering the quality of work, relevance, and achievement of the stated objectives; and the presentation skills, assessing clarity, communication effectiveness, and the ability to present the work in a structured and professional manner.
5. The external evaluation shall be carried out by the industry supervisor/external guide based on the student's performance at the workplace which will comprise the student's technical knowledge, assessment of the understanding and application of domain-specific concepts during the internship; work ethics, considering professionalism, punctuality, discipline, and adherence to organizational practices; deliverables and outcomes, evaluating the quality and completion of assigned tasks; and the ability to

learn independently, adapt to new and emerging technologies, and exhibit critical thinking, reflecting the student's capacity for continuous learning, problem-solving, and adaptability in a professional environment.

Procedure for SEE:

1. SEE for Internship will be conducted by two examiners (one internal examiner and the other an external examiner) appointed by the Controller of Examinations.
2. Students must present their Internship work to the examiners.
3. Each student shall bring to the SEE, an Internship report which includes the Internship Completion Certificate from the organization. The report shall also carry signatures of the student, Internship guides (Internal & External), HOD and the Principal.

Deliverables:

1. Internship Daily Report
2. Final Internship Report
3. Internship Completion Certificate

Evaluation for CIE:

There shall be two reviews and a presentation. Total of 100 CIE marks is distributed as follows:

Review – 1 & 2 (Internal Internship Evaluation Committee)	
Internship Daily Report	10 Marks
Deliverables and Outcomes	10 Marks
Presentation Skills	05 Marks
Review – 1 Total	**25 Marks**
Review – 2 Total	**25 Marks**
Review – 1 & 2 (External Internship Evaluation Committee)	
Technical Knowledge	10 Marks
Work Ethic	05 Marks
Deliverables and Outcomes	05 Marks
Ability to Learn, Adapt & Critical Thinking	05 Marks
Review – 1 Total	**25 Marks**
Review – 2 Total	**25 Marks**
Grand Total	**100 Marks**

Evaluation for SEE:

Total of 100 SEE marks is distributed as follows:

SEE (Internal & External Examiners)	
Internship Report	70 Marks
Final Presentation	30 Marks
Grand Total	**100 Marks**

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

1. Apply engineering knowledge to real-world industrial or societal problems
2. Demonstrate technical competency in a professional environment
3. Analyze and solve practical engineering problems using modern tools / techniques
4. Communicate effectively through reports and presentations
5. Exhibit professional ethics, teamwork, and adaptability
6. Inculcate industry practices, workflows, and organizational behavior

Publication / Patenting			
Semester	**VIII**	CIE Marks	**100**
Course Code	**23MESE432**	SEE Marks	-
Hrs/Week (L: T: P)	-	Exam Hrs	-
Total Hrs	-	Credit	**02**

Objectives: This course is designed to

1. Enable students to systematically document literature review and research gaps
2. Train students in research paper writing and publication process
3. Provide knowledge of patentability search and drafting patent applications
4. Motivate students to publish research work or file patents
5. Inculcate ethical research practices

Procedure for CIE:

1. The project guide from Project Phase I / II shall continue as the research guide, ensuring continuity in converting the completed project work into a research publication or patent.

2. Students shall derive research contributions from their completed project work, focusing on:
a. Accurately representing experimental results
b. Providing evidence for validated outcomes / effective performance
c. Explicit mention of novelty / innovation

3. The evaluation shall be carried out based on the following three major components:
Component 1: Literature Review & Manuscript / Patent Drafting
a. Comprehensive literature survey and identification of research gap
b. Structuring of research paper / patent document
c. Technical depth, methodology, and clarity of presentation
d. Patentability analysis (in case of patent track)

Component 2: Submission / Filing
a. Submission of manuscript to a reputed Scopus / SCI /WoS indexed journal
OR
Filing of a patent application with appropriate authority
b. Submission proof (acknowledgement / application number) is mandatory

Component 3: Publication / Patent Outcome
Publication of article in Scopus / SCI / WoS indexed journal
OR
Publication of patent

4. Marks shall be awarded proportionately based on:
   a. Paper publication status (accepted / published)
   b. Patent filing / publication status

5. Students must ensure originality and adherence to ethical practices, including proper citation and avoidance of plagiarism.

6. A plagiarism report shall be submitted, with similarity generally not exceeding 10%, failing which revision and resubmission is required.

7. Progress shall be monitored through periodic reviews by the departmental committee, focusing on:
   a. Conversion of project work into quality manuscript / patent
   b. Quality of manuscript / patent drafting
   c. Readiness for submission / publication

8. The HOD shall constitute publication/patenting evaluation/review committee(s) & the composition shall be as follows:
   a. HOD or one of the HODs in case of an interdisciplinary project, shall be the Chairman of the committee
   b. Coordinator shall be member - Convener
   c. Guide shall be the member
   d. One/Two senior faculty members nominated by the HOD (may be from different departments in case of an interdisciplinary project jointly nominated by the HODs)

Deliverables:

1. Literature Review Report / Patentability Report
   a. Representation of problem identification
   b. Representation of gap analysis
   c. Survey of recent literature / prior art

2. Manuscript / Patent Draft
   Structured manuscript (Abstract, Introduction, Methodology, Results, References)
   OR
   Patent Draft (Title, Abstract, Claims, Description, Drawings)

3. Submission Proof
   Journal submission acknowledgement / Patent filing receipt

4. Paper Publication / Patent Filing / Patent Publication Evidence

Evaluation for CIE:

Total of 100 CIE marks is distributed as follows:

Sl. No.	Description	Marks
1.	Literature Review, Research Paper Writing / Patentability Search, Drafting the Patent Application	50
2.	a. Submission & Acceptance of manuscript (Scopus / SCI / WoS) OR b. Filing a Patent Application	30
3.	a. Publication of Article (Scopus / SCI / WoS) OR b. Publication of Patent	20
	Total	**100**

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

1 Systematically document literature review and gaps in a specific domain.

2 Prepare a structured research manuscript or patent document following standard guidelines

3 Perform patentability search and analyze prior art for innovation feasibility

4 Demonstrate the ability to submit research work to journals or file patent applications

5 Apply ethical practices in research, including plagiarism avoidance and proper citation