Fourth Year BE

SCHEME & SYLLABUS

Autonomous Scheme 2021-22

Mechanical Engineering

ST JOSEPH ENGINEERING COLLEGE

AN AUTONOMOUS INSTITUTION

Vamanjoor, Mangaluru - 575028

MOTTO

Service and Excellence

VISION

To be a global premier Institution of professional education and research

MISSION

- Provide opportunities to deserving students of all communities, the Christian students in particular, for quality professional education
- Design and deliver curricula to meet the national and global changing needs through student-centric learning methodologies
- Attract, nurture and retain the best faculty and technical manpower
- Consolidate the state-of-art infrastructure and equipment for teaching and research activities
- Promote all-round personality development of the students through interaction with alumni, academia and industry
- Strengthen the Educational Social Responsibilities (ESR) of the Institution

ST JOSEPH ENGINEERING COLLEGE

An Autonomous Institution

Vamanjoor, Mangaluru - 575028

Affiliated to VTU – Belagavi & Recognized by AICTE New Delhi
NBA – Accredited: B.E.(CSE,ECE,EEE, ME and CIV) & PG (MBA and MCA)
NAAC – Accredited with A+

B.E. SCHEME & SYLLABUS

(With effect from 2021-22)

MECHANICAL ENGINEERING

FOURTH YEAR

(VII and VIII Semester)

AUTONOMY AND ACCREDITATION

St Joseph Engineering College (SJEC) is an Autonomous Institute under Visvesvaraya Technological University (VTU), Belagavi, Karnataka State, and is recognized by the All-India Council for Technical Education (AICTE), New Delhi. SJEC is registered under the trust "Diocese of Mangalore, Social Action Department".

The SJEC has been conferred Fresh Autonomous Status from the Academic Year 2021-22. The college was granted autonomy by the University Grants Commission (UGC) under the UGC Scheme for Autonomous Colleges 2018 and conferred by VTU. The UGC Expert Team had visited the college on 28-29 November 2021 and rigorously assessed the college on multiple parameters. The fact that only a handful of engineering colleges in the state have attained Autonomous Status adds to the college's credibility that has been on a constant upswing. Autonomy will make it convenient for the college to design curricula by recognizing the needs of the industry, offering elective courses of choice and conducting the continuous assessment of its students.

At SJEC, the Outcome-Based Education (OBE) system has been implemented since 2011. Owing to OBE practised at the college, SJEC has already been accredited by the National Board of Accreditation (NBA). Five of the UG programs, namely Computer Science & Engineering, Mechanical Engineering, Electronics and Communication Engineering, Electrical & Electronics Engineering and Civil Engineering and two of the PG programs, namely, MBA and MCA programs, have accreditation from the NBA.

Also, SJEC has been awarded the prestigious A+ grade by the National Assessment and Accreditation Council (NAAC) for five years. With a Cumulative Grade Point Average (CGPA) of 3.39 on a 4-point scale, SJEC has joined the elite list of colleges accredited with an A+ grade by NAAC in its first cycle. The fact that only a small percentage of the Higher Education Institutions in India have bagged A+ or higher grades by NAAC adds to the college's credibility that has been on a constant upswing.

The college is committed to offering quality education to all its students, and the accreditation by NAAC and NBA reassures this fact. True to its motto of "Service and Excellence", the college's hard work has resulted in getting this recognition, which has endorsed the academic framework and policies that the college has been practising since its inception. The college has been leveraging a flexible choice-based academic model that gives students the freedom to undergo learning in respective disciplines and a transparent and continuous evaluation process that helps in their holistic development.

CONTENTS

ABOUT THE DEPARTMENT

The Department of Mechanical Engineering was established in the year 2002 with the vision of nurturing technically competent and socially responsible Engineering Professionals. Alma mater to more than 1700 Graduate Engineers over the past 17 glorious years; the Mechanical Engineering Department, SJEC, strives to prepare students for careers across a broad range of industries such as automotive, manufacturing, materials and metallurgy, oil and gas, and aeronautical. Mechanical Engineering encompasses learning the application of physical principles of heat, force, conservation of mass and energy, design of mechanisms and machine elements, system design, manufacturing and maintenance of industrial machinery, etc. Thrust is laid on teaching CAD/CAM tools along with latest design tools, to keep the students abreast with modern technologies in the discipline of Mechanical Engineering. The Department offers Undergraduate (B.E.), Post Graduate (M.Sc. in Engineering by Research), and Doctoral (Ph.D.) programme; with an annual intake of 120 candidates for B.E. Course. The Department of Mechanical Engineering at SJEC is one of the few Departments in the region to secure NBA Accreditation since 2013 and the Department has also got permanent affiliation status from VTU Belagavi from 2019-20 to 2024-25.

DEPARTMENT VISION

To be a value-based department committed to excellence in teaching and research, nurturing technically competent and socially responsible engineering professionals

DEPARTMENT MISSION

- Providing state-of-the-art technical knowledge in Mechanical Engineering.
- Promoting research, education and training in frontier areas of Mechanical Engineering.
- Facilitating faculty development through quality improvement programmes.
- Initiating collaboration with industries, research organizations and institutes for internship, joint research and consultancy.
- Instilling social and ethical values in students, staff and faculty through personality development programmes.
- Developing innovation in engineering and technology in order to provide beneficial service to the local community.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. Graduates will engage in designing, manufacturing, testing, operating and/or maintaining systems in the field of Mechanical Engineering and allied industries.

2. Graduates will be able to communicate and perform effectively in both individual and team-based project environments, including multi-disciplinary settings.

3. Graduates will apply knowledge and skills considering ethical practices, societal, economic and environmental factors and/or pursue higher education and research.

4. Graduates will develop the practice of continuously updating themselves with the latest knowledge and information in their field of specialization.

PROGRAM OUTCOMES (POs)

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. Conduct investigations on complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and the synthesis of information to provide valid conclusions.

5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and a leader in a team, to manage projects and in multidisciplinary environments.

12. Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of the Mechanical Engineering program are able to

PSO1: Take up research programs on contemporary areas of Mechanical engineering.

PSO2: Gain competence to face various competitive examinations and succeed in seeking the best opportunities in the corporate world and higher studies.

VII Semester (B.E. – Mechanical Engineering)													
Sl. No.	**Course and Course Code**		**Course Title**	**Teaching Department**	**Paper Setting Board**	**Teaching Hours/Week**			**Examination**				**Credits**
						Theory Lecture	**Tutorial**	**Practical/ Drawing**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total**	
						L	**T**	**P**					
1	PCC	21MEC701	Automation and Robotics	MEC	MEC	3	-	-	03	50	50	100	3
2	PCC	21MEC702	Control Engineering	MEC	MEC	2	2	-	03	50	50	100	3
3	PEC	21MEC703X	Professional Elective - 2	MEC	MEC	3	-	-	03	50	50	100	3
4	PEC	21MEC704X	Professional Elective - 3	MEC	MEC	3	-	-	03	50	50	100	3
5	OEC	21MEC705X	Open Elective - 2	MEC	MEC	3	-	-	03	50	50	100	3
6	SDC	21MES706	Technical Seminar	MEC	MEC	-	-	2	-	100	-	100	1
7	SDC	21MEP707	Major Project Work (Phase I & II)	MEC	MEC	-	-	6	03	50	50	100	5
					Total	**14**	**02**	**08**	**18**	**400**	**300**	**700**	**21**

21MEC703X : Professional Elective II					
21MEC7031	Design for Manufacturing	21MEC7033	Artificial Intelligence for Mechanical Engineers	21MEC7035	Production and Operation Management
21MEC7032	Supply Chain Management	21MEC7034	Theory of Plasticity		
21MEC704X : Professional Elective III					
21MEC7041	Additive Manufacturing	21MEC7043	Mechatronics		
21MEC7042	Project Management	21MEC7044	Computational Fluid Dynamics		

21MEC705X : Open Elective II					
21MEC7051	Industrial Safety	21MEC7053	Maintenance Engineering	21MEC7055	Nanoscience and Technology
21MEC7052	Energy Auditing	21MEC7054	Non-traditional Machining		

VIII Semester (B.E. – Mechanical Engineering)														
Sl. No.	**Course and Course Code**		**Course Title**	**Teaching Department**	**Paper Setting Board**	**Teaching Hours/Week**			**Examination**				**Credits**
						Theory Lecture	**Tutorial**	**Practical/ Drawing**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total**	
						L	**T**	**P**					
1	SDC	21AEC801	MOOC	Any MOOC topic (Choices are given by respective Department) with minimum 8 weeks to be completed between III Sem to VIII Sem								100	2
2	SDC	21MEP802	Major Project Work (Final Presentation and Report Submission)	MEC		-	-	-	03	50	50	100	5
3	INT	21INT803	Research / Industry Internship			-	-	-	03	50	50	100	10
					Total	-	-	-	**06**	**100**	**100**	**300**	**17**

Research Internship / Industry Internship is to be carried out during the 8th semester for 15 weeks.

AICTE Activity Points to be earned by students admitted to BE/B.Tech/B. Plan day college programme (For more details refer to Chapter 6, AICTE Activity Point Programme, Model Internship Guidelines): Over and above the academic grades, every student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry. The Activity Points earned shall be reflected on the student's eighth semester Grade Card. The activities can be can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VII Semester

AUTOMATION AND ROBOTICS			
Course Code	21MEC701	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: This course will enable students

- To identify potential areas for automation and justify need for automation.
- To select suitable major control components required to automate a process or an activity.
- To study the various parts of robots and fields of robotics.
- To study the various kinematics and inverse kinematics of robots.
- To study the control of robots for some specific applications.

Module-1 Introduction to Automation (8 hours)

Basic elements of an automated system, advanced automation functions, levels of automation, process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control. Hardware components for automation and process control, sensors, actuators, analog to digital converters, digital to analog converters, input/output devices for discrete data.

Module-2 Automated Production Lines (8 hours)

Fundamentals of automated production lines, application of automated production lines, analysis of transfer lines, automated assembly systems, fundamentals of automated assembly systems, quantitative analysis of assembly systems.
Automatic identification methods, barcode technology, radio frequency identification, and other AIDC technologies.

Module-3 Industrial Robotics (8 hours)

Robotic configuration, robot anatomy and related attributes, robot control systems, sensors in robotics, robot accuracy and repeatability, industrial robot applications.
Robot end effectors: Types of end effectors, Mechanical grippers and their mechanisms, vacuum cups, magnetic grippers, hooks and scoops, tools as end effectors.
Different types of robots, various generations of robots, degrees of freedom – Asimov's laws of robotics.

Module-4 Spatial Descriptions and Transformations (8 hours)

Robot actuators and feedback components: Actuators: pneumatic, hydraulic actuators, electric & stepper motors, comparison. Position sensors –potentiometers, resolvers, encoders –Tactile sensors, Proximity sensors.
Manipulator Kinematics: Homogeneous transformations as applicable to rotation and translation -D-H notation, Forward and inverse kinematics.

Module-5 Robot Programming (8 hours)

Introduction, levels of robot programming, requirements of robot programming language, problems pertaining to robot programming languages, offline programming systems, central issues in OLP systems, automating subtasks in OLP systems, simple programs on robot applications.

Course Outcomes: At the end of the course the student will be able to:	
21MEC701.1	Outline the basics of automated systems, its control and hardware components required in case of manufacturing industries.
21MEC701.2	Analyze the given automated production line/assembly system for performance.
21MEC701.3	Identify suitable Automatic Identification and Data Capture (AIDC) technologies.
21MEC701.4	Explain the basics of industrial robotics: configuration, features, applications.

21MEC701.5	Describe the types of robot sensors, actuators and manipulator kinematics.
21MEC701.6	Apply the basic principles of robot programming to simple applications.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Automation Production Systems and Computer Integrated Manufacturing	Mikell P. Groover	Pearson Education Pvt Ltd	4th Edition, 2017
2	Introduction to Robotics Mechanics and Control	John J. Craig	Pearson Education	4th Edition, 2022
Reference Books				
1	Robotics for Engineers	Yoram Koren	McGraw Hill International	1st Edition, 1985
2	Industrial Robotics	Mikell P. Groover	McGraw Hill International	3rd edition, 1986
3	Robotics and Control	Mittal R. K., and Nagrath I. J.	Tata Mc Graw Hill	1st edition, 2003

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/110105155 (Automation in Production Systems and Management)
- https://nptel.ac.in/courses/112103293 (Automation in Manufacturing)
- https://nptel.ac.in/courses/107106090 (Introduction to Robotics)
- https://nptel.ac.in/courses/112105236 (Mechanism and Robot Kinematics)
- https://nptel.ac.in/courses/112105249 (Robotics)

Course Articulation Matrix

	Program Outcomes (POs)													
Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC701.1	3	-	2	-	-	-	-	-	-	2	-	-	-	1
21MEC701.2	2	3	-	-	-	-	-	-	-	-	1	-	1	-
21MEC701.3	3	-	1	-	-	2	-	-	-	-	-	-	-	1
21MEC701.4	2	-	-	-	-	-	1	-	-	-	-	-	-	-
21MEC701.5	2	2	-	2	-	-	-	1	-	-	-	-	1	-
21MEC701.6	2	1	1	-	-	-	-	-	-	-	-	1	-	1

1: Low 2: Medium 3: High

CONTROL ENGINEERING			
Course Code	21MEC702	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	2:2:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: This course will enable students

- To develop comprehensive knowledge and understanding of modern control theory, industrial
- automation, and systems analysis.
- To model mechanical, hydraulic, pneumatic and electrical systems.
- To represent system elements by blocks and its reduction techniques.
- To understand transient and steady state response analysis of a system.
- To carry out frequency response analysis using polar plot, Bode plot.
- To analyze a system using root locus plots.

Module-1 Introduction (8 hours)

Introduction: Components of a control system, Open loop and closed loop systems. Types of controllers: Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral-Differential controllers.

Modelling of Physical Systems: Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems

Module-2 Time domain performance of control systems (8 hours)

Time domain performance of control systems: Typical test signal, Unit step response and time domain specifications of first order, second order system. Steady state error, error constants.

Module-3 Block diagram & Signal flow graphs (8 hours)

Block diagram & Signal flow graphs: Block diagram algebra, Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.

Module-4 Stability of linear control systems (8 hours)

Stability of linear control systems: Routh's criterion, Root locus, Determination of phase margin and gain margin using root locus.

Module-5 Stability analysis (8 hours)

Stability analysis: Stability analysis using Polar plot, Bode plot, Determination of phase margin and gain margin using Bode plot.

Course Outcomes: At the end of the course the student will be able to:	
21MEC702.1	Identify the type of controller and control actions.
21MEC702.2	Develop the mathematical model of the physical systems
21MEC702.3	Estimate the response and error in response of first and second order systems subjected standard step input
21MEC702.4	Represent the complex physical system using block diagram and signal flow graph and obtain transfer function.
21MEC702.5	Analyze a linear feedback control system for stability using Hurwitz criterion, Routh's criterion and root Locus technique in complex domain
21MEC702.6	Analyze the stability of linear feedback control systems in frequency domain using polar plots, and Bode plots

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Modern control Engineering	K. Ogata	Pearson	5th edition, 2010
2	Control Systems Engineering	I.J. Nagrath, & M .Gopal	New Age International (P) Ltd	5th edition, 2009
3	Control Systems Engineering	S Palani	Tata McGraw Hill Publishing Co Ltd	2nd edition, 2010
Reference Books				
1	Control Systems Engineering	Norman S Nice	Wiley India Pvt Ltd	4th edition, 2007
2	Modern control Systems	Richard C Dorf	Pearson	13th edition, 2016
3	Automatic Control Systems	Farid G., Kuo B. C	McGraw Hill Education	10th Edition, 2018

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/108/106/108106098/
- https://www.youtube.com/watch?v=RcuGxWc0HyQ
- https://www.youtube.com/watch?v=vVFDm__CdQw

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC702.1	3	3	-	-	3	-	-	-	-	-	-	-	2	-
21MEC702.2	3	3	-	-	3	-	-	-	-	-	-	-	2	-
21MEC702.3	3	3	-	-	3	-	-	-	-	-	-	-	2	-
21MEC702.4	3	3	-	-	3	-	-	-	-	-	-	-	2	-
21MEC702.5	2	2	-	-	3	-	-	-	-	-	-	-	2	-
21MEC702.6	2	2	2	-	3	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

DESIGN FOR MANUFACTURING			
Course Code	21MEC7031	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objective of the course is to

- Select proper materials and manufacturing processes for designing products/components by applying the relevant principles for ease and economic production.
- Identify faulty design factors leading to increased costs in producing mechanical components.
- Apply appropriate design tolerances – dimensional, geometric and true position tolerances for the production processes of mechanical components.
- Apply the concepts related to reducing machined areas, simplification by amalgamation and separation, clamp ability, accessibility etc., in the design of mechanical components.
- Analyze the design of castings, weldments, forgings, powder metallurgy components and suggest design modifications to reduce the cost.

Module 1 Introduction (8 Hours)

Introduction: Definition, need for DFM, DFM approach for cost reduction, general design guide lines of DFM, advantages and disadvantages, application of DFM in industries, Design for Quality Manufacturability, DFQM approach, designing for economical production. Design for Excellence (DFX).

Engineering Tolerancing: Basics of dimensional tolerancing, Redundancy, tolerance allocation, Review of relationship between attainable tolerance grades and different machining processes. Geometrical tolerances. Process capability, mean, variance, skewness, kurtosis, process capability indices- Cp, and Cpk. Cumulative effect of tolerance- Sure fit law and truncated normal law, problems.

Module 2 True positional theory & Selective Assembly (8 Hours)

True positional theory: Comparison between coordinate and true position method of feature location. True position tolerance- virtual size concept, concepts of datum and changing datum, floating and fixed fasteners, projected tolerance zone and functional gages. Concept of Zero true position tolerance. Simple problems on true position tolerancing.

Selective Assembly: Interchangeable part manufacture and selective assembly. Deciding the number of groups -model-1: group tolerance of mating parts equal, model- 2: total and group tolerances of shaft equal. Control of axial play- introducing secondary machining operations, and laminated shims; examples.

Module 3 Datum Features & Component Design (8 Hours)

Datum Features: Functional datum, datum for manufacturing, changing the datum; examples.

Component Design: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility. Designing for heat treatment, roller burnishing, and economical de-burring.

Module 4 Design of components with casting & welding considerations (8 Hours)

Design of components with casting considerations: Pattern, mould, and parting line. Cored holes and machined holes. Identifying the possible and probable parting lines. Casting requires special sand cores. Designing to obviate sand cores.

Welding considerations: Advantages of weldments over other design concepts, design requirements and rules, redesign of components for welding; case studies.

Module 5 Forging considerations & Design of components for powder metallurgy (8 Hours)

Forging considerations – Requirements and rules-redesign of components for forging and case studies.
Design of components for powder metallurgy- requirements and rules-case studies.
Design of components for injection moulding requirements and rules-case studies.

Course Outcomes**:** At the end of the course the student will be able to:	
21MEC7031.1	Identify the engineering materials used for manufacturing processes which will lead to economic production with compromising the quality.
21MEC7031.2	Analyze the fault in designs and provide solutions which can lead to reduced cost of manufacturing
21MEC7031.3	Apply knowledge of design tolerance for the production processes of mechanical components.
21MEC7031.4	Apply the concepts which can lead to simplification of process and machining area which economize the process.
21MEC7031.5	Analyze various process like castings, weldments, forgings, powder metallurgy and provide ideas for improvement.
21MEC7031.6	Analyze and examine the practical problems related to powder metallurgy and injection molding.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Engineering Design	Eggert, R.J	Pearson Education, Inc., New Jersey	1st edition 2004
2	Engineering Design: A Materials and processing Approach	Dieter, G.E.	McGraw Hill Co.Ltd	4th edition 2008
3	Handbook of Products Design for Manufacturing: A Practical Guide to Low-cost Production	Bralla, James G.	McGraw Hill, New York	1st edition 1986
Reference Books				
1	Hand book of product design	Geoffrey Boothroyd	Marcel Dekker inc	3rd edition 2010
2	Engineering Design	Matousek	R Blackie and Son Limited, Glasgow	1st edition 2004

Web links and Video Lectures (e-Resources):
- Injection moulding -NPTEL -https://www.youtube.com/watch?v=QxZ54WgYhnA
- Powder metallurgy – NPTEL- https://archive.nptel.ac.in/courses/113/106/113106098/
- DFMA – NPTEL - https://archive.nptel.ac.in/courses/107/103/107103012/

Course Articulation Matrix

Course	Program Outcomes (POs)													
Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7031.1	1	1	-	-	-	-	3	-	-	-	-	-	-	-
21MEC7031.2	1	2	-	-	-	-	3	-	-	-	-	-	-	-
21MEC7031.3	1	2	-	-	-	-	3	-	-	-	-	-	-	-
21MEC7031.4	1	2	-	-	-	-	3	-	-	-	-	-	-	-
21MEC7031.5	1	2	-	-	-	-	3	-	-	-	-	-	-	-
21MEC7031.6	1	-	-	-	-	-	3	-	2	2	-	-	-	-

1: Low 2: Medium 3: High

SUPPLY CHAIN MANAGEMENT			
Course Code	21MEC7032	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objective of the course is

- To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.
- To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management & design problems.
- To study the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.
- To understand the usage of SAP material management system

Module-1 Introduction (8 hours)

Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases –Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.

Strategic Sourcing Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base Supplier Development - World Wide Sourcing.

Module-2 Warehouse Management (8 hours)

Warehouse Management Stores management-stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement.

Supply Chain Network Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models.

Module-3 Supply Chain Network optimization models (8 hours)

Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design, decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.

Module-4 Current Trends (8 hours)

Current Trends: Supply Chain Integration - Building partnership and trust in Supply Chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring, Supply Chain

Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Future of IT in supply chain- E Business in supply chain

Module-5 Introduction to SAP (8 hours)

Introduction to SAP, SAP Material Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase Info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code.

Course Outcomes: At the end of the course the student will be able to:	
21MEC7032.1	Describe the framework and scope of supply chain management.
21MEC7032.2	Build and manage a competitive supply chain using strategies, models, techniques and information technology.
21MEC7032.3	Plan the demand, inventory and supply and optimize supply chain network.
21MEC7032.4	Discuss the emerging trends and impact of IT on Supply chain.
21MEC7032.5	Explain the basics of SAP material management system
21MEC7032.6	Present the applications of SAP in industry

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Supply Chain Management	Janat Shah	Pearson Education	1st edition, 2009
2	Supply Chain Management Strategy Planning and Operation	Sunil Chopra and Peter Meindl	PHI Learning / Pearson Education	1st edition, 2007
3	The SAP Materials Management Handbook	Ashfaque Ahmed,	CRC Press Publication	1st edition, 2014
Reference Books				
1	Business Logistics and Supply Chain Management	Ballou Ronald H	Pearson Education 5th Edition	1st edition, 2007
2	Designing and Managing the Supply Chain: Concepts, Strategies, and Cases	David Simchi-Levi, Philip Kaminsky	Tata McGraw-Hill	1st edition, 2005
3	Principles of Supply Chain Management	Joel D. Wisner, G. Keong Leong, KeahChoon Tan South-Western	Cengage Learning	1st edition, 2008

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mg45/preview
- https://nptel.ac.in/courses/110106045
- https://www.udemy.com/course/sap-mm-training/
- https://www.udemy.com/course/sap-s4hana-mm-sourcing-and-procurement/
- https://nptel.ac.in/courses/110105095

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7032.1	-	1	-	-	-	3	-	-	-	-	-	-	-	-
21MEC7032.2	2	-	-	-	-	-	-	-	1	-	-	-	-	-
21MEC7032.3	-	1	-	-	-	3	-	-	-	-	-	-	-	-
21MEC7032.4	2	1	-	-	-	-	-	-	-	-	-	-	-	-
21MEC7032.5	2	1	-	-	-	-	-	-	-	-	-	-	-	-
21MEC7032.6	-	2	-	-	-	3	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

ARTIFICIAL INTELLIGENCE FOR MECHANICAL ENGINEERS			
Course Code	21MEC7033	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: This course will enable students

- To introduce the fundamentals of Artificial Intelligence (AI)
- To explore Machine Learning (ML) techniques and its applications
- To examine the role of AI in robotics
- To understand Deep Learning and its engineering applications
- To apply AI techniques in mechanical manufacturing industries

Module-1 Introduction to Artificial Intelligence (8 hours)

Introduction to AI: Definition and scope of AI. History and evolution of AI. Basic concepts: Machine Learning, Deep Learning, Neural Networks.
AI Techniques: Supervised and unsupervised learning. Reinforcement learning. Natural Language Processing (NLP) and computer vision.
Problem Formulation and Problem-Solving Methods in AI Context: Understanding problem formulation in AI. Defining problems and solutions in AI context. Problem graphs and their importance. Techniques like matching, indexing, and heuristic functions. Algorithms such as Hill Climbing, Depth First Search (DFS), and Breadth First Search (BFS).

Module-2 Machine Learning and its Applications (8 hours)

Introduction to Machine Learning: Definitions and types of learning: supervised, unsupervised, and reinforcement learning. Natural Language Processing (NLP) and computer vision.
Machine Learning Algorithms: Linear regression and decision trees. Probability and Bayesian learning. Case Studies.

Module-3 Artificial Intelligence in Robotics (8 hours)

Reinforcement Learning in Robotics: Concepts of planning and search in robotics. Techniques for localization, tracking, mapping, and control.
Search and Optimization Algorithms: Understanding A* search and path smoothing algorithms.
Introduction to Simultaneous Localization and Mapping (SLAM) algorithms.
Applications in Robotics: AI for precision agriculture and assistance robots. Case studies demonstrating AI in robotics.

Module-4 Deep Learning and its Applications (8 hours)

Introduction to Deep Learning: Biological motivation for deep learning.
Deep Learning Algorithms: Applications of feed-forward neural networks. Recurrent neural networks (RNNs) and their applications. Convolutional neural networks (CNNs) and use cases in image and pattern recognition.
Real-world applications of deep learning in various domains.

Module-5 Application of Artificial Intelligence in Mechanical Manufacturing Industries (8 hours)

AI in Fault Diagnosis and Quality Inspection: Techniques for fault detection and diagnosis in mechanical systems. AI applications for quality control and inspection processes.
AI for Safety and Smart Materials: Enhancing workplace safety through AI. AI in material modelling and the development of smart materials.
AI in Automotive and Manufacturing: Applications in automobile engineering, including self-driving cars and autonomous vehicles. Concepts of auto parking systems and machine learning in machine tools.

Course Outcomes**:** At the end of the course the student will be able to:	
21MEC7033.1	Discuss the application of AI techniques to solve engineering problems in mechanical systems.
21MEC7033.2	Evaluate machine learning models to determine the best fit for engineering applications.
21MEC7033.3	Analyze AI-based robotic solutions that are used to enhance system performance and efficiency.
21MEC7033.4	Discuss the deep learning methods used to solve complex mechanical engineering tasks.
21MEC7033.5	Evaluate the effectiveness of AI applications in manufacturing processes.
21MEC7033.6	Predict and discuss the future application of AI in mechanical engineering applications.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Artificial Intelligence	Saroj Kaushik	Cengage Learning India	1st edition, 2011
2	Introduction to Machine Learning	Alpaydin Ethem	PHI Learning Pvt. Ltd.	3rd edition, 2015
3	Artificial Intelligence: A Modern Approach	Stuart Russell and Peter Norvig	Pearson Education	4th edition, 2022
4	Deep Learning with Applications Using Python: Chatbots and Face, Object, and Speech Recognition with TensorFlow and Keras	Navin Kumar Manaswi	Apress	1st edition, 2018
5	Introduction to AI Robotics	Robin R. Murphy	Bradford Books	2nd edition, 2019
Reference Books				
1	Artificial Intelligence in Mechanical and Industrial Engineering	Divya Zindani, J. Paulo Davim, Kaushik Kumar - Editors	CRC Press	1st edition, 2021
2	Soft Computing Techniques and Applications in Mechanical Engineering	Mangey Ram, J. Paulo Davim	IGI Global	1st edition, 2017
3	Artificial Intelligence and Machine Learning Applications in Civil, Mechanical, and Industrial Engineering (Advances in Computational Intelligence and Robotics)	Gebrail Bekda, Sinan Melih Nigdeli, Melda Yücel	Business Science Reference	1st edition, 2019

Web links and Video Lectures (e-Resources):

- https://www.coursera.org/learn/machine-learning - Online course
- https://see.stanford.edu/Course/CS223A - Introduction to Robotics
- https://www.fast.ai/ - Deep Learning Resources
- https://www.youtube.com/watch?v=4X1KwYTBcKI - AI for Manufacturing
- https://www.youtube.com/watch?v=Xn46OkueJbA - AI for Manufacturing
- https://robotics.umich.edu/academics/courses/online-courses/ - Online Courses

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7033.1	-	3	-	-	2	-	-	-	-	-	-	-	-	-
21MEC7033.2	-	-	3	-	-	2	-	-	-	-	-	-	-	-
21MEC7033.3	-	-	2	-	3	-	-	-	-	-	-	-	-	-
21MEC7033.4	-	3	-	-	2	-	-	-	-	-	-	-	-	-
21MEC7033.5	-	2	-	-	3	-	-	-	-	-	-	-	-	-
21MEC7033.6	-	-	-	-	3	-	3	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

THEORY OF PLASTICITY			
Course Code	21MEC7034	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L: T: P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: At the end of the course the student will be able to

- Develop a deep understanding of the fundamental principles and concepts underlying plasticity theory, including stress, strain, and plastic deformation mechanisms.
- Acquire the skills to analyse and solve problems related to plastic deformation in materials, applying mathematical and computational techniques.
- Apply plasticity theory to engineering applications, including the design and analysis of structures subjected to plastic deformation.
- Gain practical experience in conducting experiments to validate plasticity theories and understand material behaviour under various loading conditions.
- Explore advanced topics in plasticity theory, such as time-dependent behaviour, cyclic loading, and plasticity at the microscale.
- Develop the ability to critically evaluate research literature, experimental data, and theoretical models in the field of plasticity, fostering independent thinking and problem-solving skills.

Module-1 Brief review of fundamentals of elasticity (8 hours)

Brief review of fundamentals of elasticity: Concept of stress, stress invariants, principal Stresses, octahedral normal and shear stresses, spherical and deviatoric stress, stress transformation; concept of strain, engineering and natural strains, octahedral strain, deviator and spherical strain tensors, strain rate and strain rate tensor, cubical dilation, generalized Hooke's law, numerical problems.

Module-2 Plastic Deformation of Metals & Yield Criteria (8 hours)

Plastic Deformation of Metals: Crystalline structure in metals, mechanism of plastic deformation, factors affecting plastic deformation, strain hardening, recovery, recrystallization and grain growth, flow figures or Luder's cubes.

Yield Criteria: Introduction, yield or plasticity conditions, Von Mises and Tresca criterion, geometrical representation, yield surface, yield locus (two-dimensional stress space), experimental evidence for yield.

Module-3 Stress Strain Relations (8 hours)

Stress Strain Relations: Idealised stress-strain diagrams for different material models, empirical equations, Levy-Von Mises equation, Prandtl -Reuss and Saint Venant theory, experimental verification of Saint Venant's theory of plastic flow. Concept of plastic potential, maximum work hypothesis, mechanical work for deforming a plastic substance.

Module-4 Bending of Beams & Torsion of Bars (8 hours)

Bending of Beams: Stages of plastic yielding, analysis of stresses, linear and nonlinear stress strain curve, problems.

Torsion of Bars: Introduction, plastic torsion of a circular bar, elastic perfectly plastic material, elastic work hardening of material, problems.

Module-5 Slip Line Field Theory (8 hours)

Slip Line Field Theory: Introduction, basic equations for incompressible two-dimensional flows, continuity equations, stresses in conditions of plain strain, convention for slip lines, geometry of slip line field, properties of the slip lines, construction of slip line nets.

Course Outcomes**:** At the end of the course the student will be able to:	
21MEC7034.1	Comprehend stress, strain, deformations, relation between stress and strain and plastic deformation in solids.
21MEC7034.2	Interpret plastic stress-strain relations and associated flow rules.
21MEC7034.3	Perform stress analysis in beams and bars including Material nonlinearity.
21MEC7034.4	Analyze the yielding of a material according to different yield theory for a given state of stress.
21MEC7034.5	Apply plasticity theory to design engineering structures that can withstand deformation while meeting safety standards.
21MEC7034.6	Interpret the importance of plastic deformation of metals in engineering problems.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Theory of Plasticity	Chakraborty	Elsevier	3rd edition, 2006
2	Theory of Plasticity and Metal forming Process	Sadhu Singh	Khanna Publishers, Delhi	3rd edition, 1980
Reference Books				
1	Engineering Plasticity- Theory and Application to Metal Forming Process	R.A.C. Slater	McMillan Press Ltd.	1st edition, 1977
2	Basic Engineering Plasticity	DWA Rees	Elsevier	1st edition, 2007
3	Engineering Plasticity	W. Johnson and P. B. Mellor	Van NoStrand Co. Ltd	1st edition, 2000
4	Advanced Mechanics of solids	L. S. Srinath	Tata Mc. Graw Hill	3rd edition, 2009

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/105/105/105105177/
- https://home.iitk.ac.in/~pmd/me721.html

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7034.1	-	-	2	-	-	-	-	-	-	-	-	-	1	-
21MEC7034.2	-	2	-	-	-	-	-	-	1	-	-	-	-	-
21MEC7034.3	2	-	-	-	-	-	-	-	-	1	-	-	-	-
21MEC7034.4	-	-	-	-	2	-	-	-	-	-	-	-	-	3
21MEC7034.5	-	-	-	1	-	-	-	-	2	-	-	-	-	-
21MEC7034.6	-	-	2	-	-	-	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

PRODUCTION AND OPERATION MANAGEMENT			
Course Code	21MEC7035	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objective of the course is to enable students

- To grasp the basic principles, scope, and key distinctions between goods and services within the context of Operations Management.
- To analyze and apply decision-making frameworks, methodologies, and tools such as breakeven analysis and trade-offs in operations management.
- To learn and apply various forecasting models, both qualitative and quantitative, including linear regression and moving averages, to predict future operational needs.
- To understand and utilize strategies and techniques for aggregate planning and master scheduling, ensuring effective resource allocation and production scheduling.
- To gain proficiency in MRP and SCM, including the processes, benefits, and integration of ERP systems, along with effective procurement and vendor development strategies.

Module-1 Introduction and Decision Making (8 hours)

Introduction: Production of Goods Versus Providing Services, the operation management function, The Scope of Operations Management, Types and Characteristics of Manufacturing and Service Systems, Productivity, its improvement and factors affecting productivity and topic related numerical.

Operations Decision Making: Characteristics of Decisions, Framework for Decision Making, Decision Methodology, decision making environments, Economic Models and Statistical Models. Breakeven- analysis and trade-offs. (Topic related numerical)

Module-2 Forecasting (8 hours)

Steps in forecasting process, forecasting as a planning tool, approaches to forecasting, forecasts based on judgment and opinion, analysis, forecasting models: qualitative forecasting techniques, quantitative forecasting models- linear regression, moving average, exponential smoothing, Numerical problems.

Module-3 Aggregate Planning & Master Scheduling (8 hours)

Nature and scope of aggregate planning, strategies of aggregate planning, techniques for aggregate planning – graphical and charting techniques, mathematical techniques. The master production schedule, Master scheduling process, Master scheduling methods.

Module-4 Material Requirement Planning (8 hours)

MRP and ERP: Introduction, MRP Inputs, processing, outputs, MRP in Services, Benefits and Requirements of MRP, numerical, Capacity Requirements Planning, MRP II and ERP.

Module-5 Supply Chain Management (8 hours)

Purchasing and Supply Chain Management (SCM): Introduction, Importance of purchasing and SCM, the procurement process, Concept of tenders, Approaches to SCM, Vendor development.

Course Outcomes: At the end of the course the student will be able to:	
21MEC7035.1	Describe various economical and financial cost/benefits of operations management by conducting investigation of developments in the field and explain why it is vitally important to adopt new developments in the field.
21MEC7035.2	Explain the need of decision making and forecasting technique by comprehending technical literature and solve problems within the context of syllabus.
21MEC7035.3	Identify the task and resources required to complete the aggregate planning and MPS for a given case study.

21MEC7035.4	Examine and apply moral and ethical principles to historical case studies of the SCM by conducting investigation.
21MEC7035.5	Determine the Material Requirement Planning and techniques used for a given case study
21MEC7035.6	Analyze the current operations management strategies adopted by the SMEs within the DK District

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Operations Management	William J Stevenson	Tata McGraw Hill	13th edition, 2018
2	Operations Management: Theory and Practice	B. Mahadevan	Pearson Education	3rd edition, 2015
Reference Books				
1	Production and Operations Management	K. Aswathappa, K Shridhara Bhat	Himalaya Publishing House	1st edition, 2015
2	Operations Management Along Supply Chain	Russell and Taylor	John Wiley Publications	6th edition, 2015

Web links and Video Lectures (e-Resources):

- http://nptel.ac.in/courses/110106045/
- https://www.youtube.com/watch?v=_VJkKZFuRvE&list=PL4FjpOEssq4HuaN7Q3pU9mL5uZuPBV_tF
- https://www.youtube.com/watch?v=aSd8Hbg-tuY&list=PLLy_2iUCG87A-kHGx4YUY97ShTTqBfA6-
- https://nptel.ac.in/courses/112/107/112107238/
- https://www.edx.org/course/operations-management-0

Course Articulation Matrix

Course	Program Outcomes (POs)													
Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7035.1	3	-	-	-	-	2	-	-	-	-	-	-	-	-
21MEC7035.2	2	-	-	-	-	1	-	-	-	-	1	-	-	-
21MEC7035.3	-	2	-	-	-	2	-	-	-	-	2	-	-	-
21MEC7035.4	3	-	-	-	-	2	-	2	-	-	-	-	-	-
21MEC7035.5	-	2	-	-	-	1	-	-	-	-	2	-	-	-
21MEC7035.6	-	2	-	-	-	2	-	2	-	-	-	-	-	-

1: Low 2: Medium 3: High

ADDITIVE MANUFACTURING			
Course Code	21MEC7041	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L: T:P)	3:0:0	SEE	3 Hours
Total Hours	40	Credits	03

Course Learning Objectives: This course will enable students

- To understand the principal methods, areas of usage, possibilities, and limitations of Additive Manufacturing technologies.
- To familiarize yourself with the characteristics of different materials used in Additive Manufacturing.
- To understand the principles of polymerization and powder metallurgy processes, extrusion-based systems, printing processes, sheet lamination processes, beam deposition processes, direct write technologies, and direct digital manufacturing.
- To exposure to process selection, software issues, and post-processing techniques.

Module-1 Introduction and Basic Principles (8 hours)

Introduction and Basic Principles: The Need for Additive Manufacturing (Rapid Prototyping), Generic AM Processes, Stereo lithography; The Benefits of AM, Distinction between AM and CNC Machining.

Development of Additive Manufacturing Technology: Introduction, Computer-Aided Design Technology, Use of Layers, Classification of AM Processes, Metal Systems, Hybrid Systems, Milestones in AM Development.

Additive Manufacturing Process Chain: Introduction, The Eight Steps in Additive Manufacture, Design for AM, and Application Areas.

Module-2 Photo polymerization, Powder fusion & Extrusion-based Systems (8 hours)

Photo polymerization processes: Stereo lithography (SL), Materials, SL resin curing process, Micro-stereo lithography, Process Benefits and Drawbacks, Applications of Photo Polymerization Processes.

Powder fusion processes: Introduction, Selective Laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Applications of Powder Bed Fusion Processes.

Extrusion-based Systems: Fused Deposition Modeling (FDM); Principles, Materials, Routing and path control, Applications of Extrusion-Based Processes.

Module-3 Printing, Sheet Lamination, Beam Deposition & Direct Write Technologies (8 hours)

Printing Processes: Evolution of Printing as an Additive Manufacturing Process, Research Achievements in Printing Deposition, Technical Challenges of Printing, Three-Dimensional Printing, Advantages of Binder Printing.

Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Thermal Bonding; Applications of LOM and UC.

Beam Deposition Processes: Introduction, General Beam Deposition Process, Description of Material Delivery, BD Systems, Process Parameters, Typical Materials and Microstructure, BD Benefits and Drawbacks.

Direct Write Technologies: Background, Ink-based DWI, Laser Transfer; DW Thermal Spray, DW Deposition, DW Liquid-Phase Direct Deposition.

Module-4 Guidelines for Process Selection (8 hours)

Guidelines for Process Selection: Introduction, Selection Methods for Different Applications, Challenges of Selection, Production Planning, and Control.

Software Issues for Additive Manufacturing: Introduction, the STL File, Problems with STL Files, STL File Manipulation.

Post-Processing: Support Material Removal, Surface Texture Improvements, Property Enhancements Using Non-Thermal Techniques and Thermal Techniques.
Module-5 Use of Multiple Materials in Additive Manufacturing (8 hours)
The Use of Multiple Materials in Additive Manufacturing: Introduction, Multiple Material Approaches, Discrete Multiple Material Processes, Porous Multiple Material Processes, Blended Multiple Material Processes, Commercial Applications Using Multiple Materials, AM Applications: Functional Models, Patterns for Investment and Vacuum Casting, Medical Models, Art Models, Engineering Analysis Models, Rapid Tooling, Bi-Metallic Parts, Applications: Examples for Aerospace, Defense, Automobile, Biomedical, and General Engineering Industries. Direct Digital Manufacturing: Eligibility Technology, Manufacturing vs. Prototyping; Life-Cycle Costing, Future of Direct Digital Manufacturing.

Course Outcomes**:** At the end of the course the student will be able to:	
21MEC7041.1	Distinguish between AM & CNC machining and classify the different types of AM process
21MEC7041.2	Explain the working principle of photo polymerization, powder bed fusion and extrusion based additive manufacturing process
21MEC7041.3	Examine the technical challenges of using layer technology
21MEC7041.4	Explain the working principle of laminated object manufacturing process
21MEC7041.5	Describe the use of STL file and STL file manipulation
21MEC7041.6	Explain the various applications and materials used in AM process& DDM.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing	Ian Gibson, David W. Rosen, Brent Stucker	Springer, New York / Heidelberg / Dordrecht / London	2nd edition, 2015
2	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling	D.T. Pham, S.S. Dimov	Springer,	1st edition, 2001
Reference Books				
1	Rapid Prototyping: Theory & Practice	Ali K. Kamrani, Eman Abouel Nasr	Springer	1st edition, 2006
2	Additive Manufacturing Technologies	Hari Prasad, A.V. Suresh	Cengage	1st edition, 2019

Web links and Video Lectures (e-Resources): NPTEL courses videos
Discipline: Manufacturing Technology
Manufacturing Process Technology: Part 1: https://nptel.ac.in/courses/112104195/
Manufacturing Process Technology: Part 2: https://nptel.ac.in/courses/112104204/
Rapid Manufacturing: https://nptel.ac.in/courses/112/104/112104265/
Generative Design for Additive Manufacturing: https://www.coursera.org/learn/generative-design-additive-manufacturing?
The 3D Printing Revolution: https://www.coursera.org/learn/3d-printing-revolution

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7041.1	2	-	-	-	-	2	-	-	-	-	-	-	-	-
21MEC7041.2	2	-	-	-	-	2	-	-	-	-	-	-	-	-
21MEC7041.3	-	2	-	-	2		-	-	-	-	-	-	-	-
21MEC7041.4	2	-	-	-	2		-	-	-	-	-	-	-	-
21MEC7041.5	3	-	-	-	-	1	-	-	-	-	-	-	-	-
21MEC7041.6	-	-	-	-	-	1	-	-	-	-	-	2	-	-

1: Low 2: Medium 3: High

PROJECT MANAGEMENT			
Course Code	21MEC7042	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L: T: P)	3:0:0	SEE	3 Hrs
Total Hours	40 Hours	Credits	03

Course Learning Objectives: This course will enable students

- To understand how to break down a complex project into manageable segments and use of effective project management tools and techniques to arrive at solution and ensure that the project meets its
- To impart knowledge on various components, phases, and attributes of a project.
- To prepare students to plan, develop, lead, manage, and successfully implement and deliver projects within their chosen practice area.

Module-1 Introduction (08 Hours)

Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles Project Selection and Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.

Module-2 Planning Projects (08 Hours)

Planning Projects: Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system. Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart. Case Studies on project planning methodologies in mechanical industries

Module-3 Resourcing Projects (08 Hours)

Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control.

Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kick off project, baseline and communicate project management plan, using Microsoft Project for project baselines.

Module-4 Performing Projects (08 Hours)

Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management. **Project Progress and Results**: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.

Module-5 Network Analysis (08 Hours)

Network Analysis: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects. Application Project planning software (MS Project)

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

21MEC7042.1	Apply the concepts of project selection, prioritization and initiation of individual projects and strategic role of project management.
21MEC7042.2	Analyze the work breakdown structure by integrating it with organization.

21MEC7042.3	Discuss the scheduling, uncertainty in projects, risk management planning using project quality tools.
21MEC7042.4	Determine project progress and results through balanced scorecard approach.
21MEC7042.5	Draw the network diagram to calculate the duration of the project and reduce it using crashing.
21MEC7042.6	Apply the concept of Project management for a given case study through MS Project management software.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Project Management	Timothy J Kloppenborg	Cengage Learning	2nd edition, 2009
2	Project Management -A systems approach to planning scheduling and controlling	Harold Kerzner	CBS publication	2nd edition, 2010
3	Project Management	S Choudhury	McGraw Hill Education (India) Pvt. Ltd.	1st edition, 2016
Reference Books				
1	Project Management	Pennington Lawrence	Mc Graw Hill	4th edition, 2017
2	Project Management	Bhavesh M. Patal	Vikas publishing House	2nd edition, 2012

Web links/Video Lectures/MOOCs

- https://nptel.ac.in/courses/110/104/110104073/
- https://www.youtube.com/watch?v=ZMFUEbZwlE4
- https://www.youtube.com/watch?v=uhWgn2VVL5A
- https://www.youtube.com/watch?v=eQ4qGgT3z3g
- https://www.youtube.com/watch?v=k5B5H5-t8T0
- https://www.youtube.com/watch?v=3v9w5GU5bWw

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7042.1	3	-	-	-	-	2	-	1	-	-	3	-	-	-
21MEC7042.2	-	2	-	-	-	-	1	-	-	-	-	2	-	-
21MEC7042.3	2	-	-	-	-	1	-	-	-	-	3	-	-	-
21MEC7042.4	-	2	-	-	-	-	1	-	-	-	-	-	-	-
21MEC7042.5	2	-	-	-	-	-	-	1	-	-	-	2	-	-
21MEC7042.6	2	-	-	-	-	1	-	-	-	-	-	1	-	-

1: Low 2: Medium 3: High

MECHATRONICS			
Course Code	21MEC7043	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: This course will enable students

To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.

To understand the evolution and development of Mechatronics as a discipline.

To substantiate the need for interdisciplinary study in technology education

To understand the applications of microprocessors in various systems and to know the functions of each element.

To demonstrate the integration philosophy in view of Mechatronics technology

Module-1 Introduction (8 hours)

Introduction: Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.

Module-2 Signal Conditioning & Electro Mechanical Drives (8 hours)

Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.

Electro Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.

Module-3 Microprocessor & Microcontrollers (8 hours)

Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers.

Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.

Module-4 Logic Controller (8 hours)

Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.

Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.

Module-5 Computer Numerical Control (CNC) machines (8 hours)

Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines - Machine Elements: Different types of guideways, Linear Motion guideways. Bearings: anti-friction

bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.
Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.

Course Outcomes: At the end of the course the student will be able to:	
21MEC7043.1	Illustrate various components of Mechatronics systems and assess various control systems used in automation
21MEC7043.2	Choose appropriate sensors and transducers for different engineering applications
21MEC7043.3	Assess various components of signal conditioning, Data acquisition systems, SCADA and illustrate the various types of electric motors
21MEC7043.4	Assess the architecture and basic elements of microprocessors, microcontrollers & PLCs and develop PLC programs using ladder diagrams
21MEC7043.5	Illustrate various elements of CNC machines and various types of bearings
21MEC7043.6	Assess the Mechatronics systems by case studies

Sl. No.	**Title of the Book**	**Name of the author/s**	**Name of the Publisher**	**Edition &Year**
Textbooks				
1	Mechatronics – Electronic control systems in Mechanical and Electrical Engineering	W.Bolton	Pearson Education	7th edition, 2023
2	Mechatronics – Principles, Concepts and Applications	Nitaigour Premchand Mahalik	Tata McGraw Hill	2nd edition, 2017
Reference Books				
1	Mechatronics	HMT Ltd	Tata McGraw Hill	2nd edition, 2017
2	Mechatronics – Integrated Mechanical Electronic Systems	K P Ramachandran, G K Vijayaraghavan, M S Balasundaram	Wiley India Pvt. Ltd, New Delhi	2nd edition, 2016
3	Mechatronics System Design	Devadas Shetty, Richard A Kolk	Cengage Publishers	3rd edition, 2012
4	Introduction to Mechatronics and Measurement systems	David G A & Michael B H	McGraw Hill Inc USA	2nd edition, 2017
5	Introduction to Robotics: Analysis, Systems, Applications	Saeed B Niku	Pearson Education	2nd edition, 2011
Web links and Video Lectures (e-Resources): http://nptel.ac.in/courses/112107298 (Mechatronics) http://nptel.ac.in/courses/112103174 (Mechatronics & Manufacturing Automation)				

Course Articulation Matrix

	Program Outcomes (POs)													
Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7043.1	3	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEC7043.2	-	2	2	-	-	-	-	-	2	-	2	-	-	-
21MEC7043.3	1	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEC7043.4	2	2	-	-	-	-	-	-	2	-	-	-	-	-
21MEC7043.5	3	-	-	-	-	-	-	-	-	-	-	-	-	-
21MEC7043.6	2	2	-	-	-	2	-	-	2	-	-	-	-	-

1: Low 2: Medium 3: High

COMPUTATIONAL FLUID DYNAMICS			
Course Code:	21MEC7044	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objective of the course is to

- Understand the principles of Computational Fluid Dynamics (CFD), conservation equations, and the classification of partial differential equations.
- Apply numerical methods using FDM and FVM, to solve problems, and analyze the accuracy and stability of the solutions obtained.
- Apply turbulence models to simulate and analyze turbulent flows in practical applications.
- Inculcate the knowledge required to solve real-time physical problems using simulation software.

Module 1 – Mathematical Modeling (8 Hours)

Introduction to CFD, Conservation Laws and Mathematical Preliminaries, Mass Conservation – Continuity Equation, Momentum Equation – Navier-Stokes Equation and its Simplified Forms, Energy and Scalar Transport Equations, Classification of Partial Differential Equations, Fundamentals of Discretization - Finite Element Method (FEM), Finite Difference Method (FDM), and Finite Volume Method (FVM), Initial and Boundary Conditions

Module 2 – Finite Difference Method (8 Hours)

Methodology, Numerical Discretization Methods, Time Integration Methods, Application of FDM (including computer implementation) to: 1D Steady-State Diffusion - Heat conduction in a rod, 1D Unsteady Heat Conduction -Temperature distribution in a rod over time, 2D Laplace Equation - Steady-state temperature distribution in a two-dimensional domain, 1D Wave Equation - Vibration in a string, Burger's Equation - Simplified turbulence model, 1D Advection - Transport of pollutants in a river, Laboratory Practices

Module 3 – Finite Volume Method (8 Hours)

Methodology, Pressure-Velocity Coupling Methods - SIMPLE, SIMPLER, and PISO algorithms, Flux Calculation across control volume faces, Application of FVM (including computer implementation) to: 1D Heat Conduction, 1D Convection, and Unsteady-State Heat Conduction, Laboratory Practices for 2D and 3D FVM Analysis

Module 4 – Turbulence Modeling (8 Hours)

Introduction to Turbulence Modeling, Important Features of Turbulent Flow, General Properties of Turbulent Quantities, Reynolds-Averaged Navier-Stokes (RANS) Equation, Closure Problem in Turbulence, Necessity of Turbulence Modeling and Applications, Laboratory Practices

Module 5 – Advanced Topics in CFD (8 Hours)

Multiphase Flow Modeling – Volume-of-Fluid (VOF) Method, Solidification and Melting, Porous Media Modeling, Discrete Phase Modeling, Multi-Physics Modeling - Fluid-Structure Interaction (FSI) modeling, Laboratory Practices

Course Outcomes: At the end of the course, the student will be able to:	
21MEC7044.1	Explain and apply the fundamental concepts of mathematical modeling in CFD to fluid dynamics and heat transfer problems.
21MEC7044.2	Apply discretization techniques to solve engineering problems numerically.
21MEC7044.3	Apply pressure-velocity coupling methods in the context of the Finite Volume Method, enabling them to solve complex fluid flow problems involving pressure and velocity fields.
21MEC7044.4	Evaluate the accuracy, stability, and convergence of the numerical solutions through practical computer implementations.

21MEC7044.5	Apply turbulence modeling techniques to simulate and analyze turbulent flows, and assess the effectiveness of different turbulence models in practical scenarios.
21MEC7044.6	Develop critical thinking and problem-solving skills by analyzing complex fluid dynamics problems, evaluating different numerical approaches, and making informed decisions to optimize and troubleshoot simulation outcomes.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Text Books				
1	An Introduction to Computational Fluid Dynamics	Versteeg, H.K., & Malalasekara, W	Pearson Education	2nd edition, 2007
2	The finite volume method in computational fluid dynamics. An Advanced Introduction with Open FOAM and Matlab	Moukalled, F., Mangani, L., &Darwish, M	Springer	1st edition, 2016
Reference Books				
1	Numerical Heat Transfer and Fluid Flow	Patankar, S.V	Hemisphere Publishing Corporation	2nd edition, 1980
2	Computational fluid dynamics	Anderson, J. D., & Wendt, J	McGraw-Hill	2nd edition, 1995

Course Articulation Matrix

Course Outcomes (Cos)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7044.1	1	3	2	-	-	-	-	-	-	-	-	-	-	1
21MEC7044.2	3	2	-	-	-	-	-	-	-	-	-	-	-	1
21MEC7044.3	1	1	3	-	-	-	-	-	-	-	-	-	-	2
21MEC7044.4	1	1	2	3	-	-	-	-	-	-	-	-	-	1
21MEC7044.5	1	3	2	-	-	-	-	-	-	-	-	-	-	2
21MEC7044.6	1	1	1	3	2	-	-	-	-	-	-	-	-	2

1: Low 2: Medium 3: High

INDUSTRIAL SAFETY			
Course Code	21MEC7051	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 Hours	Credits	03

Course Learning Objectives: The objective of the course is to

- Understand fundamental concepts and terminology of industrial safety, including hazard identification and risk assessment.
- Analyse workplace hazards and propose appropriate control measures for risk mitigation.
- Comprehend safety regulations, international acts, and environmental measures for pollution control.
- Apply computer-aided hazard analysis to improve safety in industrial settings.

Module-1 Introduction (8 hours)

Introduction to Safety Terms used: accident, safety, hazard, safe, safety devices, safety guard, security, precaution, caution, appliance, slip, trip, fall. Ladders and scaffolding. Unsafe acts, reason for accidents, MSDS (material safety data sheet), computer Aided Hazard Analysis, International acts and standards OSHA, WHO. Environment act, control and abatement of environmental pollution-Biomedical waste. Lockout and tag out procedures. Safe material handling and storage. Risk analysis quantification. Case studies: Students should identify the unsafe acts near their surroundings like housekeeping, lab as well as industrial layouts, road safety, campus layout, safety signs.

Module-2 Fire Safety (8 hours)

Fire Safety: Introduction, toxicity of products of combustion – vapour clouds – flash fire – jet fires – pool fires – auto ignition, sources of ignition. Class A, B, C, D and E fire. Fire triangle, Fire extinguishers, Fire hazard and analysis, prevention of fire. Fire protection and loss prevention, steps after occurrence of fire. notice-first aid for burns, Portable fire extinguishers. Fire detection, fire alarm and firefighting systems. Safety sign boards, instruction on portable fire extinguishers.

Module-3 Mechanical Safety (8 hours)

Mechanical Safety PPE, safety guards, Mechanical hazards, workplace hazards, Forklift hazard control Safety while working with machine tools like lathe, drill press, power and band saws, grinding machines. Safety during welding, forging and pressing. Safety while handling Material, compressed gas cylinders, corrosive substance, waste drum and containers.

Module-4 Electrical Safety (8 hours)

Electrical Safety Introduction to electrical safety, Indian standards on electrical safety, Electric hazards, effect of electric current on the human body, causes of electrical accidents, prevention of electric accidents, PPE used. Protection systems: Fuse, circuit breakers and overload relays – protection against over voltage and under voltage. Electric shock. Primary and secondary electric shocks, AC and DC current shocks. Safety precautions against shocks. Safety precautions in small and residential building installations. Safety procedures in electric plants.

Module-5 Chemical Safety and Other Safety Checks (8 hours)

Chemical Safety and Other Safety Checks Introduction to Chemical safety, Labelling of chemicals, acid hoods. Handling of acids, eye washers and showers. Safety thinking, accident investigation, safety policy of the company, safety, loss prevention and control, check list for LPG installations, safety precautions using CNG, fire prevention and safety audit, confined space entry, risk assessment.

Course Outcomes: At the end of the course the student will be able to:	
21MEC7051.1	Recognize and mitigate workplace hazards using appropriate controls.
21MEC7051.2	Demonstrate emergency preparedness and response skills, including the use of fire extinguishers and first aid techniques.
21MEC7051.3	Implement safety protocols for machinery and equipment, ensuring the use of safety guards and proper material handling.
21MEC7051.4	Apply electrical and chemical safety measures to prevent accidents and injuries.
21MEC7051.5	Conduct safety inspections and audits to assess compliance and propose corrective actions.
21MEC7051.6	Communicate effectively and collaborate with others to promote a culture of safety in the workplace.

Sl. No.	**Title of the Book**	**Name of Author/s**	**Name of the Publisher**	**Edition & Year**
Textbooks				
1	Industrial Safety and Management	L M Deshmukh	McGraw Hill Education (India) private Limited	1st edition, 2017
2	Fire Prevention Hand Book	Derek, James	Butter Worth's and Company, London	1st edition, 1986
3	Electrical Safety, fire safety and safety management	S.Rao, R K Jain and Saluja	Khanna Publishers	1st edition, 1997
4	Industrial health and safety management	A.M.Sarma	Himalaya publishing house	2nd edition, 2016
5	Chemical process Industrial safety	K S N Raju	McGraw Hill Education (India) private Limited.	1st edition 2014
6	Environmental Engineering	Gerard Kiely	McGraw Hill Education (India) Private Limited	1st edition, 2006
Reference Books				
1	The Environment Act (Protection) 1986	Commercial Law Publishers (India)	Commercial Law Publishers (India) Pvt. Ltd. New Delhi.	1st edition, 2022
2	Water (Prevention and control of pollution) act 1974	Commercial Law Publishers (India)	Commercial Law publishers (India) Pvt. Ltd., New Delhi.	1st edition, 2021

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc20_mg43/preview
- https://www.udemy.com/course/industrial-safety-processes/

Course Articulation Matrix

	Program Outcomes (POs)													
Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7051.1	1	-	-	-	-	-	-	-	1	-	-	-	-	-
21MEC7051.2	-	-	-	1	-	2	-	-	-	-	-	-	-	-
21MEC7051.3	-	1	-	-	-	-	2	-	-	-	-	-	-	-
21MEC7051.4	-	2	-	-	-	-	-	-	1	-	-	-	-	-
21MEC7051.5	-	-	-	1	-	-	-	-	1	-	-	-	-	-
21MEC7051.6	-	1	-	-	-	-	-	-	-	2	-	-	-	-

1: Low 2: Medium 3: High

ENERGY AUDITING			
Course Code	21MEC7052	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objectives of the course are to make the students learn about

- Introduce the concepts of energy scenario and need for energy policy for industries in India.
- Familiarize with the Energy Audit concepts and its approaches.
- Teach the principles and objectives of Energy management.

Module-1 General Aspects (8 hours)

Review of energy scenario in India, General Philosophy and need of Energy Audit and Management, Basic elements and measurements - Mass and energy balances — Scope of energy auditing industries - Evaluation of energy conserving opportunities, Energy performance contracts, Fuel and Energy substitution, Need for Energy Policy for Industries, National & State level energy Policies.

Module-2 Energy Audit Concepts (8 hours)

Need of Energy audit - Types of energy audit — Energy management (audit) approach - understanding energy costs - Bench marking — Energy performance - Matching energy use to requirement - Maximizing system efficiencies -Optimizing the input energy requirements - Duties and responsibilities of energy auditors- Energy audit instruments - Procedures and Techniques.

Module-3 Principles and Objectives of Energy Management (8 hours)

Design of Energy Management Programmes - Development of energy management systems — Importance - Indian need of Energy Management - Duties of Energy Manager - Preparation and presentation of energy audit reports - Monitoring and targeting, some case study and potential energy savings.

Module-4 Thermal Energy Management (8 hours)

Energy conservation in boilers - steam turbines and industrial heating systems - Application of FBC, Cogeneration and waste heat recovery -Thermal insulation - Heat exchangers and heat pumps J-IVC industries-Building Energy Management.

Module-5 Electrical Energy Management (8 hours)

Supply side Methods to minimize supply-demand gap- Renovation and modernization of power plants - Reactive power management — HVDC- FACTS - Demand side - Conservation in motors - Pumps and fan systems — Energy efficient motors.

Course Outcomes: At the end of the course the student will be able to:	
21MEC7052.1	Implement the basic concepts of energy audit and energy management in a practical scenario
21MEC7052.2	Describe different types of energy audits directed towards maximizing and optimizing system efficiency
21MEC7052.3	Provide a concise overview of energy management systems, emphasizing their relevance and necessity within the Indian context
21MEC7052.4	Identify energy saving potential of thermal and electrical systems
21MEC7052.5	Discuss energy audit instruments, procedures and techniques.
21MEC7052.6	Collaboratively analyze energy usage in a residential or organizational setting, and produce a comprehensive report detailing findings and recommendations

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Energy Management	Murphy W R, McKay G	Elsevier	2nd edition, 2018
2	Energy Management Principles	Smith Craig B; Parmenter Kelly E	Elsevier	2nd edition, 2016
3	Energy Management Audit and Conservation	De Barun Kumar	Vrinda Publication	2nd edition, 2019
Reference Books				
1	Handbook on energy audit and environment management	Abbi, Y.P;Jain Shashank	Terri Press	1st edition, 2006
2	A project report on Energy auditing of St Joseph engineering college campus	Harikrishna; Others	SJEC Library	2012
3	Handbook of Energy Audit	Sonal Desai	Mcgraw Hill Education Private Ltd	1st edition, 2015

Web links and Video Lectures (e-Resources):

- http://www.em-ea.org/gbook11.asp

(General Aspects of Energy Management & Energy Audit, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India)

- http://www.em-ea.org/gbook14.asp

(Energy Performance Assessment for Equipment and Utility systems, National Certificate Examination for Energy Managers and Energy Auditors, National Productivity Council of India)

Course Articulation Matrix

	Program Outcomes (POs)													
Course Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7052.1	3	2	-	-	-	-	-	-	-	-	-	-	-	-
21MEC7052.2	2	3	-	-	-	-	-	-	-	-	-	-	-	-
21MEC7052.3	-	-	-	-	-	-	2	-	-	-	3	-	-	-
21MEC7052.4	-	-	2	3	-	-	-	-	-	-	-	-	-	-
21MEC7052.5	2	3	-	-	-	-	-	-	-	-	-	-	-	-
21MEC7052.6	-	-	-	-	-	-	-	-	3	3	2	-	-	-

1: Low 2: Medium 3: High

MAINTENANCE ENGINEERING			
Course Code	21MEC7053	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 hours	Credits	03

Course Learning Objectives: The objective of the course is

- To understand the principles and practices of maintenance engineering.
- To analyze and evaluate different maintenance strategies and their applications.
- To develop skills in diagnosing, troubleshooting, and rectifying maintenance issues.
- To assess and apply reliability and maintenance metrics to improve system performance.
- To design and implement maintenance programs in an industrial context

Module-1 Introduction and Maintenance Strategies (8 hours)
Definition, scope, and significance of maintenance engineering. Historical perspective and evolution of maintenance strategies. Types of maintenance: reactive, preventive, predictive, and proactive. Comparative analysis of maintenance strategies. Maintenance planning and scheduling. Total Quality Management (TQM), Total Productive Maintenance (TPM), Environmental Issues in Maintenance, ISO 9000.
Module-2 Maintenance Management and Systems (8 hours)
Computerized Maintenance Management Systems (CMMS). Key performance indicators (KPIs) for maintenance. Life cycle cost analysis. Reliability engineering fundamentals. Introduction to RAM (Reliability, Availability, & Maintainability), Failure Mechanisms, Failure Data Analysis, Failure Distribution, Reliability of Repairable and Non-Repairable Systems.
Module-3 Diagnostics and Condition Monitoring (8 hours)
Fault detection and diagnosis methods. Condition monitoring techniques: vibration analysis, thermography, oil analysis, and ultrasonic testing. Root cause analysis (RCA). Diagnostic tools and techniques.
Module-4 Predictive and Preventive Maintenance (8 hours)
Principles and benefits of predictive maintenance. Predictive maintenance technologies: Infrared thermography, Acoustic analysis, Motor Current analysis. Preventive maintenance: planning, scheduling, and execution. Corrective maintenance: strategies and techniques. Implementation and case studies.
Module-5 Latest Trends and Maintenance Program Development (8 hours)
Steps in developing a maintenance program. Integration of various maintenance strategies. Maintenance resource planning. Industry 4.0 and its impact on maintenance engineering. Use of Artificial Intelligence (AI) and Machine Learning (ML) in maintenance. Internet of Things (IoT) for smart maintenance. Future trends and innovations in maintenance engineering.

Course Outcomes: At the end of the course the student will be able to:	
21MEC7053.1	Critically evaluate maintenance strategies and their effectiveness in various industrial settings.
21MEC7053.2	Assess the impact of maintenance decisions on the operational efficiency and reliability of engineering systems.
21MEC7053.3	Design comprehensive maintenance plans incorporating predictive, preventive, and corrective maintenance techniques.
21MEC7053.4	Implement diagnostic tools and techniques to identify and solve maintenance issues.
21MEC7053.5	Interpret reliability and maintenance data to make informed decisions that enhance system performance.

21ME7053.6	Discuss latest trends in Maintenance Engineering and imagine the role of emerging technologies to enhance maintenance activities.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Maintenance and Spare Parts Management	P. Gopalakrishnan, A. K. Banerji.	PHI Learning	2nd Edition, 2013
2	Maintenance Engineering & Management	R. C. Mishra & K. Pathak	PHI Learning	2nd Edition, 2012
3	Maintenance Engineering Principles, Practices & Management	Sushil Kumar Srivastava	S Chand Publishing	1st edition, 1998
Reference Books				
1	Maintenance Engineering Handbook	R. Keith Mobley	McGraw-Hill Education	8th Edition, 2014
2	Maintenance and Reliability Best Practices	Ramesh D. Gulati	Industrial Press Inc.,U.S.	2nd Edition 2012
3	Handbook of Condition Monitoring	B. K. N. Rao	Elsevier Advanced Technology	1st edition, 1996

Web links and Video Lectures (e-Resources):

- https://www.udemy.com/course/master-in-predictive-maintenance
- https://www.udemy.com/course/engineering-and-maintenance-management-in-a-lean-environment/
- https://www.youtube.com/watch?v=f58SW0Hwcf0
- https://onlinecourses.swayam2.ac.in/nou21_me10/preview

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7053.1	-	2	-	-	-	-	3	-	-	-	-	-	-	-
21MEC7053.2	-	-	-	3	-	-	2	-	-	-	-	-	-	-
21MEC7053.3	-	-	-	2	-	3	-	-	-	-	-	-	-	-
21MEC7053.4	-	-	-	2	3	-	-	-	-	-	-	-	-	-
21MEC7053.5	-	-	-	3	-	2	-	-	-	-	-	-	-	-
21MEC7053.6	-	-	-	2	3	-	-	-	-	-	-	-	-	-

1: Low 2: Medium 3: High

NON-TRADITIONAL MACHINING			
Course Code	21MEC7054	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 Hours Theory	Credits	03

Course Learning Objectives: The objective of the course is

- To learn various concepts related to machining processes & their applications.
- To appreciate the differences between conventional and non-conventional machining processes.
- To acquire a functional understanding of non-traditional manufacturing equipment.
- To know about various process parameters and their influence on performance and applications.
- To impart knowledge on various types of energy involved in non-traditional machining processes.

Module-1 Introduction to nontraditional machining process (8 hours)

Introduction to machining: Need for machining process, Comparison between conventional and advanced machining, general classification, classification based on nature of energy employed in machining, selection of machining processes, Specific advantages, limitations and applications of machining processes.

Module-2 Mechanical processes (8 hours)

Ultrasonic Machining (USM): Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM. Abrasive Jet Machining (AJM): Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process Characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM. Water Jet Machining (WJM): Equipment & process, Operation, applications, advantages and limitations of WJM.

Module-3 Electro chemical & Chemical Processes (8 hours)

Introduction, Principle of electro chemical machining: ECM equipment, elements of ECM Operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, Surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of Electrolytes. ECM Tooling: ECM tooling technique, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECM. CHM Elements of the process: Resists (maskants), Etchants. Chemical Blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.

Module-4 Thermal Processes (8 hours)

Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (Relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM. PLASMA ARC MACHINING (PAM) Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety Precautions, applications, advantages and limitations.

LASER BEAM MACHINING (LBM) Introduction, generation of LASER, 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.
Module-5 Hybrid Machining Processes (8 hours)
Hybrid Machining Process: Importance of hybrid machining process; Process principal, process parameters, and application of: - Electrochemical Discharge Machining (ECDM), Ultrasonic Assisted Electric Discharge Machining (UAEDM), Electrochemical Discharge Grinding (EDG), Powder Assisted Electric Discharge Machining (PAEDM).

Course Outcomes: At the end of the course the student will be able to:	
21MEC7054.1	Compare various conventional and nontraditional machining processes and recognize the need for machining processes.
21MEC7054.2	Explain the constructional features, performance parameters, applications, advantages and limitations of USM, AJM and WJM.
21MEC7054.3	Identify the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages and limitations
21MEC7054.4	Explain the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations of Electro thermal machining processes
21MEC7054.5	Explain the Importance of hybrid machining process. Explain the equipment, mechanism of metal removal, applications, advantages and limitations of hybrid machining process
21MEC7054.6	Select advanced machining process based on material and required properties in the finished product, Identify the recent developments in machining processes.

Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
		Textbooks		
1	Modern Machining Process	P.C Pandey & H S Shan	McGraw Hill Ed. India Pvt. Ltd.	1st edition, 2000
2	Production technology	HMT	McGraw Hill Ed. India Pvt. Ltd.	1st edition, 2001
		Reference Books		
1	New Technology	Dr. A. Bhattacharyya	The IE (India)	1st edition, 2000
2	Manufacturing Engg. & Technology,	Serope Kalpakjian and Steven R. Schmid	Pearson Education	1st edition, 2000
3	Non-Conventional Machining	P. K. Mishra & IE (I) Test book series	Narosa Publishing House	1st edition, 2005

Web links and Video Lectures (e-Resources):
http://videos.vtu.ac.in/video_groups.php?group=Mechanical%20Engineering
https://www.youtube.com/watch?v=qVcwT0FfAIc
https://www.youtube.com/watch?v=pI1QGpmKqow
https://www.youtube.com/watch?v=QtJvJ3jscGA
https://www.youtube.com/watch?v=uA6wfkboWtg
https://www.youtube.com/watch?v=6ERbGtJFcBw
https://www.youtube.com/watch?v=EI2iakzRbeM
https://www.youtube.com/watch?v=lPMaASlBShA
https://www.youtube.com/watch?v=B-2nzWfJE-k
https://www.youtube.com/watch?v=dP2m7-WAdos

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7054.1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
21MEC7054.2	3	1	-	-	-	-	-	-	-	-	-	-	-	2
21MEC7054.3	3	-	2	-	-	2	-	-	-	-	-	-	2	-
21MEC7054.4	3	-	-	-	-	2	-	-	-	-	-	-	-	2
21MEC7054.5	3	1	2	-	-	-	-	-	-	-	-	-	2	-
21MEC7054.6	3					2							-	2

1: Low 2: Medium 3: High

NANOSCIENCE AND TECHNOLOGY			
Course Code	21MEC7055	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	3:0:0	SEE	3 Hours
Total Hours	40 Hours	Credits	03

Course Learning Objectives: The objective of the course is to

- Impart the basic knowledge of Nano chemistry and synthetic methods involved in nanotechnology
- Understand the basic principles and instrumentation of characterization techniques used in nanotechnology and its technological importance.
- Master the knowledge about green systems.
- Enlighten the needs and utilization of nanomaterials in the various fields such as energy, water treatment process, Agriculture, medicine, engineering and textile industries.
- Apply the knowledge of Nanocomposites, Biodegradable polymer-based nanocomposites, Clay polymer nanocomposites.

Module-1 Basic concepts of Nanomaterials (8 hours)

Introduction to Nanoscience; History and Scope, Interdisciplinary nature, Structure of nanomaterials, general properties of bulk materials and nanomaterials, Methods of synthesis- Top down and Bottom up approaches, Chemical methods of synthesis & advantages- Sol-gel, Co-precipitation Solution combustion methods, Chemical vapor deposition method and Spray pyrolysis. Introduction, Synthesis, Properties and applications of: Carbon nanowires, CNTs-Single walled & Multiwalled CNTs, Fullerenes, Carbon nanorods, Graphene, Graphite, Carbon black.

Module-2 Characterization of Nanomaterials (8 hours)

Principle, instrumentation and applications of Powder X-ray diffraction, Fourier transform infrared spectroscopy, UV-Vis spectroscopy, Scanning electron microscopy, transmission electron microscopy, Thermal gravimetric analysis, Energy dispersive spectroscopy and BET-analysis.

Module-3 Nanomaterials for Green systems (8 hours)

Green materials, including biomaterials, biopolymers, bioplastics, and composites Nanotech Materials for Truly Sustainable Construction: Windows, Skylights, and Lighting. Paints, Roofs, Walls, and Cooling. Multifunctional Gas Sensors, Biomimetic Sensors, Optical Interference Sensors Thermo, light, and stimulus responsive smart materials.

Module-4 Nanotechnology & its applications (8 hours)

Introduction, materials used and applications in renewable energy generation, drug delivery, cosmetics, tissue engineering, bioinformatics, information technology, agriculture & food technology, high integrated circuits, nanomedicine, molecular motors, bioelectronics & spintronics, Fuel cells, Photocatalytic hydrogen generation. Electrochemical sensor, Biosensors, Textiles & Cosmetics, Defense & Aerospace.

Module-5 Nanocomposites (8 hours)

Introduction, doping technique, binary and ternary nanocomposites, synthesis, properties and applications of metal-metal oxide and metal oxide-metal oxide nanocomposites, Biodegradable polymer-based nanocomposites, Ternary epoxy nanocomposite systems, glass-metal nanocomposites, nanocomposites from biomaterials, Thermo plastic based nanocomposites, Nylon-6 nanocomposites, Clay polymer nanocomposites.

Course Outcomes: At the end of the course the student will be able to:	
21MEC7055.1	Discuss the fundamental principles, synthetic method and advantages of nanomaterials.
21MEC7055.2	Classify nanostructures by composition, size, shape, and properties, encompassing nanoparticles, nanotubes, nanowires, and nanostructured surfaces.

21MEC7055.3	Explain the concepts of characterization techniques used in Nanoscience and Nanotechnology.
21MEC7055.4	Enumerate the principles of Green systems.
21MEC7055.5	Describe the applications of nanomaterials in energy, water purification, agriculture, textile and engineering fields
21MEC7055.6	Illustrate the functioning and properties nanocomposites namely nanometal oxides, nanopolymers and nanoclays.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	NANO: The Essentials: Understanding Nanoscience and Nanotechnology	T Pradeep	McGraw Hill Education	1st Edition, 2017
2	Textbook On Fundamentals & Applications of Nanotechnology	K S Subramanian, K Raja, M Kannan	Daya Publishing House	1st Edition, 2018
Reference Books				
1	Textbook of Nanoscience and Nanotechnology	B.S. Murty, P. Shankar, Baldev Raj, B B Rath	Springer Universities Press	1st edition, 2016
2	Introduction to Nanoscience and Nanotechnology, An Indian Adaptation.	Charles P Poole, Jr Frank J Owens	Wiley	1st edition, 2020
3	Nanophysics and Nanotechnology - An Introduction to Modern Concepts in Nanoscience	Edward L. Wolf	John Wiley & Sons	2nd edition, 2006.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/results?search_query=Characterization+of+Nanomaterials
- https://www.youtube.com/watch?v=qUEbxTkPIWI&list=PLbMVogVj5nJSl_2XmFjuRmvuAgCOZXUjv
- https://www.youtube.com/watch?v=qUEbxTkPIWI
- https://www.youtube.com/watch?v=4j5cMHVPStc

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning:

- https://www.vlab.co.in/broad-area-chemical-sciences
- https://demonstrations.wolfram.com/topics.php
- https://interestingengineering.com/science

Course Articulation Matrix

Course	Program Outcomes (POs)													
Outcomes (COs)	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MEC7055.1	2	-	-	-	-	-	2	-	-	-	-	-	-	-
21MEC7055.2	2	-	-	-	3	-	-	-	-	-	-	-	2	-
21MEC7055.3	-	2	-	-	2	-	-	-	-	-	-	-	-	-
21MEC7055.4	-	-	-	2	-	-	2	-	-	-	-	-	-	-
21MEC7055.5	-	-	3	-	-	-	2	-	-	-	-	-	2	-
21MEC7055.6	-	-	-	2	-	-	2	-	-	-	-	-	2	-

1: Low 2: Medium 3: High

Technical Seminar			
Course Code	**21MES706**	CIE Marks	100
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	-
		Total Marks	100
Teaching Hours/Week (L:T:P)	(0:0:2)	SEE	-
Total Hours	20 hours	Credits	01

Course Learning Objectives:

1. To equip students with the ability to conduct in-depth research, analyze technical literature, and explore contemporary advancements in their field of study.
2. To effectively organize, design, and deliver technical presentations that convey complex information clearly to a diverse audience.
3. To encourage students to critically analyse and evaluate emerging trends, technologies, or methodologies relevant to their chosen seminar topic.
4. To enable students to improve their written and oral communication by preparing well-structured seminar reports and articulating ideas confidently during presentations.
5. To stimulate independent learning and problem-solving abilities by allowing students to explore specific topics of interest, enhancing self-directed research and learning.
6. To prepare students to effectively discuss and defend their technical knowledge in a professional setting, such as viva-voce, aligning with future industry or academic pursuits.

1. Selection of Technical Seminar Topic

- Students should select a technical topic related to their field of study, preferably focusing on recent advancements or emerging technologies. Inter-disciplinary/Multi-disciplinary topics are appreciated.
- Topics must be approved by the seminar coordinator within the first few weeks of the semester.

2 Research and Preparation

- Extensive research should be carried out using credible sources such as research papers, technical journals, books, and online databases.
- A minimum of 10-20 references is recommended, ensuring a mix of primary and secondary sources.

3. Seminar Report

- A detailed report (approximately 20-30 pages) must be prepared, summarizing the research findings and organized in a structured manner.
- The report should include sections like introduction, literature review, methodology, results, discussion, conclusion, and references.
- The report should follow a standard format as prescribed by the Department (font, spacing, citation style, etc.).

4. Oral Presentation

- Students must deliver an oral presentation lasting 15-20 minutes, followed by a question-and-answer session.
- Presentations should be well-structured, with appropriate use of visuals (slides, graphs, diagrams) to clearly convey technical content.
- All presentations must be conducted on scheduled dates, and attendance is mandatory for both presenters and all other students.

5. Question and Answer Session

- After the presentation, students will face a viva-voce where they are required to answer questions posed by the Departmental Seminar Evaluation Committee regarding their seminar topic.
- The viva will test the student's depth of understanding, research analysis, and ability to think critically about the subject matter.

6. Evaluation Criteria
• **Seminar Report**: Clarity, technical depth, comprehensiveness, quality of research, organization, and adherence to format (50 marks). • **Oral Presentation**: Communication skills, visual aids, clarity of content, timing, etc. (25 marks). • **Viva-Voce**: Ability to answer questions effectively, depth of understanding, and analytical skills (25 marks).
7. Submission Deadlines
• The report should be submitted at least one week prior to the scheduled presentation date. • Late submissions will be penalized as per department rules.
8. Plagiarism Check
• All seminar reports must be subjected to plagiarism checking, and the similarity index should be within acceptable limits specified by the Department. • Instances of plagiarism will result in penalties, which could include rejection of the report or a reduction in marks.
9. Mentorship and Feedback
• Students are required to consult with their faculty mentors regularly throughout the preparation phase to seek guidance and feedback. • At least three mentorship meetings should be recorded before the final presentation.
10. Attendance
• Students must attend all seminar sessions conducted by their peers, as it promotes collaborative learning and constructive feedback. • Attendance could be considered for internal evaluation.

Course Outcomes: At the end of the course the student will be able to :	
21MES706.1	Demonstrate a thorough understanding of a specialized topic by conducting extensive research and presenting technical content effectively.
21MES706.2	Exhibit proficiency in delivering well-organized and visually supported oral presentations, clearly articulating complex technical ideas to an audience.
21MES706.3	Apply critical thinking and research methodologies to explore, analyze, and synthesize information from various sources, leading to sound conclusions.
21MES706.4	Prepare a detailed and well-structured seminar report that adheres to technical writing standards, showcasing the ability to document research findings comprehensively.
21MES706.5	Respond confidently and competently to questions during the viva-voce, defending the technical work and demonstrating an in-depth understanding of the topic.
21MES706.6	Engage actively in peer seminars, providing constructive feedback, and reflecting on insights gained from discussions with fellow students and faculty.

Useful Links:
• https://homes.cs.washington.edu/~mernst/advice/giving-talk.html (How to give a technical presentation) • https://learnerbits.com/essential-tips-for-engineering-presentations • https://onlinecourses.nptel.ac.in/noc24_hs175/preview (Technical English for Engineers)

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21MES706.1	-	1	-	3	-	-	-	-	-	2	-	-	-	-
21MES706.2	-	-	-	-	2	-	-	-	-	3	-	1	-	-
21MES706.3	-	2	-	3	-	-	-	-	-	-	-	-	-	-
21MES706.4	-	-	-	-	-	1	-	2	-	3	-	-	-	-
21MES706.5	-	-	-	-	-	-	-	-	-	3	-	-	-	-
21MES706.6	-	-	-	-	-	1	-	-	-	3	-	2	-	-

1: Low 2: Medium 3: High

Major Project Work			
Course Code	**21MEP707**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	(0:0:6)	SEE	3 Hrs
Total Hours	60 hours	Credits	05

Course Learning Objectives:

1. Utilize fundamental principles of engineering and interdisciplinary knowledge to identify, analyse, and solve complex problems in the project domain.
2. Develop and execute a comprehensive project plan that includes designing, prototyping, testing, and evaluating a system, component, or process to meet specific needs and constraints.
3. Conduct in-depth research, critically review literature, and integrate innovative solutions or techniques within the project framework.
4. Demonstrate effective teamwork, communication, and collaboration skills in a multidisciplinary environment to achieve project objectives.
5. Incorporate ethical considerations, societal impact, and sustainable practices in the project development, while adhering to professional engineering standards.
6. Prepare and present a well-structured project report, supported by technical documentation and visual aids, and confidently defend the work during project viva-voce or presentations.

1. Project Selection

- **Relevance**: Projects should align with the students' specialization and current industry trends.
- **Innovation**: Projects that offer innovative solutions to existing problems or explore new ideas are encouraged.
- **Feasibility**: The project should be achievable within the given timeframe and resources.
- **Team Composition**: Students can work in teams, typically comprising maximum 4 members.

2. Project Proposal

- **Submission**: Students must submit a detailed project proposal (project synopsis) outlining the problem statement, objectives, methodology, expected outcomes, and a work plan.
- **Approval**: The proposal should be reviewed and approved by the Department Project Evaluation Committee (DPEC).

3. Project Execution

- **Regular Meetings**: Students should meet regularly with their project-guide to discuss progress, challenges, and next steps.
- **Documentation**: Maintain detailed documentation throughout the project in a project work-dairy, including design decisions, experiments, and testing results.
- **Milestones**: Set clear milestones and deadlines to ensure steady progress. These could include design completion, initial prototype, testing, etc.

4. Mid-term Review

- **Progress Presentation**: DPEC shall conduct a mid-term review where students present their progress to a panel of faculty members.
- **Feedback**: Provide constructive feedback and guidance to help students refine their projects.

5. Final Submission

- **Report**: The final project report should include an abstract, introduction, literature review, methodology, implementation, results, discussion, conclusion, and references.
- **Code and Data**: If applicable, students should submit their code, datasets, and any other relevant materials.

6. Project Presentations

- **Oral Presentation**: Students should present their projects to a panel, explaining their work, findings, and contributions.

- **Demonstration**: If possible, include a live demonstration of the project or show relevant simulations and results.
- **Q&A**: Be prepared to answer questions from the panel and justify the project's methodology and conclusions.

7. Evaluation Criteria

- **Originality and Innovation**: Assess the novelty and creativity of the project.
- **Technical Competence**: Evaluate the depth of technical knowledge and problem-solving ability demonstrated.
- **Project Execution**: Consider the effectiveness of project planning, adherence to timelines, and quality of implementation.
- **Presentation and Communication**: Judge the clarity and coherence of the final report, presentation, and the ability to answer questions.

8. Plagiarism Check

- **Academic Integrity**: Ensure that the work submitted is original and properly cites all references and sources.
- **Plagiarism Check**: Run all reports through plagiarism detection software and ensure that similarity index is less than the threshold value (25%).

9. Mentorship and Feedback

- **Feedback:** Students are required to consult with their project guide regularly throughout the project work to seek guidance and feedback.
- **Weekly Meetings:** At least one mentorship meeting every week shall be held and recorded in the project work-dairy.

10. Post Submission

- **Publication**: DPEC shall encourage students to publish their work in conferences or journals, especially if it contributes significantly to their field.
- **Project Archive**: Store all projects in the department's digital archive for future reference.

Continuous Internal Evaluation (CIE)		
Description	**Proposed Dates**	**CIE Weightage (Max 50 marks)**
1. Project Synopsis Evaluation (Phase I)	Beginning of the 7th Semester	10 marks
2. Project Progress Evaluation	Middle of the 7th Semester	20 marks
3. Project Report Evaluation (Phase II)	End of the 7th Semester	20 marks
Semester End Examinations (SEE)		
4. SEE will be conducted for 100 marks (after the last working day of the 7th semester) in the presence of the external examiner with the weightage as **Project Report: 50 marks, Project Presentation: 25 marks and Question & Answer Session: 25 marks**. Marks awarded for Project Report is same for all batch-mates.		
• When all the Project Objectives are met and the Project Work is successfully completed and final Project Report is submitted as reported by the Department Project Evaluation Committee (DPEC), the CIE and SEE performance of the 7th semester will be carried forward to the 8th semester. There will not be any separate CIE and SEE for such project batches in the 8th semester. • In case of any Project Objectives not met, Project Work not completed or final Project Report not submitted, as reported by the DPEC, the CIE and SEE will be conducted in the 7th semester for the completed portion of the Project Work. In such cases, the submission of the Draft Copy of the Project Report is mandatory for evaluation. The remaining part of		

the project shall be completed during the 8th semester and there will be a CIE and SEE for the Project Work in the 8th semester.

Students are advised to complete the Project Work during the 7th semester and devote the 8th semester for Industry Internship/Research Internship.

Course Outcomes: At the end of the course the student will be able to :	
21MEP707.1	Demonstrate the ability to identify, define, and solve complex engineering problems using appropriate methodologies and modern tools.
21MEP707.2	Successfully design, develop, and test an engineering solution that meets specified requirements, addressing technical, economic, environmental, and social constraints.
21MEP707.3	Apply research skills to review existing literature, gather and analyze data, and incorporate innovative or state-of-the-art technologies in the project
21MEP707.4	Collaborate effectively within a team, taking on leadership or supportive roles as needed, while ensuring clear communication and efficient project management.
21MEP707.5	Demonstrate awareness of professional ethics, societal impact, and sustainability in the design and implementation of engineering solutions.
21MEP707.6	Exhibit strong written and oral communication skills by preparing technical reports, project documentation, and delivering persuasive project presentations.

Course Articulation Matrix

Course Outcomes (COs)	**Program Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21MEP707.1	**2**	**3**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
21MEP707.2	**-**	**-**	**3**	**-**	**-**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
21MEP707.3	**1**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
21MEP707.4	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**3**	**2**	**2**	**-**	**-**	**-**
21MEP707.5	**-**	**-**	**1**	**-**	**-**	**-**	**2**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
21MEP707.6	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**1**	**-**	**-**

1: Low 2: Medium 3: High

VIII Semester

Massive Open Online Course (MOOC)			
Course Code	**21AEC801**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Theory	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	(2:0:0)	SEE	3 Hrs
Total Hours	20 hours	Credits	02

Course Learning Objectives:

1. Enable students to acquire a strong foundation in core engineering subjects through high-quality, accessible online resources.
2. Facilitate skill development in specific engineering domains using practical exercises, simulations, and projects offered through the MOOC platform.
3. Encourage students to develop autonomy in learning by navigating and managing their course content, assignments, and assessments independently.
4. Expose students to interdisciplinary concepts and applications, fostering an understanding of how engineering principles integrate with other fields.
5. Provide exposure to global best practices and trends in engineering, allowing students to learn from international faculty and peer collaboration.
6. Develop essential soft skills by participating in discussion forums, group projects, and peer assessments, enhancing communication and teamwork skills.

1. Selection of MOOCs

1.1 Accredited Platforms: Students shall select MOOCs from accredited platforms such as Coursera, edX, SWAYAM/NPTEL, Udacity, or any online learning platform recognized by the respective Engineering Department / Board of Studies (BoS). Engineering Departments with the approval of BoS shall publish a list of MOOCs courses in the beginning of every semester.

1.2 Prerequisites: Students shall ensure that he/she has completed any foundational courses or prerequisites required for the chosen MOOCs.

1.3 Relevant Courses: Students shall choose courses that are relevant to the Student's Engineering discipline and career goals. Students shall NOT opt for the course which is part of their curriculum (I to VIII semester B.E program) and Honors Degree/Minor Degree courses. In case of any overlapping in the contents of the MOOC Course with that in the curriculum or other courses, the maximum permitted overlapping in the course contents (syllabus) is 20-25%.

1.4 Credit Value: Students shall ensure that the selected MOOCs collectively account for 2 credits. Typically, a 2-credit MOOC will require around 20-25 hours of study and a 1-credit MOOC will require 10-12 hours of study.

1.5 Duration of Course: A 4-weeks MOOCs is eligible for 1-credit. Students are advised to enrol for one 8-weeks MOOCs course to earn 2 credits. However, Students can also take two 4-weeks MOOCs instead of one course. In each case, the number of hours of study mentioned shall be satisfied.

2. Approval Process

2.1 Pre-Approval: Students must seek pre-approval from the Department MOOCs Coordinator before enrolling in MOOCs.

2.2 Submission of Proposal: Students can submit a detailed proposal to Department MOOCs Coordinator including the name of the MOOCs, the platforms, course duration, credit value, and relevance to their field of study.

If a Student has already completed any MOOCs course/s from the beginning of the III semester B.E, that satisfies the criteria mentioned in the clause 1. Selection of MOOCs, such course/s can be considered by the Department for credit transfer, provided the student has NOT already claimed the benefit of completing the MOOCs under any assessment in any of the subject.

2.3 Evaluation: The Department will evaluate the proposal for relevance, academic rigor, and credit equivalence and will communicate the decision to the Students.

3. Registration and Enrollment
3.1 Official Enrollment: Students shall register for the approved MOOCs on the respective platforms. **3.2 Documentation:** Students shall keep documentation of registration and course details for future reference and provide the same when asked by the Department.
4. Course Completion
4.1 Active Participation: Students shall engage actively in all course activities including lectures, assignments, quizzes, and discussion forums. **4.2 Completion Certificate:** Students shall obtain a verified certificate of completion for MOOC Course. Free versions without certificates are NOT eligible for credit.
5. Assessment and Evaluation
5.1 Performance Tracking: Students shall maintain records of performance in all assessments throughout the course. **5.2 Final Assessment:** The Department may conduct a final assessment (proctored exam) to ensure that the knowledge gained aligns with the academic standards. This summative assessment (proctored exam) by the Engineering Department is mandatory in the absence of such assessment in the MOOC course/s by the online platform.
6. Credit Transfer
6.1 Submission of Certificates: Students shall submit the completion certificate/s and performance records to the Department MOOCs Coordinator. **6.2 Credit Evaluation:** The Department will evaluate the certificates and performance records to approve the credit transfer. **6.3 Grade Conversion:** College will take care to convert the grades from the MOOCs into the grading system as per established Academic Rules and Regulations.
7. Integration into Academic Record
7.1 Transcript Update: Upon approval, the credits and grades will be integrated into the student's academic transcript. **7.2 Grade Point Average (GPA) Calculation:** The MOOC grades are included in the calculation of the student's GPA.
8. Support and Resources
8.1 Academic Advising: The Department MOOCs Coordinator shall provide guidance and support to the students throughout the process. **8. 2 Technical Support:** The Department MOOCs Coordinator shall ensure that students have access to the necessary technical resources to complete MOOCs courses.
9. Feedback and Improvement
9.1 Student Feedback: Department MOOCs Coordinator shall collect feedback from students on their MOOC experiences to improve future implementations. **9.2 Continuous Improvement:** MOOCs guidelines and processes will be updated based on student feedback, Department feedback and evolving educational standards.

Course Outcomes: At the end of the course the student will be able to :	
21AEC801.1	Students will demonstrate a strong grasp of essential engineering concepts and methodologies relevant to their chosen field.
21AEC801.2	Students will apply engineering knowledge to solve real-world problems through projects and case studies presented in the course.
21AEC801.3	Students will proficiently use online tools and resources, including simulations, interactive modules, and digital libraries, to enhance their learning experience.
21AEC801.4	Students will gain insights into new technologies and innovations within engineering, preparing them to adapt to technological advancements.

21AEC801.5	Students will exhibit improved teamwork and communication skills by engaging in online discussions, group projects, and peer assessments.
21AEC801.6	Students will develop a broader understanding of how engineering intersects with other disciplines and cultural contexts, informed by national/global perspectives gained through the MOOC.

Course Articulation Matrix

Course Outcomes (COs)	**Program Outcomes (POs)**													
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
21AEC801.1	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
21AEC801.2	**3**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
21AEC801.3	**-**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**
21AEC801.4	**3**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**
21AEC801.5	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**-**	**1**	**-**	**-**
21AEC801.6	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**-**

1: Low 2: Medium 3: High

Major Project Work			
Course Code	**21MEP802**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Teaching Hours/Week (L:T:P)	(0:0:2)	SEE	3 Hrs
Total Hours	20 hours	Credits	05

Course Learning Objectives:

1. Utilize fundamental principles of engineering and interdisciplinary knowledge to identify, analyse, and solve complex problems in the project domain.
2. Develop and execute a comprehensive project plan that includes designing, prototyping, testing, and evaluating a system, component, or process to meet specific needs and constraints.
3. Conduct in-depth research, critically review literature, and integrate innovative solutions or techniques within the project framework.
4. Demonstrate effective teamwork, communication, and collaboration skills in a multidisciplinary environment to achieve project objectives.
5. Incorporate ethical considerations, societal impact, and sustainable practices in the project development, while adhering to professional engineering standards.
6. Prepare and present a well-structured project report, supported by technical documentation and visual aids, and confidently defend the work during project viva-voce or presentations.

1. Project Execution

- **Regular Meetings**: Students should meet regularly with their project-guide to discuss progress, challenges, and next steps.
- **Documentation**: Maintain detailed documentation throughout the project in a project work-dairy, including design decisions, experiments, and testing results.
- **Milestones**: Set clear milestones and deadlines to ensure steady progress. These could include design completion, initial prototype, testing, etc.

2. Progress Review

- **Progress Presentation**: DPEC shall conduct a mid-term review where students present their progress to a panel of faculty members.
- **Feedback**: Provide constructive feedback and guidance to help students refine their projects.

3. Final Submission

- **Report**: The final project report should include an abstract, introduction, literature review, methodology, implementation, results, discussion, conclusion, and references.
- **Code and Data**: If applicable, students should submit their code, datasets, and any other relevant materials.

4. Project Presentations

- **Oral Presentation**: Students should present their projects to a panel, explaining their work, findings, and contributions.
- **Demonstration**: If possible, include a live demonstration of the project or show relevant simulations and results.
- **Q&A**: Be prepared to answer questions from the panel and justify the project's methodology and conclusions.

5. Evaluation Criteria

- **Originality and Innovation**: Assess the novelty and creativity of the project.
- **Technical Competence**: Evaluate the depth of technical knowledge and problem-solving ability demonstrated.
- **Project Execution**: Consider the effectiveness of project planning, adherence to timelines, and quality of implementation.
- **Presentation and Communication**: Judge the clarity and coherence of the final report, presentation, and the ability to answer questions.

6. Plagiarism Check
• **Academic Integrity**: Ensure that the work submitted is original and properly cites all references and sources. • **Plagiarism Check**: Run all reports through plagiarism detection software and ensure that similarity index is less than the threshold value (25%).
7. Mentorship and Feedback
• **Feedback:** Students are required to consult with their project guide regularly throughout the project work to seek guidance and feedback. • **Weekly Meetings:** At least one mentorship meeting every week shall be held and recorded in the project work-dairy.
8. Post Submission
• **Publication**: DPEC shall encourage students to publish their work in conferences or journals, especially if it contributes significantly to their field. • **Project Archive**: Store all projects in the department's digital archive for future reference.

Continuous Internal Evaluation (CIE)		
Description	**Proposed Dates**	**CIE Weightage (Max 50 marks)**
1. Progress Review	During the 8th semester	25 marks
2. Project Report Evaluation	End of the 8th Semester	25 marks
Semester End Examinations (SEE)		
3. SEE will be conducted for 100 marks (after the last working day of the 7th semester) in the presence of the external examiner with the weightage as **Project Report: 50 marks, Project Presentation: 25 marks and Question & Answer Session: 25 marks**. Marks awarded for Project Report is same for all batch-mates.		

Course Outcomes: At the end of the course the student will be able to :	
21MEP802.1	Demonstrate the ability to identify, define, and solve complex engineering problems using appropriate methodologies and modern tools.
21MEP802.2	Successfully design, develop, and test an engineering solution that meets specified requirements, addressing technical, economic, environmental, and social constraints.
21MEP802.3	Apply research skills to review existing literature, gather and analyze data, and incorporate innovative or state-of-the-art technologies in the project
21MEP802.4	Collaborate effectively within a team, taking on leadership or supportive roles as needed, while ensuring clear communication and efficient project management.
21MEP802.5	Demonstrate awareness of professional ethics, societal impact, and sustainability in the design and implementation of engineering solutions.
21MEP802.6	Exhibit strong written and oral communication skills by preparing technical reports, project documentation, and delivering persuasive project presentations.

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1	PO1	PO1	PSO	PSO
21MEP802.1	2	3	-	-	1	-	-	-	-	-	-	-	-	-
21MEP802.2	-	-	3	-	-	2	1	-	-	-	-	-	-	-
21MEP802.3	1	2	-	3	-	-	-	-	-	-	-	-	-	-
21MEP802.4	-	-	-	-	-	1	-	-	3	2	2	-	-	-
21MEP802.5	-	-	1	-	-	-	2	3	-	-	-	-	-	-
21MEP802.6	-	-	-	-	-	-	-	-	-	3	2	1	-	-

1: Low 2: Medium 3: High

Research/Industry Internship			
Course Code	**21INT803**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Number of Weeks	15 Weeks	SEE	3 Hours
		Credits	10

Research Internship

Course Learning Objectives:

1. To equip students with the knowledge of fundamental research principles, methodologies, and techniques applicable to their engineering discipline.
2. To enable students to formulate research questions, design experiments or studies, and use appropriate data collection and analysis tools.
3. To foster the ability to think critically and innovatively while solving complex engineering problems during the research process.
4. To guide students in developing the skills necessary for writing clear and well-structured research reports, papers, and presentations.
5. To instill an understanding of ethical practices in research, including integrity, responsible data handling, and respect for intellectual property.
6. To prepare students to work effectively in research teams, communicate their ideas clearly, and present their findings to both technical and non-technical audiences.

Pre-Internship Preparation

1. **Orientation Session:** Attend an orientation session with the academic mentor (allotted from the Department) and the Research Supervisor to understand the research goals, expectations, and assessment criteria.
2. **Documentation:** Complete necessary documentation, including the approval from the Department, processing of the internship request application, research agreements and confidentiality agreements, if applicable.
3. **Research Proposal:** Develop a research proposal in consultation with the Research Supervisor and academic mentor outlining the objectives, methodology, and expected outcomes.

During the Internship

1. **Work Plan:** Follow a structured research plan provided by the supervising researcher or mentor.
2. **Literature Review:** Conduct a comprehensive literature review to understand the current state of research in the chosen area.
3. **Regular Meetings:** Participate in regular meetings with academic and research mentors to discuss progress, challenges, and next steps.
4. **Lab Work/Field Work:** Engage in experimental work, simulations, or field studies as required by the research project.
5. **Data Collection and Analysis:** Collect, analyze, and interpret data using appropriate tools and techniques.
6. **Documentation:** Maintain detailed records of research activities, experiments, and findings.

Deliverables

1. **Weekly Reports:** Submit weekly progress reports to academic and research mentors.
2. **Monthly Reports:** Submit monthly progress reports to academic and research mentors.
3. **Mid-Term Review:** Participate in a mid-term review meeting to assess progress and realign research goals if necessary.
4. **Report and Research Paper:** Prepare a draft report and a research paper detailing the research problem, methodology, results and discussions, and conclusions.
5. **Presentation:** Deliver a presentation summarizing the research work to faculty, peers, and other stakeholders upon completion of the internship.

Assessment Criteria
1. **Research Quality:** Evaluate the quality and rigor of the research conducted. 2. **Report Quality:** Assess the clarity, organization, and thoroughness of the report and the research paper. 3. **Presentation:** Evaluate the effectiveness and clarity of the final presentation. 4. **Innovation and Creativity:** Consider the originality and innovative aspects of the research. 5. **Self-Reflection:** Review the student's ability to critically reflect on their research experience and identify areas for future growth.
Post-Internship
1. **Feedback Session:** Attend a feedback session with academic mentors to discuss the research experience and areas of improvement. 2. **Publication:** Explore opportunities to publish the research findings in academic journals or conferences. 3. **Networking:** Maintain professional relationships established during the internship for future research collaborations.
Additional Tips
• **Curiosity:** Cultivate a curious mindset and a willingness to explore new ideas. • **Collaboration:** Work collaboratively with other researchers and team members. • **Adaptability:** Be open to modifying research approaches based on findings and feedback. • **Communication:** Develop strong written and oral communication skills to effectively present research findings. • **Time Management:** Prioritize tasks and manage time efficiently to meet research deadlines.

Evaluation Scheme	
Continuous Internal Evaluation (CIE): I (Only OFFLINE)	Will be conducted during the 7th semester BE. Students shall submit the Research Internship Proposal and make a presentation and answer questions raised by the Departmental Internship Evaluation Committee (DIEC). Marks split-up: Research Internship Proposal – 50 marks + Oral Presentation-25 marks + Question and Answer-25 marks.
Continuous Internal Evaluation (CIE): II (ONLINE/OFFLINE)	Will be conducted during the middle of the 8th semester BE. Students shall submit the Reports (daily/weekly/monthly reports), make a presentation on progress done so far and answer questions raised by the Departmental Internship Evaluation Committee. Marks split-up: Reports – 50 marks + Oral Presentation-25 marks + Question and Answer-25 marks.
Continuous Internal Evaluation (CIE): III (Only OFFLINE)	Will be conducted at the end of the 8th semester BE. Students shall submit the Reports (daily/weekly/monthly reports) and the final internship report, make a presentation on work completed and answer questions raised by the Departmental Internship Evaluation Committee. Marks split-up: Reports – 50 marks + Oral Presentation-25 marks + Question and Answer-25 marks.
CIE Marks (Max 100)	Average of the CIE:I , CIE-II and CIE:III marks
Semester-End-Examinations (SEE) (Only OFFLINE)	Will be conducted within a week of the last working day of the 8th semester BE. Student shall submit the internship report approved by all the concerned, make a presentation and answer the questions raised by the internal and external examiners. Marks split-up: Reports – 50 marks + Oral Presentation-25 marks + Question and Answer-25 marks.

Course Outcomes: At the end of the course the student will be able to:	
21INT803.1	Apply appropriate research methodologies and tools to design and conduct experiments, analyze data, and draw conclusions.
21INT803.2	Demonstrate the ability to identify and solve complex engineering problems through innovative and systematic research approaches.
21INT803.3	Acquire proficiency in using advanced technologies, tools, and techniques relevant to their field of research.
21INT803.4	Develop skills in writing comprehensive research reports, documentation, and effectively presenting research findings.
21INT803.5	Understand and apply ethical standards in research, including plagiarism avoidance, proper citations, and data integrity.
21INT803.6	Gain experience in working collaboratively within a research team and contributing effectively to the shared goals of the project.

References

1. AICTE Internship Policy : Guidelines and Procedures 2019.
Available at https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

2. UGC Guidelines for Internship/Research Internship for Under Graduate Students 2023.
Available at https://www.ugc.gov.in/pdfnews/0063650_Draft-Guidelines-for-Internship-and-Research-Internship-for-Under-Graduate-Students.pdf

3. VTU Mandatory Internship Guidelines 2021.
Available at https://vtu.ac.in/pdf/regulations2021/anex4.pdf

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21INT803.1	1	-	2	3	-	-	-	-	-	-	-	-	-	-
21INT803.2	3	2	-	-	-	-	-	-	-	-	-	-	-	-
21INT803.3	-	-	-	-	3	2	-	-	-	-	-	1	-	-
21INT803.4	-	-	-	-	-	-	-	-	-	3	-	1	-	-
21INT803.5	-	-	-	-	-	2	-	3	-	-	-	1	-	-
21INT803.6	-	-	-	-	-	-	-	-	3	2	1	-	-	-

1: Low 2: Medium 3: High

Research/Industry Internship			
Course Code	**21INT803**	CIE Marks	50
Course Type (Theory/Practical/Integrated)	Practical	SEE Marks	50
		Total Marks	100
Number of Weeks	15 Weeks	SEE	3 Hours
		Credits	10

Industry Internship

Course Learning Objectives:

1. To develop practical engineering skills through hands-on experience in a real-world industrial environment.
2. To enhance the ability to identify, analyze, and solve complex engineering problems encountered during the internship.
3. To gain an understanding of the functioning of the industry, including exposure to its standards, practices, and emerging technologies.
4. To improve communication, collaboration, and teamwork skills by working with professionals in a multidisciplinary team setting.
5. To foster adaptability by learning to work in dynamic and fast-paced industrial environments while embracing lifelong learning.
6. To instill a sense of professional ethics, responsibility, and accountability in engineering practice by adhering to industry-specific codes of conduct.

Pre-Internship Preparation

1. **Orientation Session:** Attend an orientation session with the academic mentor (allotted from the Department) to understand the internship goals, expectations, and assessment criteria.
2. **Documentation:** Complete necessary documentation, including the approval from the Department, processing of the internship request application, internship agreements if applicable etc.
3. **Goal Setting:** Define specific, measurable, achievable, relevant, and time-bound (SMART) goals in consultation with academic and industry mentors.

During the Internship

1. **Work Plan:** Follow a structured work plan provided by the host organization.
2. **Mentorship:** Regularly meet with assigned industry and academic mentors to review progress and seek guidance.
3. **Work Diary/Daily Report/Learning Diary:** Maintain a diary/logbook documenting daily activities, learnings, challenges, and reflections.
4. **Professional Conduct:** Adhere to the professional and ethical standards of the host organization, including dress code, punctuality, and communication protocols.
5. **Skill Application:** Actively participate in projects and tasks assigned, applying theoretical knowledge to practical situations.

Deliverables

1. **Weekly Reports:** Submit the weekly progress reports to academic and industry mentors.
2. **Monthly Reports:** Submit the monthly progress reports to academic and industry mentors.
3. **Mid-Term Review/Evaluation:** Participate in a mid-term review meeting/evaluation to assess progress and realign goals if necessary.
4. **Final Report:** Prepare a comprehensive final report in the specified format detailing the projects undertaken, skills acquired, challenges faced, and overall learning experience.
5. **Presentation:** Deliver a presentation summarizing the internship experience to faculty evaluators and peers upon completion of the internship.

Assessment Criteria

1. **Performance Evaluation:** Receive feedback from the industry mentor based on work performance, technical skills, and professional behaviour.

2. **Report Quality:** Evaluate the quality, clarity, and comprehensiveness of the final report.
3. **Presentation:** Assess the effectiveness and clarity of the final presentation.
4. **Self-Reflection:** Review the student's ability to critically reflect on their learning experience and identify areas for future growth.

Post-Internship

1. **Feedback Session:** Attend a feedback session with academic mentors to discuss the internship experience and areas of improvement.
2. **Certification:** Obtain an internship completion certificate from the host organization.
3. **Networking:** Maintain professional relationships established during the internship for future opportunities.

Additional Tips

- **Professionalism:** Demonstrate a professional attitude and work ethic at all times.
- **Adaptability:** Be open to learning and adapting to new environments and technologies.
- **Communication:** Develop strong communication skills to effectively collaborate with colleagues and mentors.
- **Time Management:** Prioritize tasks and manage time efficiently to meet deadlines.

Evaluation Scheme	
Continuous Internal Evaluation (CIE): I (ONLINE/OFFLINE)	Will be conducted during the middle of the 8th semester BE. Students shall submit the Reports (daily/weekly/monthly reports), make a presentation on work done so far and answer questions raised by the Departmental Internship Evaluation Committee. Marks split-up: Reports – 50 marks + Oral Presentation 25 marks + Question and Answer 25 marks.
Continuous Internal Evaluation (CIE): II (Only OFFLINE)	Will be conducted at the end of the 8th semester BE. Students shall submit the Reports (daily/weekly/monthly reports) and the final report, make a presentation on work completed and answer questions raised by the Departmental Internship Evaluation Committee. Marks split-up: Reports – 50 marks + Oral Presentation 25 marks + Question and Answer 25 marks.
CIE Marks (Max 100)	Average of the CIE:I and CIE:II marks
Semester-End-Examinations (SEE) (Only OFFLINE)	Will be conducted within a week of the last working day of the 8th semester BE. Student shall submit the internship report approved by all the concerned, make a presentation and answer the questions raised by the internal and external examiners. Marks split-up: Reports – 50 marks + Oral Presentation 25 marks + Question and Answer 25 marks.

Course Outcomes: At the end of the course the student will be able to:	
21INT803.1	Apply engineering concepts and theoretical knowledge to solve real-world industry problems.
21INT803.2	Enhance their problem-solving abilities by identifying, analyzing, and providing innovative solutions to engineering challenges in the industry.
21INT803.3	Develop key professional skills such as teamwork, communication, and time management in a corporate or industrial environment.
21INT803.4	Gain exposure to industry-standard tools, technologies, methodologies, and regulatory standards relevant to their field of study.
21INT803.5	Demonstrate understanding and adherence to professional ethics, safety regulations, and responsibilities in an industrial setting.

21INT803.6	Build a network of industry professionals and gain insights into career opportunities, preparing them for future employment in the engineering sector.

References

1. AICTE Internship Policy : Guidelines and Procedures 2019.
Available at https://aicte-india.org/sites/default/files/AICTE%20Internship%20Policy.pdf

2. UGC Guidelines for Internship/Research Internship for Under Graduate Students 2023.
Available at https://www.ugc.gov.in/pdfnews/0063650_Draft-Guidelines-for-Internship-and-Research-Internship-for-Under-Graduate-Students.pdf

3. VTU Mandatory Internship Guidelines 2021.
Available at https://vtu.ac.in/pdf/regulations2021/anex4.pdf

Course Articulation Matrix

Course Outcomes (COs)	Program Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
21INT803.1	3	2	-	-	-	1	-	-	-	-	1	-	-	-
21INT803.2	-	3	2	1	-	-	-	-	-	-	1	-	-	-
21INT803.3	-	-	-	-	-	-	-	-	3	2	-	-	-	-
21INT803.4	-	-	-	-	3	2	-	-	-	-	-	1	-	-
21INT803.5	-	-	-	-	-	2	-	3	-	-	-	-	-	-
21INT803.6	-	-	-	-	-	-	-	-	2	3	-	1	-	-

1: Low 2: Medium 3: High

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Core Values of the Institution

SERVICE

A Josephite will keep service as the prime goal in everything that is undertaken. Meeting the needs of the stakeholders will be the prime focus of all our endeavors.

EXCELLENCE

A Josephite will not only endeavor to serve, but serve with excellence. Preparing rigorously to excel in whatever we do will be our hallmark.

ACCOUNTABILITY

Every member of the SJEC Family will be guided to deliver on assurances given within the constraints set. A Josephite will always keep budgets and deadlines in mind when delivering a service.

CONTINUOUS ADAPTATION

Every member of the SJEC Family will strive to provide reliable and continuous service by adapting to the changing environment.

COLLABORATION

A Josephite will always seek to collaborate with others and be a team-player in the service of the stakeholders.

Objectives

- Provide Quality Technical Education facilities to every student admitted to the College and facilitate the development of all round personality of the students.
- Provide most competent staff and excellent support facilities like laboratory, library and internet required for good education on a continuous basis.
- Encourage organizing and participation of staff and students in in-house and outside Training programmes, seminars, conferences and workshops on continuous basis.
- Provide incentives and encouragement to motivate staff and students to actively involve in research-innovative projects in collaboration with industry and R &D centres on continuous basis
- Invite more and more number of persons from industry from India and abroad for collaboration and promote Industry-Institute Partnership.
- Encourage consultancy and testing and respond to the needs of the immediate neighbourhood.

St Joseph Engineering College

AN AUTONOMOUS INSTITUTION

Affiliated to VTU, Belagavi | Recognised by AICTE, New Delhi
Accredited by NAAC with A+ Grade
B.E. (CSE, ECE, EEE, ME, CIV), MBA & MCA Accredited by NBA, New Delhi

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