COEP Technological University Pune

(A Unitary Public University of Govt. of Maharashtra)

School of Engineering and Technology
Department of Manufacturing Engineering & Industrial Management

NEP Compliant Curriculum Structure & Detailed Syllabus

Semester- VII and VIII

B. Tech. (Manufacturing Science and Engineering)

(Effective from: A.Y. 2026-27)

Program Educational Objectives (PEOs)

After the completion of the program,

I Advance professionally as a result of his/her ability to solve complex technical problems using the knowledge of mathematics, science, engineering and humanities and to work in multidisciplinary areas whose solutions lead to significant societal benefits.

II. Demonstrate professional engineering competence to real life problems and compete successfully using principles of manufacturing and time and quality management in the design and manufacture of products and services.

III. Exhibit professionalism, ethical attitude, communication skills, teamwork in their profession and adapt to current trends by engaging in lifelong learning.

Program Outcomes (POs):

Engineering Graduate will be able to:

PO1: Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problem.

PO2: Problem Analysis: Identify, formulate, review research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural science, and engineering sciences.

PO3: Design/Development Solution: Design solution for complex engineering problems and design system component or process that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, social and environmental conditions.

PO4: Conduct Investigation of Complex Problem: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusion.

PO5: Method, Tool Usage: Create, select and apply appropriately technique, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with understanding the limitation.

PO6: The Engineer and Society: Apply reasoning informed by the contextual knowledge to access societal health, safety, legal and cultural and consequent responsibility relevant to the professional engineering practice.

PO7: Environment and Sustainability: Understand the impact of the professional engineering solution in societal and environmental context, and demonstrate the knowledge of, and need for sustainable development.

PO8: Ethics: Apply ethical principle and commitment to professional ethics and responsibilities and norms of the engineering practices.

PO9: Individual and Team Work: Function effectively as an individual, and as the member or leader in diverse team and multidisciplinary setting.

PO10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, and being able to comprehend and write effective reports and design documentation and effective presentation and give and receive clear instructions.

PO11: Project management and Finance: Demonstrate knowledge & understanding of the engineering and management principles and apply these to one's work, as the member and the leader in a team to manage projects and in multidisciplinary environment.

PO12: Lifelong Learning: Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in broadest context of technological change.

Semester - VII

Semester VII (Proposed from AY 2026-27)

Sr. No	Course Type	Course Code	Course Name	L	T	P	S	Cr	Evaluation Scheme				
									Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1	PCC-08	<tbd>	Robotics and Intelligent Manufacturing	2	0	0	1	2	30	20	50	-	
2	PCC-09	<tbd>	Advanced Manufacturing Technology	2	0	0	1	2	30	20	50	-	
3	PCC-10	<tbd>	Machine Tool and Manufacturing System	2	0	0	1	2	30	20	50	---	---
4	PEC-01	<tbd>	Department Elective-III	3	0	0	1	3	30	20	50	---	---
5	MDM-01	<tbd>	Multidisciplinary Minor	3	0	0	1	3	30	20	50	---	---
6	RM	<tbd>	Research Methodology	2	0	0	1	2	30	20	50	--	
7	ELC	<tbd>	Project Stage-III	0	0	10	1	5	---	---	---	CIE 100	
8	ELC	<tbd>	Internship-III	0	0	2		1	---	---	---	CIE 100	
Total				**14**	**0**	**12**	**7**	**20**					

Summer internship-II after semester-VI during summer vacation and evaluation will be done in the starting of VIIth semester.

PEC Department Elective-III

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	PEC 3	Supply Chain and Logistics Management	3	0	0	1	3	3
2	PEC 3	Micro Electromechanical Systems	3	0	0	1	3	3
3	PEC 3	Manufacturing control system	3	0	0	1	3	3
4	PEC 3	Reliability Engineering	3	0	0	1	3	3
5	PEC 3	Total Quality Management	3	0	0	1	3	3

Semester VIII (Proposed from AY 2026-27)

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme					Credits
				L	T	P	S	Hrs	
1	PEC	<tbd>	Department Elective-IV (MOOCS)	3	0	0	1	3	3
2	PEC	<tbd>	Department Elective-V (MOOCS)	3	0	0	2	3	3
3	PEC	<tbd>	Department Elective-VI (MOOCS)	3	0	0	2	3	3
4	ELC	<tbd>	Internship-III/On Campus Project	0	0	6	0	6	3
Total Academic Engagement and Credits				**9**	**0**	**06**	**05**	**15**	**12**

Department Elective -IV (MOOCs)

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	PEC 4	Product Communication and Interface Design	3	0	0	1	3	3
2	PEC 4	Production and Operations Management	3	0	0	1	3	3
3	PEC 4	Design of Precision Machines	3	0	0	1	3	3
4	PEC 4	Facility Planning and Design	3	0	0	1	3	3
5	PEC 4	Advanced Operation Research and Optimisation	3	0	0	1	3	3

Department Elective -V (MOOCs)

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
2	PEC 5	Agile Project management	3	0	0	1	3	3
3	PEC 5	Selection of Materials & Process for Product Design	3	0	0	1	3	3
4	PEC 5	Production Planning and Control	3	0	0	1	3	3
5	PEC 5	MRP & ERP	3	0	0	1	3	3

Department Elective -VI (MOOCs)

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	PEC 6	Biomedical Device Design	3	0	0	1	3	3
2	PEC 6	Inventory management	3	0	0	1	3	3
3	PEC 6	Business Environment and Corporate Strategy	3	0	0	1	3	3
4	PEC 6	Vibration and Acoustics	3	0	0	1	3	3
5	PEC 6	Concurrent engineering and product life cycle Management	3	0	0	1	3	3

Semester Wise Credit Distribution	**Teaching Scheme**					**Credits**
	L	**T**	**P**	**S**	**Hrs**	
I	**11**	**1**	**16**	**6**	28	20
II	**13**	**1**	**12**	**8**	26	20
III	**12**	**1**	**12**	**8**	25	19
IV	**19**	**0**	**10**	**6**	29	23
V	**17**	**1**	**12**	**4**	30	24
VI	**14**	**2**	**10**	**6**	26	22
VII	**12**	**1**	**14**	**6**	27	20
VIII	**9**	**0**	**6**	**5**	15	12
Total Academic Engagement and Credits	**107**	**7**	**92**	**49**	**206**	**160**

<table>
<tr><td colspan="8">Robotics and Intelligent Manufacturing</td></tr>
<tr><td>Course Code</td><td colspan="2"></td><td colspan="5">Examination Scheme</td></tr>
<tr><td>Teaching Scheme</td><td>2-0-0-1</td><td></td><td>Theory</td><td>TA: 20</td><td>MSE: 30</td><td colspan="2">ESE: 50</td></tr>
<tr><td>Credits</td><td>2</td><td></td><td>Laboratory</td><td>CIE: 100</td><td>ESE: --</td><td colspan="2">--</td></tr>
<tr><td colspan="8">Course Objective:</td></tr>
<tr><td colspan="8">1. To introduce fundamentals of robotics and intelligent manufacturing systems.
2. To understand robot kinematics, sensors, actuators, and robot programming.
3. To study industrial robots used in modern manufacturing environments.
4. To gain hands-on experience with industrial and collaborative robots.
5. To explore AI and intelligent automation in manufacturing systems</td></tr>
<tr><td colspan="7">Introduction</td><td>05 L</td></tr>
<tr><td colspan="8">Definition and history of robotics Components of robotic system Types of robots (industrial, service, humanoid, collaborative) basic structure of robots, resolution, accuracy and repeatability. Robot configurations (Cartesian, Cylindrical, SCARA, Articulated) Degrees of freedom, Robot workspace Robot End Effectors / Grippers: Grippers and tools, Types of end effectors-mechanical, magnetic and vacuum, gripper force analysis and gripper design considerations.</td></tr>
<tr><td colspan="7">Sensors, Actuators and Robot Control</td><td>05 L</td></tr>
<tr><td colspan="8">Robot sensors Sensors, internal-external sensors, contact and non-contact sensors, position and velocity sensors, Touch and slip sensors, Force and torque sensors, tactile sensors, Proximity, and range sensors.Types of controllers P, PI, PID controllers. Types of actuators (electric, hydraulic, pneumatic) DC servo motors, Numerical on sensors and actuator.</td></tr>
<tr><td colspan="7">Robot Arm Kinematics and Dynamics</td><td>05 L</td></tr>
<tr><td colspan="8">Homogenous coordinates and homogenous transformations, Forward and Inverse kinematics in robot, Denavit Hartenberg convention and its applications, Robot dynamics control</td></tr>
<tr><td colspan="7">Vision system and robot programming</td><td>05 L</td></tr>
<tr><td colspan="8">Vision Systems: Vision equipment, line scan and area scan sensor, Charge Coupled Device, image processing, and analysis, preprocessing, segmentation, and feature recognition, smoothening of binary image.
Robot Programming: Methods of robot programming, Online vs offline programming Robot Language: The textual robot languages, generations of robot programming languages, VAL, MELFA, Python, ROS</td></tr>
<tr><td colspan="7">Application of robotics and Intelligent manufacturing</td><td>05 L</td></tr>
<tr><td colspan="8">Manufacturing automation levels, Automated material handling systems Intelligent manufacturing systems, Industry 4.0, Digital twins and smart factories AI in robotics Machine vision in manufacturing Human-robot collaboration, Cobots in modern manufacturing, Applications of humanoid and service robots</td></tr>
<tr><td colspan="8">Course Outcomes: Students will be able to:</td></tr>
<tr><td colspan="8">1. Explain the fundamentals of robotics and intelligent manufacturing systems.
2. Analyze robot kinematics, actuators, sensors, and control systems.
3. Develop basic robot programs for industrial robots and cobots.
4. Apply robotics in intelligent manufacturing and automation processes.
5. Demonstrate hands-on operation of industrial and service robots.</td></tr>
<tr><td colspan="8"></td></tr>
<tr><td colspan="8">Textbooks:</td></tr>
<tr><td>1</td><td colspan="7">S. R. Deb.: Robotics Technology and Flexible Automation</td></tr>
<tr><td colspan="8">Reference Books:</td></tr>
</table>

1	Mikell Groover Industrial Robotics
2	John J. Craig Introduction to Robotics: Mechanics and Control
3	P.A. Janakiraman, Robotics and Image Processing, Tata Mcgraw Hill, 199
4	Peter Corke Robotics, Vision and Control
5	Kumar, Tiwari et al. – Smart Manufacturing: Concepts and Methods
6	Mikell P. Groover – Automation, Production Systems, and Computer-Integrated Manufacturing

Advanced Manufacturing Technology (AMT)						
Course Code			**Examination Scheme**			
Teaching Scheme	2-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: 100	ESE: --	--

Course Objective:

1. Understand the limitations of conventional machining and the need for advanced, hybrid, and non-conventional manufacturing processes for machining advanced engineering materials used in aerospace, defense, and high-precision industries.
2. Explain the mechanics and physics of material removal in mechanical, electrochemical, and beam-based advanced machining processes such as USM, AJM, ECM, EBM, and LBM.
3. Analyze the influence of process parameters on performance measures, including material removal rate (MRR), surface integrity, dimensional accuracy, and thermal effects, using analytical and numerical approaches.
4. Develop and apply analytical and numerical models to predict machining characteristics, heat transfer behaviour, electrolyte flow dynamics, and tool–work interactions in advanced manufacturing processes.
5. Apply design principles to tooling systems, energy delivery mechanisms, and auxiliary subsystems, and gain exposure to micro-fabrication and advanced finishing processes for precision and micro-scale manufacturing applications.

Machining Challenges in Advanced Materials and the Need for Advanced Manufacturing Processes:	**05 L**
Limitations of conventional machining processes; advanced engineering materials are used across sectors such as automotive, aerospace, and defense. Machining challenges of advanced materials, Need for advanced machining processes, Overview of Hybrid machining process: Ultrasonic-assisted turning, Laser-assisted machining, EDM-assisted grinding, Electrochemical discharge machining (ECDM), **Self Study**: Industrial Case Studies (Application Perspective), Turbine blade cooling holes, Micro-holes in fuel injectors, Composite aircraft panels, Optical mirror finishing, Armor plate cutting.	
Ultrasonic Machining (USM) and Abrasive Jet Machining (AJM):	**05 L**
Basics of USM processes, Mechanics of USM. Process parameters of USM, Shaw's model of USM mechanics, Dependence of process parameters in estimation of MRR, Numerical approach to USM, Ultrasonic machining setup, Design of acoustic ultrasonic head and feed mechanism in USM. Introduction to abrasive jet machining (AJM), Mechanics of AJM, AJM process parameters, Components of AJM (Abrasive, Gas, Setup), Mixing and Mass ratio, and Material removal rate, Numerical approach to AJM, Modelling of Material Removal Rate (MRR). **Self-Study:** AJMM, Mask materials of AJMM, and applications. .	
Electrochemical Machining Process (ECM)	**05 L**
Basics of Electrochemical Machining: Electrochemistry basics, Debye-Hückel theory of Ion transport, Finding out of potential on the electrode surface, Basic Principle of Electrochemical Machining, Estimation of MRR in ECM, Electrode potential in ECM, MRR in multiphase alloys, Numerical approach to ECM, Tool shape determination in ECM, Effect of electrolyte flow velocity, Electrolyte flow dynamics and design of electrode for electrolyte flow, Effect of insulation in ECM, Defects in ECM and reasons, Basics of Electrochemical drilling, Basics of Electrochemical Grinding, **Self-Study:** Basics of Electro stream drilling, Process parameters from Electro stream drilling and Electrochemical Grinding	
Electron Beam Machining (EBM) and Laser Beam Machining (LBM):	**05 L**

Introduction to electron beam machining, Comparison of E-beam machining with other thermal processes, Setup for EBM, Power requirement in E-Beam, Mechanics of EBM process, Numerical model for heat transfer in EBM and estimation of MRR, Derivation of functional characteristics in EBM by using Buckingham's Pie theorem, Introduction to Lasers and Laser beam machining, Types of lasers and feedback mechanisms in Lasers, Mechanics of material removal in Laser machining, Numerical on heat conduction model and temperature rise in LBM, Numerical estimation of time of machining in both the semi-infinite and circular beam cases, **Self-Study**: Power requirements for different work-piece materials in EBM, Dependence of heat input on cutting speed of laser beam, Introduction to Plasma Arc Machining.	
Overview of Micro-fabrication Processes and Advanced Finishing Processes:	**05 L**
Overview of soft lithography processes for polymer micro-fabrication. Introduction to the use of non-conventional processes for micromachining. Basics of Abrasive flow finishing (AFF) and Magneto-rheological abrasive flow finishing processes (MRAF), Physics of MRAF, Process parameters of AFF and MRAF.	

Course Outcomes: Students will be able to:

1. Describe and classify advanced, hybrid, and non-traditional machining processes, and justify their necessity over conventional machining for advanced engineering materials used in aerospace and defense applications.
2. Explain the mechanics and physics of material removal in ultrasonic, abrasive jet, electrochemical, and beam-based machining processes using theoretical and physical models.
3. Analyze and estimate machining performance parameters such as material removal rate (MRR), accuracy, surface integrity, and thermal effects using analytical and numerical approaches.
4. Apply electrochemical, thermal, and transport principles to model heat transfer, electrolyte flow, tool–work interactions, and process dynamics in ECM, EBM, and LBM.
5. Design and evaluate tooling systems and auxiliary subsystems, and demonstrate understanding of micro-fabrication and advanced finishing processes for precision and micro-scale manufacturing applications.

Textbooks:

1	Ghosh, A., Mallik, A.K., Manufacturing Science (2nd edition), EastWest Press, 2010.

Reference Books:

1	M.P. Groover, Fundamentals of Modern Manufacturing, John Wiley& Sons Inc., 2010
2	V.K. Jain, Advanced Machining Processes, Allied Publishers Private Limited, 2004
3	Advanced manufacturing processes, Hassan Abdel, Gabad El Hoffy, McGraw-Hill, 2005.
4	The Science and Engineering of Micro-fabrication (2nd edition), Stephen P. Campbell, Oxford University Press,2001.
5	Fundamentals of Stereolithography (1st Edition), Paul F. Jacobs, Society of Manufacturing Engineers, 2000.
6	GHOSHDASTIDAR, P. "Ghoshdastidar, P.S. Ghoshdastidar - Heat Transfer - Oxford University Press (2012).

Machine tool and Mmanufacturing System						
Course Code			**Examination Scheme**			
Teaching Scheme	2-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	2		**Laboratory**	CIE: ---	ESE: --	--

Course Objective:

1. To understand machine tool drives, motions, and transmission systems.
2. To learn speed and feed regulation mechanisms and gearbox design.
3. To study design principles of machine tool structures, guideways, and power screws.
4. To analyze spindle design, bearings, and support systems.
5. To understand dynamic behavior and stability of machine tools during cutting operations.

Machine Tool Drive	**05 L**
working and auxiliary motion in machine, Machine tool drives, Hydraulic transmission, Mechanical transmission, General requirements of machine tool design, Layout of machine tools.	
Regulation of Speed and Feed Rates	**05 L**
Aim of speed feed regulation, stepped regulation of speed, design of speed box, Design of feed box, Special cases of gear box design, Set stopped regulation of speed and feed rates.	
Design of Machine Tool Structure	**05 L**
Fundamentals of machine tool structures and their requirements, Design criteria of machine tool structure, Static and dynamic stiffness, Design of beds and columns, Design of housing models, Techniques in design of machine tool structure.	
Design of Guide-ways and power Screws, Design of Spindles and Spindle Supports:	**05 L**
Function and type of guide-ways, design of slide-ways, Protecting devices for slide-ways, Design of power screws. Materials for spindles, Design of spindles, Antifriction bearings, Sliding bearings.	
Dynamics of Machines Tools	**05 L**
General procedure of assessing dynamic stability of EES, Cutting processing, Closed loop system, Dynamic characteristics of cutting process, Stability	

Course Outcomes: Students will be able to:

1.Explain machine tool drives, layouts, and transmission systems.
2.Design speed and feed mechanisms including gearboxes.
3.Apply design principles for machine tool structures and guideways.
4.Analyze spindle systems and select appropriate bearings.
5. Evaluate dynamic stability and performance of machine tools.

Textbooks:

1	N.K. Mehta – *Machine Tool Design and Numerical Control*, Tata McGraw-Hill.
2	A. Bhattacharya – *Machine Tool Design*, New Central Book Agency.

Reference Books:

1	G.C. Sen & A. Bhattacharya – *Principles of Machine Tools*, New Central Book Agency.
2	K.C. Jain & A.K. Chitale – *Machine Tool Design*, PHI Learning.
3	S.K. Basu & D.K. Pal – *Design of Machine Tools*, Oxford & IBH.
4	Geoffrey Boothroyd – *Fundamentals of Metal Machining and Machine Tools*, CRC Press.

Department Elective-III

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	PEC 3	Supply Chain and Logistics Management	3	0	0	1	3	3
2	PEC 3	Micro Electromechanical Systems	3	0	0	1	3	3
3	PEC 3	Manufacturing control system	3	0	0	1	3	3
4	PEC 3	Reliability Engineering	3	0	0	1	3	3
5	PEC 3	Total Quality Management	3	0	0	1	3	3

PEC 3: Supply Chain and Logistics Management						
Course Code			**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: ---	ESE: --	--

Course Objective:

1. To understand the basic concepts, models, and operations of Supply Chain Management in manufacturing and service sectors.
2. To analyze supply chain uncertainties and develop strategies for achieving effective supply chain performance.
3. To learn sourcing, supplier selection, distribution network design, and facility location decisions.
4. To understand logistics systems, warehousing, and key performance indicators in national and international contexts.
5. To explore modern advancements such as green logistics, reverse logistics, lean logistics, and sustainable supply chains.

Introduction to SCM	**06 L**
Fundamentals of Supply Chain Management (SCM); Supply Chain Decisions; Types of Supply Chain Models; Supply Chain (SC) Operations: Manufacturing versus Service SC; Examples of Manufacturing and Service Sector; Principle Streams of Supply Chain: 1st stream, 2nd stream, and 3rd stream, Objectives of Supply Chain Networks; Factors influencing Supply Chain Network Decisions; Framework of Network Design Decision; Case studies.	
Control and Strategies in SC	**06 L**
Supply Chain Uncertainty and Processes; How to mitigate Supply Chain Uncertainty; Supply Chain Operational Views: SCOR Model; Cyclic View and Push/Pull View of Supply Chain; Supply Chain Model and Modelling Systems; Supply Chain Control Towers (Future of SC Modelling); Supply Chain Drivers; SC performance and Strategy: Impellers of Supply Chain and Value Chain. Supply Chain Strategy: Introduction; Achieving Strategic Fit in the Supply Chain, Models for developing Supply Chain Strategy; Make-or-Buy Decisions; Case studies.	
Sourcing and Distribution in SC	**06 L**
Strategic sourcing; Supplier selection and management; Vendor selection and rating; Global sourcing; Coordination in Supply Chain; SC Performance Measurement. Importance of distribution in SC; Decision-making in distribution networks design; Designing distribution networks and Distribution Management; Facility Location Decisions. Case Studies	
Basics of Logistics	**06 L**

Introduction to Logistics: Design and Management, Logistics Stakeholders and Modern Logistics Concepts, E-logistics, Manufacturing Logistics: National and International Scenario, Storage and Warehousing, Logistics Services Providers, Outsourcing logistics. Industry Scenario: E-commerce Industry; International Logistics; International Market Penetration Strategies; Logistics Key Performance Area (KPIs): Transportation, Supply, Distribution, Warehousing and Order management; Tools for Improving Logistics Efficiency; Case studies.	
Advancements in Logistics & SCM	**06 L**
Reverse Logistics; Performance measures in reverse logistics; Green Supply Chain Management (GSCM); Key Technologies in Green Logistics for Minimizing Carbon Emissions; Implementing green logistics; Lean Logistics; Principles of lean logistics. Trends in Logistics: Technological Advancements; Categories of Modern Logistics; Performance measures for modern logistics; Logistics versus SCM; Logistical Components of the Supply Chain; Designing Smart, Resilient and Sustainable Supply Chains; Smart practices in SCM: 21st Century Supply Chains; Supply chain 4.0 and its benefits; Sustainable SCs; Designing emergency supply chains; Assets Management in the Supply Chains; Future perspectives of SCM; Case Studies	
Course Outcomes: Students will be able to:	
1. Explain the fundamental concepts of Supply Chain Management, supply chain models, operations, and network design decisions in manufacturing and service sectors. 2. Analyze supply chain uncertainties, operational views (SCOR, push–pull, cyclic), and develop strategies to achieve strategic fit in supply chains. 3. Apply sourcing, supplier management, distribution network design, and facility location concepts for effective supply chain operations. 4. Describe logistics systems, warehousing, outsourcing, logistics service providers, and key performance indicators in national and international logistics. 5. Evaluate modern advancements in logistics and SCM including reverse logistics, green logistics, lean logistics, and smart sustainable supply chains.	
Textbooks /Reference Books:	

1	Sunil Chopra & Peter Mcindl, “Supply Chain Management -Strategy, Planning & Operation” Pearson Education Inc, 11th Edition, 2003
2	Douglas Lanibert& James Stock, “Strategic Logistics Management” McGraw Hill, 4th Edition, 2004.

PEC 3: Micro Electromechanical Systems						
Course Code			**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: ---	ESE: --	--

Course Objective:

1. To provide a comprehensive understanding of MEMS fundamentals, microsystem concepts, and material properties relevant to micro-scale devices.
2. To introduce smart materials and their electromechanical coupling mechanisms used in MEMS sensors and actuators.
3. To explain micro-fabrication techniques, lithography processes, and microsystem packaging technologies used in MEMS manufacturing.
4. To develop knowledge of MEMS-based sensors, actuators, and smart transducers, including their working principles and performance characteristics.
5. To apply micro-mechanics, scaling laws, and electrostatic actuation principles for modelling and design of MEMS structures.
6. To understand reliability issues, failure mechanisms, and system-level integration aspects of MEMS devices.

Overview of MEMS and Microsystems	**06 L**
Definition – historical development – properties, design, and fabrication of micro-systems, microelectronics, working principle, applications, and advantages of micro-systems. Substrates and wafers, silicon as substrate material, mechanical properties of Si, Silicon Compounds - silicon piezo resistors, Galium arsenide, quartz, polymers for MEMS, conductive polymers	
MEMS materials	**06 L**
Overview of Smart Materials, Structures, and Products Technologies Smart Materials (Physical Properties) Piezoelectric Materials, Electrostrictive Materials, Magnetostrictive Materials, Magneto-electric Materials, Magneto-rheological Fluids Electro-rheological Fluids, Shape Memory Materials, Bio-Materials, metal matrix composites (MMC), their applications in aerospace and automobiles, Super-plastic materials	
Fabrication processes and micro system packaging	**08 L**
Photolithography, photo resist applications, light sources, ion implantation, diffusion–Oxidation - thermal oxidation, silicon dioxide, chemical vapor deposition, sputtering - deposition by epitaxy – etching – bulk and surface machining – LIGA process – LASER, Electron beam, Ion beam processes– Maskless lithography. Microsystem packaging – packaging design– levels of microsystem packaging -die level, device level and system level – interfaces in packaging – packaging technologies- Assembly of Microsystems	
Micro devices	**06 L**
Sensors – classification – signal conversion, ideal characterization of sensors, micro actuators, mechanical sensors – measurands - displacement sensors, pressure sensor, flow sensors, Accelerometer, chemical and bio sensor - sensitivity, reliability, and response of micro-sensor - micro actuators – applications.	
Smart Actuators	**04 L**

Displacement Actuators; Force Actuators; Power Actuators; Vibration Dampers; Shakers; micro–Fluidic Pumps; micro-motors Smart Transducers: Ultrasonic Transducers; Sonic Transducers.	
Modelling, Design Principles and Reliability of MEMS	**06 L**
Scaling Laws in MEMS, Micro-mechanics and Structural Modelling, Electrostatic Actuation and Pull-in Phenomenon, Damping in MEMS, Reliability and Failure Mechanisms, MEMS System Integration & Applications.	
Course Outcomes: Students will be able to:	
1. Describe MEMS fundamentals, materials, and microsystem concepts, and explain their advantages over conventional systems. 2. Explain the working principles and electromechanical behavior of smart materials used in MEMS applications. 3. Analyze MEMS fabrication processes, lithography techniques, and microsystem packaging methods for device realization. 4. Classify and evaluate MEMS sensors, actuators, and smart transducers based on their operating principles and performance parameters. 5. Apply scaling laws, beam theory, electrostatic actuation models, and dynamic response analysis for modelling and design of MEMS devices. 6. Assess reliability, failure mechanisms, and integration challenges in MEMS systems for practical engineering applications.	

Textbooks /Reference Books:

1	Madou, M., *Fundamentals of Microfabrication*, CRC Press, New York, 1997.
2	Gad-el-Hak, M., *The MEMS Handbook*, CRC Press, 2006. ISBN: 0-8493-9138-5.
3	Franssila, S., *Introduction to Microfabrication*, John Wiley & Sons Ltd., 2004. ISBN: 0-470-85106-7.
4	Hsu, T.-R., *MEMS and Microsystems: Design and Manufacture*, Tata McGraw-Hill, New Delhi, 2002.
5	Gandhi, M. V., and Thompson, B. S., *Smart Materials and Structures*, Chapman & Hall, London and New York, 1992. ISBN: 0-412-37010-7.
6	Westbrook, J. H., and Fleischer, R. L., *Intermetallic Compounds*, Vol. I & II, John Wiley & Sons, Chichester, 1995.
7	Gardner, J. W., and Varadan, V. K., *Microsensors, MEMS and Smart Devices*, John Wiley & Sons, 2001.
8	Srinivasan, A. V., *Smart Structures: Analysis and Design*, Cambridge University Press, Cambridge and New York, 2001. ISBN: 0-521-65026-7.

PEC 3: Manufacturing Control Systems (MCS)

Course Code			**Examination Scheme**			
Teaching Scheme	3-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	3		**Laboratory**	CIE: ---	ESE: --	--

Course Objective:

1. To introduce the fundamentals of production systems, manufacturing control, and production planning methodologies.
2. To Introduce various order generation and order release mechanisms for effective production control.
3. To Enable students to configure manufacturing control systems by selecting suitable control strategies and sequencing rules.
4. To Analyze capacity control techniques and evaluate production performance
5. To explain modern manufacturing control architectures including the ISA-95 automation pyramid, MES–ERP integration, and Industry 4.0 and 5.0 concepts.

Introduction to Manufacturing Control and Planning systems	**08 L**

Introduction to Manufacturing control planning system, Forecasting Methods ,Methods for Generating Orders**:** Order Point System, Kanban, Capacity Oriented Material Management, Synchro MRP, Hybrid Kanban/CONWIP Control, Production Authorization Cards, Cumulative Production Figures.

Self-Learning Topics:

Comparison of push vs pull production control systems, Case studies on Kanban

Methods for Releasing Orders	**08L**

Due Date Based Order Release, Constant Work in Process, Bottleneck Control, Workload Control, Load Oriented Order Release, POLCA Control.

Fundamentals of Manufacturing Control, Logistic Objectives, , Modeling the Logistic Objectives , Supply Chain Management (SCM)

Self-Learning Topics:

CONWIP implementation, SAP Manufacturing use cases

Configuring the Manufacturing Control	**07L**

Selecting an Order Generation Method, Selecting an Order Release Method, Selecting Sequencing Rules, Fundamentals of Capacity Control, Backlog Control, selecting a Capacity Control Method, Case Studies, Implementing a Configuration model for assembly line.

Self-Learning Topics:

Application case studies

Controlling Capacities	**08L**

Capacity utilization, efficiency, and OEE calculation using industrial data. Application of takt time and line balancing in capacity stabilization. AI-based predictive capacity planning models.

Self-Learning Topics:

Case study: AI models to optimize capacity and reduce downtime.

Manufacturing Control and Automation Pyramid ISA-95	**09L**

Automation Pyramid ISA-95 (Level 0- Level 4), Case study application: MES–ERP integration in discrete manufacturing industries (Manufacturing/ Assembly Line), Mapping ISA-95 layers to a real factory system, Digital Manufacturing workflow, Human-Centric Manufacturing-Industry 5.0, AI Upskilling and Digital Twins: Perspective on the Industry 4.0 to Industry 5.0 Shift, Human robot-collaboration in assembly and manufacturing, Digital factory and digital twin application in assembly line.

Self-Learning Topics:

robots (Cobots) in assembly, AI-based manufacturing applications

Course Outcomes: Students will be able to:

1. Explain the fundamental concepts of production systems, manufacturing control, and production planning.

2. Apply appropriate order generation and order release methods for effective shop floor production control. 3. Configure manufacturing control systems by selecting suitable control strategies and sequencing rules. 4. Analyze production system performance using capacity control techniques and metrics such as capacity utilization, efficiency, takt time, and OEE.. 5. Interpret modern manufacturing control architectures including ISA-95 automation pyramid, MES–ERP integration, and Industry 4.0 and 5.0 technologies in manufacturing systems.		
Textbooks		
1	John Kenworthy, Planning and Control of Manufacturing Operations, Taylor &Francis, 2013	
2	D.R. Kiran, Production Planning and Control: A Comprehensive Approach, Butterworth-Heinemann, 2019	
3	Automation, Production Systems, and Computer-Integrated Manufacturing – Mikell P. Groover	
4	Manufacturing Facilities: Location, Planning, and Design – Dileep R. Sule	
Reference Books		
1	Industry 4.0 to Industry 5.0 Explorations in the Transition from a Techno-economic to a Socio-technical Future, Susu Nousala, Gary Metcalf, David Ing, Springer Singapore,2024	
2	Digital Manufacturing and Assembly Systems in Industry 4.0 – Kaushik Kumar, Divya Zindani & J. Paulo Davim	
3	Hermann Lödding, Handbook of Manufacturing Control Fundamentals, Description, Configuration, Springer Berlin Heidelberg, 2012.	
4	Nyhuis, P., Wiendahl, H.-P.: Fundamentals of Production Logistics. Theory, Tools and Applications. Springer, Berlin (2009)	
5	Hans-Peter Wiendahl, Load-Oriented Manufacturing Control, Springer Berlin Heidelberg, 2012.	
6	Harold Bright Maynard, Handbook of Modern Manufacturing Management, McGraw- Hill, 1970	
7	Industry 4.0 to Industry 5.0 Explorations in the Transition from a Techno-economic to a Socio-technical Future, Susu Nousala, Gary Metcalf, David Ing, Springer Singapore,2024	
NPTEL / Web Resources/ Research Papers		
1	Automation in Manufacturing By Prof. Shrikrishna N. Joshi | IIT Guwahati, Link: https://onlinecourses.nptel.ac.in/noc22_me123/preview	
2	Cohen, Y., Faccio, M., Pilati, F. *et al.* **Design and management of digital manufacturing and assembly systems in the Industry 4.0 era** . *Int J Adv Manuf Technol* **105**, 3565–3577 (2019). https://doi.org/10.1007/s00170-019-04595-0	
3	Szilárd Jaskó, Adrienn Skrop, Tibor Holczinger, Tibor Chován, János Abonyi, Development of manufacturing execution systems in accordance with Industry 4.0 requirements: A review of standard- and ontology-based methodologies and tools,Computers in Industry, Volume 123,2020,103300,	
4	https://www.sw.siemens.com/en-US/technology/isa-95-framework-layers/	
5	https://www.emqx.com/en/blog/exploring-isa95-standards-in-manufacturing	
6	Automation in Manufacturing By Prof. Shrikrishna N. Joshi | IIT Guwahati, Link: https://onlinecourses.nptel.ac.in/noc22_me123/preview	

<table>
<tr><th colspan="7">PEC 3: Reliability Engineering</th></tr>
<tr><td>Course Code</td><td colspan="2"></td><td colspan="4">Examination Scheme</td></tr>
<tr><td>Teaching Scheme</td><td>3-0-0-1</td><td></td><td>Theory</td><td>TA: 20</td><td>MSE: 30</td><td>ESE: 50</td></tr>
<tr><td>Credits</td><td>3</td><td></td><td>Laboratory</td><td>CIE: ---</td><td>ESE: --</td><td>--</td></tr>
<tr><td colspan="7">Course Objective:</td></tr>
<tr><td colspan="7">1. To understand fundamental concepts of reliability, failure mechanisms, and reliability mathematics.
2. To analyze system reliability using models such as series–parallel configurations, Markov analysis, and reliability block diagrams.
3. To study failure distributions, reliability testing methods, and life prediction techniques.
4. To apply reliability tools such as FMEA/FMECA, FTA, and FRACAS for failure analysis and improvement.
5. To learn reliability management concepts including design for reliability, maintenance strategies, and AI-based approaches.</td></tr>
<tr><td colspan="6">Introduction</td><td>06 L</td></tr>
<tr><td colspan="7">Basic definitions: Reliability, Availability, Serviceability, Failure rate, Reliability Mathematics, Failure distribution - constant failure rate model, Time dependent failure rate models and its types, Bath tub curve. case study or Videos on Human Reliability, Software Reliability.</td></tr>
<tr><td colspan="6">System Reliability & Reliability testing</td><td>06 L</td></tr>
<tr><td colspan="7">Reliability Block Diagram - Series, Parallel & combined series parallel configurations; redundant-active and passive types, Failure Mode, Effects and Criticality Analysis (FMECA), Failure Reporting, Analysis and Corrective Action System (FRACAS), Fault Tree Analysis (FTA), System state analysis-Markov Model, Availability, Downtime. Reliability testing: Failures and types of failures; Intrinsic & extrinsic failures; Failure cascade; Failure mode; Failure rate, MTTF, MTBF, Accelerated life testing (ALT) - Qualitative ALT, Quantitative ALT & its types, AF, Samples</td></tr>
<tr><td colspan="6">Reliability estimation and life Prediction</td><td>08 L</td></tr>
<tr><td colspan="7">Types of Failure data – Data censoring, Parametric and Non Parametric distribution, Probability density function, Exponential, Normal, lognormal & weibull distributions, weibull Goodness of fit distributions, Electronics reliability prediction-parts count, parts stress method, MIL standard, Naval Surface Warfare Center (NSWC).</td></tr>
<tr><td colspan="6">Reliability Management</td><td>06 L</td></tr>
<tr><td colspan="7">Design for Reliability, Relationship between Reliability and Safety factor, Stress-Strength interference theory, Reliability growth testing, Reliability centered maintenance (RCM), Spares planning.</td></tr>
<tr><td colspan="6">Design for reliability</td><td>04 L</td></tr>
<tr><td colspan="7">Reliability allocation, derating-Maintainability-Design for maintainability-Availability-Maintenance and space provisioning. Failure data analysis-Reliability Testing-Identifying failure distributions– parameter estimation.</td></tr>
<tr><td colspan="6">Approaches to intelligent control</td><td>06 L</td></tr>
<tr><td colspan="7">AI approach- Concept of artificial neural network and its model, fuzzy logic and its model- Case study.</td></tr>
<tr><td colspan="7">Course Outcomes: Students will be able to:</td></tr>
<tr><td colspan="7">1. Explain reliability concepts, failure distributions, and hazard models.
2. Evaluate reliability of systems using RBD, Markov models, and different configurations.
3. Apply reliability testing and life prediction techniques using statistical distributions.
4. Analyze failures using tools like FMEA, FTA, and reliability data analysis methods.</td></tr>
</table>

5. Implement reliability management practices including maintenance planning and intelligent control techniques.	
Textbooks /Reference Books:	
1	E. Balagurusamy – *Reliability Engineering*, Tata McGraw-Hill.
2	L.S. Srinath – *Reliability Engineering*, Affiliated East-West Press
Reference Books	
1	Charles E. Ebeling – *An Introduction to Reliability and Maintainability Engineering*, Tata McGraw-Hill.
2	Patrick D.T. O'Connor & Andre Kleyner – *Practical Reliability Engineering*, Wiley.
3	Kishor S. Trivedi – *Probability and Statistics with Reliability, Queuing and Computer Science Applications*, Wiley.
4	Roy Billinton & Ronald Allan – *Reliability Evaluation of Engineering Systems*, Springer.
5	Charles E. Ebeling – *An Introduction to Reliability and Maintainability Engineering*, Tata McGraw-Hill.

<table>
<tr><th colspan="7">PEC 3: Total Quality Management</th></tr>
<tr><td>Course Code</td><td colspan="2"></td><td colspan="4">Examination Scheme</td></tr>
<tr><td>Teaching Scheme</td><td>3-0-0-1</td><td></td><td>Theory</td><td>TA: 20</td><td>MSE: 30</td><td>ESE: 50</td></tr>
<tr><td>Credits</td><td>3</td><td></td><td>Laboratory</td><td>CIE: ---</td><td>ESE: --</td><td>--</td></tr>
<tr><td colspan="7">Course Objective:</td></tr>
<tr><td colspan="7">1. To understand fundamental concepts, philosophies, and frameworks of Total Quality Management.
2. To learn statistical process control (SPC) and process capability analysis for quality improvement.
3. To apply quality tools and techniques such as DOE, Six Sigma, and quality circles in problem-solving.
4. To study reliability concepts and continuous improvement approaches like Kaizen, JIT, and benchmarking.
5. To understand quality systems, ISO standards, and organizational practices for effective quality management</td></tr>
<tr><td colspan="6">Introduction To Quality Management</td><td>06 L</td></tr>
<tr><td colspan="7">Definitions – TOM framework, benefits, awareness and obstacles. Quality – vision, mission, and policy statements. Customer Focus – customer perception of quality, Translating needs into requirements, customer retention. Dimensions of product and service quality. Cost of quality. Historical review, Ten principles of quality management. Overview of the contributions of Deming, Juran, Crosby, Masaaki Imai, Feigenbaum, Ishikawa, PDSA cycle, Taguchi techniques – introduction, loss function, parameter and tolerance design, signal to noise ratio. Concepts of Quality circle, Japanese 5S principles and 8D methodology</td></tr>
<tr><td colspan="6">Statistical Process Control And Process Capability</td><td>06 L</td></tr>
<tr><td colspan="7">Meaning and significance of statistical process control (SPC) – construction of control charts for variables and attributed. Process capability – meaning, significance and measurement. Acceptance Sampling by variables, some aspects of specifications and tolerances, Process capability. Sampling inspection, OC Curves and Sampling Plan, 100% Inspection and Selective Inspection, Statistics in Selective inspection. Measurement system capability, Gauge R&R study, Machine Capability study, statistical tolerances. Control charts for individual measurements, X chart, moving average and moving range charts, exponential weighted moving average chart, cumulative sum chart.</td></tr>
<tr><td colspan="6">Quality Improvement Through Design Of Experiments</td><td>08 L</td></tr>
<tr><td colspan="7">Data analysis, Analysis of variance, t test, f test, Normal probability plot, box plot, full factorial experiments, main effects of a factor, two factor experiments. Regression, Taguchi method, Design of orthogonal experiments, data analysis by response graph method and analysis of variance</td></tr>
<tr><td colspan="6">Six Sigma Approach To Quality And Concepts Of Reliability</td><td>06 L</td></tr>
<tr><td colspan="7">Six sigma introduction, Sigma Quality level, Six sigma methodology, DMAIC, DMADV, tools used in six sigma projects. Six Sigma case studies. Reliability concepts – definitions, reliability in series and parallel, product life characteristics curve, maintainability.</td></tr>
<tr><td colspan="6">Tools And Techniques For Quality Management</td><td>04 L</td></tr>
<tr><td colspan="7">Quality functions development (QFD) – Benefits, Voice of customer, information organization, House of quality (HOQ), building a HOQ, QFD process. Failure mode effect analysis (FMEA) – requirements of reliability, failure rate, FMEA stages, design, process, and documentation. Seven old (statistical) tools. Seven new management tools. Zero defect concept, Bench marking and POKA YOKE. Selection of sources of supply, evaluation of suppliers. Kaizen, JIT</td></tr>
<tr><td colspan="6">Quality Systems Organizing And Implementation</td><td>06 L</td></tr>
<tr><td colspan="7">Total productive maintenance (TMP) – relevance to TQM, Business process re-engineering (BPR) – principles, applications, reengineering process, benefits, and limitations. Introduction to IS/ISO 9001:2015 – quality management systems – guidelines for performance improvements. Quality Audits. TQM culture, Leadership – quality council, employee involvement, motivation, empowerment, recognition, and reward- Benefits of implementing ISO 9001 standard.</td></tr>
</table>

Course Outcomes: Students will be able to:	
1. Understand quality management philosophies, frameworks etc. 2. Analysis of problems using various tools and techniques of quality management. 3. Apply various quality tools and techniques in both manufacturing and service industry. 4. Evaluate the current process using Six Sigma Methodology 5. Develop strategies for continuous process improvement. 6. Design experiments for manufacturing and service industries to find out the effective solution.	
Textbooks /Reference Books:	
1	Dale H. Besterfield et al, Total Quality Management, Third edition, Pearson Education (First Indian Reprints 2004).
2	L Suganthi, Anand A. Samuel, Total Quality Management, PHI learning Pvt. Ltd., Sixth Edition 2010.
3	K. Krishnaiah, Applied Statistical Quality Control and Improvement, PHI learning Pvt. Ltd., First Edition 2014.
4	Design and Analysis of Experiments, By Douglas C. Montgomery, Wiley, 2008
Reference Books	
1	Roger C. Swanson, "The Quality Improvement Handbook", Publisher Vanity Books International, New Delhi.
2	Williarn. C. Johnson and Richard J. Chavia, "Encyclopedia of Total Quality Management", New Delhi.

MDM-IV: Production Planning						
Course Code			**Examination Scheme**			
Teaching Scheme	2-0-0-1		**Theory**	TA: 20	MSE: 30	ESE: 50
Credits	2		**Laboratory**	CIE: ---	ESE: --	--

Methods of Manufacturing:	**04 L**
Project/Jobbing, Batch Production, Continuous Flow Production, Process Production - Characteristics of Each Method	
Introduction to Production Planning and Control:	**06 L**
Scheduling, Gantt Charts, Documentation, Production Work Order. Inspection: Cent percent Inspection, Sample Inspection, Operation, Characteristics Curves , Statistical Control Curves, Control Charts – X- R Charts, MPS, MRP, BOM. Introduction to quality Management, Acceptance Sampling, SPC, Six Sigma, Introduction to SAP QM.	
Plant Location	**07 L**
: Importance, Factors Affecting Location, Factory Building, Plant Layout, Installation of Facilities, Line balancing buffers.	
Materials Requirement Planning	**07 L**
: MRP procedures, MRP types, MRP strategies, MRP parameters, MRP processing	
Introduction to Organizational Units	**05 L**
: Introduction to enterprise structure and organization structure of SAP Production Planning. Master Data in SAP PP : Material Master, Bills of Materials, Work Center, Routing	
Processes in Production Planning Cycle	**07 L**
Make to Stock Production, Make to Order Production	

Textbooks /Reference Books:	
1	
2	
3	
Reference Books	
1	
2	

<table>
<tr><td colspan="8">RM: Research Methodology</td></tr>
<tr><td>Course Code</td><td colspan="2"></td><td colspan="4">Examination Scheme</td></tr>
<tr><td>Teaching Scheme</td><td>2-0-0-1</td><td></td><td>Theory</td><td>TA: 20</td><td>MSE: 30</td><td>ESE: 50</td></tr>
<tr><td>Credits</td><td>2</td><td></td><td>Laboratory</td><td>CIE: ---</td><td>ESE: --</td><td>--</td></tr>
<tr><td colspan="7">Course Objective:</td></tr>
<tr><td colspan="7">At the end of this course, the students will demonstrate the ability to:
1. Formulate research problems by defining objectives, hypotheses, variables, and feasibility.
2. Synthesize literature using reproducible search and screening strategies.
3. Apply research ethics, authorship norms, compliance rules, and FAIR data practices.
4. Produce research outputs through ethical analysis, documentation, and dissemination</td></tr>
<tr><td colspan="6">Introduction to Research:</td><td>04 L</td></tr>
<tr><td colspan="7">What is scientific research? The objectives of research, motivation, types of research, research approaches, research methodology, significance of research, and indications of good research</td></tr>
<tr><td colspan="6">Designing Problem Statement and Experimentation Plan</td><td>06 L</td></tr>
<tr><td colspan="7">What are the research problems? Literature review, formulation of a feasible problem, hypothesis, errors in problem selection, tabulation of relevant data from literature, selection of variables, and flow chart of experimental plan</td></tr>
<tr><td colspan="6">Methods- Simulations and Experiments:</td><td>07 L</td></tr>
<tr><td colspan="7">Conventional approaches, selection of tools, setting up production, validation of results, performance analysis, sensitivity analysis, errors in measurements</td></tr>
<tr><td colspan="6">Statistics and Uncertainty Quantification:</td><td>07 L</td></tr>
<tr><td colspan="7">Data, importance of analyzing data, types of analyses, selection practices, statistics, sampling techniques, uncertainty quantification, errors analysis, Design of Experiments</td></tr>
<tr><td colspan="6">RCR and Ethics:</td><td>05 L</td></tr>
<tr><td colspan="7">Responsible conduct of research, IEC compliance, what is plagiarism, QRPs, generative A.I. in research</td></tr>
<tr><td colspan="6">IPR, Research Ethics and Publishing:</td><td>07 L</td></tr>
<tr><td colspan="7">Introduction to IPR, significance of IPR, types of IPR, recent developments, technical writing, and aspects important for publishing in Q1/Q2 journals</td></tr>
<tr><td colspan="7">Textbooks /Reference Books:</td></tr>
<tr><td>1</td><td colspan="6">Melville, S., & Goddard, W. (1996). Research methodology: An introduction for science & engineering students. Juta & Co.</td></tr>
<tr><td>2</td><td colspan="6">Kothari, C. R. (2009). Research methodology: Methods and trends. New Age International Publishers.</td></tr>
<tr><td>3</td><td colspan="6">Goddard, W., & Melville, S. (2001). Research methodology: An introduction (2nd ed.). Juta Academic</td></tr>
<tr><td colspan="7">Reference Books</td></tr>
<tr><td>1</td><td colspan="6">Kumar, R. (2005). Research methodology: A step-by-step guide for beginners (2nd ed.). Sage Publications.</td></tr>
<tr><td>2</td><td colspan="6">Sharma, S. D. (2001). Operational research. Kedar Nath Ram Nath & Co.</td></tr>
</table>

PROJECT STAGE-III (Semester-VII)						
Course Code			**Examination Scheme**			
Teaching Scheme	0-0-10-1		**Theory**	CIE : 100	MSE: ---	ESE: --
Credits	5		**Laboratory**	CIE: ---	ESE: --	--

Course Objective:

1. Implement the proposed design or methodology developed in earlier project stages.
2. Apply engineering principles, tools, and techniques to solve real-world problems.
3. Conduct experiments, simulations, or system development as per project requirements.
4. Analyze intermediate results and validate them against objectives.
5. Develop professional project documentation and technical reporting skills.
6. Demonstrate teamwork, project management, and ethical research practices.

Sr No	Items	Description of activity
1	**Scope (TRL-3)**	Continuation of Project-I, Planning, fabrication and development of hardware / software and execution; relevant standards.
2	**Self-Study material for the student**	The department shall recommend relevant online / offline self-study materials on Incubation, Innovation (online / offline)
3	**End Semester Evaluation process**	The end semester evaluation shall be based on project work in power point presentation and a project report. The evaluation shall be done by the panel of faculty members, at least three members including one of them is project guide.

Evaluation sheet for Project -III

MIS No	Name of student	Planning	Development of hardware / software	Experimentation	Project Report	Viva Voce and presentation skill	Out of 50 marks
		10 M	**10M**	**10M**	**10M**	**10M**	

Prerequisites

Successful completion of Project Stage – I (Semester V) and Project Stage – II (Semester VI).

Project Stage – III is a continuation of the project work initiated in Project Stage – I and refined in Project Stage – II. This stage emphasizes detailed design, implementation, experimentation, validation, and interim results of the final year BTech project. Students are expected to translate the approved methodology into a working system, prototype, model, or validated framework, depending on the nature of the project.

This stage focuses on hands-on execution, technical rigor, experimentation, analysis, and professional documentation, preparing students for the final completion and defense of the project in Project Stage – IV.

Project Activities / Scope of Work

The following activities are indicative and may vary depending on the project domain:

1. Detailed system design and architecture finalization
2. Component-level design and development

3. Coding, fabrication, modeling, or system integration
4. Experimental setup, simulation, or prototype development
5. Data collection, testing, and validation
6. Interim performance analysis and refinement
7. Preparation of progress report and presentation

In Project Stage – III, students are expected to carry out the core execution phase of the project proposed and refined during Project Stage – I and Project Stage – II. This stage focuses on the detailed design, development, and implementation of the proposed system, model, process, or methodology. Students shall translate conceptual designs into functional components through coding, fabrication, modeling, simulation, or system integration, as applicable to the project domain. The work may involve setting up experimental or simulation environments, developing prototypes, integrating hardware and software components, and conducting systematic testing. Emphasis is placed on data collection, validation of intermediate results, performance evaluation, and iterative refinement of the solution. Students are also expected to critically analyze the results obtained, identify limitations, and implement necessary improvements while adhering to ethical, safety, and professional standards.

Deliverables

1. Working prototype / model / software module / experimental setup (as applicable)
2. Interim project report including:
   - Updated literature review
   - Methodology and implementation details
   - Experimental setup and results
   - Discussion and observations
3. Progress presentation during scheduled reviews

At the end of Project Stage – III, students shall submit tangible and verifiable outputs demonstrating significant progress toward project completion. The primary deliverable shall be a partially or fully functional prototype, model, software module, experimental setup, or validated framework, depending on the nature of the project. In addition, students shall submit an interim project report documenting the work carried out during this stage, including updated literature review, detailed methodology, implementation procedures, experimental or simulation setup, results obtained, and preliminary analysis. Students are also required to present the project progress during scheduled departmental reviews, supported by appropriate technical documentation, results, and demonstrations.

Teaching–Learning Methods

- Guided project work under faculty supervision
- Weekly review meetings
- Laboratory experimentation / field work / simulation
- Self-directed learning and technical exploration

The teaching–learning process for Project Stage – III is primarily based on guided, experiential, and self-directed learning. Students work under the continuous supervision of a faculty guide who provides technical direction, periodic feedback, and mentoring throughout the implementation phase. Regular review meetings, progress discussions, and milestone-based evaluations are conducted to monitor technical advancement and adherence to project objectives. Learning is reinforced through hands-on laboratory work, field studies, simulations, experimentation, and independent problem-solving. Students are encouraged to consult technical literature, standards, research papers, and online resources to support design and implementation decisions, thereby fostering critical thinking, innovation, and professional competence.

Course Outcomes: Students will be able to:
1. Implement and integrate project components based on the approved design.

2. Use appropriate software tools, hardware platforms, or analytical methods relevant to the project domain. 3. Perform experiments, simulations, testing, or case studies and collect meaningful data. 4. Analyze and interpret intermediate results with respect to project objectives. 5. Document project progress through structured reports and technical presentations. 6. Work effectively as an individual or as a team member while adhering to ethical and professional standards.

Internship-III						
Course Code			**Examination Scheme**			
Teaching Scheme	0-0-2-1		**Theory**	CIE: 100	MSE:---	ESE: --
Credits	1		**Laboratory**	CIE: ---	ESE: --	--

1. Summer Internship–III shall be undertaken by students after completion of the VIth semester during the summer vacation, in an Industry, R&D organization, or Academic/Research Institute (HEI less than 100 NIRF rank).
2. This internship is designed to enhance practical competencies, problem-solving ability, research orientation, professional ethics, teamwork, and communication skills, thereby strengthening industry–academia linkage.
3. The minimum duration of the internship shall be four weeks (one month) and the maximum duration shall be eight weeks (two months).
4. The evaluation of Summer Internship–III will be conducted at the beginning of the VIIth semester, based on the internship report, presentation, and assessment by the assigned faculty committee, ensuring effective learning outcomes and skill development

Semester - VIII

Semester VIII (Proposed from AY 2026-27)

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	PEC	Department Elective-IV (MOOCS)	3	0	0	1	3	3
2	PEC	Department Elective-V (MOOCS)	3	0	0	2	3	3
3	PEC	Department Elective-VI (MOOCS)	3	0	0	2	3	3
4	ELC	Internship-IV/On Campus Project	0	0	6	0	6	3
Total Academic Engagement and Credits			**6**	**0**	**12**	**4**	**18**	**12**

Department Elective -IV (MOOCs)

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	PEC 4	Product Communication and Interface Design	3	0	0	1	3	3
2	PEC 4	Production and Operations Management	3	0	0	1	3	3
3	PEC 4	Design of Precision Machines	3	0	0	1	3	3
4	PEC 4	Facility Planning and Design	3	0	0	1	3	3
5	PEC 4	Advanced Operation Research and Optimisation	3	0	0	1	3	3

Department Elective -V (MOOCs)

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
2	PEC 5	Agile Project management	3	0	0	1	3	3
3	PEC 5	Selection of Materials & Process for Product Design	3	0	0	1	3	3
4	PEC 5	Production Planning and Control	3	0	0	1	3	3
5	PEC 5	MRP & ERP	3	0	0	1	3	3

Department Elective -VI (MOOCs)

Sr. No.	Course Type	Course Name	Teaching Scheme					Credits
			L	T	P	S	Hrs	
1	PEC 6	Biomedical Device Design	3	0	0	1	3	3
2	PEC 6	Inventory management	3	0	0	1	3	3
3	PEC 6	Business Environment and Corporate Strategy	3	0	0	1	3	3
4	PEC 6	Vibration and Acoustics	3	0	0	1	3	3
5	PEC 6	Concurrent engineering and product life cycle Management	3	0	0	1	3	3

Internship-IV						
Course Code			**Examination Scheme**			
Teaching Scheme	0-0-6-0		**Theory**	CIE: 100	MSE:---	ESE: --
Credits	3		**Laboratory**	CIE: ---	ESE: --	--

Course Outcomes:

1. Understand different manufacturing methods and their applications.
2. Assessments and application of different manufacturing options for optimal production
3. Accomplish objectives of the project work with efficient teamwork as well as resource management skills.
4. Comprehensive report writing skills based on his/her observations, training received and assignments completed.
5. Demonstrate professional ethics and values by solving engineering problems to benefit society or industry.

Student should undergo training in large or medium size manufacturing units in various departments. Students are expected to learn following things during the Industrial Inplant Training of six months duration:

1. **Orientation / Rotational Training :** Organizational Structure of the Company, scale and type of production, types of products, functional departments like Manufacturing, Process Planning & Control, Quality Assurance, Assembly, Testing, Maintenance, Stores, Purchase, Marketing, Human Resources Department, Design and Drawing Department, General Administration, Packing and Dispatching. Tool Engineering, Materials & Material Handling etc
2. **Industrial Design and Drawing Practice:** Design and Drawing standards, study of Mechanical components and mechanical components and introduction to machine element design such as gears, gear boxes, chain and belt drives, electric motor selection, couplings, shafts, keys, bearings, brackets, bolted and welded connections. Sub - assembly and assembly design and drawings. Various ISO and BIS standards for design. Simple assignments based on the above items, selection of materials, material specification, beat treatment, and properties of materials.
3. **Study of Manufacturing Processes:** Study of Processes such as casting, forging, sheet metal working, plastic moulding, extrusion, rolling and machining operations on various machines. Study of finishing processes like grinding, lapping, honing, burnishing, buffing, etc. Chipless manufacturing processes.
4. **Study of Various Manufacturing Machine Tools** such as lathes, capstan and turret lathes, planer, shaper and milling. Mechanical and Hydraulic Presses, Gear hobbing, shaping and grinding machines.
5. **Study of special purpose machines**, jig boring machines, NCICNC machines, work centers and transfer lines and automatic machines.
6. **Study of single point cutting tools and multipoint tools**, form tools, jig and fixtures, special purpose machine tools and Press tools, Tool material and tool selection, study of cutting parameters.
7. **Study of material handling methods and equipment**, Design and development strategies.
8. **Introduction to Quality and Quality Policy**, need for Quality Control, National and International Standards on Quality and Reliability. Study of various inspection gauges, selection of gauges, comparators, calibration of gauges, Standards Room, etc. Product

9. **Study of various Production Planning and Control functions**. Process and Operation Planning, Yearly and Monthly Planning, Forecasting, Scheduling, Planning.
10. **Study of various Industrial Engineering functions**, Work Study, (Motion Study and Time analysis),Ergonomic considerations, Plant Layout, Safety aspects of working, Safety gadgets used on machines and Personal Safety Equipment. The students shall be asked to do assignments in various departments where he/she is undergoing training. Industries shall be requested to prepare training program before hand, covering as much as possible from above mentioned topics depending upon the type of industry.

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Term Work : Term Work will consist of a comprehensive report based on his observation, training received and assignments completed during 6 months of training. The report shall also include good drawing figure, process sheets and machine and product specifications. Students should maintain training project diary and report to internal guide every week. For writing project report, students must follow the format given in the project diary. A report comprising preliminary literature review, objective, methodology and scope of the project work undertaken, duly signed by project guide(s) and head of the department, will be submitted for the end semester examination.

On Campus project/In house project						
Course Code			**Examination Scheme**			
Teaching Scheme	0-0-6-0		**Theory**	CIE: 100	MSE:---	ESE: --
Credits	3		**Laboratory**	CIE: ---	ESE: --	--

Course Outcomes:

At the end of the project work, students will demonstrate the ability to

1. Identify a problem statement from a rigorous literature survey or the industry requirements analysis in the domain of Manufacturing Science & Engineering
2. Identify the methods/materials /solution strategies required for the project work.
3. Accomplish all objectives of the project in allocated period with efficient teamwork.
4. Demonstrate an ability to present project work through a comprehensive report and project presentation.
5. Demonstrate professional ethics and values by solving engineering problems to benefit society or industry

Academic Project envisages that a student during the final semester will acquire the ability of applying the engineering knowledge to a practical problem. A student is required to carry out the project work in the domain of Manufacturing Science and Engineering, under the guidance of a faculty member and/or the supervisor of the concerned industry/institute/organisation. The student can undertake the project individually or in a group of students. The project must cover at least any one area suggested below:

• Design and analysis of the machine tools/equipments/test rigs

- Product design and development,
- Prototype/model development and Experimentation/Simulation using software environment,
- Advanced Manufacturing Processes
- Quality, Maintenance, Terotechnology and Reliability
- Industrial Engineering and/or Ergonomics
- Robotics / Mechatronics/Automation System Design and development

Guidelines: After interactions with project guides experts, based on a comprehensive literature survey, the student shall identify the title and define the aim and objectives of a project. These students are expected to work on details specifications, methodology, resources required, critical issues in design and implementation, and submit the project proposal. These students are also expected to work on the design, development, and testing of the proposed project work as per the planned schedule.

Deliverables: The project report is to be submitted at the end of the semester. This report includes a summary of the literature survey, detailed objectives, project specifications, design, proof of concept, developed system/Algorithm, results, contributions, and innovations in project work. A report comprising preliminary literature review, objective, methodology and scope of the project work undertaken, duly signed by project guide(s) and head of the department, will be submitted for the end semester examination.

Evaluation: A committee comprising of guide and internal evaluation panel members shall assess the progress at mid-semester. Guide and appointed external examiner shall assess the progress/performance of the student based on a report, project presentation, and Q & A. This evaluation will be conducted at the end of the semester.