BIRLA INSTITUTE OF TECHNOLOGY

In-depth Specialization in "Advanced Manufacturing and Production Management"

CHOICE BASED CREDIT SYSTEM (CBCS) CURRICULUM

(REVISED COURSE STRUCTURE - To be effective from B.Tech 2020-21)

(OFFERED ONLY TO DEPARTMENTAL U.G. STUDENTS)

Students who have registered for DEPERTMENTAL SPECIALISATION (in-depth) in "Advanced Manufacturing and Production Management" should complete 20 credits and shall opt for courses listed in Course Structure for the In-depth Specialization Program. The credits shall be over and above minimum requirement for degree award.

PRODUCTION AND INDUSTRIAL ENGINEERING DEPARTMENT

Introduced and approved in Meeting of Board of Studies, dated 23/04/2018
Revised and approved in Meeting of Board of Studies, dated 21/06/2021

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Students who have registered for DEPERTMENTAL SPECIALISATION (in-depth) in "Advanced Manufacturing and Production Management" should complete 20 credits and shall opt for courses listed in Course Structure for the In-depth Specialization Program. The credits shall be over and above minimum requirement for degree award.

PRODUCTION AND INDUSTRIAL ENGINEERING DEPARTMENT

Introduced and approved in Meeting of Board of Studies, dated 23/04/2018
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DEPARTMENT OF PRODUCTION AND INDUSTRIAL ENGINEERING
IN-DEPTH SPECIALISATION in "Advanced Manufacturing and Production Management"
(OFFERED ONLY TO THE DEPARTMENTAL U.G. STUDENTS)

Students who have registered for DEPERTMENTAL SPECIALISATION (in-depth) in "Advanced Manufacturing and Production Management" should complete 20 credits and shall opt for courses listed below. The credits shall be over and above minimum requirement for degree award.

Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Mode of delivery & credits *L-Lecture; T-Tutorial; P-Practicals*			Total Credits *C- Credits*
					L *(Periods/week)*	T *(Periods/week)*	P *(Periods/week)*	C
FIFTH / Monsoon	THEORY							
	THIRD	PC	PE339	Material Characterizations and Non-destructive Testing	4	0	0	4
			PE340	Sustainable Manufacturing Technologies	4	0	0	4
TOTAL								8
SIXTH / Spring	THEORY							
	THIRD	PE (any one)	PE310	Industrial Robotics	4	0	0	4
			PE341	Processing of Polymers, Composite and Advanced Materials	4	0	0	4
			PE342	Manufacturing Management and Cost Optimization	4	0	0	4
TOTAL								4
SEVENTH / Monsoon	THEORY							
	FOURTH	PE (any one)	PE409	Finite Elements in Manufacturing Engineering Applications	4	0	0	4
			PE415	Micro and Nano Manufacturing	4	0	0	4
	PROJECT							
	FOURTH	PC	PE450	Applications-based Project				4
TOTAL								8
GRAND TOTAL								20

Introduced and approved in Meeting of Board of Studies, dated 23/04/2018
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COURSE INFORMATION SHEET

Course code: PE 339
Course title: MATERIAL CHARACTERISATION AND NON-DESTRUCTIVE TESTING
Pre-requisite(s): PH 113 PHYSICS, PE 214 METALLURGICAL AND MATERIALS ENGINEERING, ME 205 STRENGTH OF MATERIALS
Co- requisite(s): None
Credits: 4 L: 4 T: P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: V / Third
Branch: Production Engineering (In-depth Specialization in Adv. Mfg. Prod. Mgmt.)
Name of Teacher:

Course Objectives:
This course enables the students:

1	To understand various Material Characterization techniques
2	To get acquainted with various physical and mechanical characterization methods
3	To learn about the various Non-Destructive testing methods
4	To learn about the various Surface and Sub Surface Testing methods
5	To study about the various applications of NDT Tests in Industries

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

CO1	Use various techniques of Material Characterization for industrial and scientific purposes
CO2	Identify methods of various physical and mechanical characterization
CO3	Comprehend the principal behind various Non-Destructive Testing methods
CO4	Explore various surface and subsurface Non-Destructive Methods
CO5	Distinguish between different NDT techniques in terms of technology used and their application

SYLLABUS

Module1: Material Characterization – I **[10]**
Importance of material characterisation; classification of material characterization techniques; Physical Characterization including Density, Thermal (conductivity, specific heat, etc.), Electrical (conductivity, dielectric coefficient, etc.), Chemical (composition, corrosion, etc.) and Mechanical (Hardness, Strength, Toughness, Fatigue, Torsion, Wear) Properties.

Module 2: Material Characterization – II **[10]**
Fundamentals of optics, Sample preparation and Optical Microscope, Introduction to Scanning electron microscopy (SEM), Spectroscopy, Application of SEM, Basics of XRD,

Introduction to transmission electron microscopy (TEM), Diffraction and image formation, Applications of TEM

Module 3: Introduction to Non Destructive Testing; and Surface Testing Methods [10]
NDT versus Destructive testing, Overview of the Non-Destructive Testing Methods for the detection of manufacturing defects. Relative merits and limitations, Various physical characteristics of materials, Visual inspection – Unaided and aided. Liquid Penetrant Testing, Advantages and limitations of various methods, Testing Procedure. Magnetic Particle Testing

Module 4: Thermography and Eddy Current Methods [10]
Thermography Contact and non-contact inspection method, Advantages and limitation, Instrumentations and methods, Applications. Eddy Current Testing-Generation of eddy currents, Eddy current sensing elements, Types of arrangement, Applications, advantages, Limitations, Evaluation.

Module 5: Ultrasonic Testing and Acoustic Emission [10]
Ultrasonic Testing, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique, Acoustic Emission parameters, Applications

Text Books:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2009. **[T1]**
2. Smallman R. E., 'Modern Physical Metallurgy', 4th Edition, Butterworths, 1985 **[T2]**
3. Philips V. A., 'Modern Metallographic Techniques and their Applications', Wiley
4. Interscience, 1971 **[T3]**
5. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010 **[T4]**

References:

1. ASM Metals Handbook,"Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17. **[R1]**
2. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005 **[R2]**
3. Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001. **[R3]**

Gaps in the syllabus (to meet Industry/Profession requirements):
Radiography Testing

POs met through Gaps in the Syllabus:
POs 1-5

Topics beyond syllabus/Advanced topics/Design:
Principles of various Non-destructive Testing Methods

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 1-5

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Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	2	3	2	1	3	2	2		1			2	2	3	3
CO2	2	2	3	3	1				2	2		2	2	3	3
CO3	3	2	2	3	3	2	1		2	1		2	2	2	2
CO4	3	2	2	3	3	2	1		2			2	3	2	3
CO5	3	3	2	3	3		2		1			2	1	2	2

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

Introduced and approved in Meeting of Board of Studies, dated 23/04/2018
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COURSE INFORMATION SHEET

Course code: PE 340
Course title: SUSTAINABLE MANUFACTURING TECHNOLOGIES
Pre-requisite(s): None
Co- requisite(s): None
Credits: 4 L: 4 T: 0 P: 0
Class schedule per week: 4
Class: B. Tech
Semester / Level: V / Third
Branch: Production Engineering (In-depth Specialization in Adv. Mfg. Prod. Mgmt.)
Name of Teacher:

Course Objectives:
This course enables the students:

A.	To understand the Importance of Sustainable Manufacturing
B.	To study various tools/techniques of sustainable manufacturing
C.	To assess environmental impacts of manufacturing processes
D.	To develop eco-friendly Products/processes
E.	To perform Product Life Cycle Assessment

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

CO1	Recognise the Need of Sustainable Manufacturing;
CO2	Explore the State-of-art Tools & Techniques of Stainable Manufacturing
CO3	Solve case studies related to sustainability assessment of projects
CO4	Characterise Eco-friendly processes/products
CO5	Perform Product Life cycle assessment

SYLLABUS

Module 1: Introduction to Sustainable Manufacturing **[10]**
Introduction to Sustainable Manufacturing; Drivers of Sustainable Manufacturing; Concept of Triple bottom line; Environmental, Economic and Social Dimensions of Sustainability; Relation between Lean and Sustainable manufacturing; Green manufacturing

Module 2: Tools and Techniques **[10]**
Environmental Conscious, Quality Function Deployment, Design for Environment; Design for Disassembly, Design for recycling, Eco friendly Product design methods. Environmental Impact Assessment Methods and Standards;

Module 3: Sustainability Assessment **[10]**

Sustainability Assessment -Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment; Corporate Social Responsibility.

Module 4: Sustainable Characteristics **[10]**

Sustainable characteristics of manufacturing processes - Energy efficiency analysis of manufacturing processes - Sustainability analysis and Scope of sustainable manufacturing centers.

Module 5: Sustainable Technologies **[10]**

Sustainable Product design; Principles of Life cycle assessment; Product Life Cycle Assessment, Introduction to Software packages related to Sustainable Manufacturing.

Text books:

1. Mrityunjay Singh, T.Ohji and Rajiv Asthana, "Green and Sustainable Manufacturing of Advanced Materials" Elsevier (1st Ed.) 2015. **[T1]**
2. G. Seliger, Marwan, M.K. Khraisheh, I.S. Jawahir, D. Rodick, "Advances in Sustainable Manufacturing", IRP, Springer publishers, 2011 **[T2]**

Reference books:

1. G. Atkinson, S. Dietz, E. Neumayer, "Handbook of Sustainable Manufacturing", Edward Elgar Publishing Limited, 2007. **[R1]**
2. P. Lawn, Sustainable Development Indicators in Ecological Economics, Edward Elgar Publishing Limited. **[R2]**
3. D. Rodick, Industrial Development for the 21st Century: Sustainable Development Perspectives, New York, 2007. **[R3]**

Gaps in the syllabus (to meet Industry/Profession requirements):

Sustainability for global challenges, climate and environmental protection

POs met through Gaps in the Syllabus:

POs 3,12

Topics beyond syllabus/Advanced topics/Design:

Sustainable Business Management

POs met through Topics beyond syllabus/Advanced topics/Design:

POs 2, 3, 12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	√
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	1	1	1				1	1	3	3	2	2
CO2	3	2	1			1				1	2	2	3	1	3
CO3	3	3	3			1				1	1	3	2	2	3
CO4	3	2	1			1	1	1		1	2	2	3	2	2
CO5	3	2	1							1	2	2	3	1	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

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COURSE INFORMATION SHEET

Course code: PE 310
Course title: INDUSTRIAL ROBOTICS
Pre-requisite(s): None
Co- requisite(s): None
Credits: 4 L:3 T:1 P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering (In-depth Specialization in Adv. Mfg. Prod. Mgmt.)
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Know the various robot structures and their workspace
2	Understand the use of end-effectors and sensors
3	Perform kinematics analysis of robot systems
4	Get the knowledge of dynamic and trajectory planning of robot
5	Provide robot programming in area of manufacturing automation

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

CO1	Classify the robots based on mechanical structures, operational workspace and characteristics
CO2	Select the robot end-effectors and sensors
CO3	Solve forward and inverse kinematics of simple robot manipulators
CO4	Analyse the dynamic and Trajectory Planning of robot
CO5	Programme of simple robot manipulators for manufacturing applications

SYLLABUS

Module 1: Fundamental of Robot Technology **[8]**
Introduction, Types of robot joints, Robot classification, specification, Robot anatomy, Arm Geometry, Degree of freedom, Drive and configuration of industrial robots, Robot selection.

Module 2: Robot End-effectors and Sensors **[10]**
Types of end-effectors, Mechanical grippers, Gripper force analysis, Special-purpose grippers, Grippers selection and design. Robot sensors, Sensor classification, Microswitches, Solid-state switches, Proximity sensors, Photoelectric sensors, Uses and selection of sensors.

Module 3: Robot Motion Analysis **[12]**
Robot motion analysis: Coordinate system in robot kinematics, Homogeneous transformation matrix, direct and inverse kinematics, D – H representation, Jacobian matrix of manipulator.

Module 4: Dynamic Analysis and Trajectory Planning **[12]**

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Lagrangian formulation of manipulator dynamics, Newton-Euler formulation, Joint space planning, Cartesian-space planning.

Module 5: Robot Programming and Industrial Application of Robots **[8]**
Methods of robot programming, Lead and teach method, Explicit languages. Selection and use of robots in metal casting, welding, material handling, machining, inspection, assembly and painting.

Text books:

1. James G. Keramas, "Robot Technology Fundamentals" Cengage Learning India. **[T1]**
2. Srinivas, J., R.V. Dukkipati, K. Ramji, "Robotics Control and Programming", Narosa **[T2]**

Reference books:

1. Yoram Koren, "Robotics for Engineers", McGraw-Hill Companies. **[R1]**
2. King Sun Fu, Rafael C. González, C. S. George Lee, "Robotics, Control, Sensing, Vision and Intelligence", McGraw-Hill. **[R2]**
3. Groover M.P., "Industrial Robotics Technology Programming Application", Tata McGrawHill. **[R3]**
4. Deb S.R., "Robotics Technology and Flexible Automaton", Tata McGraw-Hill. **[R4]**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:
Use of Internet of Things (IoT) in Robotics

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 1-5, 12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	√

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

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Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	1	1		1	1						1	3	1	2
CO2	3	2	2	1	1							1	3	1	3
CO3	3	3	2	3								1	3	2	3
CO4	3	3	1	3								1	3	2	3
CO5	3	3	2	3	1							1	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6, CD7
CO2	CD1, CD2, CD6, CD7
CO3	CD1, CD2, CD6, CD7
CO4	CD1, CD2, CD6, CD7
CO5	CD1, CD2, CD6, CD7

COURSE INFORMATION SHEET

Course code: PE 341
Course title: PROCESSING OF POLYMERS, COMPOSITE AND ADVANCED MATERIALS
Pre-requisite(s): PE 214 METALLURGICAL AND MATERIALS ENGINEERING, PE216 FOUNDRY, FORMING & WELDING TECHNOLOGIES
Co- requisite(s): None
Credits: 4 L: 4 T:0
Class schedule per week: 4
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering (In-depth Specialization in Adv. Mfg. Prod. Mgmt.)
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand different types of polymer materials
2	Learn about the plastic processing methods for different applications
3	Know about ceramic materials based on its properties for different applications
4	Familiarise with the polymer composite processing methods for different applications
5	Know about the different types of advanced materials and their applications

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

CO1	Select appropriate polymeric materials based on its properties for different applications
CO2	Decide suitable plastic processing methods for different applications
CO3	Select appropriate ceramic materials based on its properties for different applications.
CO4	Choose suitable polymer composite processing methods for different applications
CO5	Identify the different types of advanced materials and their applications

SYLLABUS

Module 1: Introduction to polymer materials **[10]**
Structure of polymers, polymerization, polymer blends, additives in polymers, thermoplastics & thermosets: behavior and properties, thermoplastics & thermosets: general characteristics and applications

Module 2: Processing of plastics **[12]**

Extrusion, Injection Molding, Blow Molding, Thermoforming, Compression Molding, Transfer Molding, Casting, Cold Forming and Solid-Phase Forming

Module 3: Introduction to composites **[10]**

Definition of composites, Classification of composites, components in a composite material, General characteristics of reinforcement, properties of composite materials, Metal matrix composites, ceramic matrix composites, polymer matrix composites, processing composite materials

Module 4: Processing of polymer composites **[10]**

Processing of polymer composites, hand-layup, spray-layup, compression molding, Injection molding, reaction injection molding, autoclaving, resin transfer molding, filament winding, pultrusion.

Module 5: Advanced Materials **[8]**

Shape memory alloys, functionally graded materials, bulk metallic glasses, nano materials (introduction-properties at nano scales-advantages & disadvantages-applications in comparison with bulk materials (nano – structure, wires, tubes, composites).

Text books:

1. Serope Kalpakjian and Steven Schmidt, Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition (SI), 2018 **(T1)**
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007 **(T2)**
3. D.H.Morton-Jones , Polymer processing, Chapmman &Hall, New York,1989 **(T3)**
4. Tadmor, Z and Gogos, C.G., Principles of Polymer Processing, John Wiley and Sons, 1982. **(T4)**

Reference books:

1. T. G. Gutowski, (Ed.) Advanced Composites Manufacturing, John Wiley & Sons, New York 1997. **(R1)**
2. K.K. Chawla, Ceramic Matrix Composites, Kluwer Academic Publishers, 2003. **(R2)**
3. N. Chawla, K.K. Chawla, Metal Matrix Composites, Springer-Verlag, 2006. **(R3)**

Gaps in the syllabus (to meet Industry/Profession requirements):

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

POs met through Topics beyond syllabus/Advanced topics/Design:

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Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	4	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	2	2	2								1	3	2	3
CO2	3	2	2	2								1	3	2	3
CO3	3	2	2	2								1	3	2	3
CO4	3	2	2	2								1	3	2	3
CO5	3	2	2	2								1	3	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2 & CD6
CO2	CD1, CD2 & CD6
CO3	CD1, CD2 & CD6
CO4	CD1, CD2 & CD6
CO5	CD1, CD2 & CD6

COURSE INFORMATION SHEET

Course code: PE 342
Course title: MANUFACTURING MANAGEMENT AND COST OPTIMISATION
Pre-requisite(s): PE 304 PRODUCTION AND OPERATION MANAGEMENT
Co- requisite(s): None
Credits: 4 L:4 T: P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering (In-depth Specialization in Adv. Mfg. Prod. Mgmt.)
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Acquire productivity concepts
2	Know the role of production management system
3	Understand the concept of product design
4	Outline the basics of Value Engineering
5	Comprehend break-even and costs in decision making

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

CO1	Define productivity concepts, productivity measurement approaches of the organizations
CO2	Discuss the role of production management system
CO3	Explain the concept of product design
CO4	Apply value analysis and engineering in an organisation
CO5	Evaluate break-even and costs in decision making

SYLLABUS

Module 1: Productivity **[10]**
Concept, productivity improvement factors, productivity appraisal, productivity analysis in the enterprise- The Kurosawa structural approach, Lawlor's approach, Gold's approach, Quick Productivity Appraisal approach (QPA), Inter-Firm Comparison (IFC).

Module 2: Production Management Systems **[10]**
Capacity Requirement Planning (CRP), Aggregate Production Planning (APP), Master Production Schedule (MPS), MRP, MRP II, Lot sizing in MRP- Lot for lot, Economic order quantity, Periodic order quantity, Part period balancing.

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Module 3: Product Design and Development **[10]**

Principles of good product design, tolerance design; quality and cost considerations; product life cycle; standardization, simplification, diversification, concurrent engineering; comparison of production alternatives.

Module 4: Value Engineering and Analysis **[10]**

Fundamental concepts, types of value, methodology, approaches and applications of value analysis and engineering, Function Analysis System Technique (FAST) diagram, case study.

Module 5: Cost Optimization **[10]**

Elements of cost, cost classification- material cost, labor costs, overheads cost, cost of a product, break-even analysis, costs in decision making, make or buy decisions.

Text books:

1. Prokopenko, J. "Productivity Management, A Practical Handbook", International Labour Organisation, 1992. **[T1]**
2. Browne, Hairnet &Shimane, "Production management – A CIM perspective", Addison Wesley publication Co., 1989. **[T2]**
3. Parker, D.E., "Value engineering theory", Sundaram publishers, 2000. **[T3]**
4. Montgomery, J.C and Levine, L. O., "The transition to agile manufacturing – Staying flexible for competitive advantage", ASQC Quality Press, Wisconsin, 1996. **[T4]**

Reference books:

1. Gopalakrishnan "Simplified Lean Manufacture – Elements, Rules, Tools and Implementation", PHI Learning Private Limited, New Delhi, India, 2010. **[R1]**
2. Devadasan, S.R., Sivakumar, V., Mohan Murugesh, R., Shalij, P, R. "Lean and Agile Manufacturing: Theoretical, Practical and Research Futurities", Prentice Hall India, 2012. **[R2]**
3. Tutty Herald G, "Compendium on Value Engineering", Indo-American Society, 1983. **[R3]**
4. Panneerselvam, R. "Production and Operation management", PHI, 2005. **[R4]**
5. Orlicky, J; "Material Requirement Planning: the new way of life in production and inventory management", McGraw Hill, 1975. **[R5]**

Gaps in the syllabus (to meet Industry/Profession requirements):

Nil

POs met through Gaps in the Syllabus:

Nil

Topics beyond syllabus/Advanced topics/Design:

Systems engineering

POs met through Topics beyond syllabus/Advanced topics/Design:

POs 1-5, 12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	√

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√	√		
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	2	1		2	1		2	1	2	1	2	2	3
CO2	3	3	3	2	1	2			1	1	1	1	3	3	3
CO3	3	3	3	3		1	1			1	2	1	3	3	3
CO4	3	3	3	3	2	2	1				2	1	3	3	3
CO5	2	2	1										2	2	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Introduced and approved in Meeting of Board of Studies, dated 23/04/2018
Revised and approved in Meeting of Board of Studies, dated 21/06/2021

Mapping Between Course Outcomes (COs) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6, CD7
CO2	CD1, CD2, CD6, CD7
CO3	CD1, CD2, CD6, CD7
CO4	CD1, CD2, CD6, CD7
CO5	CD1, CD2, CD6, CD7

COURSE INFORMATION SHEET

Course code: PE 409
Course title: FINITE ELEMENTS IN MANUFACTURING ENGINEERING APPLICATIONS
Pre-requisite(s): MATHEMATICS (Calculus, Differential Equations, Linear Algebra), STRENGTH OF MATERIALS, BASICS OF MANUFACTURING PROCESSES
Co- requisite(s): None
Credits: 4 L:3 T:1 P:0
Class schedule per week: 4
Class: B. Tech
Semester / Level: VII / Fourth
Branch: Production Engineering (In-depth Specialization in Adv. Mfg. Prod. Mgmt.)
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the concept of finite element method (FEM)
2	Formulate and solve one-dimensional structural problems using FEM
3	Develop two-dimensional FE formulations for scalar and vector variable problems
4	Develop two-dimensional FE formulations for isoparametric elements
5	Apply the knowledge of FEM for simulation of manufacturing processes

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

CO1	Summarize the basics of finite element formulation
CO2	Apply finite element formulations to solve one-dimensional problems
CO3	Apply finite element formulations to solve two-dimensional scalar and vector problems
CO4	Apply finite element method to solve problems on isoparametric elements
CO5	Implement finite element method in manufacturing engineering

SYLLABUS

Module 1: Introduction **[10]**

Historical background, Relevance of FEM to engineering problems, Application to the continuum – Discretization, Matrix approach, Matrix algebra – Gaussian elimination, Governing equations for continuum, Classical Techniques in FEM, Weighted residual method, Ritz method, Galerkin method

Module 2: One-dimensional problems **[10]**

Finite element modeling – Coordinates and shape functions, Potential energy approach – Element matrices and vectors, Assembly for global equations, Boundary conditions, Higher order elements - Shapes functions,
Applications to axial loadings of rods – Extension to plane trusses,

Bending of beams – Finite element formulation of stiffness matrix and load vectors, Assembly to Global equations, boundary conditions, Solutions and Post processing

Module 3: Two-dimensional problems – scalar and vector variable problems **[10]**

Two dimensional problems – scalar variable problems: Finite element modeling – CST element, Element equations, Load vectors and boundary conditions, Assembly, Application to heat transfer

Two dimensional problems – vector variable problems, Elasticity equations – Plane Stress, Plane Strain and Axisymmetric problems, Formulation, element matrices, Assembly, boundary conditions and solutions

Module 4: Isoparametric elements for two dimensional problems **[8]**

Natural coordinates, Isoparametric elements, Four node quadrilateral element, Shape functions, Element stiffness matrix and force vector, Numerical integration, Stiffness integration, Displacement and Stress calculations

Module 5: Computer implementation and application in manufacturing **[12]**

Computer implementation - Pre-processor, Processor, Post-processor. Discussion about finite element packages.

Application of FEM in metal casting, cutting, metal forming and welding, moulds and dies.

Text books:

1. K-J. Bathe, Finite Element Procedures, Prentice Hall. **[T1]**
2. J.N. Reddy, An Introduction to the Finite Element Method, McGraw-Hill. **[T2]**
3. R.D. Cook, D.S. Malkus and M.E. Plesha, Concepts and Applications of Finite Element Analysis, Prentice Hall-India, New Delhi. **[T3]**
4. T.R. Chandrupatla and A.D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall of India. **[T4]**

Reference books:

1. C.S. Krishnamoorthy, Finite Element Analysis, TMH. **[R1]**
2. O.C. Zienkiewicz, R.L. Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Elsevier. **[R2]**

Gaps in the syllabus (to meet Industry/Profession requirements):

Three-dimensional FE formulation

POs met through Gaps in the Syllabus:

PO 1-5

Topics beyond syllabus/Advanced topics/Design:

Use of commercial finite element software for manufacturing engineering process modelling and analyses

POs met through Topics beyond syllabus/Advanced topics/Design:

PO 1-5, 11-12

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	√

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	2	1							2	2	2	2
CO2	3	3	3	3	1							2	2	3	3
CO3	3	3	3	3	1							2	2	3	3
CO4	3	3	3	3	1							2	2	3	3
CO5	3	3	3	3	1							3	3	3	3

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

Introduced and approved in Meeting of Board of Studies, dated 23/04/2018
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Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6, CD7
CO2	CD1, CD2, CD6, CD7
CO3	CD1, CD2, CD6, CD7
CO4	CD1, CD2, CD6, CD7
CO5	CD1, CD2, CD6, CD7

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COURSE INFORMATION SHEET

Course code: PE415
Course title: MICRO AND NANO MANUFACTURING
Pre-requisite(s): PE 214 METALLURGICAL AND MATERIALS ENGINEERING, PE216 FOUNDRY, FORMING & WELDING TECHNOLOGIES, PE327 MACHINING SCIENCE AND MACHINE TOOLS
Co- requisite(s): None
Credits: 4 L:4 T:0 P:0
Class schedule per week: 4
Class: B. Tech
Semester / Level: VII / Fourth
Branch: Production Engineering (In-depth Specialization in Adv. Mfg. Prod. Mgmt.)
Name of Teacher:

Course Objectives
This course enables the students to:

1	Understand the mechanical micro machining process.
2	Illustrate the Thermal micro machining process.
3	Learn the Nano Polishing and Nano technology Concepts.
4	Comprehend the concepts of micro forming and welding.
5	Be acquainted with Micro and Nano manufacturing process.

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

CO1	Classify the basic micro machining processes
CO2	Compare the various thermal energy based micro machining processes
CO3	Describe the Nano technology concepts and application.
CO4	Discuss the process of Micro-fabrication, forming and micro welding.
CO5	Distinguish the recent trends and applications of micro machining

SYLLABUS

Module 1: Introduction **[10]**
Introduction of micro machining process; Fundamental principles, application possibilities, process parameters, and operational characteristics of Mechanical Micro machining: micro turning, micro milling, and micro drilling; Ultrasonic, Abrasive Jet, Water Jet and Abrasive Water Jet micro machining; Chemical and Electro Chemical Micro Machining.

Module 2: Thermal micro machining **[10]**
Fundamental principles, application possibilities, process parameters, and operational characteristics of Beam Energy based micro machining: Electron beam, Laser beam, Focused

ion Beam; Electric Discharge, and Plasma Beam Micro Machining. Hybrid Micro machining processes include Electro Chemical Spark Micro Machining (ECSMM), Electrochemical Micro Deburring (EMD).

Module 3: Nano finishing **[10]**

Fundamental principles, application possibilities, process parameters, and operational characteristics of Nano Polishing using Abrasive Flow finishing, Magnetic Abrasive Finishing, Magneto Rheological abrasive flow finishing, Magnetic Float polishing, Elastic Emission Machining, chemo-mechanical Polishing.

Module 4: Micro forming and welding **[8]**

Fundamental principles, application possibilities, process parameters, and operational characteristics of Micro Forming; Micro and Nano structured surface development by Nano plastic forming and roller imprinting. LASER micro welding, Electron beam micro welding.

Module 5: Metrology and applications of micro and nano machining **[12]**

Metrology for micro machined components: Scanning Electron Microscopy, optical microscopy, atomic force microscope, molecular measuring machine, micro-CMM; Ductile regime machining, Acoustic emission-based tool wear compensation, Machining of Micro gear, micro nozzle, micro pins and their Applications.

Text books:

1. Jain V.K., Introduction to Micro machining, Narosa Publishing House. **[T1]**
2. Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group. **[T2]**
3. Norio Taniguchi, Nano Technology, Oxford University Press, New York. **[T3]**

Reference books:

1. Bharat Bhushan, Handbook of nanotechnology, springer, Germany. **[R1]**
2. Jain V.K., Advanced Machining Processes, Allied Publishers, Delhi. **[R2]**
3. Mcgeoug.J.A., Micromachining of Engineering Materials, CRC press. **[R3]**

Gaps in the syllabus (to meet Industry/Profession requirements):

Diamond turning.

POs met through Gaps in the Syllabus:

POs 1,5,6

Topics beyond syllabus/Advanced topics/Design:

Nanoimprint Lithography for Nanomanufacturing

POs met through Topics beyond syllabus/Advanced topics/Design:

POs 1,2,5,9

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	
CD4	Industrial/guest lectures	
CD5	Industrial visits/in-plant training	
CD6	Self- learning such as use of NPTEL materials and internets	√
CD7	Simulation	

Course Evaluation:

Direct Assessment-

Assessment Tool	% Contribution during CO Assessment
Progressive Evaluation	50
End Semester Examination	50

Progressive Evaluation	% Distribution
Mid Semester Examination	25
Quizzes	10 + 10
Assignment	5
End Semester Examination	**% Distribution**
End Semester Examination	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Semester Examination	√	√			
Quiz 1	√	√			
Quiz 2			√	√	√
Assignment	√	√	√	√	√
End Semester Examination	√	√	√	√	√

Indirect Assessment –

1. Student Feedback on Faculty
2. Student Feedback on Course Outcome

Mapping of Course Outcomes (Cos) onto Program Outcomes (POs) and Program Specific Outcomes (PSOs):

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3			1					1	1	1	2	1	1
CO2	2	3	1	3	2			1		1		1	2	2	3
CO3			2	3	3		1		1		1		1		2
CO4		1	3	2	3				2	1	1	1	2		2
CO5	2	2	1		1	1			2	2		1		2	1

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

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Mapping Between Course Outcomes (COs) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2, CD6
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

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