Semester-II

Rapid Prototyping Technologies			
Course Code	**MMPE201**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the need and evolution of rapid prototyping (RP) systems and their applications in product development.
- To explore the working principles, processes, and applications of various RP technologies such as Stereolithography (SLA), Selective Laser Sintering (SLS), and Fusion Deposition Modeling (FDM).
- To gain knowledge about advanced RP techniques like Laminated Object Manufacturing (LOM) and their applications in prototyping and manufacturing.
- To learn about rapid tooling methods, process optimization, and addressing errors in RP processes for improved accuracy.

Module-1

Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application.

Module-2

Selective Laser Sintering and Fusion Deposition Modeling: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, Path generation, Applications. Solid Ground Curing: Principle of operation, Machine details, Applications.

Module-3

Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application. Concepts Modelers: Principle, Thermal jet printer, Sander's model market, 3-D printer. GenisysXs printer HP system 5, object Quadra systems.

Module-4

Rapid Tooling: Indirect Rapid tooling -Silicone rubber tooling – Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, etc. Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

Module-5

RP Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Stereo lithography and other RP & M Technologies, Paul F. Jacobs, SME, NY, 1996
2. Rapid Manufacturing, Flham D.T &Dinjoy S.S, Verlog London,
3. Rapid Prototyping: Principles and Applications" by R. K. Gupta, P. S. S. S. Srinivasan, and S. S. Sharma.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/104/112104265/

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Analyze the role of rapid prototyping in modern industries.	L1 to L5
CO2	Explain principles and applications of SLA, SLS, and FDM technologies	L1 to L5
CO3	Differentiate between direct and indirect rapid tooling methods. Optimize RP processes	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	3	3	1
CO2	2	3	3	3	3	2
CO3	2	3	3	3	3	3

Advanced Metal Forming			
Course Code	**MMPE202**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the fundamentals and classification of metal forming processes.
- Analyze rolling processes, forces, defects, and power calculations.
- Explore forging techniques, press tool design, and defect analysis.
- Study extrusion and drawing processes with defect analysis and force calculations.
- Learn advanced sheet metal forming techniques and modern metal forming methods.

Module-1

Fundamentals of Metal Forming: Classification of forming processes, mechanisms of metal forming: slab method, Upper and lower bound analysis, Deformation energy method and finite element method temperature of metal working, hot working, cold working, friction and lubricants.

Module-2

Rolling of metals: Rolling processes, forces and geometrical relationship in rolling, simplified analysis, rolling load, rolling variables, theories of cold and hot rolling, problems and defects in rolling, torque and power calculations, Problems

Module-3

Forging: Classification of forging processes, forging of plate, forging of circular discs, open die and closed die forging, forging defects, and powder metallurgy forging. problems on flow stress ,true strain and forging load. Press tool design: Design of various press tools and dies like piercing dies, blanking dies, compound dies and progressive blanking dies, design of bending, forming and drawing dies.

Module-4

Extrusion: Classification, Hot Extrusion, Analysis of Extrusion process, defects in extrusion, extrusion of tubes, production of seamless pipes. Problems on extrusion load. Drawing: Drawing of tubes, rods, and wires: Wire drawing dies, tube drawing process, analysis of wire, deep drawing and tube drawing .Problems on drawforce.

Module-5

Sheet Metal forming: Forming methods, Bending, stretch forming, spinning and Advanced techniques of Sheet Metal Forming, Forming limit criteria, defect in formed parts. Advanced Metal forming processes: HERF, Electromagnetic forming, residual stresses, in-process heat treatment and computer applications in metal forming. problems on Blanking force, Blank diagram in Cup Diagram, Maximum considering shear.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Fundamentals of Metal Forming Processes – B.L.Juneja.

References:

- Principles of Metal Working processes - G.W. Rowe.
- ASM Metal Forming Hand book.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/107/112107250/
- https://archive.nptel.ac.in/courses/112/107/112107078/

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Evaluate rolling parameters, load calculations, and defect prevention strategies.	L1 to L5
CO2	Apply forging principles to design and analyze press tools and forging loads.	L1 to L5
CO3	Solve extrusion and drawing process problems, including force and defect analysis.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**2**	**3**	**3**	**3**	**1**
CO2	**2**	**3**	**3**	**3**	**3**	**2**
CO3	**2**	**3**	**3**	**3**	**3**	**3**

Semester -

Industrial Design and Ergonomics			
Course Code	**MMPE203**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

The course aims to provide an overview of ergonomics principles. A comprehensive view of ergonomics applied in various domains like industrial cognitive and interaction will be covered. The course will help in understanding the design aspects of ergonomics and their applications in real-world problems through case studies and studio sessions.

MODULE-1

Introduction: An approach to industrial design - elements of design structure for industrial design in engineering application in modem manufacturing systems. Ergonomics and Industrial Design: Introduction - general approach to the man-machine relationship- work station design-working position.

MODULE-2

ControlandDisplays:shapesandsizesofvariouscontrolsanddisplays-multipledisplaysandcontrolsituations-design of major controls in automobiles, machine tools etc., - design of furniture – design of instruments.

MODULE-3

ErgonomicsandProduction: Ergonomics and product design ergonomics in automated systems- expert systems for ergonomicdesign,Anthropomorphicdataanditsapplicationsinergonomicdesignlimitationsofanthropomorphicdata- use of computerized database

MODULE-4

VisualEffectsofLineandForm: The mechanics of seeing psychology of seeing, general influences of lined and form. Colour: colour and light - colour and objects - colour and the eye colour consistency - colour terms - reactions to colour and colour continuation - colour on engineering equipments.

MODULE 5

AestheticConcepts: Concept of unity - concept of order with variety - concept of purpose style and environment - Aesthetic expressions. Style-components of style - house style, observations style in capital goods. **IndustrialDesigninPractice:** General design - specifying design equipments - rating the importance of industrial design – industrial design in the design process.

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Rolling Process Experiment – Perform cold and hot rolling on metal sheets and analyze surface defects.
2	Forging Load Calculation – Conduct open-die and closed-die forging experiments and measure forging loads.
3	Extrusion Process Analysis – Perform hot and cold extrusion of rods and analyze defects.
4	Sheet Metal Forming – Perform bending, deep drawing, and stretch forming experiments.
5	Ergonomic Workplace Design – Analyze and redesign a workstation for improved ergonomics.

6	Press Tool Design & Testing – Design and fabricate a blanking or piercing die and test its performance.
7	Finite Element Analysis in Metal Forming – Simulate a metal forming process using FEA software.
10	Wire Drawing Experiment – Perform wire drawing and analyze strain, stress, and die wear. Can be Demo experiments for CIE
11	Electromagnetic Forming – Demonstrate high-energy rate forming and study deformation behavior. Can be Demo experiments for CIE
12	Residual Stress Measurement – Measure and analyze residual stresses in formed metal components.Can be Demo experiments for CIE

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

1. Two Tests each of **25 Marks**
2. Two assignments each of **25 Marks/One Skill Development Activity of 50 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for **10 marks**. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test at the end /after completion of all the experiments shall be conducted for **50 marks** and scaled down to **05 marks.**

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by the University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a

maximum of 3 sub-questions), **should have a mix of topics** under that module.

4. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 15 (50% of maximum marks-30) in the theory component and 10 (50% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included**.** The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course (CIE+SEE)

Suggested Learning Resources:

Books

1. IndustrialdesignforEngineers-MayallW.H.-LondonCliffee BooksLtd.
2. AppliedErgonomics HandBook-BrienShakel(Edited) -Butterworth Scientific

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/107/103/107103004/

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

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Evaluate rolling parameters, load calculations, and defect prevention strategies.	L1, L2, L3, L4, L5
CO2	Solve extrusion and drawing process problems, including force and defect analysis.	L1, L2, L3, L4, L5
CO3	Implement advanced sheet metal forming techniques and optimize forming processes.	L1, L2, L3, L4, L5

Program Outcome of this course

Sl. No.	Description	POs
1	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4	Conduct research and development to innovate and improve production methods.	PO4
5	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	2	3	2
CO2	2	3	3	2	1	3
CO3	3	3	2	3	2	3

Professional Elective-1			
Agile Manufacturing			
Course Code	**MMPE214A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the agile manufacturing and conceptual framework.
- Analyse the four core concept of agile manufacturing.
- Study the implication of advanced manufacturing system.
- Understand and design the agile manufacturing enterprises.
- Design skill and knowledge enhancing technology fragile manufacturing

Module-1

Introduction - What is agile Manufacturing? - Competitive environment of the future the business case for agile manufacturing conceptual frame work for agile manufacturing.

Module-2

Four Core Concepts: Strategy driven approach - integrating organization, people technology interdisciplinary design methodology.

Module-3

Agile Manufacturing and Change Management: The change implications. Post failures in advanced manufacturing, changes on the way, traditional management accounting, paradigm, investment appraisal, product costing - performance, measurement and control systems, Traditional organization, control technological and design paradigms traditional problems in workplace- organizational issues – role of technology.

Module-4

Agile Manufacturing Enterprise Design: Agile manufacturing - enterprise design.. system concepts as the basic manufacturing theory - joint technical & organizational design and a model for the design of agile manufacturing enterprise, enterprise design process insights into design processes, what is interdisciplinary design, Main issues - simple design example.

Module-5

Skill & Knowledge Enhancing Technologies for Agile Manufacturing: Skill and Knowledge enhancing Technologies - scheduling - technology design strategic-Design Concepts. Design and Skill of Knowledge enhancing Technologies for machine tool systems - Historical overview, Lessons, problems and Future development. .

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Agile manufacturing - Forging new Frontiers - Paul T. Kidd - Addison Wesley Publication
- Agile Manufacturing – Proceedings of International Conference - Dr. M.P Chowdiah (Editor) – TataMcGraw Hill Publications
- On Agile manufacturing - Tata McGraw Hill Publications
- Agile manufacturing - Forging Neat Furniture's - Paul T Kidd – Addition Wesley Publications

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=_n28vUPJzxM
- https://www.youtube.com/watch?v=HQEkn-mJnas
- https://www.youtube.com/watch?v=7M_uMhxZtC4
- https://www.youtube.com/watch?v=VDz-SS6-P4s
- https://www.youtube.com/watch?v=G_0bl6FHo_c

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss the implication of advanced manufacturing system.	L1 to L5
CO2	Plan and design the agile manufacturing enterprises.	L1 to L5
CO3	Invent skill and knowledge enhancing technology for agile manufacturing.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	2
CO2	2	3	2	3	3	2
CO3	2	3	3	3	3	3

Professional Elective-1			
CAE and CIM			
Course Code	**MMPE214B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To learn the basic concepts of Computer Aided Engineering and different discretization methods.
- To learn the different meshing techniques.
- To imbibe the basic knowledge of CAD, CA and CIM
- To develop the fundamental skill sets in CNC Programming
- To inculcate the fundamental knowledge automated material handling and storage system.

Module-1

Elemental Properties: Introduction to Computer Aided Engineering, CAE in product development discretization methods – Finite Element Method (FEM), Finite Difference Method (FDM) and Finite Volume Method (FVM), CAE tools Pre processor, Solver, Post processor.

Element Shapes: 1D, 2D and 3D elements, Nodal unknowns and Field variables.

Module-2

Meshing Techniques: Discretization of a structure, 1D, 2D and 3D element meshing, Elements selection criteria, Refining mesh, Effect of mesh density in critical region, use of symmetry.

Module-3

Production development through CIM: Computers in Industrial manufacturing, Product cycle & Production development cycle, Introduction of CAD/CAM & CIM, sequential and concurrent engineering, soft and hard prototyping.

Computer Process Monitoring: Process control methods, direct digital control, supervisory computer control, steady state optimal control, on line search strategies, adaptive control.

Module-4

Computer Integrated Manufacturing: Fundamentals of CAD/CAM, Computerized Manufacturing planning systems, shop floor control & automatic identification techniques. Computer Network for manufacturing and the future automated factor.

Module-5

Automated material Handling Storage: Material functions, types of material handling equipment, analysis of material handling systems, design of system, conveyor system, automated guided vehicle systems, automated storage/retrieval systems, caroused storage systems work in process storage, interfacing handling & storage with manufacturing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- CAD/CAM -Zimmers& Grover – PHI
- CAD/CAM/CIM - P.Radhakrishna - New Age International - 2nd edition
- CAD/CAM - P.N.Rao - TMH

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=fQ17i9RThvk
- https://www.youtube.com/watch?v=NXel87Do0bA
- https://www.youtube.com/watch?v=5qQCNg0Ja5Y
- https://www.youtube.com/watch?v=Sx_j50K5qZo
- https://www.youtube.com/watch?v=1_Bv9BJE2lI

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Categorize computer aided quality control work for manufacturing.	L1 to L5
CO2	List and explain different flow lines and transfer mechanisms	L1 to L5
CO3	Categorize Automated material Handling Storage system.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**2**	**2**	**3**	**3**	**3**	**2**
CO2	**2**	**3**	**2**	**3**	**1**	**2**
CO3	**2**	**2**	**3**	**3**	**3**	**3**

Professional Elective-1			
Flexible Manufacturing Systems			
Course Code	**MMPE214C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the fundamentals of planning, scheduling, and control in Flexible Manufacturing Systems (FMS).
- Explore computer control, software selection, and hierarchical control in FMS.
- Analyze FMS simulation, database management, and economic justification techniques.

Module-1

Planning, Scheduling, And Control Of Flexible Manufacturing: Introduction – development of manufacturing systems – benefits – major elements – types of flexibility – FMS application and flexibility – single product, single batch, n – batch scheduling problem – knowledge-based scheduling system

Module-2

Computer Control And Software For Flexible Manufacturing Systems: Introduction – composition of FMS – hierarchy of computer control – computer control of work center and assembly lines – FMS supervisory computer control – types of software specification and selection – trends

Module-3

FMS Simulation And Database: Application of simulation – model of FMS – simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database

Module-4

Group Technology And Justification Of FMS: Introduction – matrix formulation – mathematical programming formulation – graph formulation – knowledge-based system for group technology – economic justification of FMS – application of possibility distributions in FMS systems justification

Module-5

Applications Of FMS And Factory Of The Future: FMS application in machining, sheet metal fabrication, prismatic component production – aerospace application – FMS development towards factories of the future – artificial intelligence and expert systems in FMS – design philosophy and characteristics for future.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- "Handbook of flexible manufacturing systems", Jha, N.K. Academic Press Inc., 1991.
- "CAD/CAM/CIM", Radhakrishnan P. and Subramanyan S., Wiley Eastern Ltd., New Age International Ltd., 1994.
- "Automation, Production Systems and Computer Integrated Manufacturing", Groover M.P., Prentice Hall of India Pvt., New Delhi, 1996.
- "Manufacturing Engineering and Technology", Kalpakjian, Addison-Wesley Publishing Co., 1995.

Web links and Video Lectures (e-Resources):

https://nptel.ac.in/courses/110105155
https://www.youtube.com/watch?v=tiarT1YS-lM
https://archive.nptel.ac.in/courses/110/105/110105155/

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the role of Flexible Manufacturing Systems (FMS) in manufacturing.	L1 to L5
CO2	Explain the processes in group technologies.	L1 to L5
CO3	Understand various applications using AI and expert systems using FMS technology.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**2**	**3**	**3**	**3**	**2**
CO2	**2**	**3**	**2**	**3**	**1**	**2**
CO3	**2**	**2**	**2**	**3**	**3**	**3**

Professional Elective-1			
Product Design and Manufacturing			
Course Code	**MMPE214D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand modern product development processes.
- Understand and explain the concept of Industrial design and robust design concepts.
- Understand the concept of Design for manufacture and assembly.
- Understand the legal factors, social issues, engineering ethics related to product design

Module-1

Product Data Management : Product life cycle, Complexity in Product Development, General Description of PDM

Basic functionality of PDM: Information architecture, PDM System architecture, Applications used in PDM systems. Trends in PDM.

Module-2

Document Management Systems: Document management and PDM, Document life cycle, Content Management, Document management and related technologies, Document management resources on the Internet.

Module-3

Workflow Management in PDM: Structure Management, Engineering Change Management, Release Management, Version Management, Configuration Management.

Module-4

Creating Product Structures: Part centric approach, CAD centric approach, Product Structure configuration, Managing Product Structures, PDM Tools: Matrix One, Team Center, Windchill. Enovia, PDM resources on the Internet.

Module-5

PDM Implementation Case Studies: Sun Microsystems, Inc., Mentor Graphics Corporation, Ericsson Radio Systems AB, Ericsson Mobile Communications AB, ABB Automation Technology Products, SaabTech Electronics AB

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Computer Integrated Design and Manufacturing - David Bed worth. Mark Henderson &. Philips Wolfe - McGraw Hill Inc
- Visual Modeling with Rational Rose and UML - Terry Quatrain – Wind-chill - RS.O Reference manuals - 2000.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=oTqtY8yjUw4
- https://www.youtube.com/watch?v=bxHbP-q9InU
- https://www.youtube.com/watch?v=0XFuRPPkZvA
- https://www.technia.com/blog/cad-data-management-on-the-3dexperience-platform/
- https://www.youtube.com/watch?v=JvQI0jkv89k

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Employ research and analysis methodologies as it pertains to the product design process, meaning, and user experience.	L1 to L5
CO2	Apply creative process techniques in synthesizing information, problem-solving and critical thinking.	L1 to L5
CO3	Demonstrate and employ hand drawing and drafting principles to convey concepts.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
3.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
4.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
5.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
6.	Conduct research and development to innovate and improve production methods.	PO4
7.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
8.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**2**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**2**	**3**	**2**	**2**
CO3	**3**	**2**	**2**	**3**	**3**	**3**

Professional Elective-II			
Simulation and Modelling of Production Systems			
Course Code	**MMPE215A**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Define the basics of simulation modeling and replicating the practical situations in organizations
- Generate random numbers and random variates using different techniques.
- Develop simulation model using heuristic methods.
- Analysis of Simulation models using input analyzer, and output analyser
- Explain Verification and Validation of simulation model.

Module-1

Principle of Computer Modelling and Simulation: Monte Carlo simulation. Nature of computer- modeling and simulation. Limitations of simulation, areas of applications. System and Environment: Components of a system -discrete and continuous systems, Models of a system –a variety of modeling approaches. Simulation Software: Selection of simulation software, simulation packages.

Module-2

Discrete Event Simulation: Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, too server queue, simulation of inventory problem.
Statistical Models in Simulation: Discrete distributions, continuous distributions. **Discrete Event Simulation:** Concepts in discrete event simulation, manual simulation using event scheduling, single channel queue, too server queue, simulation of inventory problem.
Statistical Models in Simulation: Discrete distributions, continuous distributions.

Module-3

Random Number Generation: Techniques for generating random numbers- Mid square method -the mod product method -Constant multiplier technique -Additive congruential method –Linear congruential method -Tests for random numbers -The Kolmogorov-Smimov test -the Chi-square test.

Module-4

Random Variable Generation: Inversion transforms technique-exponential distribution, uniform distribution, weibul distribution, continuous distribution, generating approximate normal variates-Erlang distribution.

Module-5

Empirical Discrete Distribution: Discrete uniform -distribution poisons distribution –geometric distribution -acceptance -rejection technique for Poisson distribution gamma distribution
Designand Evalution of Simulation Experiments: variance reduction techniques -antithetic variables, variables-verification and validation of simulation models.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. **Discrete Event System Simulation** - Jerry Banks & .John S Carson II - Prentice Hall Inc.-1984.
2. **Systems Simulation** - Gordan. G. - Prentice Hall India Ltd - 1991.

REFERENCE BOOKS:

1. **System Simulation with Digital Computer** - NusingDeo - Prentice Hall of India - 1979.
2. **Computer Simulation and Modeling** - Francis Neelamkovil - John Wilely& Sons - 1987.
3. **Simulation Modeling with Pascal** - RathM.Davis& Robert M O Keefe - Prentice Hall Inc. -1989.

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=gbOn3jRc_Wc
- https://www.youtube.com/watch?v=Wp3jyLkfBQs
- https://www.youtube.com/watch?v=WfEZMhpzsT8
- https://www.youtube.com/watch?v=OH8MRT8eqRI
- https://www.youtube.com/playlist?list=PL3l_ZG2nBXNLoPB26LeNRVDP6oG6Sz8tu

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe the role of important elements of discrete event simulation and modeling paradigm.	L1 to L5
CO2	Develop skills to apply simulation software to construct and execute goal-driven system models.	L1 to L5
CO3	Interpret the model and apply the results to resolve critical issues in a real world environment.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**1**	**3**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**3**	**3**	**3**	**2**
CO3	**2**	**2**	**2**	**3**	**3**	**3**

Professional Elective-II			
Design of Experiments			
Course Code	**MMPE215B**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Plan data collection, to turn data into information and to make decisions that lead appropriate action.
- Apply the methods taught to real life situations.
- Plan, analyze, and interpret the results of experiments.
- To understand the Orthogonal arrays.
- Analyze the Parameter and tolerance design concepts.

Module-1

Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. **Concepts of random variable,** probability, density function cumulative distribution function. Sample and population, Measure of Central tendency; Mean median and mode, Measures of Variability, Concept of confidence level. Statistical Distributions: Normal, Log Normal & Weibull distributions. Hypothesis testing, Probability plots, choice of sample size. Illustration through Numerical examples.

Module-2

Classical Experiments: Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization, Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.

Module-3

Measures of variability, Ranking method, Column effect method & Plotting method, Analysis of variance (ANOVA) in Factorial Experiments: YATE's algorithm for ANOVA, Regression analysis, Mathematical models from experimental data. Illustration through Numerical examples.

Quality, Western and Taguchi's quality philosophy, elements of cost, Noise factors causes of variation. Quadratic loss function & variations of quadratic loss function. Robust Design: Steps in Robust Design: Parameter design and Tolerance Design. Reliability Improvement through experiments, Illustration through Numerical examples**.**

Module-4

Types of Orthogonal Arrays, selection of standard orthogonal arrays, Linear graphs and Interaction assignment, Dummy level Technique, Compound factor method, Modification of linear graphs. Illustration through Numerical examples.

Module-5

Evaluation of sensitivity to noise. Signal to Noise ratios for static problems: Smaller-the-better type, Nominal-the –better-type, Larger the- better type. Signal to Noise ratios for Dynamic problems. Illustration through Numerical examples.

Parameter and tolerance design concepts, Taguchi's inner and outer arrays, parameter design strategy, tolerance design strategy. Illustration through Numerical examples.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Design and Analysis of Experiments, Douglas C Montgomerry, Wiley, 8th Edition
- Design and Analysis of Experiments, R. Panneerselvam, PHI
- Quality Engineering Using Robust Design, Madhav S,Phadke, PHI
- Design of Experiments with Minitab, Paul Mathews, New Age International
- Design of Experiments with Minitab, Virgil L Anderson and Robert A Mclean, Taylor and Francis

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=G_IAeHoukvE
- https://www.youtube.com/watch?v=KhjM8YI3agk
- https://www.youtube.com/watch?v=1fgvi1dXfMg
- https://www.youtube.com/watch?v=dmvo_B91vlc
- https://www.youtube.com/watch?v=sIRl1xWrViY

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Plan data collection, to turn data into information and to make decisions that lead appropriate action.	L1 to L5
CO2	Plan, analyze, and interpret the results of experiments, To understand the Orthogonal arrays.	L1 to L5
CO3	Analyze the Parameter and tolerance design concepts.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**3**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**2**	**3**	**3**	**2**
CO3	**2**	**2**	**2**	**3**	**3**	**3**

Professional Elective-II			
Industry 4.0			
Course Code	**MMPE215C**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Definethebasics of simulationmodeling andreplicatingthepracticalsituationsinorganizations
- Generaterandomnumbersandrandomvariatesusingdifferenttechniques.
- Developsimulationmodelusingheuristicmethods.

Module-1

Introduction to Industry 4.0: Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0productionsystem,current stateof industry4.0,Technologies,HowisIndiapreparingforIndustry4.0 08Hrs

Module-2

AConceptualFrameworkforIndustry4.0: Introduction,MainConceptsandComponentsofIndustry4.0,StateofArt ,SupportiveTechnologies,ProposedFrameworkforIndustry4.0.
08Hrs

Module-3

Technology Roadmap for Industry 4.0 : Introduction, Proposed Framework for Technology Roadmap, StrategyPhase, Strategy Phase, New Product and Process Development Phase.
08Hrs

Module-4

AdvancesinRoboticsintheEraofIndustry4.0:Introduction,RecentTechnologicalComponentsofRobots-AdvancedSensorTechnologies,InternetofRoboticThings,CloudRobotics,andCognitiveArchitectureforCyber-PhysicalRobotics,IndustrialRoboticApplications-Manufacturing,Maintenance andAssembly.
08Hrs

Module-5

ObstaclesandFrameworkConditionsforIndustry4.0:LackofADigitalStrategyalongsideResourceScarcity,Lack ofstandardsandpoordatasecurity,Financingconditions,availabilityofskilledworkers,comprehensive broadband infra- structure
08Hrs

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- AlpUstundagandEmreCevikcan,"Industry4.0:ManagingtheDigitalTransformation".
- Bartodziej,ChristophJan,"TheConceptIndustry4.0".
- KlausSchwab,"TheFourthIndustrialRevolution".
- ChristianSchröder,"TheChallengesofIndustry4.0forSmallandMedium-sizedEnterprises".

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe the role of important elements of discrete event simulation and modeling paradigm.	L1 to L5
CO2	Developskillstoapplysimulationsoftwaretoconstructandexecutegoal-driven systemmodels.	L1 to L5
CO3	Interpret the model and apply the results to resolve critical issues in a real worldenvironment.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	3	3	3	2
CO2	3	3	2	3	2	2
CO3	3	2	2	3	3	3

Professional Elective-II			
Non Destructive Testing			
Course Code	**MMPE215D**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To inspect a component in a safe, reliable and cost effective manner without causing damage to the equipment
- To weld inspectors can determine whether a weld is strong or has potential defects that could compromise it integrity
- Ultrasonic testing is to detection of defect, measurement of their parameters assessment of their hazard assessment feasibility operation of the particular tested objected
- Liquid penetrate testing is to provide visual evidence of surface discontinuities in solid non-porous materials
- Magnetic Particle inspection is a NDT method, to detect surface and subsurface flaws in ferromagnetic Materials

Module-1

Introduction: Definition of Non-destructive testing, Need for NDT techniques and its applications, Types of NDT techniques, benefits from Non-destructive Testing, nature of flaws ,various steps involved in NDT, uses of Non-destructive techniques.

Non-Destructive Testing of Welds: Definition of weld, types of weld joints, Welding processes; Gas welding, shielded metal arc welding, TIG spot welding, Defects in welded joints, Defects associated with residual stresses, Testing, measurement and control (TMC) of welds, Testing of welded joints; destructive test, Non-destructive tests

Module-2

Ultrasonic Testing : Introduction frequency of ultrasonic Waves, Generation of Ultrasonic waves, Piezo-electric materials for Ultrasonic Transducers, Types of Ultrasonic Waves, Different kinds of Ultrasonic Transducers, Types of ultrasonic waves, Reflection, Refraction and scattering of Ultrasonic beam, working of ultrasonic Flaws detectors, industrial application.

Liquid Penetrants Testing: Types of Penetrants, Types of developers, Penetration time, Inspection, Post emulsifiable fluorescent penetrants system, Water washable fluorescent Penetrants, Low and High temperature Penetrants, High sensitivity fluorescence penetrant examination, Advanced LPT techniques; Ultrasonic pumping to enhance performance, ultrasonically enhanced penetrant inspection of small weldments, Mechanised remote liquid penetrant testing of piping of reactors.

Module-4

Eddy current Testing: instrumentation of ECT, inspection of welds, advanced eddy current testing, Multi-frequency ECT, 3D phase array ECT, Remote field ECT, Magnetically based eddy current. Flux leakage, Computer modelling of ECT, Digital signal Processing, Eddy current imaging; eddy current imaging system, imaging and characterisation of defects, Eddy current array instrumentation for fixed position scanning.

Module-5

Magnetic particle Flaws detection: Principle of Magnetic Flaw detection, Types and methods of

Magnetisation, Magnetic particles, Dry and Wet methods of Magnetic Particles inspection, Use of fluorescent Coated Magnetic particles, Industrial applications, Working of a Few Commercially available Magnetic Crack Detectors, Flaw detection in Rods, pipes and a short work piece, Precautions, Limitations, Residual magnetism, Need for Demagnetisation Research Techniques using Magnetic Particle Methods.

Assessment Details (both CIE and SEE)

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Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks** to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**
CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Non-Destructive Testing Techniques Ravi Prakash 3rd Edition 2010 New Age International (P) Ltd., publishers
- Non-destructive Testing of Welds Baldev Raj C.V. Subramanian T. Jayakumar Revised Edditon 2000Narosa Publishing House
- Welding Technology O.P. KhannaDhanpatRai Publication 2008

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=gbOn3jRc_Wc
- https://www.youtube.com/watch?v=Wp3jyLkfBQs
- https://www.youtube.com/watch?v=WfEZMhpzsT8
- https://www.youtube.com/watch?v=OH8MRT8eqRI
- https://www.youtube.com/playlist?list=PL3l_ZG2nBXNLoPB26LeNRVDP6oG6Sz8tu

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Distinguish the destructive and non-destructive testing and find effectiveness.	L1 to L5
CO2	Ultrasonic testing is to detection of defect, measurement of their parameters assessment of their hazard assessment feasibility operation of the particular tested objected	L1 to L5
CO3	Find the surface defect using liquid penetrate and magnetic particle test and eddy current test.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	3	3	3	3	2
CO2	3	3	3	3	3	2
CO3	2	2	2	3	3	3

Finite Element Techniques			
Course Code	**MMPE206**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- Understand the fundamentals of the Finite Element Method (FEM) for solving engineering field problems.
- Develop FEM models for structural analysis of trusses, frames, and beams.
- Apply FEM to heat transfer, dynamic analysis, and axisymmetric problems in engineering.

Module-1

Introduction to Finite Element Method of solving field problems. Stress and Equilibrium. Boundary conditions. Strain-Displacement relations. Stress-strain relations. One Dimensional Problem: Finite element modeling. Local, natural and global coordinates and shape functions. Potential Energy approach : Assembly of Global stiffness matrix and load vector. Finite element equations, treatment of boundary conditions. Quadratic shape functions

Module-2

Analysis of trusses and frames: Analysis of plane truss with number of unknowns not exceeding two at each node. Analysis of frames with two translations and a rotational degree of freedom at each node. Analysis of Beams: Element stiffness matrix for two noded, two degrees of freedom per node for beam element.

Module-3

Finite element modeling of two dimensional stress analysis problems with constant strain triangles and treatment of boundary conditions. Two dimensional four noded isoparametric elements and numerical integration. Finite element modeling of Axisymmentric solids subjected of axisymmetric loading with triangular elements.

Module-4

Steady state heat transfer analysis: One dimensional analysis of a fin and two dimensional conduction analysis of thin plate. Time dependent field problems: Application to one dimensional heat flow in a rod.

Module-5

Dynamic analysis: Formulation of finite element modeling of Eigen value problem for a stepped bar and beam. Evaluation of Eigen values and Eigen vectors. Analysis of a uniform shaft subjected to torsion using Finite Element Analysis.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Two Unit Tests each of **25 Marks**
2. Two assignments each of **25 Marks** or **one Skill Development Activity of 50 marks**

to attain the COs and POs

The sum of two tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Tirupathi R Chandraputla and Ashok. D. Belegundu, Introduction of Finite Element in Engineering, Prentice Hal of India, 1997.
- Rao S.S., The Finite Element Methods in Engineering, Pergamon Press, 1989.
- Segerland. L.J., Applied Finite Element Analysis, Wiley Publication, 1984.
- Reddy J.N., An Introduction to Finite Element Methods, Mc Graw Hil Company, 1984.

Web links and Video Lectures (e-Resources):

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Apply the Finite Element Method to solve structural, thermal, and dynamic engineering problems.	L1 to L5
CO2	Develop and analyze FEM models for trusses, beams, frames, and axisymmetric structures.	L1 to L5
CO3	Implement numerical techniques for heat transfer, eigenvalue analysis, and torsional problems.	L1 to L5

Program Outcome of this course

Sl. No.	Description	POs
1.	Apply advanced knowledge of production engineering to solve complex industrial challenges.	PO1
2.	Design and optimize manufacturing systems for improved productivity and sustainability.	PO2
3.	Utilize modern tools and technologies in advanced manufacturing processes.	PO3
4.	Conduct research and development to innovate and improve production methods.	PO4
5.	Demonstrate leadership and teamwork skills in multidisciplinary engineering projects.	PO5
6.	Uphold professional ethics and sustainability principles in engineering practices.	PO6

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	**3**	**2**	**3**	**3**	**3**	**2**
CO2	**2**	**3**	**3**	**3**	**3**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**3**

Production Engineering Lab			
Course Code	**MPEL207**	CIE Marks	50
Teaching Hours/Week (L:P:T)	0:0:2	SEE Marks	50
Credits	02	Exam Hours	03

Course objectives:

Themainobjectiveofthiscourseistoemphasizetheimportancemanufacturingsciencesintheday-to-daylife,and to study the basic manufacturing processes and tools used.

Sl.NO	Experiments
1	Todesignandmakingofpattern-foronecastingdrawing
2	Todeterminesandproperties-Exercise-forstrengths,andpermeability.
3	ToPrepareMouldforCasting
4	TopreparеabuttjointwiththespecimensbyArcWelding.
5	TojointhesheetsbySpotWeldingoperation.
6	Toperformblanking&piercingoperation.
7	TopreparetheproductbyInjectionMouldingmachine.
	Demonstration Experiments (For CIE) if any
8	TopreparetheproductbyBlowMouldingmachine.
9	Design&processingofICEnginecomponentsby3Dprinting
10	TojointhespecimensbyTIGweldingprocess.

Course outcomes (Course Skill Set):

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

1. Learnaboutpatternsandcastingofmetals.
2. UnderstandtheconceptofArc,Spot,TIGweldingandbrazingprocess.
3. UnderstandtheProcessof simple,compoundandprogressive pressandHydraulicpress

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 50% of the maximum marks. A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 40% of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with an observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- **Total marks scored by the students are scaled down to 30 marks** (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 01 tests for 100 marks, test shall be conducted after the 14th week of the semester.
- In test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability.
- **The test marksis scaled down to 20 marks** (40% of the maximum marks).

The Sum of **scaled-down** marks scored in the report write-up/journal and marks of test is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University.

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure

and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

- MetalCuttingPrinciples-M.C.Shaw-OxfordPublication–1985.
- FundamentalsofmetalcuttingMachineTools-byB.L.Juneja&G.S–Sekhar-WileyEastern.
- MetalCutting-V.C.Venkatesh&S.Chandrasekhanan-PanticeHall–1991.
- Metal Cutting- Dr.B.J.Ranganath-VikasPublications

Ability/Skill Enhancement Course			
Nano Technology		Semester	
Course Code	**MMPE258A**	CIE Marks	50
Teaching Hours/Week (L:T:SDA)	00:02/01:00	SEE Marks	50
Total Hours of Pedagogy	30/15	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- To provide an intensive and in-depth learning to the students in field of Nanotechnology.
- Beyond simulating, learning, understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today scientific and changing business world.
- To develop awareness & knowledge of different organization requirement and subject knowledge through varied subjects and training methodology in students.
- To train the students to take up wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Module-1

Metal based nanocomposites- Metal-Oxide or Metal-Ceramic composites, Different aspects of their preparation techniques and their final properties and functionality. Metal-metal nanocomposites, some simple preparation techniques and their new electrical and magnetic properties

Module-2

Design of Super hard materials- Super hard nanocomposites, its designing and improvements of mechanical properties.

Nanofiller synthesis - applications, Polymer nanocomposites, particulate and fibre modified nano composites, matrices and fibres, polymer- filler interphase, pull- out strength, effect of various treatments

Module-3

Mechanics of polymer nanocomposites, Interfacial adhesion and characterisation, factors influencing the performance of nanocomposites, physical and functional properties. Nano composite fabrication, matrices, methods, additives, moulding processes.

Module-4

Polymer-carbon nano tubes based composites-processing methods and characterization using OM, SEM, XRD, TEM

Module-5

Characterization of Polymer nanotubes based composites for Mechanical, Electrical and Thermal Properties and their applications - Polymer / nanofillers (metallic nanopowders) systems, Rheological measurements, processing characteristics. Testing of nanocomposites, ThermalanalysissuchasTGA,TMA,DSC,DMTA.

Course outcome (Course Skill Set)

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

1. Understand the synthesis, properties, and applications of metal-based and polymer nanocomposites.
2. Analyze the mechanical, electrical, and thermal behavior of nanocomposites through characterization techniques.
3. Apply processing methods and testing techniques to evaluate the performance of polymer-based nanocomposites.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. **Polymer Science and Technology**-JoelR. Fried-Prentice-Hall, Inc. Englewood Cliffs, N. J., USA - 2000.
2. **New Developments and Technology** -Hand book of Elastomers - (Eds. A. K.Bhowmic and H. C. Stephense), Marcel - Dekker Inc., New York - 1995.
3. **Polymer Blends**-D.R.PaulandS.Newman-AcademicPress, New York - 1978.
4. **Polymer Science** -FredW.Billimeyer,Jr-WileyInterscience Publication – thirdedition , 1994

Web links and Video Lectures (e-Resources):

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

Ability/Skill Enhancement Course			
Smart Materials		Semester	
Course Code	**MMPE258B**	CIE Marks	50
Teaching Hours/Week (L:T:SDA)	00:02/01:00	SEE Marks	50
Total Hours of Pedagogy	30/15	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- Learn about composite materials, smart materials, their properties, classification and applications
- Understand types of smart material based on their electrical and magnetic properties
- Characterize piezoelectric, ferroelectric and multi-ferroic materials,
- Identify novel functions of smart materials,
- Apply the acquired knowledge of smart materials in different applications
- Evaluate the importance of smart materials in day-to-day life.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Module-1

Introduction: Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Shape Memory Alloys: Introduction, Phenomenology, and Influence of stress on characteristic temperatures. Vibration control through shape memory alloys.

Module-2

Electro rheological and Magneto rheological Fluids: Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others).

Module-3

Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations. Biomimetics: Characteristics of Natural structures.

Module-4

MEMS: History of MEMS, Intrinsic Characteristics, Devices: Sensors and Actuators. Micro fabrication: Photolithography, Thermal oxidation, Thin film deposition, etching types, Doping, Dicing, Bonding. Microelectronics fabrication process flow.

Module-5

Polymer MEMS& Micro fluidics: Introduction, Polymers in MEMS (Polyimide, SU8, LCP, PDMS, PMMA, Parylene, Others) Applications(Acceleration, Pressure, Flow, Tactile sensors).Motivation for micro fluidics, Biological Concepts, Design and Fabrication of Selective components. Channels and Valves.

Course outcome (Course Skill Set)

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

- Understand the principles, properties, and applications of smart materials like shape memory alloys, piezoelectrics, and magneto-rheological fluids.
- Analyze vibration control techniques, biomimetic structures, and their applications in smart systems.
- Apply MEMS and microfluidics concepts in designing sensors, actuators, and advanced smart structures.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. "Smart Structures –Analysis and Design", A.V.Srinivasan, CambridgeUniversityPress,NewYork,2001,(ISBN:0521650267).
2. "Smart Materials and Structures", M.V.Gandhi and B.S.Thompson Chapmen & Hall, London, 1992 (ISBN:0412370107
3. Duerig,T. W., Melton, K. N, Stockel, D. and Wayman, C.M., "Engineering aspects ofShapememory Alloys", Butterworth – Heinemann, 1990.
4. Rogers,C.A., Smart Materials ,"Structures and Mathematical issues", Technomic Publishing Co., U.S.A, 1989.
5. MelSchwartz(Ed), Encyclopaedia of Smart Materials" Volume –I and II, John Wiley &Sons, Inc.2002

Web links and Video Lectures (e-Resources):

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

Ability/Skill Enhancement Course			
Precision Engineering		Semester	
Course Code	**MMPE258C**	CIE Marks	50
Teaching Hours/Week (L:T:SDA)	00:02/01:00	SEE Marks	50
Total Hours of Pedagogy	30/15	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- A basic understanding of Precision Engineering, its machines and the different techniques of super finishing.
- To learn the calculation of allowances, tolerances and DOE techniques.
- To learn about tool materials and its different coating methods for Precision Machining.
- To learn the techniques used for quality control and quality improvement and the different quality standards.
- To learn the importance of reliability concepts and a modern quality systems.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Module-1

Concepts Of Accuracy And MachineTools: Part Accuracy – errors, accuracy of machine tools – spindle accuracy – displacement accuracy – errors due to numerical interpolation – definition of accuracy of N.C system –errors in the NC machines– feed stiffness – zero stability

Module-2

Stiffness,ThermalEffectsAndFinishMachining: Overall stiffness of Lathe – compliance of work piece – errors caused by cutting forces – deformation in turning – boring – milling – heat sources – thermal effects – Finish Turning, boring, grinding – Surfaceroughness

Module-3

Dimensioning: Definition of terms–Key dimension– Superfluous dimension – dimensional stepped shaft – Assigning tolerances in the constituent dimensions–dimensional chains.

Module-4

Micro-Machining Micro-Fabrication: Micro Machining–Photo resist process–Lithography–LIGA Process– Optical, processing of materials–electron beam machining–beam machining–micro forming, diamond turning–micro positioning devices – etching – physical vapour deposition – Chemical vapour deposition.

Module-5

SmartStructures,MaterialsAndMicroActuators: Smart structures – Smart materials types and applications – smart sensors – micro valves –MEMS – Micro motors – Micropumps– micro dynamo meter– micro machines– micro optics–micro nozzles

Course outcome (Course Skill Set)

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

- Analyze machine tool accuracy, errors, and factors affecting precision in NC systems.
- Evaluate the effects of stiffness, thermal influences, and machining forces on dimensional accuracy and surface finish.
- Understand micro-machining, smart materials, and MEMS-based micro-actuators for advanced manufacturing applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Murthy R.L.,"Precision Engineering in Manufacturing", New Age International Pvt, 2005.
2. JuliarW. Gardner.VijayK.Varadan,"Microsensors, MEMS and Smart Devices", John Wiley and sons, 2001.
3. StephenA. Campbell,"The Science and Engineering of Microelectronic Fabrication",OxfordUniversityPress,1996.
4. RaadyFrank, "Understanding Smart Sensors", Artech.House, Boston, 1996.
5. MEMSHandBook,CRCPress,2001.

Web links and Video Lectures (e-Resources):

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

Ability/Skill Enhancement Course			
Advanced Processing of Materials		Semester	
Course Code	**MMPE258D**	CIE Marks	50
Teaching Hours/Week (L:T:SDA)	00:02/01:00	SEE Marks	50
Total Hours of Pedagogy	30/15	Total Marks	100
Credits	01	Exam Hours	1 Hour
Examination type (SEE)	**MCQ**		

Course objectives:

- Impart knowledge to students in the latest technological topics on Production and Industrial Engineering and to provide them with opportunities in taking up advanced topics in the field of study.
- Create a congenial environment that promotes learning, growth and imparts ability to work with multi-disciplinary groups in professional, industry and research organizations.
- Broaden and deepen their capabilities in analytical and experimental research methods, analysis of data and drawing relevant conclusions for scholarly writing and presentation.
- Provide guidance to students for their choices in research and professional career outlook and to encourage students to take up research.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

Module-1

Casting Process: Introduction, various manufacturing processes, convectional casting processes, special casting processes, squeeze casting processes, foam casting, melting processes, Types of furnace, melting using cupola furnace, Resistance furnace, Induction furnace.

Module-2

Powder Metallurgy Process: Introduction, benefits of power metallurgy process, limitations and applications of process, flow chart of process, various methods of production of powder, powder treatment, powder characteristics, compaction of powder and its methods, pre-sintering, operation before sintering, sintering.

Module-3

Advance Processing and Forming: Introduction: abrasive finishing, Chemical mechanical polishing (CMP) technology, photochemical machining, high voltage forming of metal, explosive forming or fabrication, Electrochemical hydraulic forming, magnetic pulse forming

Module-4

Mechanical Alloying: Introduction and process of mechanical alloying, milling parameters in mechanical alloying, material synthesizing using mechanical alloying, phase formed in mechanical alloying.

Module-5

Metal injection moulding (MIM) and self-propagating high temperature synthesis processes: Introduction, steps in MIM, Advantages and requirements of MIM, materials processes of MIM.

Course outcome (Course Skill Set)

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

- Understand various casting, powder metallurgy, and advanced forming processes used in manufacturing.
- Analyze mechanical alloying, its process parameters, and material synthesis applications.
- Apply metal injection molding (MIM) and high-temperature synthesis techniques in industrial applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). The student is declared as a pass in the course if he/she secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of the 01 marks. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

- Modern machining processes by PC Pandey and shah, Tata Mc Grew Hill, New Delhi.
- Principles of materials science and engineering by WFSMITH, Tata Mc Grew Hill
- Manufacturing engineering and technology by Kalpakjain

Web links and Video Lectures (e-Resources):

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