BIRLA INSTITUTE OF TECHNOLOGY

CHOICE BASED CREDIT SYSTEM (CBCS) CURRICULUM

(Effective from Academic Session: Monsoon 2018)

B.TECH IN PRODUCTION ENGINEERING

PRODUCTION AND INDUSTRIAL ENGINEERING DEPARTMENT

Institute Vision

To become a Globally Recognised Academic Institution in consonance with the social, economic and ecological environment, striving continuously for excellence in education, research, and technological service to the National needs.

Institute Mission

- To educate students at Under Graduate, Post Graduate, Doctoral, and Post-Doctoral levels to perform challenging engineering and managerial jobs in industry.
- To provide excellent research and development facilities to take up Ph.D programmes and research projects.
- To develop effective teaching learning skills and state of art research potential of the faculty.
- To build national capabilities in technology, education, and research in emerging areas.
- To provide excellent technological services to satisfy the requirements of the industry and overall academic needs of society.

Department Vision:

To become a Centre of Repute striving continuously towards providing Quality Education, Research and Innovation in the field of Production Engineering

Department Mission

- To provide quality education at both undergraduate and post graduate levels
- To provide opportunities and facilities for research and innovation
- To produce engineering graduates to meet the demands of manufacturing industries and R&D organizations
- To emphasize on integrating manufacturing technology with management
- To impart latest technological knowledge to students by continuous development of curricula and faculty

Graduate Attributes

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

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

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

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

5. **Modern Tool Usage**: Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

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

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

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

9. **Individual and Team Work**: Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

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

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

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

Programme Educational Objectives (PEOs)

PEO 1: Developing capability for continuous learning and problem identification in the field of Production and Industrial Engineering

PEO 2: To be more explorative in finding state-of-art solutions and implementations for complex real-life problems

PEO 3: Inculcating managerial aptitude for communication, problem solving and decision making

PEO 4: To enhance inter-personal skill, team spirit and employability while believing on the ethical values

PEO 5: To develop a strong foundation for building an engineering career with societal and humanitarian responsibility

(A) Programme Outcomes (POs)

Engineering Graduates will be able to:

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

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

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

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

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

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

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

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

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

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

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

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

(B) Programme Specific Outcomes (PSOs)

13. **PSO 1:** To empower with comprehensive knowledge in the wide domain of sciences of manufacturing, technologies for present and future industries and operations management while emphasizing professional ethics and societal responsibility to face the evolution in industry.

14. **PSO 2:** To develop expertise in solving complex technical or managerial problems related to industries through innovative solutions using technological skills, analytical aptitude, communication flair and team spirit.

15. **PSO 3:** Enable to apply the attained theoretical and practical knowledge to solve the industrial and societal problems in the broad areas of production and industrial engineering.

PROGRAMME COURSE STRUCTURE

DEPARTMENT OF PRODUCTION AND INDUSTRIAL ENGINEERING

Course Structure - Based on CBCS system & OBE model

Recommended scheme of study

(B. TECH in PRODUCTION ENGINEERING)

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**
	THEORY							
FIRST Monsoon	**FIRST**	**FS** *Foundation Sciences*	MA103	Mathematics - I	3	1	0	4
			PH113	Physics	3	1	0	4
		GE *General Engineering*	EE101	Basics of Electrical Engineering	3	1	0	4
			CS101	Programming for Problem Solving	3	1	0	4
	LABORATORIES							
	FIRST	**FS**	PH114	Physics Lab	0	0	3	1.5
		GE	CS102	Programming for Problem Solving Lab	0	0	3	1.5
		GE	PE101	Workshop Practice	0	0	3	1.5
		MC Mandatory Course	MC101/102/103/ 104	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
TOTAL								**21.5**
SECOND Spring	**THEORY**							
	FIRST	**FS**	MA107	Mathematics - II	3	1	0	4
			CH101	Chemistry	3	1	0	4
		GE	ME101	Basics of Mechanical Engineering	3	1	0	4
			EC101	Basics of Electronics & Communication Engineering	3	1	0	4
	LABORATORIES							
	FIRST	**FS**	CH102	Chemistry Lab	0	0	3	1.5
		GE	EC102	Electronics & Communication Lab	0	0	3	1.5
			ME102	Engineering Graphics	0	0	4	2
		MC	MC105/106/107/ 108	Choice of: NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
TOTAL								**22**
GRAND TOTAL FOR FIRST YEAR								**43.5**

THIRD Monsoon	**THEORY**							
	SECOND	**FS**	MA203	Numerical Methods	2	0	0	2
	FIRST		CE101	Environmental Sciences	2	0	0	2
	SECOND	**PC** ***Programme Core***	PE201	Metallurgy	3	0	0	3
			ME203	Fluid Mechanics and Hydraulic Machines	3	0	0	3
			ME205	Strength of Materials	3	1	0	4
			PE203	Operations Research	3	0	0	3
	LABORATORIES							
	SECOND	**GE**	IT202	Basic IT Workshop	0	0	2	1
		FS	MA204	Numerical Methods Lab	0	0	2	1
		PC	PE202	Metallurgy Lab	0	0	3	1.5
			ME204	Mechanical Engineering Lab - I	0	0	3	1.5
		MC	MC201/202/203/204	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
TOTAL								**23**
FOURTH Spring	**THEORY**							
	SECOND	**GE**	IT201	Basics of Intelligent Computing	3	0	0	3
	FIRST	**FS**	BE101	Biological Sciences for Engineers	2	0	0	2
	SECOND	**PC**	PE204	Manufacturing Processes - I	3	0	0	3
			PE206	Metrology & Measurement	3	0	0	3
			ME207	Kinematics and Dynamics of Machines	3	0	0	3
		PE ***Programme Elective***		Programme Elective - I	3	0	0	3
	LABORATORIES							
	FIRST	**GE**	EE102	Electrical Engineering Lab	0	0	3	1.5
	SECOND	**PC**	PE205	Manufacturing Processes - I Lab	0	0	3	1.5
			PE207	Metrology & Measurement Lab	0	0	3	1.5
		MC	MC205/206/207/208	Choice of : NCC/NSS/ PT & Games/ Creative Arts (CA)	0	0	2	1
								22.5
FIFTH Monsoon	**THEORY**							
	FIRST	**HSS** ***Humanities & Social Sciences***	MT123	Business Communications	2	0	2	3
	THIRD	**PC**	PE301	Manufacturing Processes - II	3	0	0	3
			PE303	Design of Machine Elements	3	1	0	4
			PE304	Production & Operations Management	4	0	0	4
		PE		Programme Elective - II	3	0	0	3
		OE ***Open Elective***		Open Elective - I	3	0	0	3
	LABORATORIES							
	THIRD	**PC**	PE302	Manufacturing Processes - II Lab	0	0	3	1.5
			PE305	Computer Aided Design and Drafting Lab	0	0	3	1.5
TOTAL								**23**

SIXTH Spring	**THEORY**							
	THIRD	**PC**	PE311	Machine Tool Design	3	1	0	4
			PE313	Tool Design	3	1	0	4
			PE314	Statistical Quality Control	3	0	0	3
			PE315	Work Study & Ergonomics	3	0	0	3
		PE		Programme Elective - III	3	0	0	3
		OE		Open Elective - II	3	0	0	3
		MC	MC300	Summer Training	NA	NA	NA	3
	LABORATORIES							
	THIRD	**PC**	PE312	Machine Tool Design Sessional	0	0	3	1.5
			PE316	Work Study & Ergonomics Lab.	0	0	3	1.5
TOTAL								**26**
THEORY								
SEVENTH Monsoon	**FOURTH**	**HSS**	MT130	Professional Practice, Law & Ethics	2	0	0	2
		PC	PE402	Automation in Manufacturing	3	0	0	3
		PE		Programme Elective - IV	3	0	0	3
		OE		Open Elective - III / MOOC-I	3	0	0	3
				Open Elective - IV / MOOC-II	3	0	0	3
	SECOND	**MC**	MT204	Constitution of India	2	0	0	NIL
	LABORATORIES							
	FOURTH	**PC**	PE403	Automation in Manufacturing Lab	0	0	3	1.5
			PE404	Modelling and Simulation Lab	0	0	3	1.5
TOTAL								**17**
EIGTH Spring	**FOURTH**		PE400	**Research Project / Industrial Internship**	**Total**			**12**
GRAND TOTAL *Minimum requirement for Degree award*								**167**

DEPARTMENT OF PRODUCTION AND INDUSTRIAL ENGINEERING PROGRAMME ELECTIVES (PE)**								
LEVEL		**Course Code**	**Name of the PE courses**	**Prerequisites courses with code**	**L**	**T**	**P**	**C**
SECOND	**PE - I** **(Any one)** *(Industrial Engineering and Management)*	PE208	Project Engineering	None	3	0	0	3
		PE209	Engineering Economy, Costing and Accounting	None	3	0	0	3
		PE210	Reliability and Maintenance Engineering	None	3	0	0	3
THIRD	**PE - II** **(Any one)** *(Industrial Engineering and Management)*	PE306	Advanced Operations Research	PE 203 Operations Research	3	0	0	3
		PE307	Competitive Manufacturing Strategies	None	3	0	0	3
		PE308	Logistics and Supply Chain Management	PE 203 Operations Research	3	0	0	3
	PE - III **(Any one)** *(Advanced Manufacturing Technology)*	PE317	Advanced Welding Technology	PE 201 Metallurgy, PE 204 Manufacturing Processes - I	3	0	0	3
		PE318	Rapid Prototyping and Tooling	None	3	0	0	3
		PE319	Material Deformation Processes	PE 204 Manufacturing Processes - I, ME 205 Strength of Materials	3	0	0	3
		PE324	Surface Engineering and Laser Additive Manufacturing	None	3	0	0	3
FOURTH	**PE - I V** **(Any one)** *(Advanced Manufacturing Technology)*	PE405	Manufacturing Science	PE 204 Manufacturing Processes - I, PE 301 Manufacturing Processes - II	3	0	0	3
		PE406	Non-conventional Machining Processes	None	3	0	0	3
		PE407	Advanced Manufacturing Processes	PE 204 Manufacturing Processes - I, PE 301 Manufacturing Processes - II	3	0	0	3

**** PROGRAMME ELECTIVES TO BE OPTED ONLY BY THE B.TECH IN PRODUCTION ENGINEERING STUDENTS**

DEPARTMENT OF PRODUCTION AND INDUSTRIAL ENGINEERING OPEN ELECTIVES (OE)*								
SEMESTER / SESSION OF STUDY	**LEVEL**	**Code no.**	**Name of the OE courses**	**Prerequisites courses with code**	**L**	**T**	**P**	**C**
FIFTH / Monsoon	**SECOND**	PE211	Engineering Economy	None	3	0	0	3
SIXTH / Spring	**THIRD**	PE309	Project Management	None	3	0	0	3

*** OPEN ELECTIVES TO BE OFFERED TO THE STUDENTS OF OTHER DEPT.**

DEPARTMENT OF PRODUCTION AND INDUSTRIAL ENGINEERING
IN-DEPTH SPECIALISATION in "Advanced Manufacturing and Production Management"
(OFFERED ONLY TO THE B.TECH IN PRODUCTION ENGINEERING 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**	PE310	Industrial Robotics	3	1	0	4
			PE320	Sustainable Manufacturing	3	0	0	3
TOTAL								**7**
SIXTH / Spring	**THEORY**							
	THIRD	**PC**	PE321	Manufacturing Management and Cost Optimization	3	0	0	3
		PE (any one)	PE322	Processing of Polymers, Composite and Advanced Materials	3	0	0	3
			PE323	Material Characterisation and Non-destructive Testing	3	0	0	3
TOTAL								**6**
SEVENTH / Monsoon	**THEORY**							
	FOURTH	**PC**	PE408	Micro and Nano Manufacturing	3	0	0	3
			PE409	Finite Elements in Manufacturing Engineering Applications	3	1	0	4
TOTAL								**7**
GRAND TOTAL								**20**

DEPARTMENT OF PRODUCTION AND INDUSTRIAL ENGINEERING
MINOR in "Production Engineering"
(OFFERED ONLY TO OTHER THAN B.TECH IN PRODUCTION ENGINEERING STUDENTS)

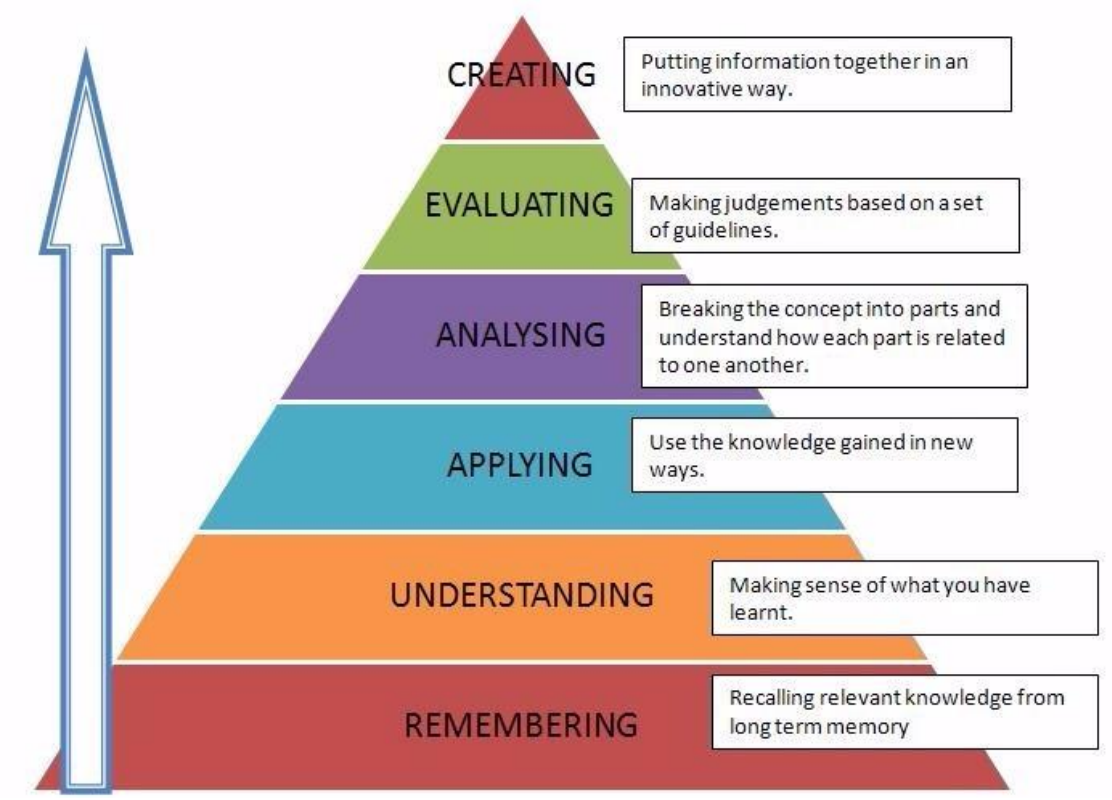
Students who have registered for B. Tech Minor in Production Engineering should complete 20 credits and shall opt for courses listed below. The credits shall be over and above minimum requirement for degree award.

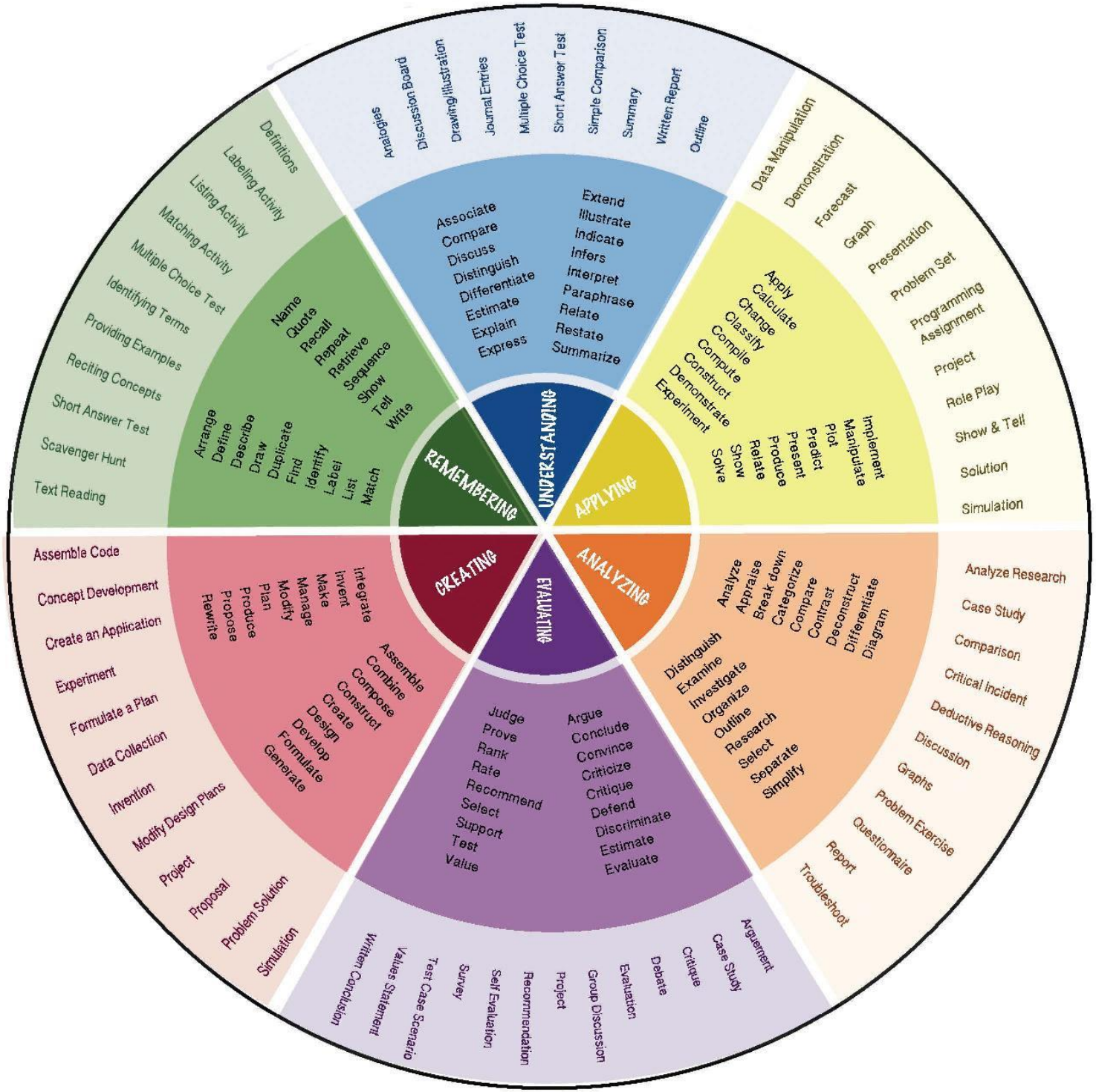
Semester/ Session of Study (Recommended)	Course Level	Category of course	Course Code	Courses	Prerequisites courses with code	Mode of delivery & credits *L-Lecture; T-Tutorial; P-Practicals*			Total Credits *C-Credits*
						L (*Periods/week*)	**T *(Periods/week)***	**P *(Periods/week)***	**C**
FIFTH / Monsoon	**THEORY**								
	SECOND	**PC**	PE203	Operations Research	Nil	3	0	0	3
	SECOND	**PE (any one)**	PE213	Manufacturing Processes	Nil	3	0	0	3
	THIRD		PE307	Competitive Manufacturing Strategies	Nil	3	0	0	3
TOTAL									**6**
SIXTH / Spring	**THEORY**								
	SECOND	**PC**	PE206	Metrology & Measurement	Nil	3	0	0	3
	THIRD	**PE (any one)**	PE318	Rapid Prototyping and Tooling	Nil	3	0	0	3
			PE314	Statistical Quality Control	Nil	3	0	0	3
			PE308	Logistics and Supply Chain Management	PE203 Operations Research	3	0	0	3
	LABORATORY								
	SECOND	**PC**	PE207	Metrology & Measurement Lab	(Co-requisite PE206)	0	0	3	1.5
TOTAL									**7.5**
SEVENTH / Monsoon	**THEORY**								
	THIRD	**PC**	PE304	Production & Operations Management	Nil	4	0	0	4
	LABORATORY								
	FOURTH	**PC**	PE404	Modelling and Simulation Lab	Nil	0	0	3	1.5
	PROJECT								
	FOURTH	**PC**	PE450	Mini Project		0	0	2	1
TOTAL									**6.5**
GRAND TOTAL									**20**

BLOOM'S TAXONOMY FOR CURRICULUM DESIGN AND ASSESSMENT:

Preamble

The design of curriculum and assessment is based on Bloom's Taxonomy. A comprehensive guideline for using Bloom's Taxonomy is given below for reference.




REMEMBERING
UNDERSTANDING
APPLYING
ANALYZING
EVALUATING
CREATING
Definitions
Labeling Activity
Listing Activity
Matching Activity
Multiple Choice Test
Identifying Terms
Providing Examples
Reciting Concepts
Short Answer Test
Scavenger Hunt
Text Reading
Name
Quote
Recall
Repeat
Retrieve
Sequence
Show
Tell
Write
Arrange
Define
Describe
Draw
Duplicate
Find
Identify
Label
List
Match
Analogies
Discussion Board
Drawing/Illustration
Journal Entries
Multiple Choice Test
Short Answer Test
Simple Comparison
Summary
Written Report
Outline
Associate
Compare
Discuss
Distinguish
Differentiate
Estimate
Explain
Express
Extend
Illustrate
Indicate
Infers
Interpret
Paraphrase
Relate
Restate
Summarize
Data Manipulation
Demonstration
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Modify Design Plans
Project
Proposal
Problem Solution
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Rewrite
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Compose
Construct
Create
Design
Develop
Formulate
Generate
Analyze
Appraise
Break down
Categorize
Compare
Contrast
Deconstruct
Differentiate
Diagram
Distinguish
Examine
Investigate
Organize
Outline
Research
Select
Separate
Simplify
Analyze Research
Case Study
Comparison
Critical Incident
Deductive Reasoning
Discussion
Graphs
Problem Exercise
Questionnaire
Report
Troubleshoot
Judge
Prove
Rank
Rate
Recommend
Select
Support
Test
Value
Argue
Conclude
Convince
Criticize
Critique
Defend
Discriminate
Estimate
Evaluate
Written Conclusion
Values Statement
Test Case Scenario
Survey
Self Evaluation
Recommendation
Project
Group Discussion
Evaluation
Debate
Critique
Case Study
Argument

As appro

COURSE INFORMATION SHEET

Course code: PE 101
Course title: WORKSHOP PRACTICE
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: I or II / First
Branch: All
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Familiarize with the basic manufacturing processes.
2	Impart knowledge and skill to use tools, machines, equipment, and measuring instruments.
3	Practice on manufacturing of components using workshop trades.
4	Educate students of safe handling of machines and tools.
5	Exercise individual as well as group activity with hands-on training in different workshop trades.

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

CO1	Be conversant with the basic manufacturing processes.
CO2	Identify and apply suitable tools and instruments for machining, welding, fitting, carpentry, foundry and forging.
CO3	Manufacture different components using various workshop trades.
CO4	Take safety and precautionary measures of self and machines during operations.
CO5	Develop skills to work as an individual or in a team during trade practices.

SYLLABUS

LIST OF EXPERIMENT:

MACHINE SHOP

1. **EXPERIMENT – I: Center Lathe**
   Objective: To study lathe machine and to machine a given job on center lathe as per drawing.

2. **MACHINE SHOP**

   EXPERIMENT-II: Shaper Machine

   Objective: To study Shaper machine and to machine a given job on shaper as per drawing.

3. **CARPENTRY SHOP**

   EXPERIMENT-I: Carpentry Tools and Instruments

   Objective: To study the various tools, instruments and equipment used in carpentry practice.

4. **CARPENTRY SHOP**

   EXPERIMENT-II: Carpentry Practice

   Objective: To perform the carpentry work by making a wooden job using different tools.

5. **FITTING SHOP**

   EXPERIMENT-I: Fitting Tools and Measuring Instruments

   Objective: To study the various tools used in fitting shop and perform fitting operations (like marking, chipping, hack-sawing, filing, drilling etc.)

6. **FITTING SHOP**

   EXPERIMENT-II: Fitting Assembly Practice

   Objective: To make a job clamping plate as per given drawing by fitting operations and to check for its assembly with a given component.

7. **FORGING SHOP**

   EXPERIMENT-I: Forging Tools

   Objective: To study different tools and equipment used in hand forging practice.

8. **FORGING SHOP**

   EXPERIMENT-II: Forging Practice

   Objective: To learn about hand forging practice by making a job (make a square bar from round blank and bend it at a sharp corner of 90 degree as per drawing).

9. **FOUNDRY SHOP**

   EXPERIMENT-I: Green Sand Moulding

   Objective: To get acquainted with various tools and equipment used in making green sand mould (to practice green sand mould making with single piece pattern).

10. **FOUNDRY SHOP**

    EXPERIMENT-II: Aluminium Casting

    Objective: To get acquainted with melting and pouring of metal in a mould (given two-piece patterns of handle) and to make aluminium casting.

11. WELDING SHOP

EXPERIMENT-I: Manual Metal Arc Welding

Objective: To study arc welding processes including arc welding machines (AC & DC), electrodes and equipment. To joint two pieces of given metal by arc welding process.

12. WELDING SHOP

EXPERIMENT-II: Gas Welding

Objective: To study gas welding processes including types of flames produced, filler metals and fluxes etc. To joint two pieces of given metal by gas welding process.

Books recommended:

TEXT BOOK

1. S K Hajra Choudhury, A K. Hajra, "Elements of Workshop Technology: Vol- I and Vol -II", Media Promotors Pvt Ltd. **(T1)**
2. B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

EFERENCE BOOK

1. P.N. Rao, "Manufacturing Technology Vol-1and Vol-II", Tata McGraw Hill. **(R1)**
2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

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:

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√	√		
Quiz 2	√	√	√		
Viva-voce	√	√	√	√	
Examination: Experiment Performance	√	√	√	√	√

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	2	2				1					2	3	2	2
CO2	3	1	2									1	3	2	3
CO3	3	2	2	1								2	2	2	3
CO4	2					2						1	1	1	2
CO5	2	2	2	1		1			3	1		1	2	2	2

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, CD3, CD6
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD3
CO5	CD3

COURSE INFORMATION SHEET

Course code: PE 201
Course title: METALLURGY
Pre-requisite(s): Nil
Co- requisite(s): PE 202 METALLURGY LAB
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B.Tech
Semester / Level: III / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students:

1	Examine the properties and structures of materials and get acquainted with steel making processes
2	Construct the Iron carbon equilibrium diagram and differentiate amongst its various phases
3	Analyse the transformation curve of steel and select the appropriate heat treatment process based upon its application
4	Define various nonferrous alloys and study their properties
5	Understand the concept of various conventional and modern methods of testing material properties and their crystal structures

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

CO1.	Analyse and select various engineering materials for various purposes and describe the iron and steel making processes
CO2.	Explain the iron carbon equilibrium diagram and effects of alloying elements on steel
CO3.	Describe the TTT curve and heat treatment processes of steel
CO4.	Identify the different types of non-ferrous alloys and explain its properties
CO5.	Apply and explain various methods of material testing procedures

SYLLABUS

Module 1: Introduction to Material Science and Metallurgy [8]
Review of Engineering and industrial materials – their classification and application, Crystalline structure of materials, Dislocation mechanism, Grains and Grain structure, Brief description of iron and steel making – Raw materials Principles and processes

Module 2: Phase Diagrams and Fe-C equilibrium Diagram [10]
Isomorphous, eutectic and peritectic systems, Iron – Carbon equilibrium diagram, classification of steels, effect of alloying elements on steels.

Module 3: Transformation Curve and Heat Treatment Methods [10]

Isothermal decomposition of austenite (TTT Curve), recovery, recrystallisation and grain growth, strain hardening mechanism, transformation of austenite upon continuous cooling, annealing, normalizing, hardening, tempering, hardenability of steel, Jominey hardening test, end quench test, surface hardening, case hardening

Module 4: Types of Alloys and applications [6]

Grey iron, S.G. Iron, white iron, malleable iron. Non-Ferrous Metals, Alloys composition-properties and applications of copper, nickel, lead, tin, zinc, aluminium, Mg and Ti alloys-Heat treatment of Non-Ferrous alloy, Non-Metallic Materials and alloys.

Module 5: Material Testing methods [6]

Testing of Materials-Tensile testing, Compression testing, Hardness testing, Impact testing, Fatigue testing, Creep, Basic principle of XRD, SEM, TEM

Text Books:

1. V. Raghvan, Material Science and Engineering, Prentice Hall India **(T1)**
2. William Callister, Materials Science and Engineering, Wiley Publication **(T2)**
3. Physical Metallurgy, Y. Lakhtin, CBS Publishers India **(T3)**
4. Vijendra Singh, Physical Metallurgy, Standard Publishers **(T3)**

Reference Books:

1. George Dieter, Physical Metallurgy, McGraw Hill Education (**R1)**
2. B.D. Cullity, Elements of X Ray Diffraction, Pearson Education (**R2)**

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

Study of Advanced Materials, Nano Materials, Non-Destructive Testing methods

POs met through Gaps in the Syllabus:

PO 1-5

Topics beyond syllabus/Advanced topics/Design:

Electrical, Optical, Thermal, Magnetic and Electrical properties of materials. Composites, Degradation of Materials, Environmental and Societal Considerations in Material Science. Powder Metallurgy, Plastic Technology.

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	3		2	2		3	2		3	3	3	3
CO2	3	3	3	3	1	2	2			2		3	3	2	3
CO3	3	3	2	3	1	1	1		2			3	3	2	3
CO4	3	3	2	3	2	3	3	1	2		2	2	2	3	3
CO5	3	3	2	3	3	1			2	2		2	2	2	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, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code: PE 202
Course title: METALLURGY LAB
Pre-requisite(s): Nil
Co- requisite(s): PE 201 METALLURGY
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech
Semester / Level: III / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Get acquainted with basics of process metallurgy
2	Impart knowledge and skill to use tools, equipment, and measuring instruments related to metallographic study
3	Analyze microstructure of metals/alloys (ferrous/non-ferrous)
4	Conduct heat treatment processes and analyze various factors related to those processes

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

CO1	Learn how to prepare samples for metallographic study
CO2	Use tools, equipment, and measuring instruments related to metallographic study
CO3	Analyze microstructure of metals/alloys (ferrous/non-ferrous)
CO4	Conduct heat treatment processes and analyze various factors related to those processes

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT 1: Study of metallurgical microscope**
   Objective: To study the working of metallurgical microscope

2. **EXPERIMENT 2: Sample preparation (ferrous alloy) for metallography**
   Objective: To prepare the sample for microstructure study of mild steel specimen containing 0.1% carbon

3. **EXPERIMENT 3: Microstructure study**
   Objective: To Observe the microstructure of mild steel specimen (0.1% Carbon) through metallurgical microscope

4. **EXPERIMENT 4: Effect of quenching media on microstructure**
   Objective: To study the effect of quenching media on the hardness of steel specimens containing 0.2, 0.4, 0.6, 0.8 and 1.0% carbon

i. Heat treatment and cooling in different quenching media viz. furnace cooling, air cooling, water cooling and oil cooling
ii. Observation of the microstructure through metallurgical microscope

5. EXPERIMENT 5: Effect of time of heat treatment on material property
Objective: To study the effect of period of time of heat treatment on the hardness of steel specimens containing 0.2, 0.4, 0.6, 0.8 and 1.0% carbon
i. Calculation of optimum period of heat treatment for maximum hardness
ii. Observation of the microstructure through metallurgical microscope

6. EXPERIMENT 6: Effect of temperature of heat treatment on material property
Objective: To study the effect of temperature on the hardness of steel specimens containing 0.2, 0.4, 0.6, 0.8 and 1.0% carbon
i. Calculation of optimum temperature for heating the steel specimens for maximum hardness
ii. Observation of the microstructure through microscope

7. Experiment 7: Effect of tempering temperature on Steel
Objective: To study the effect of tempering temperature on the properties of water quenched steel

8. Experiment 8: Effect of tempering time on Steel
Objective: To study the effect of tempering time on the properties of water quenched steel

9. Experiment 9: Jominy end-quench test
Objective: To conduct Jominy End Quenching test on a mild steel specimen.

10. Experiment 10: Non-ferrous alloy sample preparation
Objective: To prepare the sample for study of microstructure of Aluminum Alloy.

11. Experiment 11: Non-ferrous alloy microstructure study
Objective: To Observe the microstructure of Aluminum alloy through Metallurgical microscope.

12. Experiment 12: Recent methods for microstructure and materials property analysis
Objective: To Demonstrate the basic principle and working of modern testing methods such as XRD, SEM, TEM

Text Book
1. V. Raghvan, Material Science and Engineering, Prentice Hall India **(T1)**
2. William Callister, Materials Science and Engineering, Wiley Publication **(T2)**
3. Physical Metallurgy, Y. Lakhtin, CBS Publishers India **(T3)**
4. Vijendra Singh, Physical Metallurgy, Standard Publishers **(T4)**

Reference Book
1. George Dieter, Physical Metallurgy, McGraw Hill Education **(R1)**
2. B.D. Cullity, Elements of X Ray Diffraction, Pearson Education **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):
Metallurgy Laboratory experiments are majorly demonstration of different processes. Scope for individual practices are limited.

POs met through Gaps in the Syllabus:
POs 9, 10

Topics beyond syllabus/Advanced topics/Design:
Heat Treatment for non-ferrous metals/alloys, Latest techniques in destructive/non-destructive testing of materials

POs met through Topics beyond syllabus/Advanced topics/Design:
PO 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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√			
Quiz 2			√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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	3				1			1	2	2	3
CO2	2	2		1	3				2			1	2	2	3
CO3	2	1		2	1				2			1	3	2	3
CO4	2	1		3	1				2			1	3	2	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
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD3

COURSE INFORMATION SHEET

Course code: CE 101
Course title: ENVIRONMENTAL SCIENCE
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L:2 T: P:
Class schedule per week: 2
Class: B. Tech
Semester / Level: III / First
Branch: All
Name of Teacher:

Course Objectives:
This course enables the students:

1	To develop basic knowledge of ecological principles and their applications in environment.
2	To identify the structure and composition of the spheres of the earth, the only planet sustaining life.
3	To analyse, how the environment is getting contaminated and probable control mechanisms for them.
4	To generate awareness and become a sensitive citizen towards the changing environment.

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

CO1	Able to explain the structure and function of ecosystems and their importance in the holistic environment.
CO2	Able to identify the sources, causes, impacts and control of air pollution
CO3	Able to distinguish the various types of water pollution happening in the environment and understand about their effects and potential control mechanisms
CO4	Able to judge the importance of soil, causes of contamination and need of solid waste management
CO5	Able to predict the sources of radiation hazards and pros and cons of noise pollution

SYLLABUS

Module 1: Ecosystem and Environment [5]
Concepts of Ecology and Environmental science, ecosystem: structure, function and services, Biogeochemical cycles, energy and nutrient flow, ecosystem management, fate of environmental pollutants, environmental status and reports on climate change.

Module 2: Air Pollution [5]
Structure and composition of unpolluted atmosphere, classification of air pollution sources, types of air pollutants, effects of air pollution, monitoring of air pollution, control methods

and equipment for air pollution control, vehicular emissions and control, indoor air pollution, air pollution episodes and case studies.

Module 3: Water Pollution [5]

Water Resource; Water Pollution: types and Sources of Pollutants; effects of water pollution; Water quality monitoring, various water quality indices, water and waste water treatment: primary, secondary and tertiary treatment, advanced treatments (nitrate and phosphate removal); Sludge treatment and disposal.

Module 4: Soil Pollution and Solid Waste Management [5]

Lithosphere – composition, soil properties, soil pollution, ecological & health effects, Municipal solid waste management – classification of solid wastes, MSW characteristics, collection, storage, transport and disposal methods, sanitary landfills, technologies for processing of MSW: incineration, composing, pyrolysis.

Module 5: Noise pollution & Radioactive pollution [5]

Noise pollution: introduction, sources: Point, line and area sources; outdoor and indoor noise propagation, Effects of noise on health, criteria noise standards and limit values, Noise measurement techniques and analysis, prevention of noise pollution; Radioactive pollution: introduction, sources, classification, health and safety aspects, Hazards associated with nuclear reactors and disposal of spent fuel rods-safe guards from exposure to radiations, international regulation, Management of radioactive wastes.

Text books:

1. A, K. De. (3rd Ed). 2008. Environmental Chemistry. New Age Publications India Ltd. **[T1]**
2. R. Rajagopalan. 2016. Environmental Studies: From Crisis to Future by, 3rd edition, Oxford University Press. **[T2]**
3. Eugene P. Odum. 1971. Fundamentals of Ecology (3rd ed.) -. WB Sunders Company, Philadelphia. **[T3]**
4. C. N. Sawyer, P. L. McCarty and G. F. Parkin. 2002. Chemistry for Environmental Engineering and Science. John Henry Press. **[T4]**
5. S.C. Santra. 2011. Environmental Science. New Central Book Agency. **[T5]**

Reference books:

1. D.W. Conell. Basic Concepts of Environmental Chemistry, CRC Press. **[R1]**
2. Peavy, H.S, Rowe, D.R, Tchobanoglous, G. Environmental Engineering, Mc-Graw - Hill International **[R2]**
3. G.M. Masters & Wendell Ela. 1991. Introduction to Environmental Engineering and Science, PHI Publishers. **[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:

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		1	3			1	3						1	1	1
CO2		1	3			1	3						2	1	2
CO3		1	3			1	3						2	1	2
CO4		1	3			1	3						2	1	2
CO5		1	3			1	3						2	1	2

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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: MA 203
Course title: NUMERICAL METHODS
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L: 2 T:0
Class schedule per week: 2
Class: B. Tech
Semester / Level: III / Second
Branch: All
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Derive appropriate numerical methods to solve algebraic and transcendental equations
2	Derive appropriate numerical methods to solve linear system of equations
3	Approximate a function using various interpolation techniques
4	Find the numerical solution of initial value problems and boundary value problems

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

CO1	Solve algebraic and transcendental equation using an appropriate numerical method arising in various engineering problems
CO2	Solve linear system of equations using an appropriate numerical method arising in computer programming, engineering problems etc.
CO3	Approximate a function using an appropriate numerical method in various research problems
CO4	Evaluate derivative at a value using an appropriate numerical method in various research problems
CO5	Solve differential equation numerically

SYLLABUS

Module 1: Errors and Nonlinear Equations [5]
Error Analysis: Definition and sources of errors, propagation of errors, floating-point arithmetic, Solution of Nonlinear equations: Bisection method, Regula-Falsi method, Secant method, Newton- Raphson method and its variants, General Iterative method

Module 2: System of Linear Equations [5]
Gauss-Elimination, Gauss-Jordan, LU-Decomposition, Gauss-Jacobi and Gauss- Siedel methods to solve linear system of equations and Power method to find least and largest eigenvalues.

Module 3: Interpolation **[5]**
Lagrange's interpolation, Newton's divided differences interpolation formulas, inverse interpolation, interpolating polynomial using finite differences

Module 4: Differentiation and Integration **[5]**
Differentiation using interpolation formulas, Integration using Newton-Cotes formulas: Trapezoidal rule, Simpson's rule

Module 5: Solution of Ordinary Differential Equations **[5]**
Euler's method, modified Euler's method, Runge - Kutta Methods of second and fourth order to solve initial value problems.

Text books:

1. Jain M.K, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age Publications, 2004. (**T1**)
2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI. .(**T2**)
3. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. (**T3**)

Reference books:

1. S.C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, 1985. (**R1**)
2. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Seventh Edition, 2003. (**R2**)
3. R. W. Hamming: Numerical Methods for Scientists and Engineers, Second Edition, Dover (**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:

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	√	√	√		
End Semester Examination	√	√	√	√	√
Quiz (zes)	√	√	√		
Assignment	√	√	√	√	

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	2	1	1	1	1	3	3	2	2	1	2	2
CO2	3	2	2	2	1	1	2	1	3	3	2	2	1	2	2
CO3	3	3	2	2	1	1	1	1	3	3	2	2	1	2	2
CO4	2	2	3	1	1	1	1	1	3	3	2	2	1	2	2
CO5	2	2	3	3	1	2	1	1	3	3	2	2	1	2	2

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, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code: PE 203
Course title: OPERATIONS RESEARCH
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: III / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1	Apply the techniques of operations research in industrial engineering problems.
2	Formulate a real-world industrial problem as a mathematical programming model
3	Understand the simplex method for linear programming and perform iterations of it by hand
4	Solve specialized linear programming problems like the transportation and assignment problems
5	Operations research helps in solving problems in different environments that needs decisions, such as sequencing, queuing and games theory.

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

CO1	Understand how to translate a real-world problem, given in words, into a mathematical formulation.
CO2	Formulate and solve engineering and managerial situations as LPP.
CO3	Formulate and solve engineering and managerial situations as transportation and assignment problems
CO4	Apply Sequencing and Queuing theory for performance evaluation of engineering and management system.
CO5	Solve engineering and managerial decision theories problems by Game Theory

SYLLABUS

Module 1: Introduction: **[8]**
Importance of Operation Research, Methodology, Characteristics, Scope, Application and Limitation of Operations Research
Requirement of LP, Basic Assumptions, Mathematical formulation of the of LP, Graphical solution; numerical problems based on these methods.

Module 2: Linear Programming: **[8]**
Analytical Methods Simplex method, Big-M method, concept of duality; numerical problems based on these methods (preferably industrial engineering-based problems)

Module 3: Transportation & Assignment Model [9]

Basic feasible solution by different methods (North west corner method, least cost method, Vogel's approximation method), finding optimal solutions (MODI method), unbalanced transportation problems; numerical problems based on these methods (preferably industrial engineering-based problems)

Balanced and unbalanced assignments, travelling sales man Problem; numerical problems based on these methods (preferably industrial engineering-based problems)

Module 4: Sequencing and Queuing Model [8]

Processing of ***n*** jobs through two machines, processing ***n*** jobs through three machines; Processing of 2 jobs through ***m*** machines –graphical method, numerical problems based on these methods

Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Queuing system and their characteristics of M/M/1/FIFO/ Queuing system

Module 5: Games Theory [7]

Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and sub games methods.

Text books:

1. Operations Research, (Revised Edition), D.S. Hira, P.K. Gupta, S. Chand & Company Ltd, 2014 **[T1]**
2. Quantitative Techniques Vol I and Vol II, L. C. Jhamb, Everest Publishing House **[T2]**
3. Operations Research, - Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons **[T3]**

Reference books:

1. Operations Research an Introduction –Hamady A. Taha, Prentice Hall. **[R1]**
2. Introduction to Operations Research, 9e, Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu, McGraw Hill **[R2]**

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

Revised Simplex, Integer programming, other queuing models, Decision theory, Goal programming, Dynamic programming, Non-linear programming and Simulation. These topics are to be covered in an advanced course.

POs met through Gaps in the Syllabus:

POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:

Advanced Operation Research

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

POs 1, 3, 5, 7, 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	√	√			
Quiz1	√	√			
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	3	3	3	3
CO2	3	3	3	1		1	1	1	2		2	2	3	2	3
CO3	3	3	2			1	1		2		1	3	3	2	3
CO4	3	2	1			1	1	1	2		2	2	3	3	3
CO5	3	2	1			1			2		2	2	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, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course code: ME 203
Course title: FLUID MECHANICS AND HYDRAULIC MACHINES
Pre-requisite(s): BASIC OF PHYSICS, CHEMISTRY AND MATHEMATICS
Co- requisite(s): Nil
Credits: 3 L:3, T: 0, P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: III / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students:

1	To present a comprehensive and rigorous treatment of classical fluid mechanics while retaining an engineering perspective.
2	To lay the groundwork for subsequent studies in such fields as analysis of various fluid flow devices and energy conversion systems and to prepare the students to effectively use Fluid mechanics theory in the practice of engineering.
3	To develop an intuitive understanding of Fluid mechanics by emphasizing the engineering and engineering arguments.
4	To present a wealth of real-world engineering examples to give students a feel for how Fluid mechanics is applied in engineering practice.

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

CO1	Outline the concepts of continuum, system of control volume, fluid and flow properties.
CO2	Apply the appropriate fundamental laws of fluid statics, dynamics to various fluid devices.
CO3	Analyse various fluid static, dynamics problems.
CO4	Evaluate the performance of various fluid static, dynamic devices, hydraulic machines.
CO5	Create design of simple fluid flow devices using conventional methods and modern tools.

SYLLABUS

Module 1: Fluid Statics **[7]**
Concept of continuum and physical properties of fluids, specific gravity, viscosity surface Tension, vapor pressure. Buoyancy force and Metacentric height. Measurement of pressure-Piezometer, U-tube and differential tube manometers, Burdon pressure gauge, electronic pressure sensors and transducers.

Module 2: Fluid Kinematics **[9]**
Fluid kinematics: Eulerian and Lagrangian description of fluid flow, stream function and velocity potential function. Stream line, path line and streak lines and stream tub.

Classification of fluid flows-steady & unsteady, uniform, non-uniform, laminar, turbulent, rotational, and irrotational flows, Reynolds transport theorem, equation of continuity. Fluid dynamics: Surface and body forces –Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its. Buckingham's pi theorem and Rayleigh's method.

Module 3: Closed Conduit Flow [7]

Reynold's experiment- Darcy Weisbach equation, Minor losses in pipes- pipes in series and pipes in parallel- total energy line-hydraulic gradient line. Measurement of flow, pitot-static tube, venturimeter, orifice meter, Flow nozzle, Turbine flow meter. Concept of Boundary layer, separation of boundary layer and its control.

Module 4: Hydraulic Turbines [10]

Hydrodynamic force of jets on stationary and moving vanes, velocity diagrams, work don and efficiency Classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design, draft tube theory and functions and efficiency. Performance of hydraulic turbines, geometric similarity, unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic Turbine test standards.

Module 5: Hydraulic Pumps [7]

Centrifugal pumps: Classification, working, work done, manometric head, losses and efficiencies, specific speed, pumps in series and parallel, performance characteristic curves, NPS, Model studies, Reciprocating pumps, working, discharge, slip, indicator diagrams. Hydraulic Pump test standards.

Text books:

1. Hydraulics, fluid mechanics and Hydraulic machinery MODI and SETH. .(**T1**)
2. Hydraulic Machines by Jagdishlal.(**T2**)
3. Fluid Mechanics, Fundamentals and Applications (in SI Unit) by Yunus A. Cangel and John M. Cimbala, McGraw Hill. .(**T3**)

Reference books:

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, Kotaria& Sons. (**R1**)
2. Fluid Mechanics with Engineering Application by J.B. Franzini and Finnemore, McGraw Hill. (**R2**)
3. Fluid Mechanics by V. L. Streeter. (**R3**)

Online Resources

- https://www.youtube.com/watch?v=fa0zHI6nLUo
- https://www.youtube.com/watch?v=XGnGBo-FrlA
- http://engineeringvideolectures.com/video/15763

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

Analysis of different transient fluid flow systems/devices. Outline of various CFD software used in industries.

POs met through Gaps in the Syllabus:

POs 1 – 5, 12

Topics beyond syllabus/Advanced topics/Design:

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

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

Assessment Tool	% Contribution during CO Assessment
Mid Sem Examination Marks	25
End Sem Examination Marks	50
Quiz (s)	10+10
Assignment	5

Assessment Components	CO1	CO2	CO3	CO4	CO5
Mid Sem Examination	✓	✓			
End Sem Examination	✓	✓	✓	✓	✓
Quiz-1	✓	✓			
Quiz-2			✓	✓	
Assignment/Assignment by the teacher	✓	✓	✓	✓	✓

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	3	3	3	1							2	1	1	1
CO2	3	3	3	2	2							2	2	1	1
CO3	3	3	3	2	2							2	1	1	1
CO4	3	3	3	2	2				2	1	1	2	2	1	1
CO5	3	2	2	2	2				2	1	1	2	2	1	1

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, CD 6
CO2	CD1, CD2, CD3, CD 6
CO3	CD1, CD2, CD3, CD 6
CO4	CD1, CD2, CD3, CD 6
CO5	CD1, CD2, CD3, CD 6

COURSE INFORMATION SHEET

Course code: ME 204
Course title: MECHANICAL ENGINEERING LAB - I
Pre-requisite(s):
Co- requisite(s):
Credits: 1.5 L: 0, T:0, P: 3
Class schedule per week: 3
Class: B. Tech
Semester / Level: III / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1	Make student familiar with modern and conventional tools for material testing.
2	Present real-world engineering examples of solid mechanics.

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

CO1	Examine the hardness of materials (Hard steel and mild steel).
CO2	Evaluate the tensile and impact strength of materials.
CO3	Validate truss analysis for redundant truss and statically indeterminate trusses results experimentally.
CO4	Analysis of rods.
CO5	Compare the properties of two different lifting machines (Self-locking system)

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1**
Objective: To determine Brinell hardness number of mild steel

2. **EXPERIMENT – 2**
Objective: To determine Rockwell hardness number (HRC Scale) of hard steel.

3. **EXPERIMENT – 3**
Objective: To determine the tensile strength of mild steel

4. **EXPERIMENT – 4**
Objective: To determine the impact strength of hard steel using conventional method.

5. **EXPERIMENT – 5**
Objective: To determine impact strength of mild steel using computer aided system.

6. **EXPERIMENT – 6**
Objective: To determine forces in members of statically determinant truss

7. EXPERIMENT – 7
Objective: To determine forces in members of statically indeterminant truss

8. EXPERIMENT – 8
Objective: To determine the property of proving ring

9. **EXPERIMENT – 9**
Objective: To determine shear force in a simply supported beam

10. EXPERIMENT – 10
Objective: To determine bending moment in simply supported beam

11. EXPERIMENT – 11
Objective: To determine the modulus of rigidity of a shaft using Torsion test.

12. EXPERIMENT – 12
Objective: To determine the properties of Screw Jack

13. EXPERIMENT – 13
Objective: To determine the properties of Worm and Worm Wheel

Text Books:
1. Engineering Mechanics: Statics and Dynamics by Shames and Rao (**T1**)
2. Strength of Materials by S.S.Rattan. (**T2)**

Reference Books:
1. Mechanics of Materials by S. Timoshenko and James M. Gere. (**R1**)

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:

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Continuous Internal Assessment	√	√	√	√	√
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	1	1	1	3	3			3	3	3			2	1	2
CO2	1	3	2	3	3			3	3	3			2	1	2
CO3	3	3	3	3	3			3	3	3			2	1	1
CO4	3	3	3	3	3			3	3	3			2	1	1
CO5	3	3	3	3	1			3	3	3			2	1	1

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, CD3
CO2	CD1, CD3
CO3	CD1, CD3
CO4	CD1, CD3
CO5	CD1, CD3

COURSE INFORMATION SHEET

Course code: ME 205
Course title: STRENGTH OF MATERIALS
Pre-requisite(s): BASICS OF MECHANICAL ENGINEERING, MATHEMATICS COURSE WITH ORDINARY DEFERENTIAL EQUATIONS
Co- requisite(s):
Credits: 4 L: 3, T:1, P:0
Class schedule per week: 4
Class: B. Tech
Semester / Level: III / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1	Understand the nature of stresses developed in structural members such as beams, shafts, curved bars, cylinders and spheres for various types of simple loads.
2	Calculate the elastic deformation and deflection occurring in various simple geometries for different types of loading.

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

CO1	Understand the basic Strength of Materials theorems and to apply the concept in structural problems.
CO2	Analyze different structural bodies viz. beam, column, circular ring, cylinder and rotating disc.
CO3	Evaluate the influence of various geometric and loading parameters of structural bodies.
CO4	Compare the results obtained from bending theory of beam and strain energy method of structural problems.
CO5	Create new ideas in the field of Solid Mechanics and Design.

SYLLABUS

Module: 1
Stress at a point on a plane, Stress transformation equation, Principal stresses, Mohr's circle of stresses, Strain transformation equation, principal strain, strain rosette.

Module: 2
Types of Beam, Types of loading and support, Relationship between Shear force, Bending Moment and intensity of loading, SFD, BMD, Point of Contraflexure, second moment of area, parallel axes theorem, Bending stress and shear stress in beam.

Module: 3
Deflection of Beam, Double integration method, Macaulay's method, Moment area method, Buckling of column. Strain energy method, Castigliano's theorem, application of energy method on different types of beam and thin circular ring.

Module: 4
Torsion of circular shafts, Shear Centre: Theory of shear flow, shear flow diagrams and shear centre for thin walled symmetrical sections, Bending of curved beams: Beams of small and large initial curvature, evaluation of circumferential stresses.

Module: 5
Thin and thick cylinders: Radial and circumferential stresses, stresses produced due to shrink fit. Rotating Disc: Stresses in disc of uniform thickness and uniform strength.

Text Books:

1. Strength of Materials by E J Hearn. (**T1**)
2. Strength of Materials by S.S.Rattan. (**T2)**

Reference Books:

1. Mechanics of Materials by S. Timoshenko and James M. Gere. (**R1**)
2. Strength of Materials by Ryder. (**R2**)
3. Advanced Mechanics of Material by Seely & Smith (**R3**)

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

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

Topics beyond syllabus/Advanced topics/Design

POs met through Topics beyond syllabus/Advanced topics/Design

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	2	1	1		1	1		1			2	2	2	2
CO2	3	3	2	2		1	1		2			2	2	1	2
CO3	3	3	2	3		1	1		2			2	2	1	2
CO4	3	3	3	3		1	1		2	1		2	2	1	2
CO5	3	2	3	3	2	1	1	1	2		1	2	2	1	2

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, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code: IT 202
Course title: BASIC IT WORKSHOP
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1 L:0 T:0 P: 2
Class schedule per week: 2
Class: B.Tech.
Semester / Level: III / Second
Branch: All
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand and use the basic MATLAB functions and understand its environment and variables
2	Know about handling operations and advanced features like menus and toolbars
3	Implement programs with the use of arrays, strings and graphical data representations
4	Understand Python, Data Types, Operators, Arrays
5	Implement Functions and loops, object-oriented programming using Python

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

CO1	Apply features of MATLAB and algorithms to solve problems
CO2	Develop application programs with the help of various tool boxes available in MATLAB
CO3	Apply data analysis through graphical data representations
CO4	Implement programs with the use of arrays, strings in MATLAB
CO5	Implement Functions and loops, using Python

SYLLABUS

Module I: Introduction to MATLAB and Basics Part I
Introduction, Advantage, Disadvantage of MATLAB, MATLAB Environment, Variables and Array, Built-in Functions of MATLAB, Subarrays, Multidimensional Arrays, Data Files.

Module II: MATLAB Basic Part II
Scalar and Array Operations, Hierarchy of Operations, Introduction to Plotting, Polar Plots, Subplots, MATLAB profiler. String Functions, Complex Data, Three-Dimensional Plot

Module III: MATLAB Advanced Features
Sparse Arrays, Cell Arrays,Structure Arrays, I/O Functions, Object Handles, Position and Units, Graphical User Interface: Dialog Boxes, Menus, Toolbars.

Module IV: Introduction to Python Basics
Basics, I Python, Data Types, Operators, Arrays, Plotting

Module V: Python Programming Part 2:
Functions and loops, object-oriented programming, Numerical Formalism

LIST OF ASSIGNMENTS:

Sample Assignments on Python

Data Types, Input- Outputs, Variables
1. Write a program in Python to swap two variables.
2. Write a program in Python to check the input character is an alphabet or not.

Loop
3. Write a program in python to shuffle a deck of card using the module random and draw 5 cards.
4. Write a program in python to find the factors of a number.

Array and Lists
5. Write a program in python to transpose a given matrix M = [[1, 2], [4, 5], [3, 6]].
5. Write a program in python to print the median of a set of numbers in a file.

Function
6. Write a function in Python to find the resolution of a JPEG image.
7. Write a program in python and use in-built functions to convert a decimal number to binary, octal and hexadecimal number.
8. Write a program in python to sort words in alphabetical order.

Plot
9. Use Matplotlib to draw histogram to represent average age of population given as Age [21, 54, 66, 44, 32,42, 54, 62, 93, 45, 32, 70]
10. Create a 3-D plot in Python for the function $\sqrt{(x^2 - y^2)}$ over the interval $-3 \leq x \leq 3$ and $-3 \leq x \leq 3$.

Sample Assignments on MATLAB

Assignment Statements:
1. Given two sides a= 3.2 and b=4.6 of a triangle and angle theta= 600 between these two sides. Find the length of the third side and the area of the triangle.
2. Write a MATLAB statement to calculate the sum of the series:

S= 1- x2/2! + x4/4! – x6/6! + x8/8! for x= 1.5

Arrays
3. The array A is given below. Extend the 2-D array to 3-D array by including another 2-D array as second element in the third dimension.

```
      1 2 3;
A = 5 4 3;
      1 3 6;
      1  2  3  4  ;
```

4. Let a matrix A of size (3x4) is defined as, A = 5 6 7 8 ; Reshape the matrix A into matrix B of the size (6x2). 9 10 11 12;
5. Let a column vector z be given as z = [2; 3; 4; 5].

(i) Form a diagonal matrix A, using the elements of z as he main diagonal elements of A.
(ii) Form the matrix B, using the elements of vector z as elements of upper diagonal of B.
(iii) Form the matrix C, using the elements of vector z as elements of first lower diagonal of C. Polynomials

6. Integrate the polynomial y = 4x3 + 12x2 + 16x + 1. Take the constant of integration as 3.
7. Find the polynomial of degree 2 to fit the following data:

x	0	1	2	4
y	1	6	20	100

Input-Output statement and files
8. Write a program in MATLAB to illustrate the use of 'pause' command.
9. Write a program in MATLAB to illustrate the use of fwrite function for writing binary data of different formats to a file named 'check.txt'.

Plots
10. Plot the curve given by the equation y = sin(x) where x varies from 0 to 2π. Also label the x-axis and y-axis and provide a suitable title for the plot
11. Plot a bar graph for the data given as x = [1 2 3 4 5 6] and y = [10 15 25 30 27 19]
12. Given x = t2 and y = 4t for -4 < t < 4. Using MATLAB obtain a 3-D plot showing the matrix in (x, y) space as a factors of time.

Control structures
13. Write a program in MATLAB to find the count of even values in the given n numbers.

Functions
13. Write a function in MATLAB to calculate the roots of the quadratic equation ax2 + bx + c = 0, where a, b, c are constants.

Text Book

1. MATLAB® Programming for Engineers:Stephen J. Chapman, Thomson Corporation, 4th Edition**(T1)**
2. Introduction to Python for Engineers and Scientists, Sandeep Nagar, Apress, 2018**(T2)**

Reference Book

1. Learn Python The Hard Way, Zed A. Shaw, Addison-Wesley, Third Edition **(R1)**

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:

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution				
Day to day performance & Lab files	30				
Quiz 1	10				
Viva-voce	20				
End Semester Examination	**% Distribution**				
Examination: Experiment Performance	30				
Quiz 2	10				
Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√			
Quiz 2			√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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	3	2	1	3	1	2			1	1	2
CO2	2	3	3	3	3	1	1	2	1	3			1	1	2
CO3	1	3	2	1	3	1	1	1	1	1	1		1	1	2
CO4	2	3	3	2	2	1	1	2	1	3			1	1	1
CO5	3	3	1	2	3	1	1	2	1	1	1		1	1	1

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,
CO2	CD1, CD2, CD3, CD5
CO3	CD1, CD2, CD3,
CO4	CD1, CD2, CD3, CD5
CO5	CD1, CD2, CD3, CD5

COURSE INFORMATION SHEET

Course code: MA 204
Course title: NUMERICAL METHODS LAB
Pre-requisite(s): Nil
Co- requisite(s): MA 203 NUMERICAL METHODS
Credits: 1 L:0 T:0 P: 2
Class schedule per week: 2
Class: B.Tech.
Semester / Level: III / Second
Branch: All
Name of Teacher:

SYLLABUS

LIST OF EXPERIMENT:

1. **ASSIGNMENT – 1**

Objective: Find a simple root of $f(x) = 0$ using bisection method. Read the end points of the interval (a, b) in which the root lies, maximum number of iterations n and error tolerance eps.

2. **ASSIGNMENT – 2**

Objective: Find a simple root of $f(x) = 0$ using Regula-Falsi method. Read the end points of the interval (a,b) in which the root lies, maximum number of iterations n and error tolerance eps.

3. **ASSIGNMENT – 3**

Objective: Find a simple root of $f(x) = 0$ using Newton Raphson method. Read any initial approximation x_0, maximum number of iterations n and error tolerance eps.

4. **ASSIGNMENT – 4**

Objective: Solution of a system of $n \times n$ linear equations using Gauss elimination method with partial pivoting. The program is for 10 x 10 system or higher order system.

5. **ASSIGNMENT – 5**

Objective: Matrix inversion and solution of $n \times n$ system of equations using Gauss-Jordan method. If the system of equations is larger than 15 x 15 change the dimensions of the float statement.

6. **ASSIGNMENT – 6**

Objective: Program to solve a system of equation using Gauss-Seidel iteration method. Order of the matrix is n, maximum number of iterations *niter*, error tolerance is eps and the initial approximation to the solution vector is x_0. If the system of equations is larger than 10 x 10 change the dimension in float.

7. ASSIGNMENT – 7

Objective: Program to find the largest Eigen value in magnitude and the corresponding Eigen vector of a square matrix *A* of order *n* using power method.

8. ASSIGNMENT – 8

Objective: Program for Lagrange interpolation

9. ASSIGNMENT – 9

Objective: Program for Newton divided difference interpolation

10. ASSIGNMENT – 10

Objective: Program for Newton's forward and backward interpolation

11. ASSIGNMENT – 11

Objective: Program for Gauss's central difference interpolation (both backward and forward).

12. **ASSIGNMENT – 12**

Objective: Program to evaluate the integral of *f(x)* between the limits *a* to *b* using Trapezoidal rule of integration based on *n* subintervals or *n* + 1 nodal points. The values of *a, b* and *n* are to be read. The program is tested for $f(x) = 1/(1 + x)$

13. ASSIGNMENT – 13

Objective: Program to evaluate the integral of *f(x)* between the limits *a* to *b* using Simpson's rule of integration based on 2*n* subintervals or 2*n* + 1 nodal points and the integrand is written as a function subprogram. The values of *a, b* and *n* are to be read. The program is tested for $f(x) = 1/(1 + x)$

14. ASSIGNMENT – 14

Objective: Program to solve an IVP, $dy/dx = f(x)$, $y(x_0) = y_0$ using Euler method. The initial value x_0, y_0, the final value x_f and the step size *h* are to be read. The program is tested for $f(x,y) = -2xy^2$.

15. ASSIGNMENT – 15

Objective: Program to solve an IVP, $dy/dx = f(x)$, $y(x_0) = y_0$ using classical Runge-Kutta fourth order method with step size *h*, *h*/2 and also computes the estimate of the truncation error. Input parameters are: initial point, initial value, number of intervals and the step length *h*. Solutions with *h*, *h*/2 and the estimate of the truncation error are available as output. The right hand side The program is tested for $f(x,y) = -2xy^2$.

Text books:

1. Jain M.K, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age Publications, 2004. (**T1**)
2. S.S. Sastry, Introductory Methods of Numerical Analysis, PHI. .(**T2**)
3. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. (**T3**)

Reference books:

1. S.C. Chapra and R. P. Canale, Numerical Methods for Engineers, McGraw Hill, 1985. (**R1**)
2. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, Seventh Edition, 2003. (**R2**)
3. R. W. Hamming: Numerical Methods for Scientists and Engineers, Second Edition, Dover (**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:

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files					
Quiz 1					
Quiz 2					
Viva-voce					
Examination: Experiment Performance					

Indirect Assessment –

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	
CO2	
CO3	
CO4	

COURSE INFORMATION SHEET

Course code: IT 201
Course title: BASICS OF INTELLIGENT COMPUTING
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV / Second
Branch: ALL
Name of Teacher:

Course Objectives:
This course enables the students:

1	To know the basic functions of different AI branches
2	To understand the functionalities of IoT
3	To know the application of fuzzy logic.
4	To understand the basic functionalities of a cloud-based system
5	To find the basic functions of soft computing

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

CO1	Identify the difference between difference branches of AI.
CO2	Analysis a fuzzy based system
CO3	Design a Neural Network to solve a problem.
CO4	Analyze a problem in terms of ANN point of view
CO5	Identify the components of a cloud-based system

SYLLABUS

Module 1: AI Concepts [8]
Introduction to AI and Intelligent Agents, AI problems and Solution approaches, Problem solving using Search and Heuristics, AI Knowledge-base: creation, updation and reasoning, Broad category of branches in AI and intelligent Systems

Module 2: Introduction to Soft Computing and Fuzzy Logic [8]
Hard Computing: Features of Hard Computing, Soft Computing: Features of Soft Computing, Introduction to different Evolutionary Algorithms: Genetic Algorithm: Working Cycle of GA, Binary -Coded GA, Crossover, Mutation.
Classical Sets Vs Fuzzy Sets, Representation of Classical Set, Representation of Fuzzy Set, Basic Properties of Fuzzy Sets , Fuzzy Set operations: Intersection, Union, Complement, Important Terminologies in Fuzzy set Operations, Properties of fuzzy sets, Fuzzy Relations and fuzzy Compositions: Operations on Fuzzy Relations, Max-Min Composition, Max-Product Composition, Max-Average Composition, Fuzzy Inference System: Fuzzification, Fuzzy Proposition, Defuzzification Mamdani Model, Fuzzy Logic Applications : Fuzzy Controllers, Antecedent/ Consequent variables, IF-THEN rules and Inference, Fuzzy Decision Making

Module 3: Introduction to Artificial Neural Networks [8]

Development of ANNs, Biological Inspiration, Biological Neural Networks to ANN , Classification of ANN: NN Architecture, Learning/ Training, Training/ Testing Modes, Activation and Transfer Functions , First Generation Neural Network: Perceptron Network, Adaline, Madaline , Introduction to Second Generation Neural Networks: Backpropagation Training for Multi-Layer NN, Calculation of weights for Output-layer Neurons, Calculation of weights for Hidden-layer Neurons, Factors Influencing BPN training , Applications of Neural Network .

Module 4: Introduction to IoT [8]

The IoT Paradigm, Concept of Things, IoT Hardwares, IoT Protocols, IoT Architecture, enabling technologies of IoT, IoT Designing and its levels

Module 5: Introduction to Cloud Computing [7]

Brief overview, historical developments, computing platform and technologies, element of distributed computing, virtualization: characteristics of virtualized environment, virtualization and cloud computing, pros and cons of virtualization, virtualization technologies, cloud computing architecture: IAAS, PAAS, SAAS, types of cloud, cloud application**.**

Text books:

1. Madisetti Vijay and Bahga Arshdeep, Internet of Things (A Hands-on-Approach), 1st Edition, VPT, 2014. **[T1]**
2. Buyya Raj Kumar, Vecchiola Christian & Selvi S. Thamarai , Mastering Cloud Computing, McGraw Hill Publication, New Delhi, 2013. **[T2]**
3. Engelbrecht Andries P., Computational Intelligence: An Introduction, Wiley. **[T3]**

Reference books:

1. Raj Pethuru and Raman Anupama C.,The Internet of Things: Enabling Technologies, Platforms, and Use Cases, CRC Press **[R1]**
2. Konar Amit, Computational Intelligence: Principles, Techniques and Applications, Springer. **[R2]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Teaching through paper

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

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 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

COURSE INFORMATION SHEET

Course code: BE 101
Course title: BIOLOGICAL SCIENCES FOR ENGINEERS
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L:2 T: P:
Class schedule per week: 2
Class: B. Tech
Semester / Level: IV / First
Branch: ALL
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Recognize and understand the basic cell biology, biomolecules, related metabolic pathways and applicable bioenergetics.
2	Relate common biological phenomenon at molecular level.
3	Describe the chemical nature of enzymes and mechanism of action for their function in biochemical reactions
4	Correlate the molecular methods of biological signal generation and propagation in living system
5	Comprehend the steps involved in common application of biotechnology such as applicable for creation of transgenics, stem cells, plant metabolites production, PCR, ELISA

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

CO1	Demonstrate an understanding of fundamental biochemical principles, such as the structure/function of biomolecules involved in living system
CO2	Interpret the biomechanism involved in signal generation and transmission
CO3	Correlate the basic methods involved in common biotechnological application.
CO4	Apply and effectively communicate scientific reasoning and data involved in common biotechnological applications

SYLLABUS

Module 1: Basic Cell Biology [5]
Origin of life, Cell theory, Cell Structure and function, Biomolecules, Cell cycle and cell division, Biological Organization

Module 2: Bioenergetics and Metabolism [6]
Gibbs free energy and thermodynamics, aerobic and anaerobic respiration, Glycolysis, Krebs cycle and electron transport chain, Beta oxidation, Photosynthesis.

Module 3: Enzymes and its Application **[5]**

Classification of enzymes, Structure and mechanism of enzyme action and uses of enzymes, factors affecting enzyme activity, Immobilization of enzymes and their application

Module 4: Biological Signal Generation and Propagation **[6]**

Nerve cell structure and signal propagation. Mechanism of vision and hearing, cell signaling, Circadian rhythm

Module 5: Engineering Biological Systems and its Applications **[6]**

Central dogma of molecular biology, Methods in genetic engineering and application, PCR, ELISA and its application, stem cell and tissue engineering. Artificial Intelligence in Biology, Plant factory.

Text books:

1. Purves et al, (1998) Life: *The Science of Biology,* 4th Ed. **[T1]**
2. R. Dulbecco, The Design of Life. **[T2]**
3. Lehninger A, Principals of Biochemistry, 5th Ed **[T3]**

Reference books:

1. Stryer, L. (2002). *Biochemistry*. New York: W.H. Freeman. **[R1]**
2. K. Wilson & K.H. Goulding, (2006) *A biologist's guide to Principles and Techniques of*

Practical Biochemistry **[R2]**

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:

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	3	1		1		1	2	1	1			
CO2	3	3	3	3	1		1		1	2	1	1			
CO3	1	3	3	3			1		1	1		1			
CO4	2	2	2	2			2		2	2		1			
CO5	3	3	3	3	1		1		1	2	1	1			

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

COURSE INFORMATION SHEET

Course code: ME 207
Course title: KINEMATICS AND DYNAMICS OF MACHINES
Pre-requisite(s): ME101 BASICS OF MECHANICAL ENGINEERING
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students:

1	To understand basic principles of kinematic chains, Degree of freedom.
2	To analyse velocity and acceleration of planar mechanisms, balancing in rotary and reciprocating machinery, forces and moments acting in planar mechanism
3	To evaluate and design contact ratio, tooth profile and related parameters of gears.
4	To design cam profiles for specified motion of follower, Flywheel and governor.
5	To Understand vibration characteristics of single degree of freedom system and working principles of gyroscope.

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

CO1	Demonstrate various principles related to kinematics of planar mechanisms
CO2	Design planar mechanisms for relevant applications
CO3	Evaluate dimensions and kinematic parameters related to gear systems
CO4	Design cam profiles
CO5	Evaluate natural frequency of simple vibrating system, gyroscopic couple and precessional velocity of a gyroscopic system.

SYLLABUS

Module 1: Planar mechanisms and kinematic analysis [8]
Mechanisms and machines, Kinematic pairs, Kinematic chains, Kinematic inversions, Mobility and range of movement, Velocity and acceleration analysis (graphical and analytical), Coriolis' component of acceleration, Instantaneous centre of zero velocity, Aronhold-Kennedy theorem of three centres.

Module 2: Force analysis and principles flywheel and Governor: [6]
D'Alembert's principle and dynamic equilibrium, Dynamic force analysis (analytical method), Dynamically equivalent link, Turning moment on crank shaft, Turning moment diagram, fluctuation of energy and speed, flywheel, Principles of centrifugal governors: Porter, Proell and Hartnell governor.

Module 3: Balancing **[6]**

Balancing of rotating masses, Two plane balancing, Balancing of inline, V tween, and radial engines, principles of balancing machines

Module 4: Gear and Cam **[8]**

Basic terminology of a spur gear, Types of gears, Fundamental law of gearing, contact ratio, Interference and undercutting, Gear trains, Basic terminology cam, Displacement diagram, Velocity and acceleration of follower, Graphical determination of cam profiles

Module 5: Gyroscope and Vibrations **[12]**

Euler's equation of motion, Euler's modified equation of motion, Steady state, Stability of spinning top, ship, two wheeled and four wheeled vehicle, Basic elements of vibration, Lumping of parameters, Types of vibration, (a) Free undamped, (b) Damped and (c) forced vibration of a single degree of freedom system, Logarithmic decrement, Transmissibility, Vibration isolation, Torsional and transverse vibrations.

Text books:

1. A. Ghosh and A. K. Mallik, Theory of Mechanisms and Machines, Affiliated East-West Press Privet Limited, Third edition. **[T1]**
2. Thomas Bevan, The theory of Machines, CBS Publishers and Distributers Privet Limited, Third edition. **[T2]**
3. R. L. Norton, Kinematics and Dynamics of Machinery, McGraw Hill Education **[T3]**

Reference books:

1. John J. Uicker, Gordon R. Pennock and Joseph E. Shigley, Theory of Machine and Mechanisms, Oxford University Press; 4th edition. **[R1]**
2. J. L. Meriam and L. G. Kraige, Engineering Mechanics: Dynamics, John Wiley and Sons Inc. Seventh edition. **[R2]**
3. S. S. Rattan, Theory of Machines, Tata McGraw Hill education, Third Edition. **[R3]**

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

Detailed force analysis of gear and cam

POs met through Gaps in the Syllabus:

POs 1-5

Topics beyond syllabus/Advanced topics/Design:

Balancing of locomotives

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

POs 1-5

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	3	3	1	1	1	2	1	1	1	1	1	1
CO2	3	3	3	3	3	1	1	1	1			1	1	1	1
CO3	3	3	3	3	3	1	1	1	1			1	1	1	1
CO4	3	3	3	3	3	1	1	1	1	1	1	1	2	1	1
CO5	3	3	3	3	3	1	1	1	2		1	1	1	1	1

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
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2

COURSE INFORMATION SHEET

Course code: PE 204
Course title: MANUFACTURING PROCESSES - I
Pre-requisite(s): Nil
Co- requisite(s): PE 205 MANUFACTURING PROCESSES - I LAB
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Examine the technical aspect related to sand casting and riser designing
2	Get acquainted with advantages, limitations of various casting process
3	Acquire fundamentals of various types of joining processes
4	Get familiar with NDT techniques and advantages, disadvantages and limitations of various welding processes
5	Develop an understanding of forming processes

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

CO1	Interpret foundry practices like the basic principles in casting and derive relationship in riser designing, cavity filling etc.
CO2	Select appropriate casting process for a given component
CO3	Identify the advantages and limitations of the various types of joining processes and select the appropriate one according to the application. Interpret the characteristic curves for welding transformer.
CO4	Apply NDT techniques to identify various casting and welding defects
CO5	Differentiate various metal forming processes such as hot and cold working, rolling, forging, extrusion, sheet metal works and drawing Processes.

SYLLABUS

Module 1: Sand Casting [10]

Introduction to casting process and its importance, Patterns, pattern materials, types of patterns, pattern allowances, molding and core sands, properties of molding and core sands, mould and core making. Sand testing: grain fineness, moisture content, clay content and permeability test, gating system and risers, riser design, filling time problems, Sand casting defects; cleaning of casting

Module 2: Casting Processes [5]

Shell moulding; Investment casting; Evaporative Pattern casting; Vacuum Casting; Die casting; Centrifugal casting; Continuous casting

Module 3: Welding **[8]**

Welding introduction and classification of welding processes, welding terminology, general principles, welding positions, welding join types, welding edge preparation.

Gas welding and gas cutting, principles of oxy-fuel welding and cutting

Arc Welding: Power sources and arc welding electrodes and its coating, working principles and applications of SMAW, welding characteristic curve, GMAW, GTAW, SAW; Modes of metal transfer in GMAW and their applications

Soldering and brazing

Module 4: Welding Processes and NDT inspection **[10]**

Working principles and applications of thermit welding, resistance welding; spot, seam, projection and butt welding, plasma arc welding, electroslag welding, Ultrasonic welding, electron beam welding (EBM), Laser beam Welding (LBW)

Introduction to Non-Destructive Testing (NDT) testing: Dye penetration testing, eddy current testing, magnetic particles tesing, x-ray inspection, and ultrasound testing

Module 5: Forming processes **[7]**

Introduction to recovery, recrystallization and grain growth; hot working and cold working

Rolling: Classification of rolling processes, rolling mills, products of rolling and main variables

Drawing: Drawing of rods, wires and tubes

Forging: Open and closed die forging, forging operations, hammer forging, press forging and drop forging

Extrusion: Classification of extrusion processes, hot and cold extrusion processes

Sheet metal forming operations: Blanking, piercing, deep drawing, bending**.**

Text books:

1. Serope Kalpakjian and Steven Schmidt , Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition **[T1]**
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007 **[T2]**
3. P.N. Rao, Manufacturing Technology – Metal Cutting and Machine Tools, McGraw Hill. **[T3]**
4. P.N. Rao, Manufacturing Technology, Foundry, Forming and Welding, McGraw Hill **[T4]**
5. Hajra Choudhury, Elements of Workshop Technology–Vol.-II, Media Promoters and Publishers **[T5]**

Reference books:

1. E. P. DeGarmo, J. T. Black, and R. A. Kohser, Materials and processes in Manufacturing, PHI.**[R1]**
2. P. F. Ostwald, and Jairo Munoz, Manufacturing Processes and Systems, 9th ed., Wiley, India, 2002 **[R2]**
3. Principles of metal casting, Rosenthal. P. C, Tata Mc Graw Hill **[R3]**
4. M. C. Shaw, Metal Cutting Principles, Oxford University Press, Oxford, 1984 **[R4]**

Gaps in the syllabus (to meet Industry/Profession requirements):
Melting furnaces, Physics of arc welding

POs met through Gaps in the Syllabus:
POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:
Advance Forming Processes

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 1-3, 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	3
CO2	3	2	1			1				1	2	2	3	1	3
CO3	3	3	3			1				1	1	3	3	2	3
CO4	3	2	1			1	1	1		1	2	2	3	1	3
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

COURSE INFORMATION SHEET

Course code: PE 205
Course title: MANUFACTURING PROCESSES - I LAB
Pre-requisite(s): Nil
Co- requisite(s): PE204 MANUFACTURING PROCESSES - I
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: IV / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Examine different patterns used in sand casting.
2	Get familiar with sand testing and drawing inference from it.
3	Get hands on experience of arc welding and selecting best technique in engineering practices.
4	Develop skills on ultrasonic welding and spot welding.
5	Know different techniques used in polymer processing.

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

CO1	Distinguish and develop the patterns used in sand casting.
CO2	Judge the composition of molding sand for sand casting.
CO3	Compare arc welding processes and identify their respective applications.
CO4	Classify welding process and identify their respective applications.
CO5	Discriminate between the processes used in polymer processing.

SYLLABUS

LIST OF EXPERIMENT:

1. FOUNDRY SHOP
EXPERIMENT – I: Pattern Study
Objective: To study different types of pattern used in sand casting.

2. CARPENTARY SHOP
EXPERIMENT-I: Pattern Making
Objective: To prepare a single piece wooden pattern according to given dimension for Al casting.

3. FOUNDRY SHOP
EXPERIMENT-II: Permeability Test
Objective: To determine the permeability number for given molding sand sample.

4. FOUNDRY SHOP
EXPERIMENT-III: Moisture Test
Objective: To determine the amount of moisture for given molding sand sample.

5. FOUNDRY SHOP
EXPERIMENT-IV: Clay Content Test
Objective: To determine the amount of clay for given molding sand sample.

6. FOUNDRY SHOP
EXPERIMENT-V: Grain Fineness Number
Objective: To determine the Grain fineness number for given molding sand sample.

7. WELDING SHOP
EXPERIMENT-I: Shielded Metal Arc Welding
Objective: To study the effect of AC and DC arc in manual/shielded metal arc welding.

8. WELDING SHOP
EXPERIMENT-II: Gas Metal Arc Welding
Objective: To determine metal deposition rate in GMAW.

9. WELDING SHOP
EXPERIMENT-III: Submerged Arc Welding
Objective: To study Submerged arc welding equipment and perform SAW welding.

10. WELDING SHOP
EXPERIMENT-IV: Spot Welding
Objective: To study resistance welding equipment and perform spot welding on thin sheet.

11. POLYMER
EXPERIMENT-I: Ultrasonic Welding
Objective: To study ultrasonic welding setup and perform plastic welding using the same.

12. POLYMER
EXPERIMENT-II: Blow Molding
Objective: To study blow molding equipment and perform molding operation.

13. POLYMER
EXPERIMENT-III: Injection Molding
Objective: To study injection molding machine and perform molding operation.

TEXT BOOK

1. S K Hajra Choudhury, A K. Hajra, “Elements of Workshop Technology: Vol- I and Vol -II”, Media Promotors Pvt Ltd. **(T1)**
2. B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

REFERENCE BOOK

1. P.N. Rao, "Manufacturing Technology Vol-1and Vol-II", Tata McGraw Hill. **(R1)**
2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

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

Nil

POs met through Gaps in the Syllabus:

Nil

Topics beyond syllabus/Advanced topics/Design:

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

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√	√	√	√
Quiz 2	√	√	√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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	3						3	2	1	1	3	1	3
CO2	3	1	1	3					3	2	1	1	3	1	3
CO3	3	1	1	1					3	2	1	1	3	1	3
CO4	3	2	1	1					3	2	1	1	3	1	3
CO5	3	1	1						3	2	1	1	3	1	2

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD3
CO2	CD3
CO3	CD3
CO4	CD3
CO5	CD3

COURSE INFORMATION SHEET

Course code: PE 206
Course title: METROLOGY & MEASUREMENT
Pre-requisite(s): Nil
Co- requisite(s): PE 207 METROLOGY & MEASUREMENT LAB
Credits: 3 L: 3 T:
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students:

1	To understand and analyze different measurement systems, Standards of Measurement, Measurement Errors
2	To know about Limits, Fits, tolerance and gauges used in measurement and designing aspects for those
3	To familiar with different types of comparators, optical metrology and their applications
4	To enlighten students about various techniques of measurement of Screw threads, Gears, Geometric forms and Surface textures.
5	To accustom with various measuring devices for measurement of force, torque, strain and acceleration

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

CO1	Distinguish between accuracy and precision, identify different measurement errors, able to select linear or angular measuring instrument for measurement of various components
CO2	Design limit gauges used for various components and purposes
CO3	Explain principles and uses of comparators and optical instruments used in metrology
CO4	Examine various screws threads and gears parameter using different methodology and explain capabilities of machining process by measuring surface finish.
CO5	Implement and analyse appropriate measurement methods for variables like force, torque, strain and acceleration

SYLLABUS

Module – I: Introduction **[6]**
Historical development, Basics of Metrology, Need for Inspection, Accuracy and Precision, Standards of measurements, system of measurement, line, end & wavelength standards, type and source of measurement errors
Linear metrology: Steel rule, callipers, Vernier calliper, Vernier height gauge, Vernier depth gauge, micrometres, universal calliper.
Miscellaneous measurements: Taper measurement, angle measurement, radius measurement, sine bar & Angle gauges

Module – 2: Limit Fits and Gauge [10]

Interchangeable manufacture, selective assembly, concept of limits, fits and tolerances, Types of fit, Basic-Hole System, Basic-Shaft System, Problems, Tolerance grades, Metric fits, Indian standard system, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Considerations of gauge design, Taylor's principle of gauging, Wear allowance on gauges

Module – 3: Comparator and Optical gauges [6]

Principle and uses of mechanical, optical, Electrical, electronic and pneumatic Comparators
Principle of interferometer, concept of optical flat, projector, microscope, autocollimator and interferometer
Types of machine tool tests, alignment tests for lathe, milling and drilling machine tools

Module – 4: Form Measurement [10]

Terminology of screw threads, Measurement of minor, major, thread angle and effective diameter of screw threads by 2-wire and 3- wire methods, best size wire. Screw thread gauges, Tool maker's microscope
Gear tooth terminology, gear tooth thickness & pitch measurement, involutes profile testing of gear
Straightness, flatness and squareness and circularity tests, numerical evaluation, measurement of surface finish, related instruments.
Automated inspection system, Introduction & applications of Co-ordinate Measuring Machine (CMM)

Module – 5: Dynamic measurement [8]

Sensors and Transducers: Types of Sensors, types of transducers and their characteristics
Force and Torque measurement: Direct methods and indirect method, force measuring instruments-load cells, Dynamometer, Power Measurements
Measurement of strain: types of strain gauges, gauge factors, theory of strain gauges and method of measurement, Wheatstone bridge circuit
Vibration and Noise Measurement: Piezoelectric Accelerometer and decibel meters

Text Books:

1. R.K. Jain, Engineering Metrology Khanna Publications, New Delhi **(T1)**
2. I. C. Gupta, A Text book of Engineering Metrology, Dhanpat Rai, New Delhi **(T2)**
3.Er. R K Rajput, Mechanical Measurements and Instrumentations, Kataria Publication (KATSON) **(T3)**
4. M. Mahajan, Engineering Metrology, Dhanpat Rai & Co. New Delhi **(T4)**

Reference Books:

1. K. J. Hume, Engineering Metrology **(R1)**
2. N V Raghavendra and Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press **(R2)**
3. Bentley, Engineering Metrology and Measurements, Pearson Education**(R3)**
4. Anand Bewoor, Vinay Kulkarni, Metrology and Measurement, McGraw-Hill **(R4)**

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

Limited scope to get acquainted with latest gadgets/instruments used in industries.
No direct relation with environmental, societal issues, ethics etc.

POs met through Gaps in the Syllabus:
POs 5-8, 11-12

Topics beyond syllabus/Advanced topics/Design:
Latest equipment in the field of metrology

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 5, 6-8, 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	1		2									2	1	2
CO2	3			1									2	1	2
CO3	3	2	3	2									2	1	2
CO4	3	2	2	1									2	1	2
CO5	3	2	2	1									2	1	2

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, CD 3, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 3, CD 6
CO4	CD1, CD2, CD 3, CD 6
CO5	CD1, CD2, CD 3, CD 6

COURSE INFORMATION SHEET

Course code: PE 207
Course title: METROLOGY & MEASUREMENT LAB
Pre-requisite(s): Nil
Co- requisite(s): PE 206 METROLOGY & MEASUREMENT
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech
Semester / Level: IV / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	provide to the students an understanding and appreciation of the science of measurement.
2	expose the students to various mechanical and electrical engineering measuring devices and understand the different degree of accuracy obtained from different types of instruments.
3	impart knowledge and skill to use measuring tools related to screw threads, gears, surface texture.
4	handle appropriate measurement equipment or method for variables like strain, force, vibration

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

CO1	be familiar with the different instruments that are available for linear, angular, and various geometric form measurements.
CO2	select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy)
CO3	learn how to measure various parameters of screw threads, gears, surface texture.
CO4	measure cutting tool forces, vibration of machine tool, modulus of elasticity

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Linear Measurement-I**
Objective: To study the measurement of dimensions of a given work piece using Vernier caliper. Outside and inside micrometer and calculate the least count in each equipment.

2. **EXPERIMENT – 2: Linear Measurement-II**
Objective: To study the measurement of height and depth of a given work piece using height gauge and depth micrometer and calculate the least count in each equipment.

3. **EXPERIMENT – 3: Gauges**

Objective: Study of Gauges (slip gauges/feeler gauge/Go-NO Go gauges etc.).

4. EXPERIMENT – 4: Angular Measurement
Objective: Measurement of angle using Sine bar, angle gauges

5. EXPERIMENT – 5: Optical Metrology I
Objective: To study the profiles of single point cutting tool ("V" tool) / thread by profile projector

6. EXPERIMENT – 6: Optical Metrology II
Objective: To study the working of optical flat and monochromatic light source.

7. EXPERIMENT – 7: Gear Metrology
Objective: Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer

8. EXPERIMENT – 8: Screw Thread Metrology
Objective: Measurement of Screw thread parameters using two wire or Three-wire method

9. EXPERIMENT – 9: Comparator
Objective: To study the working of electronic comparator, measurement of thickness of given workpiece

10. EXPERIMENT – 10: Geometric Form Measurement
Objective: Measurement of flatness and roundness using dial gauge and electronic comparator.

11. EXPERIMENT – 11: Surface Profile
Objective: To study the Taylor Hobson contour measurement instrument and determine the contour of a given test-piece.

12. EXPERIMENT – 12: Dynamic Measurement I
Objective: Measurement of cutting tool forces using tool Dynamometer

13. EXPERIMENT – 13: Dynamic Measurement II
Objective: Determination of modulus of elasticity of a mild steel specimen using strain gauges

14. EXPERIMENT – 14: Dynamic Measurement III
Objective: To study the piezoelectric accelerometer and determine the vibration response of machine tool during operation

Text Book:

1. R.K. Jain, Engineering Metrology Khanna Publications, New Delhi **(T1)**

2. I. C. Gupta, A Text book of Engineering Metrology, Dhanpat Rai, New Delhi **(T2)**

Reference Book:

1. M. Mahajan, Engineering Metrology, Dhanpat Rai & Co. New Delhi **(R1)**
2. N V Raghavendra and Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):
Availability of limited number of advanced equipment.

POs met through Gaps in the Syllabus:
PO 5

Topics beyond syllabus/Advanced topics/Design:
Latest equipment in the field of metrology and measurement

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 5, 6-8, 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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	
Quiz 1	√	√			
Quiz 2			√	√	
Viva-voce	√	√	√	√	
Examination: Experiment Performance	√	√	√	√	

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	2		3					3			2	2	1	2
CO2	3	2		3					3			2	2	1	2
CO3	3	2		3					3			2	2	1	2
CO4	3	2		3					3			2	2	1	2

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD3, CD6
CO2	CD3, CD6
CO3	CD3, CD6
CO4	CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 208
Course title: PROJECT ENGINEERING
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Comprehend the scope and types of projects
2	Identify the Project Life Cycle and project constraints
3	Construct organizational structure of project management
4	Realize environmental issues and social cost benefit analysis of projects
5	Apply project scheduling tools (PERT and CPM)

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

CO1	Recognise the project morphology, organizational structure and elements of project
CO2	Incorporate the importance environmental issues in projects
CO3	Handle real-life projects as in various organizations
CO4	Solve complex scheduling problems in project management using PERT/CPM
CO5	Prepare project report and budget planning

SYLLABUS

Module 1: Basic terms and definitions [6]
Definition and types of project, Project engineering verses project management, Projects verses programs, Forward and backward integrated projects, Turnkey projects, Scope of project and project creep, Project life cycle, Project constraints, Iron-triangle of project management

Module 2: Organization structure [8]
Organizational structures for projects, Functional, Product and project organization, Matrix and modified matrix structure, Responsibilities of project manager, Project risk analysis, Techniques of risk analysis - Break-even, expected monetary value (EMV) and make-or-buy decision

Module 3: Social and environmental aspects of project [6]
Environmental considerations in project evaluation, Primary issues and secondary issues in Feasibility study, Social cost benefit analysis, Project appraisal (Technical, economic, financial, management)

Module 4: Network models **[10]**

Network modeling of a project, Activity on Arc (AOA) verses Activity on Node (AON), Rules for network drawing, Numbering (Fulkerson's rule), skip numbering, Forward and backward pass computation, Critical paths, floats and slack, Numerical examples

Module 5: Scheduling and monitoring of projects **[10]**

Project Scheduling Techniques, Bar charts, Program-progress chart, PERT, CPM Models**,** Crashing of project time, Line of balance, Time-Cost Trade-off in a project, Numerical problems, Project Monitoring Techniques, Resource Leveling

Text books:

1. Project Management by Prasanna and Chandra, Tata McGraw Hill.(**T1**)
2. Elements of Project Management by Pete Spinner, Prentice Hall, USA.(**T1**)

Reference books:

1. Production and Operation Management by Alan Muhlemann, John Oakland and Keith Lockyer, MacMillan India Ltd. (**R1**)
2. A course in PERT and CPM by R. C. Gupta, Dhanpat Rai Publications(P) Ltd, Delhi. (**R1**)
3. Industrial Engineering and Management by O. P. Khanna, Dhanpat Rai & Sons. (**R1**)

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

Computer and software applications in project scheduling

POs met through Gaps in the Syllabus:

POs 3, 5

Topics beyond syllabus/Advanced topics/Design:

Application of MS Project© in network modeling, Simulation models in project management

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

POs 4, 5, 11

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	1	1	1								3	2	1	2	2
CO2	1					2	3	1			1		3	1	3
CO3		3	2	3	1				1		1	1	1	3	3
CO4		2	1	1	1						1		2	3	3
CO5		2					1		2	3	2	1	1	2	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, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code: PE 209
Course title: ENGINEERING ECONOMY, COSTING AND ACCOUNTING
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Assess the best feasible investment proposal among the alternatives based on the common index
2	Perform a replacement or retention study between a defender and the best challenger
3	Explores the relationship, which exists between costs, revenue, output levels and resulting profit
4	Acquire basic concepts of cost accounting relevant for managerial decision making.
5	Understand and explain the conceptual framework of Accounting

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

CO1	Evaluate investment opportunities and compare between alternatives using single and combined engineering economy factors
CO2	Perform a replacement study considering inflation and indirect cost allocation
CO3	Perform breakeven analysis and profitability analysis under different conditions.
CO4	Estimate the cost of component and total cost of operation
CO5	Recognize, measure and record the most common business transactions

SYLLABUS

Module 1: Time Value of Money [10]

Introduction to engineering economy, Time value of money, Simple and compound interest, Minimum attractive rate of return, Cash flows - single, uniform series, and gradient series, Multiple compounding periods in a year, Continuous compounding, Bases of comparison-present worth amount, annual equivalent amount, future worth amount, rate of return, Defining mutually exclusive alternatives, Decision criteria for selection of investment proposals, Comparison of alternatives with unequal service life, Sensitivity analysis

Module 2: Replacement Analysis and Depreciation [8]

Reasons for replacement, Economic service life, Evaluation of replacement involving excessive maintenance cost, decline in efficiency, inadequacy and obsolescence; Methods of depreciation and their comparison, Decision making based on expected value decision tree in the evaluation of alternatives

Module 3: Cost Analysis [6]

Cost - implicit and explicit costs, Cost structure - fixed and variable, direct and indirect, product and period, marginal and average, sunk and opportunity, recurring and non-recurring, short-run and long-run, incremental, cash and book, life-cycle cost, Elements of cost – material, labor, overhead expenses, Selling Price, Allocation of cost, Components of cost – prime cost, office cost, total cost, Methods of allocation of overhead expenses, Standard cost

Module 4: Break-even Analysis [6]

Concept of contribution, p/v ratio and break-even point, Concept of margin of safety, Cost-volume-profit relationship, Break- even analysis and the financial decision- making, Break-even chart, Effect of different variable on break-even point, Cost comparison of two or three alternatives.

Module 5: Accounting for Business Transactions [10]

Accounting concepts and principles, Classification of accounts, Double entry system, Journal and ledger entries, Preparation of final accounts - trading, profit & loss accounts, balance sheet.

Text books:

1. G.J Thusen, W.J. Fabrycky, Engineering Economy, Prentice-Hall, New York. **(T1)**
2. W.G Sullivan, E.M. Wicks, Engineering Economy, Pearson, New York. **(T1)**
3. S.N. Maheshwari, S.K. Maheshwari, S.K. Maheshwari, An Introduction to Accountancy, Vikas Publishing, New Delhi. **(T1)**

Reference books:

1. Blank & Tarquin, Engineering Economy, McGraw-Hill. **(R1)**
2. Newnan, Eschenbach & Lavelle, Engineering Economic Analysis, Oxford University Press. **(R1)**

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

Business Ratios, Decision Making under Risk

POs met through Gaps in the Syllabus:

PO 1-5

Topics beyond syllabus/Advanced topics/Design:

Using Spreadsheets and Microsoft Excel® in Engineering Economic Analysis, Goal Seek—A Tool for Breakeven and Sensitivity Analysis, Solver—An Optimizing Tool for Capital Budgeting, Breakeven, and Sensitivity Analysis.

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	4	4	5	6	7	8	9	10	11	12	13	14	15
CO1	3	3	3	3	1						3	2	1	3	3
CO2	3	3	3	3	1						3	2	1	3	3
CO3	3	3	3	3	1						3	2	1	3	3
CO4	3	3	2	3	1						3	2	1	3	3
CO5	1	2	1	2	1					1	2	2	1	2	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, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code: PE 210
Course title: RELIABILITY AND MAINTENANCE ENGINEERING
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: IV / Second
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1.	Comprehend the fundamentals of reliability engineering
2.	Get acquainted with the concepts of reliability, maintainability and availability
3.	Familiarize with the different types of maintenance and root cause analysis
4.	Conceptualize the various levels of condition monitoring and risk assessment
5.	Explore failure mode effect analysis and Total productive maintenance

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

CO1	Analyse the reliability of different types of equipment/machines and products.
CO2	Apply the tools and techniques of reliability and maintainability
CO3	Estimate the root cause analysis and maintenance costs of different machines
CO4	Plan for risk assessment for condition monitoring
CO5	Analyse failure mode effect analysis of different machines and products.

SYLLABUS

Module 1: Reliability **[8]**

Introduction to reliability, measurement of reliability and Bath-tub curve. Probability distribution: Cumulative distribution function, Probability density function. Reliability function: Normal distribution, log normal distribution and exponential distribution function.

Module 2: **Maintainability** **[8]**

Definition, Importance, Purpose and results of maintainability efforts, maintainability in product life cycle, availability, repairability, maintainability testing, costing, budgeting, Control index of maintenance system.

Module 3: **Maintenance Strategy** **[8]**

Principle, relative advantage, limitation and application of various maintenance strategies like, preventive maintenance, predictive maintenance, Reliability based maintenance,

computer integrated maintenance system. Improvement maintenance and POKA YOKE methods. Root cause analysis.

Module 4: **Condition Monitoring** **[8]**

Condition-based maintenance: methodology and levels, condition monitoring techniques: performance monitoring, visual, optical, tactile monitoring, temperature monitoring etc. Hazard Identification and Risk Assessment. Accident/ Incidence Investigation.

Module 5: Terotechnology **[8]**

Replacement policy, Product LCA, failure mode effect and critical analysis, fault tree analysis, cause and effect diagram. Total Productive Maintenance (TPM): objectives, principles and pillars of TPM.

Text books:

1. L.S. Srinath, Reliability Engineering, East-West Press, India **(T1)**
2. B.S. Dhillon, Engineering Maintainability, Eastern Economy Edition PHI **(T2)**
3. A.K. Gupta, Reliability Engineering and Technology, Macmillan India Limited **(T3)**
4. M. Mahajan, Statistical Quality Control, Dhanpat Rai & Co., India **(T4)**

Reference books:

1. V. Venkataraman, Maintenance Engineering and Management, PHI **(R1)**
2. S.K. Srivastav, Industrial Maintenance Management, S. Chand & Company, India **(R2)**

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

Maintenance of typical rotating and process equipment's like turbine, heat exchanger and pressure vessels

POs met through Gaps in the Syllabus

POs 1, 3, 4

Topics beyond syllabus/Advanced topics/Design

Maintainability of complex machines

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

PO4

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	2	2	1	2				2	1		1	1	1	3
CO2	3	3	3		2	1	1		2	2			2	2	3
CO3	2	3	3	3	3	2	2	1	2	2	2	2	3	1	3
CO4	2	2	2	1	2		1		1	2	1	1	2	1	3
CO5	3	3	3	2	3	2	2	1	2	3	2	2	3	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 211
Course title: ENGINEERING ECONOMY
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: MO / Second
Branch: All (Open Elective)
Name of Teacher:

Course Objectives
This course enables the students to:

A.	Understand how time and interest affect money
B.	Assess the best feasible investment proposal among the alternatives based on the common index
C.	Perform a replacement or retention study considering inflation and indirect cost allocation
D.	Acquire basic concepts of cost accounting relevant for managerial decision making.
E.	Explores the relationship, which exists between costs, revenue, output levels and resulting profit

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

CO1	Calculate the present, annual and future worth of cash flows
CO2	Evaluate investment opportunities and compare between alternatives using engineering economy factors
CO3	Perform a replacement study considering inflation and indirect cost allocation
CO4	Estimate the cost of component and total cost of operation
CO5	Perform breakeven analysis and profitability analysis under different conditions.

SYLLABUS

Module 1: Time Value of Money [8]

Introduction to engineering economy, Time value of money, Interest rate and rate of return, Cash flows, Economic equivalence, Simple and compound interest, Minimum attractive rate of return, Single cash flow, Uniform series of cash flow, Arithmetic gradient and geometric gradient series, Multiple compounding periods in a year, Continuous compounding, Bonds

Module 2: Comparison of Alternative Proposals [8]

Formulating alternatives, Bases of comparison- present worth amount, annual equivalent amount, future worth amount, rate of return, Defining mutually exclusive alternatives,

Decision criteria for selection of investment proposals, Comparison of alternatives with unequal service life, Sensitivity analysis

Module 3: Replacement Analysis and Depreciation [10]

Reasons for replacement, Economic service life, Evaluation of replacement involving excessive maintenance cost, decline in efficiency, inadequacy and obsolescence; Methods of depreciation and their comparison, Decision making based on expected value decision tree in the evaluation of alternatives

Module 4: Cost and Cost Analysis [8]

Cost - implicit and explicit costs, Cost structure - fixed and variable, direct and indirect, product and period, marginal and average, sunk and opportunity, recurring and non-recurring, short-run and long-run, incremental, cash and book, life-cycle cost, Elements of cost – material, labor, overhead expenses, Selling Price, Allocation of cost, Components of cost – prime cost, office cost, total cost, Methods of allocation of overhead expenses, Standard cost

Module 5: Break Even Analysis [6]

Concept of contribution, p/v ratio and break-even point, Concept of margin of safety, Cost-volume-profit relationship, Break- even analysis and the financial decision- making, Break-even chart, Effect of different variable on break-even point, Cost comparison of two or three alternatives.

Books:

Text books:

1. G.J Thusen, W.J. Fabrycky, Engineering Economy, Prentice-Hall, New York. **(T1)**
2. W.G Sullivan, E.M. Wicks, Engineering Economy, Pearson, New York. **(T1)**

Reference books:

1. Blank & Tarquin, Engineering Economy, McGraw-Hill. **(R1)**
2. Newnan, Eschenbach & Lavelle, Engineering Economic Analysis, Oxford University Press. **(R1)**

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

Business Ratios, Decision Making under Risk

POs met through Gaps in the Syllabus:

PO 1-5

Topics beyond syllabus/Advanced topics/Design:

Using Spreadsheets and Microsoft Excel® in Engineering Economic Analysis, Goal Seek—A Tool for Breakeven and Sensitivity Analysis, Solver—An Optimizing Tool for Capital Budgeting, Breakeven, and Sensitivity Analysis.

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

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, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code: EE 102
Course title: ELECTRICAL ENGINEERING LABORATORY
Pre-requisite(s): PHYSICS, FUNDAMENTALS OF MATHEMATICS AND ELECTRICAL ENGINEERING
Co- requisite(s): Nil
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: IV / First
Branch: All
Name of Teacher:

Course Objectives:
This course enables the students:

1	To describe practical knowledge of active and passive elements and operation of measuring instruments
2	To demonstrate electrical circuit fundamentals and their equivalent circuit models for both 1-φ and 3- φ circuits and use circuit theorems
3	To establish voltage & current relationships with the help of phasors and correlate them to experimental results
4	1. To conclude performance of 1 – Φ AC series circuits by resonance phenomena 2. To evaluate different power measurement for both 1-φ and 3- φ circuits

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

CO1	Classify active and passive elements, explain working and use of electrical components, different types of measuring instruments;
CO2	Illustrate fundamentals of operation of DC circuits, 1-φ and 3- φ circuits and also correlate the principles of DC, AC 1-φ and 3- φ circuits to rotating machines like Induction motor and D.C machine
CO3	Measure voltage, current, power, for DC and AC circuits and also represent them in phasor notations
CO4	Analyse response of a circuit and calculate unknown circuit parameters
CO5	Recommend and justify power factor improvement method in order to save electrical energy

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Measurement of low & high resistance of DC shunt motor**

Objective: (i) To measure low resistance of armature winding of DC shunt motor
(ii) To measure high resistance of shunt field winding of DC shunt motor.

2. EXPERIMENT – 2: AC series circuit

Objective: (i) To obtain current & voltage distribution in AC RLC series circuit and to draw phasor diagram

(ii) To obtain power & power factor of single-phase load using 3- Voltmeter method and to draw phasor diagram

3. EXPERIMENT – 3: AC parallel circuit

Objective: (i) To obtain current & voltage distribution in AC RLC parallel circuit and to draw phasor diagram

(ii) To obtain power & power factor of single-phase load using 3- Ammeter method and to draw phasor diagram

4. EXPERIMENT – 4: Resonance in AC RLC series circuit

Objective: (i) To obtain the condition of resonance in AC RLC series circuit

(ii) To draw phasor diagram

5. EXPERIMENT – 5: 3 phase Star connection

Objective: (i) To establish the relation between line & phase quantity in 3 phase star connection

(ii) To draw the phasor diagram

6. EXPERIMENT – 6: 3 phase Delta connection

Objective: (i) To establish the relation between line & phase quantity in 3 phase delta connection

(ii) To draw phasor diagram

7. EXPERIMENT – 7: 3 phase power measurement

Objective: (i) To measure the power input to a 3-phase induction motor using 2 wattmeter method

(ii) To draw phasor diagram

8. EXPERIMENT – 8: Self & mutual inductance

Objective: To determine self & mutual inductance of coils

9. EXPERIMENT – 9: Verification of Superposition, Thevenin's and Reciprocity theorem

Objective: (i) To verify Superposition theorem for a given circuit

(ii) To verify Thevenin's theorem for a given circuit

10. EXPERIMENT – 10: Verification of Norton's, Tellegen's and Maximum Power transfer theorem

Objective: (i) To verify Norton's theorem for a given circuit

(ii) To verify Maximum Power transfer theorem for a given circuit

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

1. Application of principles of magnetic circuits to electrical machines like transformers, generators and motors
2. Visualize Phase sequence

POs met through Gaps in the Syllabus:

POs 1-3,7

Topics beyond syllabus/Advanced topics/Design:

1. Assignment: Simulation of electrical circuits with dependent/independent sources by various techniques (Mesh current/Node Voltage/Thevenin's theorem/Norton's theorem/Maximum power transfer theorem etc.) using MATLAB/PSIM/C++ softwares
2. Active/reactive power calculation for 3 – Φ circuits

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

POs 5,6, 9-11

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution				
Day to day performance & Lab files	30				
Quiz 1	10				
Viva-voce	20				
End Semester Examination	**% Distribution**				
Examination: Experiment Performance	30				
Quiz 2	10				
Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√			
Quiz 2			√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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	3	3	1	3	3	3	3	3	3	1	1	1
CO2	3	3	3	2	2	2	2	3	3	3	3	3	1	1	1
CO3	3	3	3	2	2	2	2	2	3	3	2	3	1	1	1
CO4	3	3	3	3	3	1	2	2	3	3	2	2	1	1	1
CO5	3	3	3	3	3	2	3	3	3	3	3	3	1	1	1

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, CD3, CD6
CO3	CD1, CD3, CD6, CD7
CO4	CD1, CD2, CD3, CD6
CO5	CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 301
Course title: MANUFACTURING PROCESSES - II
Pre-requisite(s): Nil
Co- requisite(s): PE 302 MANUFACTURING PROCESSES - II LAB
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: V / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Examine the technical aspect related to metal cutting and tool geometry.
2	Acquire knowledge of different types of tool materials, cutting fluid and lathe machines.
3	Get familiar with shaper and drilling machines.
4	Get acquainted with milling and grinding process.
5	Develop an understanding of advanced manufacturing processes.

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

CO1	Interpret different angles of single point cutting tool and mechanics involved in metal cutting
CO2	Identify, compare and analyse different tool material, cutting fluids, lathe and its attachments.
CO3	Explain working principle and classify shaper and drilling machine. Derive relation for estimating machining time
CO4	Identify different types of milling cutters and finishing processes. Compare different indexing mechanism and grinding wheel.
CO5	Differentiate various advanced manufacturing processes such as EDM, ECM, CHM, USM and LBM.

SYLLABUS

Module 1: Theory of Metal Cutting [10]
Orthogonal and oblique cutting, Tool forces in orthogonal cutting, Power required in metal cutting, Merchant's Circle diagram and Merchant's theory of metal cutting.
Geometry and nomenclature of single point tool; ASA system

Module 2: Tool Material and Machine Tools [8]
Different types of cutting tool materials; their uses, applications and relative advantages and limitations. Types of chips, tool failure, tool life, Machinability, and cutting fluids
Constructional features, specification, operations of lathe machine, working principles of capstan and Turret lathes

Module 3: Shaper and Drilling Machine [7]

Constructional features, specification, operations and drives of Shaper, Planer, & Slotter.
Constructional features, specification and operations of drilling machine; other drilling related operations; reaming, boring, tapping. Geometry and nomenclature of twist

Module 4: Milling and Grinding Machine [8]

Constructional features, specification and operations of milling machine, indexing in milling operations, Geometry and nomenclature of plain milling cutter.
Grinding wheels and its variables, grinding wheel specification. Dressing, Truing and loading of wheels, Surface, Cylindrical and Center-less grinding.
Finishing operations: Broaching, lapping, honing and buffing

Module 5: Advance Manufacturing Processes [7]

Introduction to Non-conventional machining Processes: Need, advantages and limitation; classification, Fundamental principles and application possibilities of Ultrasonic Machining (USM), Chemical Machining (CHM), Electro-Discharge Machining (EDM), Electro-Chemical Machining (ECM) and Laser Beam Machining (LBM)

Text books:

1. Serope Kalpakjian and Steven Schmidt , Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition **[T1]**
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007 **[T2]**
3. P.N. Rao, Manufacturing Technology – Metal Cutting and Machine Tools, McGraw Hill. **[T3]**
4. P.N. Rao, Manufacturing Technology, Foundry, Forming and Welding, McGraw Hill **[T4]**
5. Hajra Choudhury, Elements of Workshop Technology–Vol.-II, Media Promoters and Publishers **[T5]**

Reference books:

1. E. P. DeGarmo, J. T. Black, and R. A. Kohser, Materials and processes in Manufacturing, PHI.**[R1]**
2. P. F. Ostwald, and Jairo Munoz, Manufacturing Processes and Systems, 9th ed., Wiley, India, 2002 **[R2]**
3. Amitabha Battacharya , Metal Cutting Theory and Practice **[R3]**

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

Inserts

POs met through Gaps in the Syllabus:

POs 1,2, 12

Topics beyond syllabus/Advanced topics/Design:

Mechanics of material removal in advanced manufacturing processes

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

POs 1-3, 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	1			1				1	1	3	3	1	2
CO2	3	3	1			2				1	2	2	3	1	2
CO3	3	3	1			1				1	1	3	3	1	2
CO4	3	3	2	1		1				1	2	3	3	1	2
CO5	3	3	1			1	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

COURSE INFORMATION SHEET

Course code: PE 302
Course title: MANUFACTURING PROCESSES – II LAB
Pre-requisite(s): Nil
Co- requisite(s): PE 301 MANUFACTURING PROCESSES - II
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: V / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Get familiar with different types of lathe machine and their operations used in machining process.
2	Get hands on experience of milling machine.
3	Get acquaintance with slotter and shaper machine.
4	Develop skills on tool grinding machine.
5	Know different techniques used in EDM.

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

CO1	Compare between the lathe machines and identify their respective applications.
CO2	Apply simple indexing mechanism
CO3	Distinguish between slotter and shaper machine with their respective applications.
CO4	Recognize different types angle used in ASA tool signature
CO5	Discriminate between the die sinking EDM and wire cut EDM.

SYLLABUS

LIST OF EXPERIMENT:

1. **MACHINE SHOP**

EXPERIMENT – I: Center Lathe

Objective: To perform different types of center lathe operation on job as per given dimensions.

2. **MACHINE SHOP**

EXPERIMENT-II: Equipment Study

Objective: To study different types of lathe attachments and milling cutters.

3. **MACHINE SHOP**

EXPERIMENT-III: Capstan Lathe

Objective: To obtain final job as per given dimensions using different types of lathe operation on Capstan lathe.

4. MACHINE SHOP
EXPERIMENT-IV: Turret Lathe
Objective: To perform taper turning on given job using turret lathe

5. MACHINE SHOP
EXPERIMENT-V: Retrofitted Lathe
Objective: To study retrofitting attachment used on lathe

6. MACHINE SHOP
EXPERIMENT-VI: Center Lathe
Objective: To perform external thread cutting operation on given job.

7. MACHINE SHOP
EXPERIMENT-VII: Slab Milling
Objective: To perform slab milling operation on job using slab milling cutter on horizontal knee type milling machine.

8. MACHINE SHOP
EXPERIMENT-VIII: Gear Cutting
Objective: To cut a tooth on gear blank using simple indexing mechanism.

9. MACHINE SHOP
EXPERIMENT-IX: Shaper Machine
Objective: To obtain hexagonal prismatic shape on rectangular job using shaper machine.

10. MACHINE SHOP
EXPERIMENT-X: Slotter Machine
Objective: To cut a slot on a job as per given dimensions.

11. MACHINE SHOP
EXPERIMENT-XI: Tool Grinding
Objective: To grind a single point cutting tool as per ASA tool signature.

12. ADVANCE MACHINE SHOP
EXPERIMENT-I: Die Sinking Electro Discharge Machine
Objective: To study Electro Discharge Machine (EDM) and its process parameter, calculate material removal rate for a particular parameter setting

13. ADVANCE MACHINE SHOP
EXPERIMENT-II: Wire cut EDM
Objective: To study wire cut EDM and cut a job as per given dimensions using NC programming.

TEXT BOOK

1. S K Hajra Choudhury, A K. Hajra, “Elements of Workshop Technology: Vol- I and Vol -II”, Media Promotors Pvt Ltd. **(T1)**
2. B S Raghuwanshi, "A course in Workshop Technology", Dhanpat Rai Publications. **(T2)**

EFERENCE BOOK

1. P.N. Rao, "Manufacturing Technology Vol-1and Vol-II", Tata McGraw Hill. **(R1)**
2. Kalpakjian, "Manufacturing Engineering and Technology", Pearson. **(R2)**

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:

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√	√	√	√
Quiz 2	√	√	√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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						3	2	1	1	3	1	2
CO2	3	2	1						3	2	1	1	3	1	2
CO3	3	1	1	1					3	2	1	1	3	1	2
CO4	3	1	1	1					3	2	1	1	3	1	2
CO5	3	1	1						3	2	1	1	3	1	2

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD3
CO2	CD3
CO3	CD3
CO4	CD3
CO5	CD3

COURSE INFORMATION SHEET

Course code: PE 303
Course title: DESIGN OF MACHINE ELEMENTS
Pre-requisite(s): ME 205 STRENGTH OF MATERIALS
Co- requisite(s): Nil
Credits: 4 L:3 T:1 P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: V / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the basics of designing various machine elements
2	Get acquainted with design considerations of stress and factor of safety
3	Analyse different aspects of design approach for machine elements
4	Derive relationship and use empirical relations for design stress calculations for various elements

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

CO1	Apply the basic design principles for design of machine elements
CO2	Able to design cotter, knuckle and weld joints
CO3	Able to design bolted and riveted joints
CO4	Able to design shaft and coupling, belt and chain drives
CO5	Able to design power screws, screw jack, helical springs and spur gear

SYLLABUS

Module 1: Principles of mechanical design [7]
Objective and scope of mechanical design; Designation and selection of materials; Design considerations; Modes of failure; Design/allowable stress; Factor of safety (FoS); Theories of failure – maximum normal stress theory, maximum shear stress theory, Distortion energy theory. Choice of Failure criteria

Module 2: Cotter, knuckle and weld joints [9]
Design of (a) Cotter joint; (b) Knuckle joint and (c) Fillet Welded joint of brackets under different types of loading

Module 3: Bolted and riveted joints [10]
Bolted joints: Metric thread, standard sizes, use of lock nuts and washers; Applications in structures including brackets, turn buckle; Pre-stressed bolts; Riveted joints: Unwin's formula; Brief discussion on single, double and triple row lap joints, butt joints with single or double strap / cover plate; simple strength design; joint efficiencies.

Module 4: Shaft and coupling, belt and chain drives [12]

Design of: (a) Solid and hollow shafts, strength design of shafts, design based on torsional rigidity; (b) Shaft coupling-rigid, pin-bush and geared flexible type, alignment of coupling; (c) Belt drives-geometrical relations, derivation of torque and power transmission by flat and V-belt drives, selection of belt from manufacturers catalogues, pulley. (d) Chain drives – roller chains, polygonal effect, power rating, sprocket wheel.

Module 5: Power screws, screw jack, helical springs and spur gear [12]

Design of transmission screw, Screw jack; Design of helical compression spring - stress and deflection equations, stiffness, curvature effect: Wahl's factor, springs in parallel and series; Gears – types of gears; Spur Gears: terminology, forces analysis, beam strength of spur gear tooth. Lewis equation and form factor, design for strength, dynamic load and wear load.

Text books:

1. Design of Machine Elements by V. B. Bhandari, TMH **[T1]**
2. Mechanical Engineering Design by Shigley and Mischke,TMH **[T2]**
3. Design of Machine Elements by M. F. Spotts, Prentice Hall **[T3]**

Reference books:

1. Machine Design by T.H. Wentzell, Cenage Learning. **[R1]**
2. Theory and Problems of Machine Design by Hall, Holowenko and Laughlin, TMH. **[R2]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Design of clutches and brakes

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

POs 1-4, 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		2	2	2	3
CO2	3	3	3	1						1		2	2	2	3
CO3	3	3	3	1						1		2	2	2	3
CO4	3	3	3	1						1		2	2	2	3
CO5	3	3	3	1						1		2	2	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 304
Course title: PRODUCTION & OPERATIONS MANAGEMENT
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 4 L:4 T: P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: V / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students:

1	To introduce to various inherent concepts of production systems, planning and control systems of Manufacturing Industry.
2	To introduce of forecasting models, Product mix and aggregate planning.
3	To make routine process, scheduling process and identify different strategies employed in manufacturing industries to production planning.
4	To give basic concept of inventory control and its technique, EOQ, ABC analysis.
5	To know Facility design process and its all component.

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

CO1	Able to understand the functions of production system its planning and control.
CO2	Able to make demand forecasts in the manufacturing sectors using selected quantitative and qualitative techniques.
CO3	Able to explain the importance and function of pre planning and post planning of production system.
CO4	Able to solve inventory problems and to be able to apply selected techniques for its control and management under dependent and independent circumstances.
CO5	Understand plant layout, building layout and location theory.

SYLLABUS

Module 1: Introduction to production and operation management [8]
Difference between manufacturing and service operations, Objectives and functions of production and operation management, historical evolution of production and operations management. type of Production systems and their characteristics, selection of a production system, concept of productivity.

Module 2: Preplanning [10]
Demand forecasting, common techniques of demand forecasting, Capacity management, aggregate planning and master scheduling.

Module 3: Production Planning **[10]**

Routing, loading and scheduling with their different techniques, dispatching, Progress Report, Expediting and corrective measures.

Module 4: Inventory Control **[10]**

Field and scope of inventory control, inventory types and classification, Inventory control models, static model, dynamic model both deterministic and stochastic, Economic lot size, reorder point and their application, ABC analysis, VED analysis, modern practices in purchasing and store Management.

Module 5: Facility design **[12]**

Facility design problems and their analysis.
Facility location- Need of location, Factors affecting the location and site selection, multi-plant location, location theories and models.
Facility layout- Objectives, principles and classification of layouts; Factors affecting plant layout; models of product layout, process layout and service layout.

Text books:

1. Production & Operations management, Jay Heizer and Barry Render, Prentice Hall **[T1]**
2. William J. Stevenson, Operations Management, McGraw-Hill, 13th edition **[T2]**
3. S. N. Chary, Production and operations management, Tata McGraw-Hill Education, 5th Edition **[T3].**
4. P K Gupta, D.S Hira, Operations Research, S chand 7th edition **[T4]**

Reference books:

1. R. Panneerselvam, Production and operations management, PHI Learning Pvt. Ltd **[R1]**
2. Richard B. Chase, Nicholas J. Aquilano, Production & Operations Management: Manufacturing and Services, Publisher: Richard D Irwin; 7th edition **[R2]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Logistics and supply chain management, Inventory model design

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

POs 1 -4, 9, 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	2		1		1	2	3	3	3	2	3
CO2	3	3	1	2	2		1		1	2	3	2	3	2	3
CO3	3	3	3	2	2		1		1	2	2	3	3	2	3
CO4	3	3	1	2	2		1		1	2	2	2	3	2	3
CO5	3	3	1	3	2		1		1	2	2	2	3	2	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

COURSE INFORMATION SHEET

Course code: PE 305
Course title: COMPUTER AIDED DESIGN AND DRAFTING LAB
Pre-requisite(s): ME 102 ENGINEERING GRAPHICS
Co- requisite(s): Nil
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: V / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Learn the concepts and principles of Computer aided Design & Drafting (CAD)
2	Understand the various types of CAD Software's like CATIA V5, Unigraphics NX, etc. and their practical usage in Manufacturing applications
3	Understand concepts of Designing various components of Manufacturing jobs
4	Develop Industrial components by interpreting 3D part models/ part drawings
5	Understand the concepts of CAD Software, Design & Assemble various parts of Manufacturing with focus on Industrial Applications

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

CO1	Apply the concepts of concepts of designing using 3D modeling software
CO2	Create Designs of various real-world Industrial components by using mechanical design Software's like CATIA, Unigraphics, etc.
CO3	Produce an industrial component by interpreting 3D part model/ part drawings using Computer Aided Design, Drafting & Analysis.
CO4	Apply the concepts of CAD Drawings and Assemble various components of Manufacturing with focus on Industrial Applications
CO5	Develop Prototype models by interpreting 3D part model/ part drawings & Assemblies

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1:**
   Objective: To study the basics of Computer Aided Design. Sketcher, Drafting & 3D Modeling.

2. **EXPERIMENT – 2:**
   Objective: To practice exercise on Padding, Pocketing & Revolving.

3. **EXPERIMENT – 3:**
   Objective: To practice exercise on Nut, Bolt & Threads

4. **EXPERIMENT – 4:**
Objective: To practice exercise on Chamfer, Fillets, Mirror & Offset

5. **EXPERIMENT – 5:**
Objective: To practice exercise on Hole & Patterns

6. **EXPERIMENT – 6:**
Objective: To practice exercise on Ribs & Shell

7. **EXPERIMENT – 7:**
Objective: To practice exercise on Sweep

8. **EXPERIMENT – 8:**
Objective: To practice exercise on Blend

9. **EXPERIMENT – 9:**
Objective: To practice exercise on Datum plane & Axis

10. **EXPERIMENT – 10:**
Objective: To practice exercise on Assembly-I: Foot-step Bearing

11. **EXPERIMENT – 11:**
Objective: To practice exercise on Assembly-II: Plumber-Block

12. **EXPERIMENT – 12:**
Objective: To practice exercise on Assembly-III: Bench-Vice assembly

Text Books

1. Rao, P.N. "CAD/CAM: Principles and Applications", McGraw Hill Publication, 2nd Edition, 2004. **(T1)**
2. Mikell P. Grover, E. Zimmer, "Computer Aided Design and Manufacturing (CAD/CAM)", Pearson Publication, 2nd Edition, 2006. **(T2)**

Reference Books

1. David Bedworth, "Computer Integrated Design and Manufacturing" Tata McGraw Hill,

New Delhi, 1998. **(R1**)

2. Radhakrishan P., Subramaniyam S., "CAD CAM and CIM", New Age International, 2002 **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time Industrial projects.

POs met through Gaps in the Syllabus:
PO 5

Topics beyond syllabus/Advanced topics/Design:
Design optimization for industrial projects

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 4,5, 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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√			
Quiz 2			√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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	2		3					3			2	2	3	3
CO2	2	2		3					3			2	3	2	3
CO3	3	2		2					3			2	2	3	3
CO4	3	2		3					3			2	2	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, CD3
CO2	CD1, CD3, CD7
CO3	CD1, CD3, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: PE 306
Course title: ADVANCED OPERATIONS RESEARCH
Pre-requisite(s): PE 203 OPERATIONS RESEARCH
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: V / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1	Apply the techniques of operations research in industrial engineering problems.
2	Understand the revised simplex method and sensitivity analysis for linear programming and perform iterations of it by hand
3	Carry out simulations of various industrial engineering problems
4	Solve problems of Decision Theory and Queueing Theory
5	Solve problems of DP, NLPP

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

CO1	Appropriately formulate Queuing models for service and manufacturing systems and apply Queuing models and algorithms to solve these Queuing problems.
CO2	Carry out sensitivity analysis for various types of LPP and apply decision theory in various managerial decision-making situations.
CO3	Appropriately formulate Integer Programming models for service and manufacturing systems and apply operations research techniques and algorithms to solve these IP problems.
CO4	Apply Monte Carlo simulation to various engineering problems.
CO5	Model and solve problems using dynamic programming and NLPP

SYLLABUS

Module 1: Queuing Theory and Revised simplex method [8]
Queuing theory: Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, essential features of queuing systems, operating characteristics of (M/M/I) (∞/FCFS/M/M/1: ∞ /SIRO, M/M/1: N/FCFS, M/M/S: N/FCFS).
Revised simplex method

Module 2: Sensitivity Analysis and Decision Theory [8]
Sensitivity analysis of LPP (Change in the Objective Coefficient: Non-Basic and Basic Variables, change in right hand side of the constraints and change in the cost/Profit coefficients),

Decision theory: Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax, Regret criterion, Hurwicz criterion, Decision tree.

Module 3: Integer Programming [8]
Integer programming: Introduction to integer programming, Branch and bound technique and its application to binary integer programming and mixed integer programming.

Module 4: Simulation and Dynamic Programming [8]
Simulation: Monte Carlo simulation and its application in queueing problem, production planning and budgeting problems etc.
Dynamic Programming: Formulation of Dynamic programming problem, solutions by tabular methods

Module 5: Non-Linear Programming [8]
Non-Linear programming methods: Problem formulation, Lagrange Multipliers, Kuhn – Tucker Conditions, Sufficiency of Kuhn – Tucker Condition, NLPP with one inequality constraint.

Text books:
1. Operations Research, D.S. Hira, P.K. Gupta, S. Chand & Company Ltd, 2014 **(T1)**
2. Quantitative Techniques Vol I and Vol II, L. C. Jhamb, Everest Publishing House **(T2)**
3. Operations Research, - Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons **(T3)**

Reference books:
1. Operations Research an Introduction, Hamady A. Taha, 4TH Edition, Pearson Education. **(R1)**
2. Introduction to Operations Research, 9e, Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu, McGraw Hill. **(R2)**

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:

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	3	3						3	2	3	3	3
CO2	3	3	2	3	3						3	2	3	3	3
CO3	3	3	2	3	3						3	2	3	3	3
CO4	3	3	2	3	3						3	2	3	3	3
CO5	3	3	2	3	3						3	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 307
Course title: COMPETITIVE MANUFACTURING STRATEGIES
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: V / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the concept manufacturing as strategy, WTO and competitive advantages
2	Learn about the product verity, manufacturability, vendor development and vendor rating.
3	Understand the concept of JIT, MRP & ERP must be explained to the students
4	Know the effectiveness CIM, E-manufacturing and simulation as tool of competitive manufacturing
5.	Learn about the various types of Manufacturing systems i.e. Dedicated manufacturing system, Flexible manufacturing system (FMS), cellular manufacturing system (CMS), and Re-configurable manufacturing system (RMS)

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

CO1	Explain the concept of manufacturing strategy.
CO2	Recognize the role of product verity management, product modularity, vendor development, vendor rating and design for manufacturing in improving competitiveness
CO3	Comprehend JIT and MRP based systems
CO4	Explore latest advancements in manufacturing like CIM and e-manufacturing and the role of ERP and simulation as strategy in manufacturing.
CO5	Select proper manufacturing system for a given product and market scenario.

SYLLABUS

Module 1: Competitive Strategies [8]
The competitive environment in the market, The WTO agreement and its effect on Indian Industries, Manufacturing as a competitive strategy, Competitive Advantages and Disadvantages

Module 2: Product Modularity [7]
Product Variety, Modular Design, Design for manufacturability, Vendor Development, Vendor rating.

Module 3: Manufacturing philosophy **[7]**

Just in time (JIT) manufacturing, Kanban system, Agile Manufacturing, Lean manufacturing and tools

Module 4: E-Manufacturing **[10]**

Simulation as tools for competitive manufacturing, MRP, ERP, Concept of CIM and E-Manufacturing, Industry 4.0

Module 5: Recent Manufacturing Scenarios **[8]**

Selection of manufacturing systems for different manufacturing scenarios - Dedicated manufacturing system, Flexible manufacturing system (FMS), cellular manufacturing system (CMS), and Re-configurable manufacturing system (RMS); Elementary of DMS, FMS, CMS, and RMS.

Text books:

1. Manufacturing Excellence in Global Markets W. Euershelm **[T1]**
2. Manufacturing Systems Design & Analysis B. Wa. **[T2]**
3. Computer Automation in Manufacturing T.O.Boucher **[T3]**
4. Intelligent Manufacturing Planning P. Gu. **[T4]**

Reference books:

1. Serope Kalpakjian and Steven Schmidt, Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition **[R1]**
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007 **[R2]**

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

Forecasting techniques, Marketing strategies,

POs met through Gaps in the Syllabus:

POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:

Advance Management and marketing techniques

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

POs 1-3, 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	√	√			
Quiz1	√	√			
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	2	3	2	2	1	1	1		1	1	3	3	2	2
CO2	3	2	1	1	1	1			1	1	2	2	3	1	3
CO3	3	3	2	1		1		1	1	1	1	3	3	2	3
CO4	3	2	1	1	1	1		1	1	1	2	2	3	1	3
CO5	3	2	1	1				1	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

COURSE INFORMATION SHEET

Course code: PE 308
Course title: LOGISTICS AND SUPPLY CHAIN MANAGEMENT
Pre-requisite(s): PE 203 OPERATIONS RESEARCH
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: V / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Provide an insight on the fundamentals of supply chain strategy
2	Know the various distribution and transportation networks and their applications
3	Acquire the concepts of logistics in improving the supply chain and other functional areas of an organization
4	Understand the role of sourcing, information technology, and coordination in a supply chain
5	Know the recent trends in supply chain management

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

CO1	Define the goal of a supply chain and analyse the impact of supply chain decisions on the success of a firm
CO2	Develop a framework for making supply chain network design decisions
CO3	Apply logistics concepts to improve supply chain operations
CO4	Evaluate and select the best supplier for a firm or organisation.
CO5	Discuss the recent trends in supply chain management

SYLLABUS

Module 1: Introduction to Supply Chain Management [8]
Understanding the supply chain, Supply Chain Performance- Achieving strategic fit and scope, key issues, Supply chain modelling, Supply Chain Drivers and Metrics, Centralized vs. decentralized systems.

Module 2: Designing the Supply Chain Network [9]
Distribution Networks– Design options for a distribution network, e-Business and the distribution network, Network design in an uncertain environment. Transportation Networks- Design options for a transportation network, Trade-offs in transportation design, Vehicle routing and scheduling, Supply Chain Optimization.

Module 3: Logistics Management **[8]**

Logistics Management: Logistical operation, integration, network design, logistical performance cycle, customer service global logistics, logistical resources, logistics planning, Third- and fourth-party logistics providers, Measuring logistics costs and performance, e-logistics, Reverse logistics.

Module 4: Managing Cross-Functional Drivers in a Supply Chain **[8]**

Sourcing Decisions- Make or buy decisions, Sourcing Processes. Information Technology in a Supply Chain, Coordination in a Supply Chain-Bullwhip effect.

Module 5: Recent Trends in Supply Chain Management **[7]**

Lean Supply Management, Agile Supply Management, Green and Sustainable Practices of Supply Chain, Supply chain cases.

Text books:

1. Chopra, S., and Meindl, P. "Supply Chain Management, strategy, planning, and operation" 6/e – PHI, second edition, 2014. **[T1]**
2. Christopher, M., "Logistics and Supply Chain Management", Pearson Education Asia, New Delhi. **[T2]**

Reference books:

1. Taylor and Brunt, "Manufacturing Operations and Supply Chain Management (The Lean Approach)", Business Press Thomson Learning, NY. **[R1]**
2. Arjan J. Van Weele, "Purchasing and Supply Chain Management (Analysis Planning and Practice)", Engineering, Business Press, Thomson Learning NY. **[R2]**
3. Shah, J. "Supply Chain Management, text and cases", Pearson Education South Asia,2009. **[R3]**
4. Balkan Cetinkaya, Richard Cuthbertson, Graham Ewer, "Sustainable Supply Chain Management: Practical ideas for moving towards best practice", Springer, 2011. **[R4]**
5. Sople, V.V "Supply Chain Management, text and cases", Pearson Education South Asia, 2012. **[R5]**
6. Donald B., "Logistic Management - The Integrated Supply Chain process", McGraw Hill. **[R6]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Industry 4.0 in supply chain

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

POs 1-5, 7, 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	1	1		2			1	1	2	1	3	1	2
CO2	3	3	3	2		2				1	1	1	3	2	3
CO3	3	3	3	3	2	1	1		1	1	1	1	3	3	3
CO4	3	3	3	2	2	1				1	1	1	3	2	3
CO5	3	3	3	3	2	2	2			1	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 309
Course title: PROJECT MANAGEMENT
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: SP / Third
Branch: All (Open Elective)
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Decide the scope and classification of projects
2	Develop the stages of Project Life Cycle and identify project constraints
3	Comprehend organizational structure of project management
4	Be aware of environmental issues and social cost benefit analysis of projects
5	Apply various project scheduling tools (PERT and CPM)

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

CO1	Comprehend the various project morphology, organizational structure and elements of project
CO2	Recognize the importance environmental issues in projects
CO3	Handle real-life projects as in various organizations
CO4	Solve complex scheduling problems in project management using PERT/CPM
CO5	Prepare project report and budget planning

SYLLABUS

Module 1: Definitions and basic terms [7]
Definition and types of project, Turnkey projects, Scope of project and creep, Project life cycle, Project constraints

Module 2: Organization and appraisal of projects [8]
Organizational structures for projects, Responsibilities of project manager, Project risk analysis, Project appraisal (Technical, economic, financial, management)

Module 3: Environmental and social aspects of project [8]
Environmental considerations in project evaluation, Primary issues and secondary issues in Feasibility study, Social cost benefit analysis

Module 4: Network analysis **[7]**

Network modeling of a project, Activity on Arc (AOA) verses Activity on Node (AON), Forward and backward pass computation, Critical paths, floats and slack

Module 5: PERT/CPM models **[10]**

Project Scheduling Techniques, PERT, CPM Models, Time-Cost Trade-off in a project, Project Monitoring Techniques,

Text books:

1. Project Management by Prasanna and Chandra, Tata McGraw Hill. [**T1**]
2. Elements of Project Management by Pete Spinner, Prentice Hall, USA. [**T2**]

Reference Books:

1. Production and Operation Management by Alan Muhlemann, John Oakland and Keith Lockyer, MacMillan India Ltd. [**R1**]
2. A course in PERT and CPM by R. C. Gupta, Dhanpat Rai Publications(P) Ltd, Delhi. [**R2**]
3. Industrial Engineering and Management by O. P. Khanna, Dhanpat Rai & Sons. [**R3**]

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

Software applications for project management

POs met through Gaps in the Syllabus:

PO 5

Topics beyond syllabus/Advanced topics/Design:

Project selection using decision making tools

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

POs 3, 11

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

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, CD4, CD6
CO2	CD1, CD2, CD4, CD6
CO3	CD1, CD2, CD4, CD6
CO4	CD1, CD2, CD4, CD6
CO5	CD1, CD2, CD4, CD6

COURSE INFORMATION SHEET

Course code: MT 123
Course title: BUSINESS COMMUNICATION
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:2 T: P:2
Class schedule per week: 4
Class: B. Tech
Semester / Level: V / First
Branch: All
Name of Teacher:

Course Objectives:
This course enables the students:

1	To analyze and demonstrate writing and speaking processes through invention, organization, drafting, revision, editing, and presentation.
2	To understand the importance of specifying audience and purpose and to select appropriate communication choices.
3	To interpret and appropriately apply modes of expression, i.e., descriptive, expositive, Narrative, scientific, and self-expressive, in written, visual, and oral communication
4	To participate effectively in groups with emphasis on listening, critical and reflective thinking, and responding.
5	To develop the ability to research and write a documented paper and/or to give an oral presentation.

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

CO1	Apply business communication strategies and principles to prepare effective communication for domestic and international business situations.
CO2	Utilize analytical and problem-solving skills appropriate to business communication.
CO3	Participate in team activities that lead to the development of collaborative work skills.
CO4	Select appropriate organizational formats and channels used in developing and presenting business messages
CO5	Communicate via electronic mail, Internet, and other technologies and deliver an effective oral business presentation.

SYLLABUS

Module 1: Introduction to Business Communication
Importance and Objectives of Business communication, Process of communication, Barriers to effective communication, Techniques of effective communication. Forms of communication (Written, Oral, audio-visual communication).

Module 2: Managing Business Communication

Formal and Informal communication, Non- verbal communication (Body language, Gestures, Postures, Facial expressions). The cross-cultural dimensions of business communication. Techniques to effective listening, methods and styles of reading.

Module 3: Other Aspects of Communication

Vocabulary: Single word substitution, Idioms and phrases, Precis writing, Comprehension.
Group Discussions, Extempore, Principles of effective speech and presentations, Role playing.

Module 4: Introduction to Managerial Writing

Business letters: Inquiries, Circulars, Quotations, Orders, Acknowledgement, Claims & adjustments, Collection letters, Sales letters, Drafting of different resumes, Covering letters Applying for a job, Social correspondence, Invitation to speak.
Official Correspondence: Memorandum, Notice, Agenda, Minutes, Circular letters.

Module 5: Report writing

Business reports, Types, Characteristics, Importance, Elements of structure, Process of writing, Order of writing, the final draft, check lists for reports.

Books recommended:

1. Communication Skills, Sanjay Kumar &PushpLata, Oxford University Press **[T1]**
2. Business Correspondence and Report Writing,R.C.Sharma, Krishna Mohan.Mcgraw Hill **[T2]**
3. Communication for Business,Shirley Taylor, V.Chandra, Pearson **[T3]**
4. Business Communication- HorySankar Mukherjee, Oxford University Press **[T4]**
5. Basic Business Communication-. Lesikar I Flatley, McGraw Hill. **[T5]**
6. Business Communication Today, Bovee, Thill and Chaterjee, Pearson **[T6]**

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:

Course Delivery Methods:

CD1	Lecture by use of boards/LCD projectors/OHP projectors	√
CD2	Assignments/Seminars	√
CD3	Laboratory experiments/teaching aids	√
CD4	Mini projects/Projects	√
CD5	Industrial/guest lectures	
CD6	Industrial visits/in-plant training	
CD7	Self- learning such as use of NPTEL materials and internets	
CD8	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
Attendance	5
End Semester Examination	**% Distribution**
End Semester Examination	50

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

Indirect Assessment –

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1, CD2
CO2	CD1, CD2
CO3	CD1, CD2
CO4	CD1, CD2, CD3, CD4
CO5	CD1, CD2, CD3

COURSE INFORMATION SHEET

Course code: PE 311
Course title: MACHINE TOOL DESIGN
Pre-requisite(s): PE 201 METALLURGY, ME 205 STRENGTH OF MATERIALS, PE 303 DESIGN OF MACHINE ELEMENTS
Co- requisite(s): PE 312 MACHINE TOOL DESIGN SESSIONAL
Credits: 4 L:3 T:1 P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Learn about kinematic structure and general requirements of machine tool design
2	Learn about regulation of spindle speeds and design of gear box
3	Understand the basic design procedures for machine tool structures like beds, tables and columns
4	Understand the basic design procedures for machine tool guideways, spindle and elements of machine tool controls
5	Understand the effect of vibrations on machine tools and the methods of elimination of vibration

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

CO1	Select drives for machine tools
CO2	Design of gear box for speed and feed regulation
CO3	Design machine tool structures like beds, tables and columns.
CO4	Design machine tool guideways, spindle and to select elements for machine tool controls
CO5	Design for elimination of vibration to increase machine tool life

SYLLABUS

Module 1: Kinematics of Machine Tools [10]

Definition and Classifications of machine tools; basic motions and general requirements of machine tool design; mechanisms for transmission of motions; fundamental of kinematic structures of machine tools; types of drives and their elements; selection and design requirements of machine tool drives; classification of speed and feed boxes.

Module 2: Regulation of spindle speeds and design of gear box [10]

Aim of speed and feed rate regulation; stepped regulations and productivity loss; layout of spindle speeds; preferred numbers; design of gear box for speed and feed regulation: structure diagram, ray diagram, determination of shaft size, number of gear teeth, gear width, module;

rules for layout of gear boxes having sliding clusters; gearing diagram for gear box; stepless regulation.

Module 3: **Design of Machine Tool Structures** **[12]**

Classifications of machine tool structures; basic principles of design for strength and rigidity; unit strength and unit rigidity, optimum design criteria; materials for machine tool structures; profiles of machine tool structures; methods of increasing strength and rigidity; basic design procedure for machine tool structure; design for strength and rigidity for bending and torsion; general design procedures for beds, tables and columns; design of lathe bed, design of column of milling machine.

Module 4: Machine Tool Guideways and Spindle **[10]**

Function, requirements and types of guideways; constructional features and tribological aspects of guideways; slideways; slideway profiles and their applications; materials for slideways; design of slideways for wear resistance and stiffness; protecting devices for slideways; antifriction guideways; antifriction guideways profiles and their applications; combination guideways; function, requirements and basic design procedure of spindles; materials for spindles.

Module 5: Control Systems for Machine Tools; and Machine Tool Vibrations **[8]**

Basic elements of machine tool controls; principle of lever, wheel and push button operations; mechanical controls, electrical controls; ergonomic considerations applied to the design of control members;

Vibration in machine tools; dynamic rigidity and stability; sources of vibration; effect of vibration on machine tool, cutting conditions, workpiece and tool life; machine tool chatter; analysis of single degree of freedom machine tool chatter: velocity principle and related models; elimination of vibration.

Text Book

1. A. Bhattacharya and S. G. Sen., Principles of Machine Tool, New central book agency Calcutta. **(T1)**
2. N.K. Mehta, Machine Tool Design and Numerical Control, Tata McGraw Hill. **(T2)**
3. D. K Pal, S. K. Basu, Design of Machine Tool, Oxford. **(T3)**

Reference Book

1. N. S. Acherkan, Machine Tool, Vol. I, II, III and IV, MIR publications. **(R1)**
2. F. Koenigsberger, Design Principles of Metal Cutting Machine Tools, The Macmillan Company, New York **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of spindle supports, Power screws

POs met through Gaps in the Syllabus:
POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:
Numerical control of machine tools

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 1-3, 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	2								2	3	2	3
CO2	3	3	3	2						1		2	3	2	3
CO3	3	3	3	2						1		2	3	2	3
CO4	3	3	3	2						1		2	3	2	3
CO5	3	3	3	2						1		2	3	2	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

COURSE INFORMATION SHEET

Course code: PE 312
Course title: MACHINE TOOL DESIGN SESSIONAL
Pre-requisite(s): Nil
Co- requisite(s): PE 311 MACHINE TOOL DESIGN
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Learn classification and requirements of machine tools
2	Get acquainted with different mechanisms of mechanical transmission
3	Understand the techniques used for regulations of spindle speeds and design of gear box
4	Develop an understanding of basic design procedures for machine tool structures like beds, guideways
5	Learn ergonomic consideration applied to the design of different control members

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

CO1	Classify the machine tools and specify different machine tools
CO2	Select feasible mechanisms of mechanical transmission during machine tool design
CO3	Design gear boxes for required speed layout of machine tools
CO4	Design machine tool structures like beds, guideways
CO5	Design control elements used in machine tools

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Classification of machine tools**

Objective: To classify the machine tools

i. Classify the machine tools according to their weight, degree of automation and degree of specialization.
ii. Classify the machine tools and to specify the machine tools available in workshop and/or machine tools lab

.

2. **EXPERIMENT – 2: Study of different mechanisms of mechanical transmission used in machine tools (Part - I)**

Objective: To study different mechanisms of mechanical transmission used in machine tools:

i. Elementary transmission that transfer rotation
ii. Elementary transmission that transform rotary motion into translatory motion

3. **EXPERIMENT – 3: Study of different mechanisms of mechanical transmission used in machine tools (Part – II)**

Objective: To study different mechanisms of mechanical transmission used in machine tools:

i. Devices for intermittent motion
ii. Reversing and differential mechanisms

4. **EXPERIMENT – 4: Study of kinematic structures of different machine tools**

Objective: To study the kinematic structures of different machine tools:

i. Elementary kinematic structure in broaching machine, milling machine, cylindrical grinding machine with hydraulic table feed movement
ii. Complex kinematic structure in screw cutting lathe, lathe for cutting taper threads
iii. Compound kinematic structure in arrangement for thread milling, cylindrical grinding (tapered or conical profile)

5. **EXPERIMENT – 5: Speed layout of machine tools and analysis of productivity loss**

Objective: To find the speed layout ad to calculate the productivity loss:

i. Find the speed layout (steps) arranged in Geometric, Harmonic and Logarithmic progression for the following conditions. N_1 = 30 rpm; N_Z = 375 rpm and speed steps Z = 12.
ii. Find the average and maximum productivity losses for above speed layouts

6. **EXPERIMENT – 6: Analysis of speed structure and design of gear box (Part - I)**

Objective: To design a 4-speed gear box for transmitting 10 HP with speeds ranging from 400 rpm, with $\varphi = 1.4$.

i. Study the basic rules for constructing admissible structural forms
ii. Select a suitable structural form
iii. Select the optimum ray diagram.
iv. Calculate the shaft sizes

7. **EXPERIMENT – 7: Analysis of speed structure and design of gear box (Part - II)**

Objective: To design a 4-speed gear box for transmitting 10 HP with speeds ranging from 400 rpm, with $\varphi = 1.4$.

i. Calculate the gear sizes, module and width of the gears.
ii. Study the rules for layout of gear boxes having sliding clusters
iii. Draw the gearing diagram.

8. **EXPERIMENT – 8: Study of different gearing arrangements for feed regulations in machine tools**

Objective: To study the different gearing arrangements for feed regulations in machine tools:

i. Feed boxes with change gears
ii. Feed boxes with sliding gears
iii. Feed boxes with gear cone and sliding key
iv. Feed boxes with tumbler gear (Norton's gear)

v. Feed boxes with Meander's mechanism

9. EXPERIMENT – 9: Design of lathe bed (Part – I)

Objective: To design a lathe bed using 'design for strength' criteria

i. Design for strength by considering the shear stress due to torsion,
ii. Design for strength by considering the bending stress due to bending in vertical and horizontal directions

10. EXPERIMENT – 10: Design of lathe bed (Part – II)

Objective: To design a lathe bed using 'design for stiffness' criteria

i. Determine the moment of inertia of the bed about Y-Y and Z-Z axes for determining σ_{zmax} and σ_{ymax} and the deflections in the Z and Y directions
ii. Determine the torsional moment of inertia for determining τ_{max} and the maximum angle of twist.

11. EXPERIMENT – 11: Design of sideways

Objective: To design of slideways for 'wear resistance'

i. Determination of forces acting on the mating surfaces in a combination of two flat slideways
ii. Determination of average pressure
iii. Determination of maximum pressure

.

12. EXPERIMENT – 12: Design of control elements

Objective: Study the various ergonomic consideration applied to the design of different control members.

i. Push buttons
ii. Toggles
iii. Knobs
iv. Crank
v. Hand wheel, etc

Text Book

1. A. Bhattacharya and S. G. Sen., Principles of Machine Tool, New central book agency Calcutta. **(T1)**
2. N.K. Mehta, Machine Tool Design and Numerical Control, Tata McGraw Hill. **(T2)**
3. D. K Pal, S. K. Basu, Design of Machine Tool, Oxford. **(T3)**

Reference Book

1. N. S. Acherkan, Machine Tool, Vol. I, II, III and IV, MIR publications. **(R1)**
2. F. Koenigsberger, Design Principles of Metal Cutting Machine Tools, The Macmillan Company, New York **(R2)**

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

Design of spindles

POs met through Gaps in the Syllabus:

POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:
Use of software for design analysis

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 1-3, 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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution				
Day to day performance & Lab files	30				
Quiz 1	10				
Viva-voce	20				
End Semester Examination	**% Distribution**				
Examination: Experiment Performance	30				
Quiz 2	10				
Assessment Components	**CO1**	**CO2**	**CO3**	**CO4**	**CO5**
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√			
Quiz 2			√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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	2	1	1						1		1	2	2	2
CO2	3	2	2	1								2	3	2	3
CO3	3	3	3	2						1		3	3	2	3
CO4	3	3	3	2						1		3	3	2	3
CO5	3	3	3	2						1		3	3	2	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, CD3, CD6
CO2	CD1, CD3, CD6
CO3	CD1, CD3, CD6
CO4	CD1, CD3, CD6
CO5	CD1, CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 313
Course title: TOOL DESIGN
Pre-requisite(s): PE 204 MANUFACTURING PROCESS-I, PE 301 MANUFACTURING PROCESS-II
Co- requisite(s): Nil
Credits: 4 L:3 T: 1 P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	To learn about materials of tooling and their properties and to learn about the economic aspects of tools
2	Understand the basic principles and types of location & clamping and Learn about various types of jigs and fixtures and their design
3	Learn the components of die set assembly and types of dies
4	Understand the concept of design of blanking and piercing die, drawing dies and forging die
5	The procedure for design of single point cutting tool, drill bits, form tools and milling cutter to be explained to students

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

CO1	Understand the types and choice of tool materials and perform economic analysis of using tools.
CO2	Design various jig and fixture for industrial requirement through creative thinking.
CO3	Demonstrate the process of designing blanking & piercing die.
CO4	Demonstrate the process of designing drawing dies and forging die.
CO5	Design single point cutting tools, form tools, drills and milling cutters.

SYLLABUS

Module 1: Introduction [7]
Introduction to tool design, Materials for tooling: Materials for cutting tools, dies and punches; Economics of Tooling.

Module 2: Jigs & Fixtures [11]
Jigs & Fixtures: Principal of design and construction, Location and clamping; Basic concept for design of Turning, Milling, Drilling and Indexing Jigs and fixtures

Module 3: Cutting Die **[12]**

Components of dies assembly, Classification of dies; Blanking and piercing die: Shearing action, Punch and die clearance, centre of pressure, cutting force, design of die elements.

Module 4: Forming Die **[10]**

Drawing Die: Calculation of blank diameter, number of draws; Forging die

Module 5: Cutting tool **[10]**

Design of tools for the production of holes, and surfaces of revolution, and flat surfaces like single point tools, form tools, drills, milling cutters.

Text books:

1. Production Engineering Design (Tool Design) bySurender Kumar, Umesh Chandra and S.C. Srivastava, Satya Prakashan **[T1]**
2. Tool Design by C. Donaldson**,** G.H.Lecain, V.C.Goold, and Joyjeet Ghose, Tata McGraw Hill **[T2]]**

Reference books:

1. K. A. Victor, Properties and Selection of Tool Material, ASM, 1975.**[R1]**
2. Fred H. Colvin, Jigs & Fixtures, McGraw-Hill Book Co., 1948. **[R2]**
3. P. H. Joshi, Jigs and Fixtures Design Manual, Mc Graw Hill, 2003 **[R3]**
4. Handbook, Fundamentals of Tool Design, ASTME **[R4]**
5. E. Osterguard, Basic Die Making, Mc-Graw Hill Book Co, 2013. **[R5]**
6. F. W. Wilson, Fundamentals of Tool Design, Literary Licensing, LLC, 2012. **[R6]**

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:

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	2			3	2	1	1	1	1	2	3	3	2	2
CO2	3	3	1	1	1	2	1	1	1	1	2	2	3	2	3
CO3	3	3	3	1	1	2	1	1	1	1	2	2	2	2	3
CO4	3	3	1	1	1	2	1	1	1	1	2	2	2	2	3
CO5	3	3	1	1	1	2	1	1	1	1	2	2	2	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 314
Course title: STATISTICAL QUALITY CONTROL
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the philosophy of quality improvement and use of statistics in quality control.
2	To learn various methods for measurement of central tendency and dispersion
3	Understand and use various control charts for attributes and variables.
4	Learn the concept of process capability analysis.
5	Understand the concept of acceptance sampling, OC curves and preparation of acceptance sampling plans for attributes.
6	Understanding the general idea of Robust Parameter Design approaches
7	Understand the concept of quality circle, quality audit, ISO 9000 and six sigma

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

CO1.	Understand the philosophy of quality improvement, basic concept of statistical quality control, Quality audit and six sigma.
CO2.	Demonstrate the ability to design, use, and interpret control charts and perform analysis of process capability.
CO3.	Prepare and analyse sampling plans for attributes
CO4.	Understand the general idea of Robust Parameter Design approaches
CO5	Understand the concept of ISO-9000 quality system, quality audit and six sigma.

SYLLABUS

Module 1: Basics in statistical quality [6]
Introduction to Quality Control, Statistics in quality control, Cost of Quality, Graphical and Analytical Methods for Central Tendency and Dispersion

Module 2: Control charts for variables and attributes [10]
General Theory of Control Charts, Theory and Application of Control Charts for Averages, Range, Standard Deviation, Fraction Defective and Number of Defects, Process Capability Study, Interpretation of Control Chart

Module 3: Acceptance sampling plans [10]

100% Sampling Vs. Statistical Sampling, Elementary Concepts of Acceptance Sampling by Attributes, Concept and Characteristics of O.C. Curves, Single, Double and Multiple Sampling Plans, Construction and Use of O.C. Curves for Sampling Plans, MIL – STD Plans, Sequential Sampling Plan

Module 4: Quality Engineering [8]

Quality loss function, Concepts of Taguchi technique and robust design, signal-to-noise ratio, Introduction to Design of experiments (DOE), Orthogonal array and Analysis of variance (ANOVA)

Module 5: Quality management systems [6]

Concept of Quality Circle and TQM, ISO–9000 Quality Systems, Quality Audit, Concept of Six Sigma and DMAIC

Text Books:

1. Introduction to Statistical Quality Control, Douglas C. Montgomery, Wiley **[T1]**
2. Fundamentals of quality control and improvement, A Mitra, Wiley **[T2]**
3. Mechanical Reliability, L.S. Srinath, Affiliated East – West Press **[T3]**
4. Statistical Quality Control & Reliability, D.H. Besterfield, Prentice Hall, **[T4]**
5. Total Quality Management, D.H. Besterfield, Prentice HallStatistical, **[T5]**
6. Quality control, M. Mahajan, Dhanpat Rai & Sons, **[T6]**

Reference books:

1. Manufacturing Excellence in Global Markets, W. Euershelm **[R1]**
2. Manufacturing Systems Design & Analysis, B. Wa. **[R2]**
3. Computer Automation in Manufacturing, T.O.Boucher **[R3]**
4. Intelligent Manufacturing Planning, P. Gu. **[R4]**

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

Sampling plan for variables

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

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

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	3	3	2	3
CO2	3	2	1		2					1	2	2	3	1	3
CO3	3	3	3		2		1			1	1	3	3	2	3
CO4	3	2	1				1	1		1	2	2	3	1	3
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

COURSE INFORMATION SHEET

Course code: PE 315
Course title: WORK STUDY & ERGONOMICS
Pre-requisite(s): Nil
Co- requisite(s): PE 316 WORK STUDY & ERGONOMICS LAB
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the basic concept as well as scope of work study and Ergonomics.
2	Analyses existing work method at macro and micro level to eliminate the unwanted activities for improvement of existing method and development of the best work method.
3	Estimate standard time for existing as well as proposed work method.
4	Evaluate job as well as rate the merit of the worker and estimate the wages and wage incentives for fair days' work.
5	Understand the basic principle of ergonomics, metabolism and measure of physiological functions.

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

CO1	Apply the concept of work study and ergonomics for enhancement of industrial productivity.
CO2	Analyse the work method and develop an improved work method.
CO3	Find out the standard time of carrying out task under specified working conditions.
CO4	Evaluate the job and rate the merit of the worker.
CO5	Analyse the human factor engineering.

SYLLABUS

Module 1: Productivity and Work Study [10]
Definition, objective and scope of work study and ergonomics and its historical background, Interrelationship between work study and ergonomics, Concept of Productivity, Reasons for low productivity, Role of work study and ergonomics in productivity improvement.

Module 2: Method study [6]
Definition, objectives and procedure of method study, Various recording techniques for method analysis, principles of motion economy and their application in work design, Therbligs, Objectives procedure and application of micromotion analysis.

Module 3: Work measurement **[8]**

Conceptual framework, objectives and basic procedure of work measurement; procedure of stop watch time study, concept and methods of rating and allowances, evaluation of standard time. Work sampling: Basic procedure of work sampling study and establishment of standard-time by work sampling method. Predetermined motion time system, Methods Time Measurement (MTM).

Module 4: Job evaluation, merit rating and wage incentive plans **[8]**

Definition, objectives and techniques of job evaluation and merit rating. Cvarious wage incentive techniques such as straight-line method, Taylor's differential wage incentives plans, Mevrick plan, Gantt plan, Emersion's efficiency plan, Halsey plan, Rowan plan.

Module 5: Ergonomics **[8]**

Man – machine interaction, design of controls and displays, work physiology and its application in work design, work station design.

Text Books:

1. Ralph M. Barnes, Motion and Time Study: Design and Measurement of Work, Wiley, 7th Edition **[T1]**
2. Sanders, M. S., & McCormick, E. J., Human factors in engineering and design. McGraw-Hill book company. **[T2]**
3. David J. Oborne, Ergonomics at Work, Wiley, 2nd edition **[T3]**
4. O.P. Khanna, A Text-Book of Work Study, Dhanpat Rai Publications **[T4]**

Reference Books:

1. George Kanawaty, Introduction to work study. 4th revised edition, ILO **[R1]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Advance human factor Engineering

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

POs 1-5, 7, 9, 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	2	1	1		1	2	2	3	3	2	3
CO2	3	3	2	2	2	1	1		1	2	2	2	3	2	3
CO3	3	3	3	2	3	1	1		1	2	2	3	3	2	3
CO4	3	3	2	2	2	1	1		1	2	2	2	3	2	3
CO5	3	3	2	3	3	1	1		1	2	2	2	3	2	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

COURSE INFORMATION SHEET

Course code: PE 316
Course title: WORK STUDY AND ERGONOMICS LAB
Pre-requisite(s): Nil
Co- requisite(s): PE 315 WORK STUDY AND ERGONOMICS
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the method of draw process chat and learn best way of assembly.
2	expose the students to various work sampling methods and performance evaluation.
3	Evaluate the physical working capacity of various machine.
4	Measure the effect of posture.
5	Understand to evaluate multi activity chart.

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

CO1	Draw different process chart and do time study.
CO2	Find idle time of operation and evaluate performance by different rating methods.
CO3	Prepare flow process chart as per given narrative.
CO4	Analyze the effect of posture in any operation by cycle ergometer.
CO5	Draw multi activity chart for any assembly.

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Two hand process chart**
   Objective: To draw two hand process charts for bolt and washer assembly by old and improved method.

2. **EXPERIMENT – 2: Assembly of rope clip**
   Objective: Assembly of rope clip by old and improved methods.

3. **EXPERIMENT – 3: Pin board assembly**
   Objective: To find the best method for pin board assembly.

4. **EXPERIMENT – 4: Assembly of bracket**
   Objective: Assembly of bracket and bolt by old and improved methods.

5. **EXPERIMENT – 5: Work sampling method-I**
Objective: To find the idle tome by work sampling method.

6. **EXPERIMENT – 6: Performance evaluation**
Objective: Performance evaluation by card rating.

7. **EXPERIMENT – 7: Time study-I**
Objective: Time study for drilling and chamfering operations.

8. **EXPERIMENT – 8: Preparation of flow process chart**
Objective: To prepare flow process chart as per the given narrative.

9. **EXPERIMENT – 9: Assembly of nuts and bolts**
Objective: Assembly of nuts and bolts in various subjects.

10. **EXPERIMENT – 10: Effect of posture**
Objective: Effect of posture on the response to cycle ergometer exercise.

11. **EXPERIMENT – 11: Multiple activity chart**
Objective: To make multiple activity chart from the given operations.

12. **EXPERIMENT – 12: Physical working capacity**
Objective: Evaluation of physical working capacity of various machines.

13. **EXPERIMENT – 13: Time study-II**
Objective: Time study for turning operation in center lathe.

14. **EXPERIMENT – 14: Work sampling-II**
Objective: work sampling study from the given machines.

Text Book

1. Ralph M. Barnes, Motion and Time Study: Design and Measurement of Work, Wiley, 7th Edition [**T1**]
2. Sanders, M. S., & McCormick, E. J., Human factors in engineering and design. McGRAW-HILL book company. [**T2**]
3. O.P. Khanna, A Text-Book of Work Study, Dhanpat Rai Publications [**T3**]

Reference Book

1. George Kanawaty, Introduction to work study. 4th revised edition, ILO **[R1]**

Gaps in the syllabus (to meet Industry/Profession requirements):
Unavailability of advanced equipment.

POs met through Gaps in the Syllabus:
PO-5

Topics beyond syllabus/Advanced topics/Design:
Latest equipment in the field of work study and ergonomics.

POs met through Topics beyond syllabus/Advanced topics/Design:
PO-5, 6, 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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√			
Quiz 2			√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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	2		3					3			2	2	3	3
CO2	3	2		3					3			2	2	3	3
CO3	3	2		3					3			2	2	3	3
CO4	3	2		3					3			2	2	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	CD3, CD6
CO2	CD3, CD6
CO3	CD3, CD6
CO4	CD3, CD6
CO5	CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 317
Course title: ADVANCED WELDING TECHNOLOGY
Pre-requisite(s): PE 201 METALLURGY, PE 204 MANUFACTURING PROCESSES - I
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Learn about the fundamental principles, process parameters and application possibilities of solid-state welding and radiant beam welding processes
2	Learn about the fundamental principles, process parameters and application possibilities of hybrid welding and allied processes
3	Understand different techniques applied for different welding positions and welding conditions
4	Understand the use of welding symbols and design procedure for weld joints under different loading conditions
5	Learn about weldability of specific materials and welding applications

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

CO1	Classify solid-state welding and radiant beam welding processes and identify their advantages, limitations and application possibilities
CO2	Compare the fundamental principles, equipment, parameters and applications of different hybrid welding, thermal cutting and metal surfacing processes
CO3	Select appropriate techniques for different welding positions and welding conditions
CO4	Design weld joints for different loading conditions and to minimize weld distortion
CO5	Select appropriate welding techniques for different sets of materials for different welding applications

SYLLABUS

Module 1: Solid state welding and radiant beam welding [8]

Fundamental principles, process parameters, machines and equipment, advantages, limitations and application possibilities of cold welding, diffusion welding, forge welding, friction and inertia welding, explosive welding, ultrasonic welding;

Fundamental principles, process parameters, machines and equipment, advantages, limitations and application possibilities of electron beam welding and laser beam welding; principle of conduction mode and keyhole welding;

Module 2: Advanced welding and allied processes [8]

Laser arc hybrid welding - fundamental principles, hybrid laser GMAW process, hybrid laser GTAW process, hybrid laser PAW process, paraxial and coaxial arrangements, welding parameters, joint gap, joint configuration and edge preparation, weld quality and industrial applications;

Thermal cutting processes – oxygen cutting, arc cutting, high energy beam cutting; metal surfacing – cladding, hard facing, build-up, buttering; metal spaying processes; soldering, brazing and braze welding;

Module 3: Welding positions and welding conditions [7]

Processes and conditions for welding in down hand or flat, horizontal, vertical and overhead positions;

Welding in wind; welding at low ambient temperatures; welding in vacuum; welding in space; underwater welding processes;

Module 4: Residual stress, weld design, and pre/post heat treatments [9]

Principle of residual stress, types of residual stress, methods of identifying residual and the stress reliving methods. Numerical problems in residual stresses; principle of distortions, types of distortion, methods of the eliminating distortion;

Types of welded joints, design of butt joints, lap joints, eccentrically loaded joints, welding symbols, estimation of preheat temperature and post heat temperature

Module 5: Weldability of specific materials and welding applications [8]

Weldability of carbon steels, stainless steels, high alloy steels, cast iron, aluminium, copper and titanium;

Application of welding in automobile industries, aerospace industries, ship building industries; concept of robotized welding and welding automation

Text books:

1. R. L. Little, Welding and Welding Technology, Tata McGraw Hill **[T1]**
2. R.S. Parmar, Welding Process and Technology, Khanna Publishers [**T2]**
3. O.P. Khanna, Welding Technology, Dhanpat Rai Publication **[T3]**

Reference books:

1. H.B. Cary and S.C. Helzer, Modern Welding Technology, Pearson/Prentice Hall. **[R1]**
2. J. Lawrence, Advances in Laser Materials Processing 2e, Woodhead Publishing/ Elsevier. **[R2]**
3. Welding Handbook, 9th ed., Vol. 2, Welding Processes. American Welding Society. **[R3]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Welding of polymers and composites, Simulation of welding process

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 1-4, 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	2	2	1								2	3	2	3
CO2	3	2	2	1	1							2	3	2	3
CO3	3	3	3	2	1							2	3	3	3
CO4	3	3	3	2	1					1		2	3	3	3
CO5	3	3	3	2	1							3	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, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 318
Course title: RAPID PROTOTYPING AND TOOLING
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students to:

1	Understand technology used in rapid prototyping and tooling.
2	Recognized importance of rapid prototyping in advance manufacturing process.
3	Acquire knowledge, techniques and skills to select relevant rapid prototyping and tooling process.
4	Comprehend the potential of rapid prototyping and tooling in different industrial sectors.
5	Illustrated 3D printing technology for Rapid prototyping and tooling

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

CO1	Explain rapid prototyping and tooling for manufacturing complex geometries.
CO2	Identify and solve problems related to rapid prototyping and tooling.
CO3	Select suitable process and materials for rapid prototyping and tooling
CO4	Distinguish technique of CAD and reverse engineering for geometric transformation in rapid prototyping and tooling.
CO5	Determine part orientation, apply suitable slicing algorithm and generate tool path for minimum build time.

SYLLABUS

Module 1: Introduction [8]

Evolution, basic principle, concept, procedure and need of rapid prototyping and tooling, Classification of rapid prototyping and tooling processes (Additive/Subtractive/Deformative), Classifications of materials used for Rapid prototyping and tooling, Industrial applications of rapid prototyping and tooling, Most commonly used processes for rapid prototyping.

Module 2: Processes used for rapid prototyping and tooling [8]

Stereolithography Apparatus (SLA), Fused Deposition Modeling (FDM), Selective Deposition Lamination (SDL), Laminated Object Manufacturing (LOM), Ultrasonic Consolidation, Laser Engineered Net Shaping (LENS), Electron Beam Free Form Fabrication (EBFFF), Selective Laser Sintering (SLS), Electron Beam Melting (EBM).

Convectional Tooling vs Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect rapid tooling methods.

Module 3: CAD for rapid prototyping and tooling [8]
Preparation of 3D-CAD model in STL format, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and generation of codes for tool path.

Module 4: Constructions of manipulator systems for rapid prototyping and tooling [8]
Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors, Energy delivery systems, Material delivery systems.

Module 5: Post processing in rapid prototyping and tooling [8]
Support material removal, Surface texture improvement, Accuracy improvement, Aesthetic improvement, Property enhancements using non-thermal and thermal techniques.

Text books:
1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010. **[T1]**
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003. **[T2]**
3. Ian Gibson, "Software Solutions for Rapid Prototyping", Professional Engineering Publishing Limited, UK, 2002. **[T3]**

Reference books:
1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007. **[R1]**
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. **[R2]**
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000. **[R3]**

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

POs met through Gaps in the Syllabus:
POs 1,2,5

Topics beyond syllabus/Advanced topics/Design:
Rapid Tooling Injection Molded Prototypes

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 1,8,12

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	1	2		3	2		1	1	1			1	2	1	2
CO2	1	3	1	2					2			1	2	2	2
CO3	1		2	1		1			1				3	1	3
CO4		2	2	1	2		1		1	2			3	1	3
CO5	1	3		1	1		1		2	1		1	2	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 319
Course title: MATERIAL DEFORMATION PROCESSES
Pre-requisite(s): ME 205 STRENGTH OF MATERIALS, PE 204 MANUFACTURING PROCESSES - I
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives
This course enables the students:

1	To study various metal working, un-conventional forming operations (conventional as well as modern) and thermo-mechanical treatment
2	To conceptualize theory of elasticity, plasticity and yielding as related to material deformation processes
3	To apply the concepts of friction and lubrication in various material deformation processes
4	To analyse plane-strain and axi-symmetric deformation processes
5	To conceptualize and apply various methods for analysis of deformation processes

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

CO1	Understand the principles of various material deformation processes
CO2	Learn the importance of various mechanical and metallurgical factors which control forming processes
CO3	Analyze the forming processes mathematically, in terms of their operating parameters and outputs
CO4	Familiarize about recent trends and techniques adopted in the field of material deformation processes.
CO5	Select proper lubrication based on type of material deformation process they are required for

SYLLABUS

Module 1: Basics of Plastic Deformation [7]
Basic concepts of hot, cold and worm working, forming operations, forces and stresses in forming processes, Thermo-mechanical treatment**.** Emerging Deformation Processes: Principles and applications of Isothermal forging, water hammer forging, liquid metal forging (squeeze casting), continuous extrusion (conform extrusion), hydro–static extrusion, hydro–dynamic wire drawing, spray forming, explosive forming

Module 2: Material Deformation theories [10]

State of stress at a point, equilibrium equations, stress tensor, spherical tensor and deviator stress tensor, principal stress, deformation tensor, compatibility equation

Engineering and true stress –strain, flow curve, idealized stress-strain model, plastic deformation equations, Levy–Mises equations, Prandlt–Reuss equations, strain hardening, strain rate and Bauschinger effects

Velocity field and strain rate, Von – Mises and Tresca yield criterion, biaxial and triaxial yield surfaces, experimental verification of yield criterion, lode–stress parameter

Module 3: Friction and lubrication [5]

Interfacial friction laws–Coulombs friction law, constant shear factor law, composite friction law and hydrodynamic friction law, friction mechanism during plastic deformation, lubrication mechanisms– boundary, hydrodynamic and solid lubrication, metal working lubricants–types and characteristics

Module 4: Plain Strain Deformation Processes [9]

Basic concepts of slip-line method, slab method (equilibrium technique) and energy method (upper bound technique)

Analysis of following deformation processes:

Forging of strip: pressure distribution and forging load

Rolling of strip: pressure distribution, roll–separating force and driving torque

Module 5: Axi-Symmetric Deformation Processes [9]

Analysis of following deformation processes:

Forging of disc: pressure distribution and forging load

Extrusion of cylindrical rod: extrusion load and frictional power loss

Drawing of cylindrical wire: drawing load and maximum allowable reduction

Pipe drawing operation

Text books:

1. George E. Dieter, Mechanical Metallurgy, McGraw Hill, 3rd Edition **[T1]**
2. Ghosh and Mallik, Manufacturing Science, Pearson India, 2nd Edition **[T2]**
3. B.L Juneja, Fundamentals of Metal Forming Processes, New Age International, 2nd Edition [**T3]**

Reference books:

1. G.W. Rowe, Edward Arnold, Principle of Industrial Metal Working, CBS Publishers, 1st edition **[R1]**
2. B. Avitzur, Metal Working Processes and Analysis, McGraw Hill, 1st edition **[R2]**

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

Finite Element Method, Slip Line method

POs met through Gaps in the Syllabus:

POs 1-5

Topics beyond syllabus/Advanced topics/Design:

Upper Bound Solution

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

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	2	2	3	2		1		2		1	2	2	3	2
CO2	3	3	2	3	3	2	1					2	2	3	2
CO3	3	3	3	3	3				2	2		2	2	2	2
CO4	1	2		2	3	2	2	3	1	2		1	3	2	2
CO5	2			2		2	3	1			1	2	1	2	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

COURSE INFORMATION SHEET

Course code: PE 324
Course title: SURFACE ENGINEERING AND LASER ADDITIVE MANUFACTURING
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 03 L: 03 T: 00 P: 00
Class schedule per week: 03
Class: B. Tech
Semester / Level: VI/ Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the science and importance of surfaces, surface dependent properties of engineering solids
2	Learn about appropriate testing procedures to evaluate surface dependent engineering properties
3	Acquire fundamentals and practices of various surface engineering techniques to improve surface dependent engineering properties of metallic, ceramic and polymeric solids
4	Get familiar with directed energy beam techniques (laser, ion, and electron beams) and in particular laser assisted surface engineering and material processing
5	Develop an understanding of laser assisted additive manufacturing techniques and its application

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

CO1	Classify and relate various surface degradation and surface-initiated failure mechanisms of engineering solids occurring under different service conditions.
CO2	Analyze the importance, relative advantages and limitations and overall scope of application of various surface engineering methods
CO3	Compare and contrast different surface modification and coating technologies from various perspectives of applicability, economy, efficiency, and scopes of further improvement
CO4	Analyze real life surface failure problems (case studies) and prescribe the correct surface engineering solution
CO5	Explore the applications potential of laser additive manufacturing of engineering components – flexibility, advantages, limitations, current status and future developments awaited

SYLLABUS

Module 1: Structure of Solids; Surface Dependent Engineering Properties [4]
Introduction to structure of solids: structure, morphology, energy, types and classification.
Surface dependent engineering properties: physical, chemical and mechanical – their definition, origin and importance.

Module 2: Mechanisms of Surface Degradation and Failures [8]

Common surface-initiated engineering degradation/failures and their mechanism: wear, friction, fatigue, corrosion, oxidation.

Importance of surface engineering (SE), Classification and scope of surface engineering of alloys and components, Methods and principles of surface modification of materials; Strengthening mechanism of engineering materials – metallic and non-metallic.

Module 3: Surface Modification and Surface Coating Techniques [16]

Conventional surface modification methods: shot peening, flame and induction hardening, carburizing, nitriding, diffusion aided surface alloying

Surface coating techniques by chemical/electro-chemical routes: electro/electroless deposition, anodizing, galvanizing, etc.

Surface coating by physical routes: thermal/plasma spray, physical/chemical vapor deposition, sputtering, etc.

Module 4: Advanced Surface Modification Techniques [6]

Advanced surface modification methods: laser, plasma, ion and electron beam assisted surface engineering.

Module 5: Laser Additive Manufacturing [6]

Additive manufacturing vis-à-vis subtractive manufacturing, Advantages and challenges, recent trend and innovation, laser assisted additive manufacturing of polymers, metals and alloys, characterization and testing.

Text and Reference Books:

1. Surface Engineering for Wear Resistances (Introduction and classification of Wear), By: K.G. Budinski, Prentice Hall, Englewood Cliffs, 1988 **[T1]**
2. Corrosion Engineering (classification of Corrosion), By: M.G. Fontana, M.C. Graw Hill, N. York, 1987 **[T2]**
3. Materials Science and Engineering by W. D. Callister
4. Introduction to Surface Engineering and Functionally Engineered Materials, by Peter Martin, WILEY, 2011
5. Surface Engineering of Metals: Principles, Equipment, Technologies, by: Tadeusz Burakowski, Tadeusz Wierzchon, CRC Press, 1988
6. Surface Engineering for Corrosion and Wear Resistance, by JR Davis, ASM International, 2001
7. Additive Manufacturing by Andreas Gebhardt and Jan-Steffen Hötter, Springer, 2016
8. Additive Manufacturing of Metals by John O. Milewski, Springer, 2017

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:

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	2	3	2	1	1	1	1	1	3	2	3	3
CO2	3	3	3	2	3	2	1	1	1	1	1	3	2	3	3
CO3	3	3	3	2	3	2	1	1	1	1	2	3	3	3	3
CO4	3	3	3	3	3	2	1	1	1	1	1	3	3	3	3
CO5	3	3	3	2	3	2	1	1	1	1	1	3	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, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 6
CO4	CD1, CD2, CD 6
CO5	CD1, CD2, CD 6

COURSE INFORMATION SHEET

Course code: MC 300
Course title: SUMMER TRAINING
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L: T: P:
Class schedule per week: NA
Class: B. Tech
Semester / Level: VI / Third
Branch: Production Engineering
Name of Teacher:

Course Objectives:

1	To provide opportunities for learning, understanding and sharpening the technical / management skills required in the job in real time
2	To enhance knowledge of production engineering acquired by students in the classroom through field experience
3	To expose students to current technological developments relevant to the training subject
4	To expose students to the duties and ethics of the engineer
5	To promote professional, academic and/or personal development

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

CO1	Understand an industry's structure, culture and work and gain awareness of potential careers
CO2	Relate and strengthen what was taught at the classes through practical experience in the related field
CO3	Effectively perform in assigned responsibilities
CO4	Identify and understand different industrial practices and professional ethics
CO5	Effectively and professionally communicate with people and work in groups

The student should undergo industrial training / internship for a minimum period of one month during the summer vacation of 3rd year. Research project or internship in an academic institution within the country (IISc / IITs / NITs / Engineering Institute or University of repute) or university abroad is also permitted instead of industrial training.

Course Evaluation:

Evaluation through Seminar Presentation/Viva-Voce
The assessment will be based on the following criteria:

i. Quality of content presented.
ii. Proper planning of presentation.
iii. Effectiveness of Presentation
iv. Depth of knowledge and skills.

Evaluation of Student's Report

The training report will be evaluated according to the following criteria:

i. Originality
ii. Adequacy and purposeful write-up
iii. Organization, format, drawing, sketches, style, language etc.
iv. Variety and relevance of learning experience
v. Practical applications, relationships with basic theory and concepts taught in the course.

Assessment Tool	% Contribution during CO Assessment
Presentation and/or Viva-voce	60
Student's reports	40

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	1	1	1	1		2					1	2	2	2	2
CO2	2	1	1	2	2	2						2	3	3	2
CO3	2	1	1	1	1	1			3				3	3	2
CO4	1	1	1	1		3	3	3			2	2	3	3	3
CO5	1	1	1	1	1	3	1			3	1		2	2	3

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

COURSE INFORMATION SHEET

Course code: MT 130
Course title: PROFESSIONAL PRACTICE, LAW & ETHICS
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 2 L:2 T:0 P:0
Class schedule per week: 2
Class: B. Tech
Semester / Level: VII / First
Branch: All
Name of Teacher:

Course Objectives

1.	To make the students aware about engineering ethics and human values
2.	To instill moral and social values and loyalty
3.	To enable the students to appreciate the rights of others
4.	To balance work dynamics with environmental ethics
5.	To balance global issues with engineering studies

SYLLABUS

Module 1: Human values
Morals, Values and Ethics – Work Ethics; Civic Sense; Time Management; Empathy; Self Confidence and Character Building
Spirituality – Introduction to Yoga and Meditation Leading to Professional Excellence
Dynamics of Stress Management

Module 2: Engineering ethics and global issues
Professional Responsibilities of Engineers- Engineers as Emerging Strategists; Codes of Ethics for Engineers with Special Reference to ABET; Teaching of Engineering Ethics
Basis of Engineering Ethics – Variety of Moral Issues; Moral Dilemmas; Moral Rules in Engineering Practice
Dynamics of Multi Culturalism and Multi Nationalism

Module 3: Health, safety and environment issues
Safety, Responsibilities and Rights; Risk Benefit Analysis; Corporate Social Responsibility
Occupational Hazards and Health Issues
An Overview of Waste Management

Module 4: Basics of general established laws for engineeers
Overview of the Following Acts-
Contract Act 1972; FEMA 2002; Industrial Disputes Act 1947; Factories Act 1948

Module 5: Contemporary legal issues for engineeering practices
A Balanced Outlook in Law- Professional Rights, Employee Rights and Human Rights; Collective Bargaining;

Blue Collar and White Collar Crime;
Intellectual Property Rights (IPR); Cyber Crime and Information Technology Act 2000

Text books:

1. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003. **[T1]**
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004. **[T2]**

Reference books:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004. **[R1]**
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003. **[R2]**

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 Gaps in the Syllabus

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															
CO2															
CO3															
CO4															
CO5															

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	
CO2	
CO3	
CO4	
CO5	

COURSE INFORMATION SHEET

Course code: PE 402
Course title: AUTOMATION IN MANUFACTURING
Pre-requisite(s): PE 204 MANUFACTURING PROCESSES - I, PE 301 MANUFACTURING PROCESSES - II
Co- requisite(s): PE 403 AUTOMATION IN MANUFACTURING LAB
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VII / Fourth
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	To learn how to apply the principles of mechatronics and automation for the development of productive and efficient manufacturing systems
2	To recognize the meaning of Machine tool automation, and to develop skill in part programming
3	Acquire knowledge about controllers and Sensor
4	To acquire knowledge about Machining Lines Automation, Assembly automation
5	Apply concepts for the planning, design, analysis and implementation of flexible manufacturing systems and CIM

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

CO1	Know the various aspects of automation in manufacturing.
CO2	Recognize the fundamentals of Machine Tool Automation and part programming
CO3	Knowledge about various control systems and Product Automation
CO4	Machining Lines Automation and Assembly automation
CO5	Implement FMS, and CIM concept in a manufacturing environment and product development through automation.

SYLLABUS

Module 1: Introduction to Automation **[8]**
Manufacturing automation, components and types of automation, CAD, CAM, Computer Control of Manufacturing Systems. Mechatronics in Manufacturing Systems. Modeling of Mechanical Systems for Mechatronics Applications, Automation Strategies in manufacturing industries,

Module 2: CNC Tools **[8]**
Basic Principles, classification and structure of NC systems, NC-coordinate system, Constructional features and feedback devices for CNC machine tools, part programming (Fanuc), DNC and adaptive control.

Module 3: Sensors and Actuators **[8]**
Sensors, Actuators, Control System in manufacturing: Mechanical & Electric mechanical system, Pneumatics and hydraulics and servo control in CNC machine tools, Illustrative examples and case studies

Module 4: Assembly Automation **[8]**
Assembly Automation: Automatic Assembly Transfer Systems, Transfer mechanism, buffer storage and control functions for transfer devices, feeding mechanism definition and concept, AGV, AS/RS

Module 5: Flexible Automation **[8]**
Flexible automation: Flexible manufacturing systems: concept, need, structure & operation, objectives and benefits. Quantitative Analysis of Flexible Manufacturing Systems, Cellular Manufacturing, CIM

Text books:

1. M.P. Groover, Automation, Production System, and CIM [**T1]**
2. P. Radhakrishnan, CNC Machines **[T2]**
3. Nanua Singh, System approach to Computer Integrated Design and Manufacturing [**T3]**

Reference books:

1. Y. Koren, Numerical Control of Machine Tools **[R1]**
2. P.N. Rao, Manufacturing Technology II, **[R2]**
3. N. Viswannadham & Y Narhari, Performance Modeling of Automated Manufacturing System **[R3]**

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time industrial projects

POs met through Gaps in the Syllabus:
POs 3,5,6

Topics beyond syllabus/Advanced topics/Design:
PLC Technology

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 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	3
CO2	3	2	1			1				1	2	2	3	1	3
CO3	2	3	3			1				1	1	3	2	2	2
CO4	3	2	1			1	1	1		1	2	2	3	1	3
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, CD6
CO4	CD1, CD3, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 403
Course title: AUTOMATION IN MANUFACTURING LAB
Pre-requisite(s): Nil
Co- requisite(s): PE 402 AUTOMATION IN MANUFACTURING
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: VII / Fourth
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the various types of CAM Software's like Fanuc, Siemen's, etc. and their practical usage in manufacturing applications
2	Learn concepts of machining parameters and cutting tools for CNC milling and turning jobs and Develop industrial components by interpreting 3D part models/ part drawings
3	Gain the concepts of CAM Software, CNC technology, to convert a CNC-lathe into a CNC-Milling machine and vice-versa
4	Be acquainted with standard industrial robot, its sub-systems and prepare a demonstration of a simple programmed task
5	Give a hands-on experience in a rigging an industrial pneumatics and electro-pneumatics circuit and PLCs

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

CO1	Apply the concepts of machining for selection of appropriate machining centers, machining parameters, select appropriate cutting tools for CNC milling and turning equipment, set-up, program, and operate CNC milling and turning equipment.
CO2	Create and validate NC part program data using manual data input (MDI) for manufacturing of required component using CNC milling or turning applications through CAM Software's like Fanuc, Siemen's, Unimat etc.
CO3	Apply the concepts of CNC technology to convert a CNC-lathe into a CNC-Milling machine and vice-versa and also to carry out machining using programmed part programs.
CO4	Calibrate program a standard industrial robot and analyse the control behaviour of a robot controller
CO5	Create a typical pneumatic and electro-pneumatic circuit and program a PLC and create a simple demonstration.

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1:**
Objective: To write a manual part program for step turning operation for a given drawing and simulate in FANUC/SIEMENS CNC lathe simulator.

2. **EXPERIMENT – 2:**
Objective: To write a manual part program for radius cutting and taper turning operation for a given drawing and simulate in FANUC/SIEMENS CNC lathe simulator.

3. **EXPERIMENT – 3:**
Objective: To write a program for grooving and threading operation for a given drawing. and simulate in FANUC/SIEMENS CNC lathe simulator.

4. **EXPERIMENT – 4:**
Objective: To Convert a modular CNC-mill machine into CNC-Lathe machine and write a program for step turning operation in CNC Lathe.

5. **EXPERIMENT – 5:**
Objective: To write a manual part program for taper turning operation for a given drawing in CNC Lathe

6. **EXPERIMENT – 6:**
Objective: To write a part program for profile milling operation using linear and circular interpolation cutting for a given drawing and simulate in FANUC/SIEMENS CNC milling

7. **EXPERIMENT – 7:**
Objective: To write a manual part program for circular and rectangular pocketing for a given drawing and simulate in FANUC/SIEMENS CNC milling simulator

8. **EXPERIMENT – 8:**
Objective: To write a manual part program for Profile cutting with sub-program and right compensation for given drawing and simulate in FANUC/SIEMENS CNC milling

9. **EXPERIMENT – 9:**
Objective: To study and learn how to operate CNC milling machine - FANUC/SIEMENS controller.

10. **EXPERIMENT – 10:**
Objective: To machine a part for a given drawing on a CNC milling machine.

11. EXPERIMENT – 11:
Objective: To study the functional details of robots; programm and simulate the pick and place operation of a Robot

12. EXPERIMENT – 12:
Objective: To study the various types of sensors and PLC Programming

Text Books:

1. Mikell P. Grover "Automation, Production Systems and Computer-Integrated Manufacturing" Pearson Education, New Delhi. **(T1)**
2. Rao, P.N. "CAD/CAM: Principles and Applications", McGraw Hill Publication, 2nd Edition, 2004. **(T2)**
3. Mikell P. Grover, E. Zimmer, "Computer Aided Design and Manufacturing (CAD/CAM)", Pearson Publication, 2nd Edition, 2006. **(T3)**

Reference Books:

1. David Bedworth, "Computer Integrated Design and Manufacturing" Tata McGraw Hill,

New Delhi, 1998. **(R1**)

2. Radhakrishan P., Subramaniyam S., "CAD CAM and CIM", New Age International, 2002 **(R2)**

Gaps in the syllabus (to meet Industry/Profession requirements):
Design of real-time Industrial projects.

POs met through Gaps in the Syllabus:
PO 5

Topics beyond syllabus/Advanced topics/Design:
Design optimization for industrial projects

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 4,5, 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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	√
Quiz 1	√	√			
Quiz 2			√	√	√
Viva-voce	√	√	√	√	√
Examination: Experiment Performance	√	√	√	√	√

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	2		3					3			2	2	3	3
CO2	2	2		3					3			2	3	2	3
CO3	3	2		2					3			2	2	3	3
CO4	3	2		3					3			2	2	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, CD3
CO2	CD1, CD3, CD7
CO3	CD1, CD3, CD7
CO4	CD1, CD3, CD6, CD7
CO5	CD1, CD2, CD3, CD6, CD7

COURSE INFORMATION SHEET

Course code: PE 404
Course title: MODELLING AND SIMULATION LAB
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: VII / Fourth
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Impart skill to use simulation software
2	Develop the ability to build models before simulation.
3	Think of various practical applications of simulation in manufacturing
4	Manually solve small simulation problems using random numbers and probability distributions.

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

CO1	Comprehend the basics of discrete event simulation as applied to various manufacturing and service problems
CO2	Build soft models in computer program/software for a given situation using randomly generated distributions
CO3	Develop a simulation table using pseudo-random numbers or a simulation model using software program
CO4	Analyze the output from a simulation model

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Introduction to simulation**
   Objective: To explain the basics of modelling and simulation like discrete events, activities, queue and random numbers in simulation

2. **EXPERIMENT – 2: Simulation software**
   Objective: To study the various simulation software and their features particularly useful in manufacturing and logistics

3. **EXPERIMENT – 3: Introduction to simulation exercise (Manual)**
   Objective: To use pseudo-random numbers in solving simulation problems

4. **EXPERIMENT – 4: Simulation of bank operation**
   Objective: Simulation of a bank is to be performed using manual approach using probability distributions for arrival and service time

5. **EXPERIMENT – 5: Simulation of robotic work cell**
   Objective: Simulation of a robotic work cell is to be performed using manual approach using probability distributions for machine operation, loading unloading by robot

6. **EXPERIMENT – 6: Simulation of drill press operation**
   Objective: Simulation of a drill press is to be performed using manual approach using probability distributions for operation.

7. **EXPERIMENT – 7: Simulation of a grocery shop**
   Objective: Simulation of a grocery shop is to be performed using manual approach using probability distributions for arrival and service for customers

8. **EXPERIMENT – 8: Simulation exercise using GPSS software**
   Objective: Simulation of a food store is to be performed using GPSS software and analyze the output

9. **EXPERIMENT – 9: Simulation of factory maintenance**
   Objective: Simulation of a factory maintenance service is to be performed using GPSS software and analyze the output

10. **EXPERIMENT – 10: Simulation of ambulance dispatch**
    Objective: Simulation of an ambulance dispatch service is to be performed using GPSS software and analyze the output

11. **EXPERIMENT – 11: Simulation using WITNESS software**
    Objective: To learn the software WITNESS and its features for simulation

12. **EXPERIMENT – 12: Simulation of factory shop floor**
    Objective: To apply the software WITNESS for simulation of a factory shop floor

13. **EXPERIMENT – 13: Monte Carlo simulation**
    Objective: To apply MINITAB software for a Monte Carlo simulation problem

Reference Book

1. Jerry Banks, Discrete event system simulation, Pearson new International Edition **[R1]**
2. Averil M. Law and David Kelton, Simulation modelling and analysis, McGraw Hill **[R2]**

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

Ware house and logistic simulation

POs met through Gaps in the Syllabus:

POs 3,5

Topics beyond syllabus/Advanced topics/Design:
Simulation of sheet metal forming, casting and welding

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 2,4,5

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	
Quiz 1	√	√	√		
Quiz 2			√	√	
Viva-voce	√	√	√	√	
Examination: Experiment Performance	√	√	√	√	

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	1	2			3		1				1	1	2	2	2
CO2		2	2	3	2	1		1				1	1	3	3
CO3		2		3	3		1	1	3		1		2	3	3
CO4			2	2	2	1			2	2		1	3	2	2

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, CD3, CD7
CO2	CD1, CD3, CD7
CO3	CD1, CD3, CD7
CO4	CD1, CD3, CD7

COURSE INFORMATION SHEET

Course code: PE 405
Course title: MANUFACTURING SCIENCE
Pre-requisite(s): PE 204 MANUFACTURING PROCESSES – I, PE 301 MANUFACTURING PROCESSES - II
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VII / Fourth
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Learn about the gating system design, riser design and product design for casting
2	Understand the mechanisms of different bulk forming and sheet metal forming techniques
3	Understand the mechanics of orthogonal and oblique cutting including process mechanics of different machining processes
4	Understand the principles of fusion welding, solid state welding and solid-liquid state welding
5	Learn about the mechanism of material removal, process parameters and applications of different modern machining processes

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

CO1	Design the gating system, riser and products for sand casting
CO2	Explain the mechanisms of forming processes and able to design of dies and presses for sheet-metal processes
CO3	Analyse the cutting forces, estimate machining time, determine economics of machining
CO4	Describe and utilise the conceptual ideas of fusion, solid state and solid-liquid state welding, including techniques for weld inspection and defect minimization
CO5	Exploit the technical know how about different modern machining processes for manufacturing applications

SYLLABUS

Module 1: Casting Processes [8]

Pattern, mould and pattern allowances; melting and pouring - gating design, pouring time, choke area, sprue design and aspiration effect, other gating elements and gating ratios, slag trap systems; riser design and placement – Caine's method, modulus method, Naval Research Laboratory method, feeding distances and chills; product design for sand casting.

Module 2: Forming processes **[8]**

Bulk forming and sheet metal forming; material behaviour in metal forming; temperature in metal forming; strain rate sensitivity; friction and lubrication in metal forming; mechanisms of forming processes – rolling, forging, drawing, deep drawing, extrusion, punching and blanking; hydroforming and electroforming.

Module 3: **Machining processes** **[8]**

Mechanics of orthogonal and oblique cutting; mechanics of machining processes – shaping and planning, turning and boring, drilling and milling; selection of cutting conditions and calculation of machining time; economics of machining.

Module 4: Joining processes **[8]**

Principle of fusion welding – heat sources, modes of metal transfer in arc welding, heat flow characteristics, gas metal reaction, heat balance in resistance welding, cooling of fusion weld; principle of solid state welding – friction and forge welding; principle of solid-liquid state welding - soldering and brazing; weld design considerations, weld defects and inspection, weldability.

Module 5: Modern manufacturing processes **[8]**

Mechanism of material removal, process parameters and applications of abrasive jet machining, water jet machining, ultrasonic machining, electro-discharge machining, electro-chemical machining, laser beam machining, electron beam machining; concept and principle of operation of layered manufacturing.

Text books:

1. Ghosh and A.K. Mallik, Manufacturing Science, Affiliated East- West Press **[T1]**
2. P. N. Rao, Manufacturing Technology, Vol 1 & 2, Tata McGraw Hill **[T2]**
3. J.T. Black and R.A. Kohser, Degarmo's materials and processes in manufacturing, John Wiley & Sons,Inc **[T3]**

Reference books:

1. M P. Groover, Fundamentals of modern manufacturing John Wiley & Sons, Inc.**[R1]**
2. T. Childs, K. Maekawa, T. Obikawa, Y. Yamane, Metal Machining: Theory and Applications, Arnold.**[R2]**
3. P.K. Mishra, Nonconventional Machining, Narosa Publishing House Pvt. Ltd.**[R3]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Process modelling of casting, forming, machining and joining. Advanced studies on non-conventional machining and additive manufacturing.

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	3	3	1					1		3	3	3	3
CO2	3	3	3	2	1					1		3	3	3	3
CO3	3	3	3	3	1							3	3	2	3
CO4	3	3	3	2	1							3	3	2	3
CO5	3	3	3	3	1							3	3	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 406
Course title: NON-CONVENTIONAL MACHINING PROCESSES
Pre-requisite(s):
Co- requisite(s):
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VII / Fourth
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Learn about the different non-conventional machining processes and their operational characteristics
2	Learn about the basic construction of the different non-conventional machines, and about the tools, equipment and consumable required
3	Understand the effects of different process parameters on part quality, and how the parameters are to be controlled
4	Study different empirical, analytical and theoretical approach for analysis of material removal for different processes.
5	Learn about the developments of different hybrid non-conventional machining techniques

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

CO1	Explain the fundamental principles, techniques, equipment, applications, advantages and limitations of different non-conventional machining processes.
CO2	Find solutions for meeting demand of machining hard-to-machine materials, producing complex shape and size with greater product accuracy and surface finish
CO3	Analyse the influence of process parameters on part quality
CO4	Explain the developments and operation potential of different hybrid non-conventional machining techniques
CO5	Select appropriate non-conventional machining technique based on work materials used and the part features to be produced

SYLLABUS

Module 1: Introduction and mechanical processes (AJM, WJM, AWJM, USM) [8]
Need and classifications of non-conventional Machining Processes
Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Abrasive Jet Machining (AJM), Water Jet Machining (WJM) and Abrasive Water Jet Machining (AWJM); calculation of material removal rate (MRR) for ductile and brittle materials in AJM;

Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Ultrasonic Machining (USM); Calculation of MRR in USM by empirical approach, Cook's model, Shaw theory.

Module 2: Chemical and electrochemical processes (ChM, ECM) [8]
Fundamental principles, application possibilities, process parameters, operational characteristics and tooling of Chemical Machining (ChM); Chemical Milling, Photochemical Milling, Electropolishing;
Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Electrochemical Machining (ECM); electrolytes; electrochemistry of ECM; kinematics and dynamics of ECM, Effect of heat and hydrogen bubble generation; design of tool shape, electrolyte flow and insulation, surface finish and accuracy.

Module 3: Thermal processes (EDM, WEDM) [8]
Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Electro Discharge Machining (EDM); mechanics of EDM; theories of material removal in EDM; types of EDM; dielectric fluid; electrode material; pulse generation; flushing techniques, effects on material surface, surface finish and accuracy; dry EDM;
Operation principles, applications, process parameters of Wire Electro Discharge Machining (WEDM)

Module 4: Thermal Processes (LBM, EBM, PAM, IBM) [8]
Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Laser Beam Machining (LBM); types of lasers and lasing process; mechanics of LBM; surface finish and accuracy;
Fundamental principles, application possibilities, process parameters, schematic layout of machine and operational characteristics of Electron Beam Machining (EBM), and Plasma Arc Machining (PAM), Ion Beam Machining (IBM).

Module 5: Hybrid Machining Processes [8]
Fundamental principles, applications and operational characteristics of Electrochemical Grinding, Electrodischarge Grinding, Electrochemical Discharge Machining and Electrochemical Discharge Grinding, Abrasive Electrodischarge Machining, EDM with Ultrasonic Assistance, Ultrasonic-Assisted ECM, Laser-Assisted ECM, Laser-Assisted Oxygen cutting.

Text books:

1. P. C. Pandey and H. S. Shan, Modern Machining Processes, Tata McGraw-Hill **[T1]**
2. P. K. Mishra, Non-conventional Machining, Narosa Publishing House **[T2]**
3. Hassan El-Hofy, Advanced Machining Processes, McGraw-Hill **[T3]**

Reference books:

1. Ghosh and A.K. Mallik, Manufacturing Science, Affiliated East- West Press **[R1]**
2. Bhattacharyya, New Technology, The Institution of Engineers (India) **[R2]**
3. M P. Groover, Fundamentals of Modern Manufacturing, John Wiley & Sons, Inc. **[R3]**

Gaps in the syllabus (to meet Industry/Profession requirements):
Hands-on exposure on non-conventional machining processes

POs met through Gaps in the Syllabus:
POs 1-5, 12

Topics beyond syllabus/Advanced topics/Design:
Machining and super-finishing in sub-micron level

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	3	1								3	3	2	3
CO2	3	3	3	3	1							3	3	2	3
CO3	3	3	3	2	1							3	3	2	3
CO4	3	3	3	2								3	3	2	3
CO5	3	3	3	3	1							3	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 407
Course title: ADVANCED MANUFACTURING PROCESSES
Pre-requisite(s): PE 204 MANUFACTURING PROCESSES - I, PE 301 MANUFACTURING PROCESSES - II
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: VII / Fourth
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students:

1	To understand the concepts of advanced casting processes like Squeeze casting; Rheo-casting; Thixo-casting;
2	To identify suitable hybrid welding processes for joining dissimilar materials.
3	To understand the latest forming Techniques like Super plastic forming, Thixoforming, etc.
4	To understand the principles of powder metallurgy processes and their applications.
5	To understand the Processing methods of Plastics.

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

CO1	Design the Gating and Riser systems of modern casting processes;
CO2	Understand the environmental issues of advanced welding processes;
CO3	Handle real-life projects in various organizations
CO4	Solve complex problems with the knowledge of latest powder metallurgy processes
CO5	Explore the processing methods of Plastics and advanced materials.

SYLLABUS

Module 1: Advanced Casting Processes [8]

Newer casting processes - plaster mold and ceramic mold casting – vacuum casting – Evaporative pattern casting, ceramic shell and investment casting, slush casting, squeeze casting; Rheo-casting, and Thixo-casting -Rapid solidification of Amorphous alloys.

Module 2: Advanced Welding Processes [8]

Cold welding, diffusion welding, forge welding, Friction stir welding, explosive welding, Vacuum welding, vacuum welding, Underwater Welding Processes, Laser beam welding; Concept of robotized welding and welding automation.

Module 3: Advanced Forming **[8]**

High Energy Rate Forming (HERF) techniques, Super plastic forming techniques, Orbital forging, Ring Rolling, Incremental forming, Isothermal forging, Hot and cold iso-static pressing, High speed extrusion, Rubber pad forming, Explosive forming, Hydroforming; Vacuum forming; Thixoforming;

Module 4: Powder Metallurgy **[8]**

Methods of Powder production – Blending of metal powders- Compaction of metal powders- Sintering – hot pressing –Isostatic pressing – hot and cold (HIPing and CIPing), laser Sintering; Metal Injection moulding, pressure less compaction, ceramic moulds – spray deposition - Finishing of sintered parts.

Module 5: Manufacturing Process for plastics **[8]**

Extrusion, Injection, Blow and rotational moulding of plastics-Thermoforming-Compression moulding – Transfer moulding – Foam moulding - Processing of reinforced plastics and composite –Moulding – compression, vacuum bag – contact – resin transfer – transfer / injection moulding.

Text books:

1. Serope Kalpakjian, Steven R. Schemid, "Manufacturing processes for Engineering Materials", Fourth edition, Pearson Education, 2003 **[T1]**
2. Serope Kalpakjian, "Manufacturing Engineering and Technology", Third Edition-Addison-Wesley Publication Co., 1995. **[T2]**

Reference books:

1. Brahem.T.Smith, "Advanced machining", I.F.S., U.K.1989. **[R1]**
2. Amstead B.H., Ostwald Phylips and Bageman.R.L., "Manufacturing Processes" John Wileys Sons, 1987. **[R2]**
3. Muccic, E.A., "Plastic Processing Technology", Materials park, OHIO, ASM Int., 1994. **[R3]**
4. Jaeger R.C., "Introduction to microelectronic Fabrication", Addision-Wesley, 1988. **[R4]**

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

Advances in Machining and Non-traditional machining

POs met through Gaps in the Syllabus:

POs 4,5

Topics beyond syllabus/Advanced topics/Design:

Rapid prototyping

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

POs 4-6

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	3
CO2	3	2	1			1				1	2	2	3	1	3
CO3	3	3	3			1				1	1	2	2	2	3
CO4	3	2	1			1	1	1		1	2	3	3	2	3
CO5	3	3	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

COURSE INFORMATION SHEET

Course code: MT 204
Course title: CONSTITUTION OF INDIA
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 0 L:2 T: P:
Class schedule per week: 2
Class: B. Tech
Semester / Level: VII / Second
Branch: All
Name of Teacher:

Course Objectives:
This course enables the students:

1	To describe the importance and role of Constitution of India
2	To explain the provisions related to social problems and issues.
3	To explain the significance of the constitution for maintaining social unity and integrity.
4	To describe the process for formulating and designing public policies in accordance with the constitutional provisions.

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

CO1	Outline the need and importance of the Indian constitution.
CO2	Explain the fundamental rights and duties of the citizens of India.
CO3	Relate appropriate constitutional provisions with relevant social issues
CO4	Describe the role of different departments of government.
CO5	Critique the Government policies and programmes designed for the society at large.

SYLLABUS

Module 1
Introduction to the Constitution of India, Salient Features of the Constitution: Sources and constitutional history, Features: Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy

Module 2
Union and State Executives: President and Prime Minister, Council of Ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha. Governor: Role and Position, Chief Ministers and Council of ministers.

Module 3
The Indian Judicial System – The Supreme Court and The High Court's – composition, Jurisdiction and functions, The Role of the Judiciary.

Module 4

Local Government- District's Administration: Role and Importance, The Panchayatas – Gram Sabha, Constitution and Composition of Panchayats, Constitution and Composition of Municipalities

Module 5

Miscellaneous- Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Books recommended:

1. The Constitution of India by "Ministry of Law India" Kindle Edition
2. Constitutional History of India by Prof.M.V.PYLEE-S.Chand Publishing
3. Indian Administration by Avasti and Avasti-Lakshmi Narain Agarwal Educational Publishers.2017 edition.
4. Introduction to the Constitution of India by D D Basu by Lexis Nexis : 20th edition.
5. Constitution of India V.N.Shukla's EBC Explorer Edition 13th ,2017

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:

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 Between Course Outcomes (COs) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD1
CO2	CD1
CO3	CD1, CD2
CO4	CD1, CD2
CO5	CD1, CD2, CD4

COURSE INFORMATION SHEET

Course code: PE 400
Course title: RESEARCH PROJECT / INDUSTRIAL INTERNSHIP
Pre-requisite(s):
Co- requisite(s):
Credits: 12 L: T: P:
Class schedule per week: NA
Class: B. Tech
Semester / Level: VIII / Fourth
Branch: Production Engineering
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Use the relevant knowledge and skills acquired during the domain course to solve the problem.
2	Extract relevant literature survey information and formulate project specifications, and implement project plan
3	Use appropriate techniques and tools to conduct experiments, analyse data and draw appropriate results-based conclusions and identify applications
4	Draw appropriate conclusions based on the results and identify applications
5	Prepare a technical report in the form of a thesis and effectively communicate using multimedia tools through oral presentation

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

CO1	Identify and understand current trends and real-world issues in production engineering
CO2	Formulate project specifications, identify a set of feasible solutions and prepare and implement project plan
CO3	Use critical thinking skills to review, analyse and interpret data and results
CO4	Demonstrate work knowledge of ethics and professional responsibility at various stages such as project formulation, design, implementation and presentation
CO5	Publish the results of the project work in journal or conference proceedings, present the work effectively and communicate with confidence in the defence of the work

Course Evaluation:

Project work can be carried out preferably independently or by a group of students not exceeding two (2). More than two students in a group shall be discouraged. Internship shall be independent. Department Committee shall be appointed by the Head of the Department. The Guide of the candidate shall not participate in the evaluation process by the department committee.

Direct Assessment-

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

Progressive Evaluation	% Distribution
Assessment by Department Committee	25
Assessment by Project Guide (s):	25
End Semester Examination	**% Distribution**
End Sem Exam (External Examiner)	50

Assessment Components	CO1	CO2	CO3	CO4	CO5
Assessment by Department committee	√	√	√	√	√
Assessment by Project Guide (s):	√	√	√	√	√
End Sem Exam (External Examiner)	√	√	√	√	√

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	3	3	3			1			2	3	3	3
CO2	3	3	3	3	3	3			1			2	3	3	3
CO3	3	3	3	3	3	3			1			2	3	3	3
CO4	3	3	3	3	3	3	1	3	2		3	2	3	3	3
CO5	2	2	2	2	2	2			1	3		2	3	3	3

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

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

Syllabus (CBCS UG Program)
B.Tech. in Production Engineering

(OFFERED ONLY TO B.TECH IN PRODUCTION ENGINEERING 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.

COURSE INFORMATION SHEET

Course code: PE 310
Course title: INDUSTRIAL ROBOTICS
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 4 L:3 T:1 P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: V (MO) / 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]
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:

9. James G. Keramas, "Robot Technology Fundamentals" Cengage Learning India. **[T1]**
10. 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

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 320
Course title: SUSTAINABLE MANUFACTURING
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L: 3 T: 0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: V (MO) / 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 [8]

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 [8]

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 [8]

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

Module 4: Sustainable characteristics **[8]**

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

Module 5: Sustainable Product design **[8]**

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:

4. G. Atkinson, S. Dietz, E. Neumayer, "Handbook of Sustainable Manufacturing", Edward Elgar Publishing Limited, 2007. **[R1]**
5. P. Lawn, Sustainable Development Indicators in Ecological Economics, Edward Elgar Publishing Limited. **[R2]**
6. 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

COURSE INFORMATION SHEET

Course code: PE 321
Course title: MANUFACTURING MANAGEMENT AND COST OPTIMISATION
Pre-requisite(s): PE 304 PRODUCTION AND OPERATION MANAGEMENT
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / 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 [8]
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 [8]
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.

Module 3: Product Design and Development [8]
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 **[8]**

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 Optimisation **[8]**

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)

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 322
Course title: PROCESSING OF POLYMERS, COMPOSITE AND ADVANCED MATERIALS
Pre-requisite(s): PE 201 METALLURGY, PE 204 MANUFACTURING PROCESSES - I
Co- requisite(s): Nil
Credits: 3 L: 3 T:0
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / 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 [8]

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 [10]

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

Module 3: **Introduction to composites** **[8]**

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 **[8]**

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 **[6]**

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:

3. T. G. Gutowski, (Ed.) Advanced Composites Manufacturing, John Wiley & Sons, New York 1997. **(R1)**
4. K.K. Chawla, Ceramic Matrix Composites, Kluwer Academic Publishers, 2003. **(R2)**
5. 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:

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)

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 323
Course title: MATERIAL CHARACTERISATION AND NON-DESTRUCTIVE TESTING
Pre-requisite(s): PH 113 PHYSICS, PE 201 METALLURGY, ME 205 STRENGTH OF MATERIALS
Co- requisite(s): Nil
Credits: 3 L: 3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / 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 [8]
Importance of material characterisation; classification of material characterisation 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 [8]
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 [8]
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 [8]
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 [8]
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

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)

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

COURSE INFORMATION SHEET

Course code: PE 408
Course title: MICRO AND NANO MANUFACTURING
Pre-requisite(s): PE 201 METALLURGY, PE 204 MANUFACTURING PROCESSES – I, PE 301 MANUFACTURING PROCESSES - II
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VII (MO) / 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 [8]

Introduction of micro machining process. Mechanical Micro machining; Ultra Sonic, Abrasive Jet, Water Jet and Abrasive Water Jet micro machining. Chemical and Electro Chemical Micro Machining.

Module 2: Thermal micro machining [8]

Introduction of Beam Energy based micro machining; Electron Beam, Laser Beam, Electric Discharge, Ion Beam, Focused ion Beam and Plasma Beam Micro Machining. Hybrid Micro machining processes include Electro Chemical Spark Micro Machining (ECSMM).

Module 3: Nano Polishing [8]

Nano Polishing of Abrasive Flow finishing; Magnetic Abrasive Finishing, Magneto rheological finishing, Magneto Rheological abrasive flow finishing, Magnetic Float polishing, Elastic Emission Machining, chemo-mechanical Polishing.

Module 4: Micro forming and welding [8]

Micro Forming; Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting, Micro Extrusion. Micro bending with LASER. LASER micro welding, Electron beam for micro welding.

Module 5: Applications of micro machining [8]

Metrology for micro machined components, 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	13	14	15
CO1	2	3			1					1	1	1	2	1	2
CO2	2	3	1	3	2			1		1		1	2	2	3
CO3			2	3	3		1		1		1		2	1	2
CO4		1	3	2	3				2	1	1	1	2	1	3
CO5	2	2	1		1	1			2	2		1	2	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

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, MANUFACTURING PROCESSES – I & II
Co- requisite(s): Nil
Credits: 4 L:3 T:1 P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: VII (MO) / 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)

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

MINOR in "Production Engineering"

Syllabus (CBCS UG Program)

(OFFERED ONLY TO OTHER THAN B.TECH IN PRODUCTION ENGINEERING STUDENTS)

Students who have registered for B. Tech Minor in "Production Engineering" should complete 20 credits and shall opt for courses listed in Course Structure for the Minor Program. The credits shall be over and above minimum requirement for degree award.

COURSE INFORMATION SHEET

Course code: PE 203
Course title: OPERATIONS RESEARCH
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T:0 P: 0
Class schedule per week: 3
Class: B. Tech
Semester / Level: V (MO) / Second
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives
This course enables the students to:

1	Apply the techniques of operations research in industrial engineering problems.
2	Formulate a real-world industrial problem as a mathematical programming model
3	Understand the simplex method for linear programming and perform iterations of it by hand
4	Solve specialized linear programming problems like the transportation and assignment problems
5	Operations research helps in solving problems in different environments that needs decisions, such as sequencing, queuing and games theory .

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

CO1	Understand how to translate a real-world problem, given in words, into a mathematical formulation.
CO2	Formulate and solve engineering and managerial situations as LPP.
CO3	Formulate and solve engineering and managerial situations as transportation and assignment problems
CO4	Apply Sequencing and Queuing theory for performance evaluation of engineering and management system.
CO5	Solve engineering and managerial decision theories problems by Game Theory

SYLLABUS

Module 1 Introduction: [8]
Importance of Operation Research, Methodology, Characteristics, Scope, Application and Limitation of Operations Research
Requirement of LP, Basic Assumptions, Mathematical formulation of the of LP, Graphical solution; numerical problems based on these methods.

Module 2 Linear Programming: [8]
Analytical Methods Simplex method, Big-M method, concept of duality; numerical problems based on these methods (preferably industrial engineering-based problems)

Module 3 Transportation & Assignment Model [9]

Basic feasible solution by different methods (North west corner method, least cost method, Vogel's approximation method), finding optimal solutions (MODI method), unbalanced transportation problems; numerical problems based on these methods (preferably industrial engineering-based problems)

Balanced and unbalanced assignments, travelling salesman Problem; numerical problems based on these methods (preferably industrial engineering-based problems)

Module 4 Sequencing and Queuing Model [8]

Processing of ***n*** jobs through two machines, processing ***n*** jobs through three machines; Processing of 2 jobs through ***m*** machines –graphical method, numerical problems based on these methods

Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Queuing system and their characteristics of M/M/1/FIFO/ Queuing system

Module 5: Games Theory [7]

Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and sub games methods.

Text books:

4. Operations Research, (Revised Edition), D.S. Hira, P.K. Gupta, S. Chand & Company Ltd, 2014 [**T1]**
5. Quantitative Techniques Vol I and Vol II, L. C. Jhamb, Everest Publishing House **[T2]**
6. Operations Research, - Kanti Swarup, P. K. Gupta and Man Mohan, Sultan Chand & Sons **[T3]**

Reference books:

3. Operations Research an Introduction –Hamady A. Taha, Prentice Hall. **[R1]**
4. Introduction to Operations Research, 9e, Frederick S. Hillier, Gerald J. Lieberman, Bodhibrata Nag and Preetam Basu, McGraw Hill **[R2]**

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

Revised Simplex, Integer programming, other queuing models, Decision theory, Goal programming, Dynamic programming, Non-linear programming and Simulation. These topics are to be covered in a advanced course.

POs met through Gaps in the Syllabus:

POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:

Advanced Operation Research

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

POs 1, 3, 5, 7, 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	√	√			
Quiz1	√	√			
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	3	3	3	3
CO2	3	3	3	1		1	1	1	2		2	2	3	2	3
CO3	3	3	2			1	1		2		1	3	3	2	3
CO4	3	2	1			1	1	1	2		2	2	3	3	3
CO5	3	2	1			1			2		2	2	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, CD3, CD6
CO2	CD1, CD2, CD3, CD6
CO3	CD1, CD2, CD3, CD6
CO4	CD1, CD2, CD3, CD6
CO5	CD1, CD2, CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 213
Course title: MANUFACTURING PROCESSES
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: V (MO) / Second
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Examine the technical aspect related to basic manufacturing processes
2	Get acquainted with different methods of manufacturing used
3	Analyse different aspects of a manufacturing process along with their appropriate usage and scope
4	Derive relationship and use empirical relations to study the effects of manufacturing parameters on a process
5	Develop an understanding of existing and emerging manufacturing processes

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

CO1	Explain the basic principles behind different Casting, Welding, Forming and machining processes
CO2	Select appropriate manufacturing process for a given component design
CO3	Identify advantages and limitations of various casting, welding, machining and forming techniques
CO4	Correctly explain and construct mathematical relationships existing amongst various parameters in different manufacturing processes
CO5	Select appropriate welding process for a given joint

SYLLABUS

Module 1: Casting **[8]**
Introduction to foundry process and its importance; sand casting: patterns, pattern allowances, gating system components introduction and significance. Centrifugal casting, Hot chamber and cold chamber die casting; Investment casting,

Module 2: Theory of Metal Cutting **[8]**

Geometry of single point cutting tool, Introduction to orthogonal cutting; Tool forces in orthogonal cutting, types of chips, tool failure, tool life, cutting tool materials.

Module 3: Machine Tools **[8]**

Construction, operations and specifications of lathe and shaper. Construction, operations and specifications of milling & drilling machine. Introduction to grinding and types of grinding processes.

Module 4: Metal Deformation Processes **[8]**

Metal forming processes: Introduction to recovery, recrystallization and grain growth; Hot working and cold working

Rolling: Classification of rolling processes, rolling mills, products of rolling and main variables

Forging: Open and closed die forging, forging operations

Extrusion: Classification of extrusion processes, hot and cold extrusion processes

Sheet metal forming operations: Blanking and piercing, deep drawing, bending.

Module 5: Welding **[8]**

Principle, working and application of oxy- acetylene gas welding. Electric arc welding: MMAW/SMAW, SAW, GTAW and GMAW, Resistance welding. Soldering and Brazing

Text books:

11. Serope Kalpakjian and Steven Schmidt, Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition
12. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007
13. P.N. Rao, Manufacturing Technology – Metal Cutting and Machine Tools, McGraw Hill.
14. P.N. Rao, Manufacturing Technology, Foundry, Forming and Welding, McGraw Hill
15. Hajra Choudhury, Elements of Workshop Technology–Vol.-II, Media Promoters and Publishers

Reference books:

7. E. P. DeGarmo, J. T. Black, and R. A. Kohser, Materials and processes in Manufacturing, PHI.
8. P. F. Ostwald, and Jairo Munoz, Manufacturing Processes and Systems, 9th ed., Wiley, India, 2002
9. Principles of metal casting, Rosenthal. P. C, Tata Mc Graw Hill
10. M. C. Shaw, Metal Cutting Principles, Oxford University Press, Oxford, 1984

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

Non-Conventional Machining Processes, Analysis of Manufacturing Processes

POs met through Gaps in the Syllabus:

PO 1-5, PO12

Topics beyond syllabus/Advanced topics/Design:

Advanced Manufacturing Processes

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

PO 1-5, PO12

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		
	3	3	2	2	3		1			1		1	13	14	15
CO1	3	3	3	2	3		1			1		1	3	2	3
CO2	3	3	2	2	3		1			1		1	3	2	3
CO3	3	3	3	2	3		1			1		1	3	2	3
CO4	3	3	3	2	3		1			1		1	3	2	3
CO5	3	3	2	2	3		1			1		1	3	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 307
Course title: COMPETITIVE MANUFACTURING STRATEGIES
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: V (MO) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the concept manufacturing as strategy, WTO and competitive advantages
2	Learn about the product verity, manufacturability, vendor development and vendor rating.
3	Understand the concept of JIT, MRP & ERP must be explained to the students
4	Know the effectiveness CIM, E-manufacturing and simulation as tool of competitive manufacturing
5.	Learn about the various types of Manufacturing systems i.e. Dedicated manufacturing system, Flexible manufacturing system (FMS), cellular manufacturing system (CMS), and Re-configurable manufacturing system (RMS)

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

CO1	Explain the concept of manufacturing strategy.
CO2	Recognize the role of product verity management, product modularity, vendor development, vendor rating and design for manufacturing in improving competitiveness
CO3	Comprehend JIT and MRP based systems
CO4	Explore latest advancements in manufacturing like CIM and e-manufacturing and the role of ERP and simulation as strategy in manufacturing.
CO5	Select proper manufacturing system for a given product and market scenario.

SYLLABUS

Module 1: Competitive Strategies [8]
The competitive environment in the market, The WTO agreement and its effect on Indian Industries, Manufacturing as a competitive strategy, Competitive Advantages and Disadvantages

Module 2: Product Modularity [7]
Product Variety, Modular Design, Design for manufacturability, Vendor Development, Vendor rating.

Module 3: Manufacturing philosophy **[7]**

Just in time (JIT) manufacturing, Kanban system, Agile Manufacturing, Lean manufacturing and tools

Module 4: E-Manufacturing **[10]**

Simulation as tools for competitive manufacturing, MRP, ERP, Concept of CIM and E-Manufacturing, Industry 4.0

Module 5: Recent Manufacturing Scenarios **[8]**

Selection of manufacturing systems for different manufacturing scenarios - Dedicated manufacturing system, Flexible manufacturing system (FMS), cellular manufacturing system (CMS), and Re-configurable manufacturing system (RMS); Elementary of DMS, FMS, CMS, and RMS.

Text books:

1. Manufacturing Excellence in Global Markets W. Euershelm **[T1]**
2. Manufacturing Systems Design & Analysis B. Wa. **[T2]**
3. Computer Automation in Manufacturing T.O.Boucher **[T3]**
4. Intelligent Manufacturing Planning P. Gu. **[T4]**

Reference books:

1. SeropeKalpakjian and Steven Schmidt, Manufacturing Processes for Engineering Materials, Pearson Education, 6th Edition **[R1]**
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Material. Processes, and systems, 2nd Edition, Wiley India, 2007 **[R2]**

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

Forecasting techniques, Marketing strategies,

POs met through Gaps in the Syllabus:

POs 1-3, 12

Topics beyond syllabus/Advanced topics/Design:

Advance Management and marketing techniques

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

POs 1-3, 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	√	√			
Quiz1	√	√			
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	2	3	2	2	1	1	1		1	1	3	3	2	2
CO2	3	2	1	1	1	1			1	1	2	2	3	1	3
CO3	3	3	2	1		1		1	1	1	1	3	3	2	3
CO4	3	2	1	1	1	1		1	1	1	2	2	3	1	3
CO5	3	2	1	1				1	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

COURSE INFORMATION SHEET

Course code: PE 206
Course title: METROLOGY & MEASUREMENT
Pre-requisite(s): Nil
Co- requisite(s): PE 207 METROLOGY & MEASUREMENT LAB
Credits: 3 L: 3 T:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / Second
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives
This course enables the students to:

1	To understand and analyze different measurement systems, Standards of Measurement, Measurement Errors
2	To know about Limits, Fits, tolerance and gauges used in measurement and designing aspects for those
3	To familiar with different types of comparators, optical metrology and their applications
4	To enlighten students about various techniques of measurement of Screw threads, Gears, Geometric forms and Surface textures.
5	To accustom with various measuring devices for measurement of force, torque, strain and acceleration

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

CO1	Distinguish between accuracy and precision, identify different measurement errors, able to select linear or angular measuring instrument for measurement of various components
CO2	Design limit gauges used for various components and purposes
CO3	Explain principles and uses of comparators and optical instruments used in metrology
CO4	Examine various screws threads and gears parameter using different methodology and explain capabilities of machining process by measuring surface finish.
CO5	Implement and analyse appropriate measurement methods for variables like force, torque, strain and acceleration

SYLLABUS

Module – I: Introduction **[6]**
Historical development, Basics of Metrology, Need for Inspection, Accuracy and Precision, Standards of measurements, system of measurement, line, end & wavelength standards, type and source of measurement errors
Linear metrology: Steel rule, callipers, Vernier calliper, Vernier height gauge, Vernier depth gauge, micrometres, universal calliper.

Miscellaneous measurements: Taper measurement, angle measurement, radius measurement, sine bar & Angle gauges

Module – 2: Limit Fits and Gauge [10]

Interchangeable manufacture, selective assembly, concept of limits, fits and tolerances, Types of fit, Basic-Hole System, Basic-Shaft System, Problems, Tolerance grades, Metric fits, Indian standard system, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials, Considerations of gauge design, Taylor's principle of gauging, Wear allowance on gauges

Module – 3: Comparator and Optical gauges [6]

Principle and uses of mechanical, optical, Electrical, electronic and pneumatic Comparators
Principle of interferometer, concept of optical flat, projector, microscope, autocollimator and interferometer
Types of machine tool tests, alignment tests for lathe, milling and drilling machine tools

Module – 4: Form Measurement [10]

Terminology of screw threads, Measurement of minor, major, thread angle and effective diameter of screw threads by 2-wire and 3- wire methods, best size wire. Screw thread gauges, Tool maker's microscope
Gear tooth terminology, gear tooth thickness & pitch measurement, involutes profile testing of gear
Straightness, flatness and squareness and circularity tests, numerical evaluation, measurement of surface finish, related instruments.
Automated inspection system, Introduction & applications of Co-ordinate Measuring Machine (CMM)

Module – 5: Dynamic measurement [8]

Sensors and Transducers: Types of Sensors, types of transducers and their characteristics
Force and Torque measurement: Direct methods and indirect method, force measuring instruments-load cells, Dynamometer, Power Measurements
Measurement of strain: types of strain gauges, gauge factors, theory of strain gauges and method of measurement, Wheatstone bridge circuit
Vibration and Noise Measurement: Piezoelectric Accelerometer and decibel meters

Text Books:

1. R.K. Jain, Engineering Metrology Khanna Publications, New Delhi **(T1)**
2. I. C. Gupta, A Text book of Engineering Metrology, Dhanpat Rai, New Delhi **(T2)**
3.Er. R K Rajput, Mechanical Measurements and Instrumentations, Kataria Publication (KATSON) **(T3)**
4. M. Mahajan, Engineering Metrology, Dhanpat Rai & Co. New Delhi **(T4)**

Reference Books:

1. K. J. Hume, Engineering Metrology **(R1)**
2. N V Raghavendra and Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press **(R2)**

3. Bentley, Engineering Metrology and Measurements, Pearson Education**(R3)**
4. Anand Bewoor, Vinay Kulkarni, Metrology and Measurement, McGraw-Hill **(R4)**

Gaps in the syllabus (to meet Industry/Profession requirements):
Limited scope to get acquainted with latest gadgets/instruments used in industries.
No direct relation with environmental, societal issues, ethics etc.

POs met through Gaps in the Syllabus:
POs 5-8, 11-12

Topics beyond syllabus/Advanced topics/Design:
Latest equipment in the field of metrology

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 5, 6-8, 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	1		2									2	1	2
CO2	3			1									2	1	2
CO3	3	2	3	2									2	1	2
CO4	3	2	2	1									2	1	2
CO5	3	2	2	1									2	1	2

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, CD 3, CD 6
CO2	CD1, CD2, CD 6
CO3	CD1, CD2, CD 3, CD 6
CO4	CD1, CD2, CD 3, CD 6
CO5	CD1, CD2, CD 3, CD 6

COURSE INFORMATION SHEET

Course code: PE 318
Course title: RAPID PROTOTYPING AND TOOLING
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives
This course enables the students to:

1	Understand technology used in rapid prototyping and tooling.
2	Recognized importance of rapid prototyping in advance manufacturing process.
3	Acquire knowledge, techniques and skills to select relevant rapid prototyping and tooling process.
4	Comprehend the potential of rapid prototyping and tooling in different industrial sectors.
5	Illustrated 3D printing technology for Rapid prototyping and tooling

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

CO1	Explain rapid prototyping and tooling for manufacturing complex geometries.
CO2	Identify and solve problems related to rapid prototyping and tooling.
CO3	Select suitable process and materials for rapid prototyping and tooling
CO4	Distinguish technique of CAD and reverse engineering for geometric transformation in rapid prototyping and tooling.
CO5	Determine part orientation, apply suitable slicing algorithm and generate tool path for minimum build time.

SYLLABUS

Module 1: Introduction [8]

Evolution, basic principle, concept, procedure and need of rapid prototyping and tooling, Classification of rapid prototyping and tooling processes (Additive/Subtractive/Deformative), Classifications of materials used for Rapid prototyping and tooling, Industrial applications of rapid prototyping and tooling, Most commonly used processes for rapid prototyping.

Module 2: Processes used for rapid prototyping and tooling [8]

Stereolithography Apparatus (SLA), Fused Deposition Modeling (FDM), Selective Deposition Lamination (SDL), Laminated Object Manufacturing (LOM), Ultrasonic Consolidation, Laser Engineered Net Shaping (LENS), Electron Beam Free Form Fabrication (EBFFF), Selective Laser Sintering (SLS), Electron Beam Melting (EBM).

Convectional Tooling vs Rapid Tooling, Classification of Rapid Tooling, Direct and Indirect rapid tooling methods.

Module 3: CAD for rapid prototyping and tooling [8]
Preparation of 3D-CAD model in STL format, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation, STL Conversion, STL error diagnostics, Slicing and generation of codes for tool path.

Module 4: Constructions of manipulator systems for rapid prototyping and tooling [8]
Axes, Linear motion guide ways, Ball screws, Motors, Bearings, Encoders/ Glass scales, Process Chamber, Safety interlocks, Sensors, Energy delivery systems, Material delivery systems.

Module 5: Post processing in rapid prototyping and tooling [8]
Support material removal, Surface texture improvement, Accuracy improvement, Aesthetic improvement, Property enhancements using non-thermal and thermal techniques.

Text books:

1. Chua C.K., Leong K.F., and Lim C.S., "Rapid prototyping: Principles and applications", Third Edition, World Scientific Publishers, 2010. **[T1]**
2. Gebhardt A., "Rapid prototyping", Hanser Gardener Publications, 2003. **[T2]**
3. Ian Gibson, "Software Solutions for Rapid Prototyping", Professional Engineering Publishing Limited, UK, 2002. **[T3]**

Reference books:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A toolbox for prototype development", CRC Press, 2007. **[R1]**
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. **[R2]**
3. Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000. **[R3]**

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

POs met through Gaps in the Syllabus:
POs 1,2,5

Topics beyond syllabus/Advanced topics/Design:
Rapid Tooling Injection Molded Prototypes

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 1,8,12

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	1	2		3	2		1	1	1			1	2	1	2
CO2	1	3	1	2					2			1	2	2	2
CO3	1		2	1		1			1				3	1	3
CO4		2	2	1	2		1		1	2			3	1	3
CO5	1	3		1	1		1		2	1		1	2	2	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
CO2	CD1, CD2, CD6
CO3	CD1, CD2, CD6
CO4	CD1, CD2, CD6
CO5	CD1, CD2, CD6

COURSE INFORMATION SHEET

Course code: PE 314
Course title: STATISTICAL QUALITY CONTROL
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Understand the philosophy of quality improvement and use of statistics in quality control.
2	Learn various methods for measurement of central tendency and dispersion
3	Understand and use various control charts for attributes and variables.
4	Learn the concept of process capability analysis.
5	Understand the concept of acceptance sampling, OC curves and preparation of acceptance sampling plans for attributes.
6	Understanding the general idea of Robust Parameter Design approaches
7	Understand the concept of quality circle, quality audit, ISO 9000 and six sigma

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

CO1.	Understand the philosophy of quality improvement, basic concept of statistical quality control, Quality audit and six sigma.
CO2.	Demonstrate the ability to design, use, and interpret control charts and perform analysis of process capability.
CO3.	Prepare and analyse sampling plans for attributes
CO4.	Understand the general idea of Robust Parameter Design approaches
CO5	Understand the concept of ISO-9000 quality system, quality audit and six sigma.

SYLLABUS

Module 1: Basics in statistical quality [6]
Introduction to Quality Control, Statistics in quality control, Cost of Quality, Graphical and Analytical Methods for Central Tendency and Dispersion

Module 2: Control charts for variables and attributes [10]
General Theory of Control Charts, Theory and Application of Control Charts for Averages, Range, Standard Deviation, Fraction Defective and Number of Defects, Process Capability Study, Interpretation of Control Chart

Module 3: Acceptance sampling plans **[10]**

100% Sampling Vs. Statistical Sampling, Elementary Concepts of Acceptance Sampling by Attributes, Concept and Characteristics of O.C. Curves, Single, Double and Multiple Sampling Plans, Construction and Use of O.C. Curves for Sampling Plans, MIL – STD Plans, Sequential Sampling Plan

Module 4: Quality Engineering **[8]**

Quality loss function, Concepts of Taguchi technique and robust design, signal-to-noise ratio, Introduction to Design of experiments (DOE), Orthogonal array and Analysis of variance (ANOVA)

Module 5: Quality management systems **[6]**

Concept of Quality Circle and TQM, ISO–9000 Quality Systems, Quality Audit, Concept of Six Sigma and DMAIC

Text Books:

1. Introduction to Statistical Quality Control, Douglas C. Montgomery, Wiley **[T1]**
2. Fundamentals of quality control and improvement, A Mitra, Wiley **[T2]**
3. Mechanical Reliability, L.S. Srinath, Affiliated East – West Press **[T3]**
4. Statistical Quality Control & Reliability, D.H. Besterfield, Prentice Hall, **[T4]**
5. Total Quality Management, D.H. Besterfield, Prentice HallStatistical, **[T5]**
6. Quality control, M. Mahajan, Dhanpat Rai & Sons, **[T6]**

Reference books:

1. Manufacturing Excellence in Global Markets, W. Euershelm **[R1]**
2. Manufacturing Systems Design & Analysis, B. Wa. **[R2]**
3. Computer Automation in Manufacturing, T.O.Boucher **[R3]**
4. Intelligent Manufacturing Planning, P. Gu. **[R4]**

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

Sampling plan for variables

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

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

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	3	3	2	3
CO2	3	2	1		2					1	2	2	3	1	3
CO3	3	3	3		2		1			1	1	3	3	2	3
CO4	3	2	1				1	1		1	2	2	3	1	3
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

COURSE INFORMATION SHEET

Course code: PE 308
Course title: LOGISTICS AND SUPPLY CHAIN MANAGEMENT
Pre-requisite(s): PE 203 OPERATIONS RESEARCH
Co- requisite(s): Nil
Credits: 3 L:3 T: P:
Class schedule per week: 3
Class: B. Tech
Semester / Level: VI (SP) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Provide an insight on the fundamentals of supply chain strategy
2	Know the various distribution and transportation networks and their applications
3	Acquire the concepts of logistics in improving the supply chain and other functional areas of an organization
4	Understand the role of sourcing, information technology, and coordination in a supply chain
5	Know the recent trends in supply chain management

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

CO1	Define the goal of a supply chain and analyse the impact of supply chain decisions on the success of a firm
CO2	Develop a framework for making supply chain network design decisions
CO3	Apply logistics concepts to improve supply chain operations
CO4	Evaluate and select the best supplier for a firm or organisation.
CO5	Discuss the recent trends in supply chain management

SYLLABUS

Module 1: Introduction to Supply Chain Management [8]
Understanding the supply chain, Supply Chain Performance- Achieving strategic fit and scope, key issues, Supply chain modelling, Supply Chain Drivers and Metrics, Centralized vs. decentralized systems.

Module 2: Designing the Supply Chain Network [9]
Distribution Networks– Design options for a distribution network, e-Business and the distribution network, Network design in an uncertain environment. Transportation Networks- Design options for a transportation network, Trade-offs in transportation design, Vehicle routing and scheduling, Supply Chain Optimization.

Module 3: Logistics Management **[8]**

Logistics Management: Logistical operation, integration, network design, logistical performance cycle, customer service global logistics, logistical resources, logistics planning, Third- and fourth-party logistics providers, Measuring logistics costs and performance, e-logistics, Reverse logistics.

Module 4: Managing Cross-Functional Drivers in a Supply Chain **[8]**

Sourcing Decisions- Make or buy decisions, Sourcing Processes. Information Technology in a Supply Chain, Coordination in a Supply Chain-Bullwhip effect.

Module 5: Recent Trends in Supply Chain Management **[7]**

Lean Supply Management, Agile Supply Management, Green and Sustainable Practices of Supply Chain, Supply chain cases.

Text books:

1. Chopra, S., and Meindl, P. "Supply Chain Management, strategy, planning, and operation" 6/e – PHI, second edition, 2014. **[T1]**
2. Christopher, M., "Logistics and Supply Chain Management", Pearson Education Asia, New Delhi. **[T2]**

Reference books:

7. Taylor and Brunt, "Manufacturing Operations and Supply Chain Management (The Lean Approach)", Business Press Thomson Learning, NY. **[R1]**
8. Arjan J. Van Weele, "Purchasing and Supply Chain Management (Analysis Planning and Practice)", Engineering, Business Press, Thomson Learning NY. **[R2]**
9. Shah, J. "Supply Chain Management, text and cases", Pearson Education South Asia,2009. **[R3]**
10. Balkan Cetinkaya, Richard Cuthbertson, Graham Ewer, "Sustainable Supply Chain Management: Practical ideas for moving towards best practice", Springer, 2011. **[R4]**
11. Sople, V.V "Supply Chain Management, text and cases", Pearson Education South Asia, 2012. **[R5]**
12. Donald B., "Logistic Management - The Integrated Supply Chain process", McGraw Hill. **[R6]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Industry 4.0 in supply chain

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

POs 1-5, 7, 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	1	1		2			1	1	2	1	3	1	2
CO2	3	3	3	2		2				1	1	1	3	2	3
CO3	3	3	3	3	2	1	1		1	1	1	1	3	3	3
CO4	3	3	3	2	2	1				1	1	1	3	2	3
CO5	3	3	3	3	2	2	2			1	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 207
Course title: METROLOGY & MEASUREMENT LAB
Pre-requisite(s): Nil
Co- requisite(s): PE 206 METROLOGY & MEASUREMENT
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech
Semester / Level: VI (SP) / Second
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	provide to the students an understanding and appreciation of the science of measurement.
2	expose the students to various mechanical and electrical engineering measuring devices and understand the different degree of accuracy obtained from different types of instruments.
3	impart knowledge and skill to use measuring tools related to screw threads, gears, surface texture.
4	handle appropriate measurement equipment or method for variables like strain, force, vibration

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

CO1	be familiar with the different instruments that are available for linear, angular, and various geometric form measurements.
CO2	select and use the appropriate measuring instrument according to a specific requirement (in terms of accuracy)
CO3	learn how to measure various parameters of screw threads, gears, surface texture.
CO4	measure cutting tool forces, vibration of machine tool, modulus of elasticity

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Linear Measurement-I**
Objective: To study the measurement of dimensions of a given work piece using Vernier caliper. Outside and inside micrometer and calculate the least count in each equipment.

2. **EXPERIMENT – 2: Linear Measurement-II**
Objective: To study the measurement of height and depth of a given work piece using height gauge and depth micrometer and calculate the least count in each equipment.

3. EXPERIMENT – 3: Gauges
Objective: Study of Gauges (slip gauges/feeler gauge/Go-NO Go gauges etc.).

4. EXPERIMENT – 4: Angular Measurement
Objective: Measurement of angle using Sine bar, angle gauges

5. EXPERIMENT – 5: Optical Metrology I
Objective: To study the profiles of single point cutting tool ("V" tool) / thread by profile projector

6. EXPERIMENT – 6: Optical Metrology II
Objective: To study the working of optical flat and monochromatic light source.

7. EXPERIMENT – 7: Gear Metrology
Objective: Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer

8. EXPERIMENT – 8: Screw Thread Metrology
Objective: Measurement of Screw thread parameters using two wire or Three-wire method

9. EXPERIMENT – 9: Comparator
Objective: To study the working of electronic comparator, measurement of thickness of given workpiece

10. EXPERIMENT – 10: Geometric Form Measurement
Objective: Measurement of flatness and roundness using dial gauge and electronic comparator.

11. EXPERIMENT – 11: Surface Profile
Objective: To study the Taylor Hobson contour measurement instrument and determine the contour of a given test-piece.

12. EXPERIMENT – 12: Dynamic Measurement I
Objective: Measurement of cutting tool forces using tool Dynamometer

13. EXPERIMENT – 13: Dynamic Measurement II
Objective: Determination of modulus of elasticity of a mild steel specimen using strain gauges

14. EXPERIMENT – 14: Dynamic Measurement III
Objective: To study the piezoelectric accelerometer and determine the vibration response of machine tool during operation

Text Book

1. R.K. Jain, Engineering Metrology Khanna Publications, New Delhi **(T1)**
2. I. C. Gupta, A Text book of Engineering Metrology, Dhanpat Rai, New Delhi **(T2)**

Reference Book

3. M. Mahajan, Engineering Metrology, Dhanpat Rai & Co. New Delhi **(R1)**
4. N V Raghavendra and Krishnamurthy, Engineering Metrology and Measurement, Oxford University Press **(R2)**

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

Availability of limited number of advanced equipment.

POs met through Gaps in the Syllabus:

PO 5

Topics beyond syllabus/Advanced topics/Design:

Latest equipment in the field of metrology and measurement

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

POs 5, 6-8, 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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	
Quiz 1	√	√			
Quiz 2			√	√	
Viva-voce	√	√	√	√	
Examination: Experiment Performance	√	√	√	√	

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	2		3					3			2	2	1	2
CO2	3	2		3					3			2	2	1	2
CO3	3	2		3					3			2	2	1	2
CO4	3	2		3					3			2	2	1	2

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

Mapping Between Course Outcomes (Cos) and Course Delivery Method

Course Outcomes	Course Delivery Method
CO1	CD3, CD6
CO2	CD3, CD6
CO3	CD3, CD6
CO4	CD3, CD6

COURSE INFORMATION SHEET

Course code: PE 304
Course title: PRODUCTION & OPERATIONS MANAGEMENT
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 4 L:4 T: P:
Class schedule per week: 4
Class: B. Tech
Semester / Level: VII (MO) / Third
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students:

1	To introduce to various inherent concepts of production systems, planning and control systems of Manufacturing Industry.
2	To introduce of forecasting models, Product mix and aggregate planning.
3	To make routine process, scheduling process and identify different strategies employed in manufacturing industries to production planning.
4	To give basic concept of inventory control and its technique, EOQ, ABC analysis.
5	To know Facility design process and its all component.

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

CO1	Able to understand the functions of production system its planning and control.
CO2	Able to make demand forecasts in the manufacturing sectors using selected quantitative and qualitative techniques.
CO3	Able to explain the importance and function of pre planning and post planning of production system.
CO4	Able to solve inventory problems and to be able to apply selected techniques for its control and management under dependent and independent circumstances.
CO5	Understand plant layout, building layout and location theory.

SYLLABUS

Module 1: Introduction to production and operation management [8]
Difference between manufacturing and service operations, Objectives and functions of production and operation management, historical evolution of production and operations management. type of Production systems and their characteristics, selection of a production system, concept of productivity.

Module 2: Preplanning [10]
Demand forecasting, common techniques of demand forecasting, Capacity management, aggregate planning and master scheduling.

Module 3: Production Planning **[10]**

Routing, loading and scheduling with their different techniques, dispatching, Progress Report, Expediting and corrective measures.

Module 4: Inventory Control **[10]**

Field and scope of inventory control, inventory types and classification, Inventory control models, static model, dynamic model both deterministic and stochastic, Economic lot size, reorder point and their application, ABC analysis, VED analysis, modern practices in purchasing and store Management.

Module 5: Facility design **[12]**

Facility design problems and their analysis.
Facility location- Need of location, Factors affecting the location and site selection, multi-plant location, location theories and models.
Facility layout- Objectives, principles and classification of layouts; Factors affecting plant layout; models of product layout, process layout and service layout.

Text books:

5. Production & Operations management, Jay Heizer and Barry Render, Prentice Hall **[T1]**
6. William J. Stevenson, Operations Management, McGraw-Hill, 13th edition **[T2]**
7. S. N. Chary, Production and operations management, Tata McGraw-Hill Education, 5th Edition **[T3].**
8. P K Gupta, D.S Hira, Operations Research, S chand 7th edition **[T4]**

Reference books:

3. R. Panneerselvam, Production and operations management, PHI Learning Pvt. Ltd **[R1]**
4. Richard B. Chase, Nicholas J. Aquilano, Production & Operations Management: Manufacturing and Services, Publisher: Richard D Irwin; 7th edition **[R2]**

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

POs met through Gaps in the Syllabus:

Topics beyond syllabus/Advanced topics/Design:

Logistics and supply chain management, Inventory model design

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

POs 1 -4, 9, 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	2		1		1	2	3	3	3	2	3
CO2	3	3	1	2	2		1		1	2	3	2	3	2	3
CO3	3	3	3	2	2		1		1	2	2	3	3	2	3
CO4	3	3	1	2	2		1		1	2	2	2	3	2	3
CO5	3	3	1	3	2		1		1	2	2	2	3	2	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

COURSE INFORMATION SHEET

Course code: PE 404
Course title: MODELLING AND SIMULATION LAB
Pre-requisite(s): Nil
Co- requisite(s): Nil
Credits: 1.5 L:0 T:0 P: 3
Class schedule per week: 3
Class: B.Tech.
Semester / Level: VII (MO) / Fourth
Branch: All (MINOR in "Production Engineering")
Name of Teacher:

Course Objectives:
This course enables the students to:

1	Impart skill to use simulation software
2	Develop the ability to build models before simulation.
3	Think of various practical applications of simulation in manufacturing
4	Manually solve small simulation problems using random numbers and probability distributions.

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

CO1	Comprehend the basics of discrete event simulation as applied to various manufacturing and service problems
CO2	Build soft models in computer program/software for a given situation using randomly generated distributions
CO3	Develop a simulation table using pseudo-random numbers or a simulation model using software program
CO4	Analyze the output from a simulation model

SYLLABUS

LIST OF EXPERIMENT:

1. **EXPERIMENT – 1: Introduction to simulation**
   Objective: To explain the basics of modelling and simulation like discrete events, activities, queue and random numbers in simulation

2. **EXPERIMENT – 2: Simulation software**
   Objective: To study the various simulation software and their features particularly useful in manufacturing and logistics

3. **EXPERIMENT – 3: Introduction to simulation exercise (Manual)**
   Objective: To use pseudo-random numbers in solving simulation problems

4. **EXPERIMENT – 4: Simulation of bank operation**
   Objective: Simulation of a bank is to be performed using manual approach using probability distributions for arrival and service time

5. **EXPERIMENT – 5: Simulation of robotic work cell**
   Objective: Simulation of a robotic work cell is to be performed using manual approach using probability distributions for machine operation, loading unloading by robot

6. **EXPERIMENT – 6: Simulation of drill press operation**
   Objective: Simulation of a drill press is to be performed using manual approach using probability distributions for operation.

7. **EXPERIMENT – 7: Simulation of a grocery shop**
   Objective: Simulation of a grocery shop is to be performed using manual approach using probability distributions for arrival and service for customers

8. **EXPERIMENT – 8: Simulation exercise using GPSS software**
   Objective: Simulation of a food store is to be performed using GPSS software and analyze the output

9. **EXPERIMENT – 9: Simulation of factory maintenance**
   Objective: Simulation of a factory maintenance service is to be performed using GPSS software and analyze the output

10. **EXPERIMENT – 10: Simulation of ambulance dispatch**
    Objective: Simulation of an ambulance dispatch service is to be performed using GPSS software and analyze the output

11. **EXPERIMENT – 11: Simulation using WITNESS software**
    Objective: To learn the software WITNESS and its features for simulation

12. **EXPERIMENT – 12: Simulation of factory shop floor**
    Objective: To apply the software WITNESS for simulation of a factory shop floor

13. **EXPERIMENT – 13: Monte Carlo simulation**
    Objective: To apply MINITAB software for a Monte Carlo simulation problem

Reference Book

3. Jerry Banks, Discrete event system simulation, Pearson new International Edition **[R1]**
4. Averil M. Law and David Kelton, Simulation modelling and analysis, McGraw Hill **[R2]**

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

Warehouse and logistic simulation

POs met through Gaps in the Syllabus:

POs 3,5

Topics beyond syllabus/Advanced topics/Design:
Simulation of sheet metal forming, casting and welding

POs met through Topics beyond syllabus/Advanced topics/Design:
POs 2,4,5

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
Continuous Internal Assessment	60
Semester End Examination	40

Continuous Internal Assessment	% Distribution
Day to day performance & Lab files	30
Quiz 1	10
Viva-voce	20
End Semester Examination	**% Distribution**
Examination: Experiment Performance	30
Quiz 2	10

Assessment Components	CO1	CO2	CO3	CO4	CO5
Day to day performance & Lab files	√	√	√	√	
Quiz 1	√	√	√		
Quiz 2			√	√	
Viva-voce	√	√	√	√	
Examination: Experiment Performance	√	√	√	√	

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	1	2			3		1				1	1	2	2	2
CO2		2	2	3	2	1		1				1	1	3	3
CO3		2		3	3		1	1	3		1		2	3	3
CO4			2	2	2	1			2	2		1	3	2	2

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, CD3, CD7
CO2	CD1, CD3, CD7
CO3	CD1, CD3, CD7
CO4	CD1, CD3, CD7