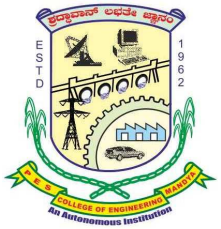
Syllabus

Out Come Based Education

III & IV Semester
Bachelor Degree
in
Mechanical Engineering



2013-14

P.E.S. College of Engineering
Mandya - 571 401. Karnataka
(An Autonomous Institution Affiliated to VTU Belgaum)
Grant -in- Aid Institution
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P.E.S. COLLEGE OF ENGINEERING, MANDYA
(An Autonomous Institution)
SCHEME OF TEACHING AND EXAMINATION
III Semester B.E. (Mechanical Engineering)

Sl No	Course Code	Course Title	Teaching Dept.	Hrs/ Week L:T:P:H	Credit	Examination Marks		
						CIE	SEE	Total Marks
1.	P13MA31	Mathematic –III	Maths	4:0:0:4	4	50	50	100
2.	P13ME32	Material Science & Metallurgy	Mechanical	4:0:0:4	4	50	50	100
3.	P13ME33	Mechanics of Materials	Mechanical	4:0:0:4	4	50	50	100
4.	P13ME34	Manufacturing Process- I	Mechanical	4:0:0:4	4	50	50	100
5.	P13ME35	Basic Thermodynamics	Mechanical	4:0:0:4	4	50	50	100
6.	P13ME36	Computer Aided Machine Drawing	Mechanical	0:0:6:6	3	50	50	100
7.	P13MEL37	Metallographic & Material Testing Laboratory	Mechanical	0:0:3:3	1.5	50	50	100
8.	P13MEL38	Foundry & Forging Lab	Mechanical	0:0:3:3	1.5	50	50	100
9.	P13HU39	Aptitude Competence and Professional Augmentation – I (ACPA- I)	HS&M	0:0:0:2	0	(50)	--	--
10	P13MEL310	Industry Interaction - I	Mechanical	0:0:1:1	0	(50)	--	--
11	P13HM311	Constitution of India & Professional Ethics	Human& Science	2:0:0:2	0	(50)	---	---
12	P13HUDIP39	English & Persona Evolution[#]	HS&M	4:0:0:4	[2][#]	[50][#]	[50][#]	[100][#]
13	P13MADIP31	Additional Maths-I	Maths	4:0:0:4	0	(50)	---	---
Total					26[28]	400[450]	400[450]	800[900]

L: Lecture, T: Tutorial, P: Practical, H: Hrs/ Week, CIE: Continuous internal evaluation, SEE semester end Examination, C: Credits.
ACPA- **I** All students shall have to pass this mandatory learning courses before completion of V - Semester.
#English & Persona Evolution Lateral entry students shall have to pass these Credit courses before completion of V- Semester.
*Additional Mathematics-I and Constitution of India & professional Ethics Lateral entry students shall have to pass these mandatory learning courses before completion of V- Semester.

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes												
	1	2	3	4	5	6	7	8	9	10	11	12
Calibrate venturimeter, orificemeter and V-notch.	✓	✓		✓						✓		
Determine friction coefficient for fluid flow in pipes.	✓	✓		✓						✓		
Determine the efficiencies of vertical, inclined and curved vanes.	✓	✓		✓						✓		
Determine the performance of turbomachines such as Pelton wheel, Centrifugal pump and Centrifugal blower.	✓	✓								✓		
Determine the performance of reciprocating pumps and compressor.	✓	✓								✓		

Exp-10

Performance test on an Air Blower.	**3Hrs**
Seminar	**3Hrs**
Test	**3Hrs**

References

1. Dr. Jagadeesh Lal "**Fluid Mechanics and Hydraulics"** Metropolitan Book Co. Pvt. Ltd, New Delhi. 1995
2. Dr. R.K.Bansal, "**Fluid mechanics and hydraulic machines"** Laxmi publications Ltd., New Delhi. 2000.

Course Outcomes

1. **Calibrate** venturimeter, orificemeter and V-notch.
2. **Determine** friction coefficient for fluid flow in pipes.
3. **Determine** the efficiencies of vertical, inclined and curved vanes.
4. **Determine** the performance of turbomachines such as Pelton wheel, Centrifugal pump and Centrifugal blower.
5. **Determine** the performance of reciprocating pumps and compressor.

P.E.S. COLLEGE OF ENGINEERING, MANDYA
(An Autonomous Institution)
SCHEME OF TEACHING AND EXAMINATION
IV Semester B.E. (Mechanical Engineering)

Sl. No	Course Code	Course Title	Teaching Dept.	Hrs/ Week L:T:P:H	Credit	Examination Marks		
						CIE	SEE	Total Marks
1	P13MA41	Engineering Mathematics-IV	Maths	4:0:0:4	4	50	50	100
2	P13ME42	Applied Thermodynamics	Mechanical	4:0:0:4	4	50	50	100
3	P13ME43	Mechanical Measurements & Metrology	Mechanical	4:0:0:4	4	50	50	100
4	P13ME44	Kinematics of Machines	Mechanical	4:0:0:4	4	50	50	100
5	P13ME45	Fluid Mechanics	Mechanical	4:0:0:4	4	50	50	100
6	P13ME46	Manufacturing Process –II	Mechanical	3:0:0:3	3	50	50	100
7	P13MEL47	Metrology & Measurements Laboratory	Mechanical	0:0:3:3	1.5	50	50	100
8	P13MEL48	Fluid Machinery Laboratory	Mechanical	0:0:3:3	1.5	50	50	100
9	P13HU49	Aptitude Competence and Professional Augmentation – Ii (ACPA- II)	HS&M	0:0:0:2	0	(50)	--	--
10	P13MEL410	Mini Project- I	Mechanical	0:0:1:1	0	(50)	--	--
11	P13MADIP41	Additional Maths-II	Maths	4:0:0:4	0	(50)	--	--
12	P13EV49	Environmental Studies	Env.	2:0:0:2	0	(50)	--	--
		Total			26	400	400	800

: Lecture, T: Tutorial, P: Practical CIE: Continuous internal evaluation, SEE semester end Examination, C: Credits
*Additional Mathematics-II and Environmental Studies Lateral entry students shall have to pass these mandatory learning courses before completion of V- Semester.

Evaluation Scheme
(For Theory Courses only)

Scheme	Weightage	Marks	Event Break Up				
			Test I	Test II	Quiz I	Quiz II	Assign-ment
CIE	50%	50	35	35	5	5	10
SEE	50%	100	Questions to Set: 10		Questions to Answer: 5		

A. Scheme of SEE Question Paper (100 Marks)

Duration: 3Hrs	Marks: 100	Weightage: 50%

Each of the two questions set shall be so comprehensive as to cover the entire contents of the unit.
There will be direct choice between the two questions within each Unit
Total questions to be set are 10. All carry equal marks of 20
The no of subdivisions in each main question shall be limited to three only
No of questions to be answered by students is 5

Course Code :P13MEL48	Semester : IV	L - T - P : 0- 0 - 3
Course Title : Fluid Machinery Laboratory		
Contact Period: Lecture: 36Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Fluid Mechanics(P13ME45)		

Course Learning Objectives

1. **Calibrate** venturimeter, orificemeter and V-notch.
2. **Determine** friction coefficient for fluid flow in pipes.
3. **Determine** the efficiencies of vertical, inclined and curved vanes.
4. **Determine** the performance of turbomachines such as Pelton wheel, Centrifugal pump and Centrifugal blower.
5. **Determine** the performance of reciprocating pumps and compressor.

Course Content

PART-A

Exp-1

Calibration of venturi meter and to determine its co-efficient of discharge **3Hrs**

Exp-2

Calibration of orifice meter and to determine its co-efficient of discharge **3Hrs**

Exp-3

Calibration of V-Notch for flow through a channel. **3Hrs**

Exp-4

Determination of coefficient of friction in flow through pipes. **3Hrs**

Exp-5

Determination of vane efficiency (Coefficient of impact) for different vanes. **3Hrs**

PART-B

Exp-6

Performance testing of Pelton wheel turbine. **3Hrs**

Exp-7

Performance testing of centrifugal pump. **3Hrs**

Exp-8

Performance testing of Reciprocating Pump. **3Hrs**

Exp-9

Performance test on two stage Reciprocating air compressor. **3Hrs**

References

1. R.K.Jain "**Engineering Metrology"** by, 20th Edition, Khanna Publishers
2. R.S.Sirohi and H.C.Radha Krishna **"Mechanical Measurements"** by, 3rd Edition, New Age International

Course Outcomes

1. **Demonstrate** calibration of pressure gauge, thermocouple and LVDT
2. **Use** Vernier/Micrometer and Sine Center / Sine bar / bevel protractor for measurement of linear dimension and angular.
3. **Measure** the thread parameters using two wire or three-wire method.
4. **Use** tool makers microscope / profile projector for measurement of the thread parameters and tool wear
5. **Use** dynamometer for measurement of Cutting tool force

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Demonstrate calibration of pressure gauge, thermocouple and LVDT	✓		✓									
Use Vernier/Micrometer and Sine Center / Sine bar / bevel protractor for measurement of linear dimension and angular.	✓		✓	✓								
Measure the thread parameters using two wire or three-wire methods.	✓		✓	✓								
Use tool makers microscope / profile projector for measurement of the thread parameters and tool wear	✓		✓	✓								
Use dynamometer for measurement of Cutting tool force	✓	✓		✓								

Course Code : P13ME32	Semester : III	L - T - P : 4 - 0 - 0
Course Title : MATERIAL SCIENCE AND METALLURGY		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Engineering Physics (P13PH12) Engineering Chemistry (P13CH22)		

Course Learning Objectives

1. **Explain** the internal Structure of Crystalline Solid, Stacking of layers, Coordination Number and Atomic Packing Factor for different crystal structure, Crystal imperfections and diffusion.
2. **Explain** the concept of Stress and strain, Hardness and plastic deformation.
3. **Analyze** phase diagram and Iron Carbon Equilibrium diagrams.
4. **Explain** heat treatment process to improve the physical and mechanical properties of different types of engineering materials.
5. **Explain** the concept of corrosion and different methods of prevention of corrosion. Explain microstructures and different types of alloys.

Course Content

Unit -1

STRUCTURE OF CRYSTALLINE SOLIDS: Fundamental concepts of unit cell, space lattice, Bravaias lattice , Unit cells for cubic structure and HCP, study of stacking of layers of atoms in cubic structures and HCP, Calculation of radius, co-ordination number and atomic packing factors for different cubic structures. Crystal imperfections – point, line, surface and volume defects. Atomic diffusion: Diffusion Mechanisms, Fick's laws of diffusion. 12 hrs

Unit - 2

CONCEPTS OF STRESS AND STRAIN: Tensile properties, true stress and true strain, Hardness, Rockwell, Vickers and Brinell hardness testing, plastic deformation - slip and twinning.

FRACTURE, FATIGUE and CREEP: Fracture type, stages in Cup & Cone fracture, fracture toughness , Griffith's criterion. Fatigue test, S-N curves, factors affecting fatigue life and protection methods. The creep curves, Mechanism of creep, creep resistant materials. 10 hrs

Unit- 3

SOLID SOLUTION AND PHASE DIAGRAMS: Solid solutions, Rules governing formation of solid solutions, Phase diagram- Basic terms, phase rule, cooling curves, construction of Phase diagrams, interpretation of equilibrium diagrams, Types of Phase diagrams, Lever rule.

IRON CARBON EQUILIBRIUM DIAGRAM: Phases in the Fe-C system, invariant reactions, critical temperatures, Microstructures of slowly cooled steels, effect of alloying elements on the Fe-C diagram, ferrite and austenite stabilizers. The TTT diagram, drawing of TTT diagram, TTT diagram for hypo & hyper eutectoid steels, effect of alloying elements on CCT diagram.

Course Code :P13MEL47	Semester : IV	L - T - P : 0- 0 - 3
Course Title : Mechanical Measurements & Metrology laboratory		
Contact Period: Lecture: 36Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Engineering Physics (P13PH12) Basic Electrical Engineering (P13EE15) Mechanical Measurements & Metrology (P13ME43)		

Course Learning Objectives

1. **Demonstrate** calibration of pressure gauge, thermocouple and LVDT
2. **Use** Vernier/Micrometer and Sine Center / Sine bar / bevel protractor for measurement of linear dimension and angular.
3. **Measure** the thread parameters using two wire or three-wire method.
4. **Use** tool makers microscope / profile projector for measurement of the thread parameters and tool wear
5. **Use** dynamometer for measurement of Cutting tool force

Course Content

PART-A

Exp-1

Calibration of Pressure Gauge **3Hrs**

Exp-2

Calibration of Thermocouple **3Hrs**

Exp-3

Calibration of LVDT **3Hrs**

Exp-4

Calibration of Load cell **3Hrs**

Exp-5

Measurements of alignment using Autocollimator / roller set **3Hrs**

PART-B

Exp-6

Measurements of angle using Sine Center / Sine bar / Bevel protractor **3Hrs**

Exp-7

Measurements of Screw thread Parameters using two wire and three-wire method. **3Hrs**

Exp-8

Measurements using Profile Projector / Toolmaker's Microscope **3Hrs**

Exp-9

Measurements of cutting tool forces using
Lathe tool Dynamometer
Drill tool Dynamometer **3Hrs**

Exp-10

Measurements of Surface roughness using Tally surf/mechanical Comparator. **3Hrs**

Seminar

Course Articulation Matrix (CAM)												
Course Outcome (CO)	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
Evaluate cutting forces on single point cutting tool	✓	✓										
Distinguish factors affecting tool life, tool wear and machinability	✓	✓	✓									
Describe lathe, shaping, planing machine tools and their operations	✓	✓										
Explain milling machine and their operations	✓	✓										
Describe drilling, grinding machine tools and super finishing operations	✓	✓										

Unit - 4

HEAT TREATMENT : Annealing and its types, normalizing, Hardening, tempering, mastempering, austempering, surface hardening, like case hardening, carburizing, cyaniding, nitriding Induction hardening, hardenabilty, Jominy end -quench test, Age hardening of Al & Cu alloys. 10hrs

Unit -5

CORROSION: Galvanic cell, the electrode potentials, polarization, passivation. General methods of corrosion prevention, cathode protection, coating corrosion prevention by alloying, stress corrosion cracking.

ENGINEERING ALLOYS: Properties, composition and uses of low carbon, mild medium & high carbon steels. Steels designation & AISI –SAE designation. Cast irons, gray CI, white CI, malleable CI, SG iron. Microstructures of cast irons. Light alloys: Al, Mg & Titanium alloys. Copper & its alloys: brasses & bronzes. 10hrs

Text books

1. Willian D. Callister Jr., Wiley **"Materials Science and Engineering – an Introduction"**, India Pvt.Ltd. 6th Edition, 2006, New Dehli".
2. Donald R. Askeland, Pradeep **"Essentials of Materials For Science and Engineering"**, P.Phule Thomson-Engineering, 2006.

References

1. James F. Shackel ford **"Introduction to material science for engineering",** 6th edition Pearson, Prentice Hall, New Jersy, 2006.
2. V. Raghavan **"Physical Metallurgy, Principles & Practices",** PHI 2nd Edition 2006, New Delhi.
3. Smith **"Foundations of Materials Science and Engineering"** 3rd Edition McGraw Hill, 1997

Course Outcomes

1. **Explain** the internal Structure of Crystalline Solid, Stacking of layers, Coordination Number and Atomic Packing Factor for different crystal structure, Crystal imperfections and diffusion.
2. **Explain** the concept of Stress and strain, Hardness and plastic deformation.
3. **Analyze** phase diagram and Iron Carbon Equilibrium diagrams.
4. **Explain** heat treatment process to improve the physical and mechanical properties of different types of engineering materials.
5. **Explain** the concept of corrosion and different methods of prevention of corrosion. Explain microstructures and different types of alloys.

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. Define unit cell, space lattice.
2. Determine the radius, co-ordination number and atomic packing factors for different cubic structures.
3. Explain Crystal imperfections.
4. Explain Atomic diffusion and Diffusion Mechanisms.

After learning all the topics of Unit-II, the student is able to

1. Explain the concepts of stress & strain and true stress & true strain.
2. Explain the concepts of Hardness and hardness testing method.
3. Explain the Concept of plastic deformation
4. Define fracture, fatigue and creep.

After learning all the topics of Unit-III, the student is able to

1.Explain Solid solutions, Rules governing formation of solid solutions.
2.Define Phase diagram- Basic terms, phase rule.
3.Explain ooling curves, construction of Phase diagrams.
4.Explain effect of allying elements on the Fe-C diagram.
5. Understand the TTT diagram, drawing of TTT diagram

After learning all the topics of Unit-IV, the student is able to

1.Define the concepts of heat treatment.
2.Explain Annealing, normalizing, Hardening, tempering and its types
3.Explain surface hardening, Induction hardening, hardenabilty.
4.Explain Age hardening of Al & Cu alloys.
5.Explain the concept of Corrosion, Galvanic cell,polarization, passivation.

After learning all the topics of Unit-V, the student is able to

1.Explain Corrosion Prevention, General methods of corrosion prevention.
2.Explain the Engineering alloys and their properties.
3.Explain the composition and uses of low carbon, mild medium & high carbon steels.
4.Explain Steels designations AISI –SAE designation
5.Explain the light metal alloys- Al, Mg & Titanium alloys, Copper & its alloys.

6. Heat generation in metal cutting, factors affecting heat generation
7. Measurement of tool tip temperature
8. Machinability and factors affecting machinability
9. Cutting Fluids- desired properties,
10. Cutting fluid types and selection

Unit- III

1. Introduction to Lathes - principle and working
2. Parts of centre lathe, specification
3. Definitions of speed, feed and depth of cut, cutting time calculation,
4. Different operations of lathe
5. Calculation of change of gears in thread cutting
6. Constructional features of turret and capstan lathes.
7. Introduction to Shaping and Planning machines: Classification, specification,
8. Constructional features
9. Driving mechanisms
10. Shaping operations
11. Planning operations
12. Comparison between shaping and planning, Problems on calculation of machining time.

Unit- IV

1. Introduction to Milling machines: Classification,
2. Constructional features
3. Milling cutters and nomenclature
4. Up milling and down milling concepts
5. Milling operations
6. Indexing: Simple, compound, differential indexing calculations
7. Numerical Problems
8. Indexing: Compound, differential indexing
9. Numerical Problems
10. Numerical Problems

Unit- V

1. Introduction to Drilling Machines, Classification, Specification
2. Constructional features
3. Types of drill & drill bit nomenclature, machining time
4. Drilling & related operations
5. Introduction to Grinding Machines classification
6. Constructional features of cylindrical and surface grinding machines
7. Types of abrasives, bonding process,
8. Specification of grinding wheel, selection of grinding wheel, balancing of grinding wheel
9. Super Finishing Operations: Lapping, honing
10. Other super finishing operations

After learning all the topics of Unit-IV, the student is able to

1. **Explain** milling machines and their classifications.
2. **Explain** up-milling and down-milling concepts and different milling operations.
3. **Perform** indexing calculations.

After learning all the topics of Unit-V, the student is able to

1. Explain drilling machine and its classifications.
2. **Explain** drill bit nomenclature and operations performed on a drilling machine.
3. **Explain** grinding machines and their classifications.
4. **Explain** various superfininshing operations.

Review Questions

1. Distinguish between oblique and orthogonal cutting.
2. Write a note on cutting tool materials.
3. What is tool wear? What are the causes of tool wear.
4. What are the desired properties of cutting fluids.
5. With a neat sketch explain the construction of an engine lathe.
6. Define speed, feed and depth of cut.
7. Distinguish between a shaping machine and a planning machine.
8. Distinguish between up-milling and down-milling.
9. Write a note on milling cutters.
10. With a neat sketch explain the construction of a radial drilling machine.
11. Write a note on selection of grinding wheels.
12. Explain lapping and honing operations.

Lesson Plan

Unit -I

1. Introduction to metal cutting
2. Single point cutting tool nomenclature, geometry,
3. Orthogonal and oblique cutting
4. Mechanism of chip formation, Types of chips
5. Merchants circle diagram and analysis
6. Ernst Merchant's solution, shear angle relationship
7. Numerical problems.
8. Numerical problems.
9. Desired properties, types of cutting tool materials- HSS, carbides
10. Coated carbides CBN, PCD and ceramics

Unit- II

1. Introduction to tool wear - causes and types of tool wear
2. Effects of cutting parameters on tool life, tool failure criteria
3. Taylor's tool life equation
4. Numerical Problems
5. Numerical Problems

Review Questions

1. Explain with neat sketch BCC, FCC and HCP
2. Define Unit cell, Lattice APF and Co-ordinate No.
3. Calculate of radius, co-ordination number and atomic packing factors for different cubic structures.
4. Explain the concepts of stress and strain.
5. What are th Factors affecting fatigue life?
6. Explain the mechanism of creep?
7. What are solid solutions? What are the rules for governing formation of solid solutions?
8. Explain steps involved in construction of Phase diagrams.
9. Explain the effect of allying elements on the Fe.
10. What is TTT curve?
11. What is Heat treatment process?
12. What is annealing and Normalizing? What is the different between them?
13. What is age hardening?
14. Explain the concepts of corrosion, galvanic cell.
15. Explain Steels designation & AISI –SAE designation.
16. Write a short note on Al and Mg alloys.

Lesson Plan

Unit – I

1. STRUCTURE OF CRYSTALLINE SOLIDS : Fundamental concepts of unit cell
2. Space lattice, Bravaias lattice
3. Unit cells for cubic structure and HCP
4. Study of stacking of layers of atoms in cubic structures and HCP
5. Calculation of radius, co-ordination number and atomic packing factors for different cubic structures.
6. Calculation of radius, co-ordination number and atomic packing factors for different cubic structures.
7. Calculation of radius, co-ordination number and atomic packing factors for different cubic structures.
8. Crystal imperfections
9. Point, line, surface and volume defects
10. Atomic diffusion
11. Diffusion Mechanisms,
12. Fick's laws of diffusion

Unit – II

1. CONCEPTS OF STRESS AND STRAIN : Tensile properties
2. True stress and true strain
3. Hardness, Rockwell, Vickers and Brinell's, hardness testing
4. Plastic deformation - slip and twinning
5. Fracture type, stages in Cup &Cone fracture

6. Griffith's criterion
7. Fatigue test, S-N curves
8. Factors affecting fatigue life and protection methods
9. The creep curves
10. Mechanism of creep, creep resistant materials

Unit – III

1. Solid solutions, Rules governing formation of solid solutions
2. Phase diagram- Basic terms, phase rule,
3. Cooling curves, construction of Phase diagrams
4. Interpretation of equilibrium diagrams
5. Types of Phase diagrams, Lever rule.
6. Phases in the Fe-C system, invariant reactions,
7. Critical temperatures, Microstructures of slowly cooled steels
8. Effect of allying elements on the Fe-C diagram, ferrite and austenite stabilizers
9. The TTT diagram, drawing of TTT diagram,
10. TTT diagram for hypo & hyper eutectoid steels, effect of alloying elements on CCT diagram.

Unit – IV

1. HEAT TREATMENT :Annealing and its types
2. Normalizing, Hardening, tempering
3. Martepmering, austempering
4. Surface hardening, like case hardening, carburizing, cyaniding, nitriding
5. Induction hardening, hardenabilty
6. Jominy end-quench test
7. Age hardening of Al &Cu alloys
8. Corrosion: Galvanic cell
9. The electrode potentials
10. Polarization, passivation

Unit – V

1. Corrosion Prevention, General methods of corrosion prevention
2. Cathode protection, coating corrosion prevention by alloying, stress corrosion cracking
3. ENGINEERING ALLOYS : Properties
4. Composition and uses of low carbon, mild medium &high carbon steels
5. Steels designation &AISI –SAE designation
6. Cast irons, gray CI, white CI, malleable CI, SG iron
7. Microstructures of cast irons
8. The light alloys, Al, Mg &Titanium alloys
9. Copper &its alloys
10. Brasses & Bronzes

Unit -V

Drilling Machines: Classification, Specification, constructional features, drilling & related operations, types of drill & drill bit nomenclature, machining time. **Grinding Machines**: Types of abrasives, bonding process, classification, constructional features of cylindrical and surface grinding machines, Centerless grinding, tool and cutter grinder, specification of grinding wheel, selection of grinding wheel, balancing of grinding wheel. Super Finishing Operations: Lapping, honing and super finishing operations. **10hrs**

Text books

1. S.K.Hajra Choudhury, A.K.Hajra Choudhury & Nirjhar Roy "**Workshop Technology Vol-II"**, Media Promoters & Publishers Pvt. Ltd. 2004
2. G. Boothroyd, " **Fundamentals of Metal Machining and Machine Tools"** , McGraw Hill, 2000.
3. HMT, **"Production technology"**, Tata McGraw Hill, 2001.

References

1. Ashok Kumar Mallik & Amitabha Ghosh,"**Manufacturing Science"** East West Press, 2003.
2. R.K.Jain **,"Production Technology"**, Khanna Publications, 2003.
3. A. Bhattacharya, "**Theory of Metal Cutting & Practice",** New Central Book Agency-Kolkata

Course Out comes

1. **Evaluate** cutting forces on single point cutting tool
2. **Distinguish** factors affecting tool life, tool wear and machinability
3. **Describe** lathe, shaping, planing machine tools and their operations
4. **Explain** milling machine and their operations
5. **Describe** drilling, grinding machine tools and super finishing operations

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. **Explain** cutting tool nomenclature.
2. **Explain** Merchant's circle.
3. **Explain** different cutting tool materials.

After learning all the topics of Unit-II, the student is able to

1. **Explain** tool wear and its causes.
2. **Determine** tool life using Taylor's equation.
3. **Explain** machinability and factors affecting it.
4. **Explain** the requirements of cutting fluids.

After learning all the topics of Unit-III, the student is able to

1. **Explain** lathe and its classifications.
2. **Explain** speed, feed and depth of cut.
3. **Explain** shaping and planing machines and operations performed on them.

Course Code :P13ME46	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : Manufacturing Processes -II		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Elements of Mechanical Engineering (P13ME14) Manufacturing Processes – I (P13ME34) Material Science & Metallurgy (P13ME32)		

Course Learning Objectives

1. **Evaluate** cutting forces on single point cutting tool
2. **Distinguish** factors affecting tool life, tool wear and machinability
3. **Describe** lathe, shaping, planing machine tools and their operations
4. **Explain** milling machine and their operations
5. **Describe** drilling, grinding machine tools and super finishing operations

Course Content

Unit -I

Theory of Metal Cutting: Single point cutting tool nomenclature, geometry, orthogonal and oblique cutting, mechanism of chip formation, types of chips, Merchants circle diagram and analysis, Ernst Merchant's solution, shear angle relationship, problems of Merchant's analysis.

Cutting Tool Materials: Desired properties, types of cutting tool materials – HSS, carbides, coated carbides CBN, PCD and ceramics **10 hrs**

Unit -II

Tool Wear: Causes and types of tool wear, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation, problems on tool life evaluation. Heat generation in metal cutting, factors affecting heat generation, measurement of tool tip temperature. Machinability and factors affecting machinability. Cutting Fluids: Desired properties, types and selection. **10 hrs**

Unit -III

Lathes: Introduction, principle and working, parts of centre lathe, specifications, different operations, definitions of speed, feed and depth of cut, Problems on cutting time calculation, Calculation of change of gears in thread cutting, constructional features of turret and capstan lathes.

Shaping And Planning Machines: Classification, specification, constructional features, driving mechanisms. Shaping and planning operations. Comparison between shaping and planning, Problems on calculation of machining time. **12 hrs**

Unit -IV

Milling Machines: Classification, constructional features, milling cutters nomenclature, up milling and down milling concepts. Milling operations Indexing: Simple, compound, differential indexing calculations. Problems on simple and compound indexing. **10 hrs**

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Explain the internal Structure of Crystalline Solid, Stacking of layers, Coordination Number and APF for different crystal structure, Crystal imperfections and diffusion.	√	√										
Explain the concept of Stress and strain, Hardness and plastic deformation.	√	√	√									
Analyze phase diagram and Iron Carbon Equilibrium diagrams.	√	√										
Explain heat treatment process to improve the physical and mechanical properties of different types of engineering materials.	√	√	√									
Explain the concept of corrosion and different methods of prevention of corrosion. Explain microstructures and different types of alloys	√	√										

Course Code : P13ME33	Semester : III	L - T - P : 4 - 0 - 0
Course Title : Mechanics of Materials		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Engineering Mathematics – I & II (P13MA11/21) Engineering Mechanics (P13CV13)		

Course Learning Objectives

1. **Classify** different types of stresses, strain and deformations induced in the mechanical components due to external loads.
2. **Determine** thermal stresses and **calculate** principal stresses in simple 2D elements.
3. **Draw** Shear Force Diagrams and Bending Moment Diagrams for different types of loads and support conditions.
4. **Compute** and analyze bending and shear stresses and deflections induced in beams.
5. **Determine** stresses in thin cylinders, torsional stresses, and **Analyze** buckling phenomenon in columns.

Course Content

Unit –I

Simple stresses and strains: Stress, types, Saint Venant's principle, stress-strain curve for mild steel, working stress, proof stress, factor of safety, Hooke's law, modulus of elasticity, strain energy, proof resilience, longitudinal strain, lateral strain, poison ratio, stress strain analysis of bars of uniform cross section, stepped bars, bars with continuously varying section, principle of superposition. Modulus of rigidity, volumetric strain, expression for volumetric strain, bulk modulus, relation among elastic constants. 10hrs

Unit - II

Compound bars: Stress analysis of composite bars. Thermal stresses in uniform and compound bars**. Compound stresses**: Principal planes and stresses, plane of maximum shear stress in general 2D system. Mohr's circle diagram. 10hrs

Unit– III

Shear force and Bending Moment: Types of beams, loads and supports. SF and BM, sign conventions, relationship between load intensity, shear force and bending moment. SFD and BMD for different beams subjected to concentrated loads, Uniformly Distributed Load and Uniformly Varying Load. 10hrs

Unit - IV

Bending and shear stresses in Beams: Theory of simple bending, assumptions in simple bending, relationship between bending stresses and radius of curvature, relationship between bending moment and radius of curvature, section modulus, moment of resistance of a section. Bending stresses in beams of uniform section.

Unit- V

1. Reynold's number, critical Reynolds's number
2. Laminar flow through a round pipe- Hagen poisuille's equation,
3. Laminar flow between parallel stationery plates
4. Navier-stokes equations of motion for viscous fluid flow
5. Dimensional Analysis: Introduction, derived quantities,
6. Dimensions of physical quantities
7. Dimensional homogeneity-Buckingham's p theorem,
8. Rayleigh's method, important dimensionless numbers.
9. Numerical problems
10. Numerical problems
11. Numerical problems

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Explain fluid properties like density, weight density, specific volume, specific gravity, viscosity and surface tension. **Solve** problems on viscosity and surface tension.	✓	✓		✓								
Derive Pascal's law and fundamental law of hydrostatics and **Explain** buoyancy and centre of buoyancy.	✓	✓		✓								
Describe the types of fluid flow and **solve** problems on continuity equation, Euler's equation of motion and Bernoulli's equation.	✓	✓		✓								
Explain boundary layer concept and **define** hydraulic gradient line and total energy line.	✓	✓										
Derive Hagen-Poiseuille equation and **apply** dimensional analysis technique to obtain dimensionless relations.	✓	✓										

Lesson Plan

Unit- I

1. Introduction, properties of fluids.
2. Viscosity, Newton's law of viscosity.
3. Surface tension
4. Capillarity, vapour pressure and cavitations.
5. Pascal's law, Fluid pressure at a point,
6. Pressure variation in a static fluid, ,
7. Absolute, gauge, atmospheric & vacuum pressures
8. General energy and momentum equations and Navier-stokes equations of motion
9. Numerical problems
10. Numerical problems
11. Numerical problems

Unit- II

1. Simple manometers.
2. Differential manometers,
3. Total pressure, centre of pressure
4. Inclined plane surfaces and curved surfaces submerged in liquid ,
5. Buoyancy, Buoyant force
6. Centre of buoyancy.
7. Meta centre and meta centric height (analytical method only)
8. Stability of submerged and floating bodies
9. Numerical problems
10. Numerical problems

Unit- III

1. Types of Fluid flow, and,
2. Continuity equation in three dimensions (Cartesian co-ordinate system only)
3. Velocity and acceleration
4. Velocity potential function, stream function and flow net.
5. Fluid Dynamics**:** Euler's equation of motion, Bernoulli's equation
6. Bernoulli's equation derived from fundamental principles & Euler's equation
7. Bernoulli's equation for real fluids.
8. Fluid Flow measurements: Venturimeter, Orifice meter and Pitot tube.
9. Numerical problems
10. Numerical problems

Unit- IV

1. Drag, lift, expression for lift and drag,
2. Pressure drag and friction drag,
3. Boundary layer concept, displacement thickness,
4. Momentum thickness and energy thickness.
5. Flow Through Pipes**:** Frictional losses in pipe flow,
6. Darcy and Chezy equations for loss of head due to friction in pipes,
7. Hydraulic gradient & total energy line.
8. Numerical problems
9. Numerical problems
10. Numerical problems

Shearing stresses in beams, shear stress across rectangular, circular, I and T sections. **(Moment of Inertia to be supplied for numerical problems).**
Deflection of Beams: Introduction, relation between slope, deflection and radius of curvature. Macaulay's method for simply supported beams with point load and UDL. 10hrs

Unit –V

Thin cylinder: Types of cylinder, stresses in thin cylinder (Hoop's and longitudinal stress), changes in dimensions of cylinder (diameter, length, volume).

Torsional stresses: Introduction to torsion, pure torsion, assumptions, derivation of torsion equation, polar modulus, torsional rigidity, and torque transmitted by solid and hallow circular shafts. **Columns:** Introduction to Columns, Euler theory for axially loaded elastic long columns, Euler equation for columns with both ends hinged. 10hrs

Text books

1. S. S. Bhavikatti "**Strength of Materials** " Vikas Publication House-Pvt Ltd 2nd edition.
2. Dr. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, **"Mechanics of Materials"** Laxmi Publications, New Delhi. 2002
3. Dr. R. K. Bansal **"Strength of Materials "**Laxmi Publication, New Delhi

References

1. W.A. Nash **"Strength of Materials "**Schaum's Outline Series, Fourth Edition 2007.
2. Ferdinand P Beer, E Russell Johnston, JR., John T DeWolf adapted by N Shivaprasad & S Krishnamurthy **" Mechanics of Materials"** Tata McGraw-Hill
3. James M. Gere, Stephen P. Timoshenko **"Mechanics of Materials"** CBS Publishers and Distributers Delhi.
4. S.S. Rattan **"Strength of Materials "** Tata McGraw-Hill New Delhi

Course Outcomes

1. **Classify** different types of stresses, strain and deformations induced in the mechanical components due to external loads.
2. **Determine** thermal stresses and **calculate** principal stresses in simple 2D elements.
3. **Draw** Shear Force Diagrams and Bending Moment Diagrams for different types of loads and support conditions.
4. **Compute** and analyze bending and shear stresses and deflections induced in beams.
5. **Determine** stresses in thin cylinders, torsional stresses, and **Analyze** buckling phenomenon in columns.

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. **Define** stress and types of stresses.
2. **Define** strain and types of strains, modulus of rigidity, volumetric strain.
3. **Explain** the Saint Venant's principle and Principle of superposition
4. **Determine** the stresses and strains on each part of the body.

After learning all the topics of Unit-II, the student is able to

1. **Define** the thermal stress, Principal plane and stresses.
2. **Apply** stress analysis to compound bars.
3. **Determine** the thermal stresses in composite bar.
4. **Draw** the Mohr's circle.

After learning all the topics of Unit-III, the student is able to

1. **Identify** the types of beams and loadings.
2. **Formulate** the relation between load intensity, shear force and bending moment.
3. **Determine** the shear force and bending moment.
4. **Draw** the shear force and bending moment diagram.

After learning all the topics of Unit-IV, the student is able to

1. **Explain** the assumptions in bending.
2. **Formulate** the expression for simple bending, relation between bending stress and radius of curvature and relation between bending moment and radius of curvature section modulus, moment of resistance.
3. **Determine** the shearing stresses in beams of I and T sections.
4. **Discuss** bending stress and shearing stress.
5. **Describe** the Macaulay's method for deflections of beams.

After learning all the topics of Unit-V, the student is able to

1. **Define** the cylinder and types of cylinder.
2. **Formulate** the Hoop's and Longitudinal stress.
3. **Describe** the driving torque and resisting torque and torsion.
4. **Identify** columns and **demonstrate** different types of columns.
5. **Derive** Euler equation.

Review Questions

1. Define the following stress, strain, shear strain, modulus of elasticity, lateral strain.
2. With the help of stress-strain diagram explain the behavior of the following (i) Mild steel in tension (ii) Mild steel in compression (iii) Cast iron in tension (iv) Aluminum in tension.
3. A circular bar of diameter 25mm is subjected to an axial force of 20KN. Find the stresses on a plane making 30° to the plane of axial stresses and also on the plane which has maximum shear stress.
4. Define Thermal stresses, principal plane, principal stress, Mohr's circle.
5. Classify types of beams and types of loading.

After learning all the topics of Unit-II, the student is able to

1. **Define** intensity of pressure and **state** the units in which it is measured.
2. **Describe** the different types of manometers
3. **Explain** gauge, absolute and vacuum pressure
4. **Determine** the absolute pressure from gauge pressure and vacuum pressure.
5. **Solve** problems related to different manometer

After learning all the topics of Unit-III, the student is able to

1. **Define** path line, stream line and potential line.
2. **Explain** irrotational flow **.** State condition of irrotationa flow.
3. **Describe** physical and mathematical concepts of stream functions.
4. **Explain** venturimeter with a sketch.`

After learning all the topics of Unit-IV, the student is able to

1. **Explain** drag force and lift force of an object immersed in a fluid
2. **Define** coefficient of drag and coefficient of lift
3. **Determine** total drag of a body fully immersed in a fluid

After learning all the topics of Unit-V, the student is able to

1. **Discribe** equations of motion for viscous fluid flow
2. **Explain** Reynolds number and **describe** upper and lower critical Reynolds numbers
3. **Discribe** Buckingham π-theorem and to formulate a dimensionally homogeneous equation

Review Questions

1. Define a fluid. What are the difference between ideal and practical fluids.
2. Name the properties of fluids and define each of them.
3. What is meant by cavitation? Why is it harm full for hydraulic machines?
4. State Pascal's law. Give some examples where these principle is applied.
5. State the advantages of mechanical gauges over the manometers.
6. Describe the different types of manometers.
7. State the advantages of U – tube manometer over the piezometer tube.
8. Define rotational flow. How is the rotation related to vorticity.
9. Define path line, stream line and potential line.
10. Explain rotational flow . state condition of irrotationa flow
11. Describe physical and mathematical concepts of stream functions.
12. Determine total drag of a body fully immersed in a fluid.
13. Explain venture meter orifice meter and pitot tube with a sketch.
14. Define coefficient of drag and coefficient of lift.
15. Determine total drag of a body fully immersed in a fluid.
16. Describe equations of motion for viscous fluid flow.
17. Explain Reynolds number and describe upper and lower critical Reynolds numbers.
18. Describe Buckingham π-theorem and to formulate a dimensionally homogeneous equation.

Unit -V

Laminar flow and viscous effects: Reynold's number, critical Reynold's number, laminar flow through a round pipe- Hagen Poisuille's equation, laminar flow between parallel stationery plates**.**

Dimensional Analysis: Introduction, derived quantities, Dimensions of physical quantities, dimensional homogeneity-Buckingham's p theorem, the Rayleigh's method, important dimensionless numbers. **11 hrs**

Text books

1. K. W. Bedford, Victor Streeter, E. Benjamin Wylie **"Fluid Mechanics"** Tata Mcgraw Hill Education Private Limited, 9th ed.
2. Dr. R.K.Bansal, "**Fluid mechanics and hydraulic machines"** Laxmi publications Ltd., New Delhi. 2000.

References

1. Dr. Jagadish Lal **"Fluid Mechanics and Hydraulics"** Metropolitan Book Co. Pvt. Ltd, New Delhi. 1995
2. Dr.K.L.Kumar,Eurosia **"Engineering Fluid Mechanics"** Publishing House (P) Ltd,
3. Dr.R.J.Garde and Dr.A.J.Mirajgaonkar **"Engineering Fluid Mechanics"** ScitechPublications (India) Chennai,2003
4. Frank M.White **"Fluid Mechanics"** Tata Mcgraw Hill Education Private Limited, 7th ed.

Course Out comes

1. **Explain** fluid properties like density, weight density, specific volume, specific gravity, viscosity and surface tension. **Solve** problems on viscosity and surface tension.
2. **Derive** Pascal's law and fundamental law of hydrostatics and **Explain** buoyancy and centre of buoyancy.
3. **Describe** the types of fluid flow and **solve** problems on continuity equation, Euler's equation of motion and Bernoulli's equation.
4. **Explain** boundary layer concept and **define** hydraulic gradient line and total energy line.
5. **Derive** Hagen-Poiseuille equation and **apply** dimensional analysis technique to obtain dimensionless relations.

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. **Define** fluid mechanics, hydrostatics, hydrodynamics and hydraulics.
2. **Explain** the concept of viscosity and the units poise and stoke.
3. **Explain** the concept of absolute and gauge pressure.
4. **Derive** Pascal's law and hydrostatic law and **solve** problems on them.
5. **Explain** the phenomenon of surface tension and capillarity and **solve** problems on them.

6. Derive the relation between load intensity, shear force and bending moment.
7. Derive the relation between bending moment and radius of curvature section modulus, moment of resistance of a section.
8. Derive the expression for simple bending.
9. Derive the relation between slope, deflection and radius of curvature.
10. List the assumptions in simple bending.
11. Define the cylinder and types of cylinder.
12. Derive the Hoop's and Longitudinal stress.
13. Derive the torsion equation and torque for solid and hallow shafts.
14. Derive Euler equation.

Lesson Plan

Unit – I

1. Stress, types of stresses, Saint Venant's principle
2. stress-strain curve for MS, working stress, proof stress
3. factor of safety, Hooke's law, modulus of elasticity, strain energy, proof resilience
4. longitudinal strain, lateral strain, poison ratio
5. stress strain analysis of bars of uniform c/s .
6. stress strain analysis of bars of stepped bars
7. Numerical problems.
8. Principle of superposition
9. Modulus of rigidity, Volumetric strain, Expression for volumetric strain
10. Relation among elastic constants.

Unit – II

1. Stress analysis of composite bars.
2. Problems on composite bars.
3. Problems on composite bars.
4. Thermal stresses in uniform bar
5. Thermal stresses in compound bar
6. Numerical problems.
7. Principal plane and stresses, plane of maximum shear stress in general 2D system.
8. Mohr's circle.
9. Problems on Mohr's circle.
10. Problems on Mohr's circle.

Unit – III

1. Types of beams, loads and supports.
2. SF and BM, sign conventions, relationship between load intensity, shear force and bending moment.
3. Problems on SF and BMD for simply supported beams subjected to concentrated loads.

4. Problems on SF and BMD for simply supported beams subjected to UDL.
5. Problems on SF and BMD for simply supported different beams subjected to UDL.
6. Problems on SF and BMD for simply supported different beams subjected to UVL.
7. Problems on SF and BMD for cantilever beams subjected to concentrated loads.
8. Problems on SF and BMD for cantilever beams subjected to concentrated loads.
9. Problems on SF and BMD for cantilever beams subjected to UDL.
10. Problems on SF and BMD for cantilever beams subjected to UDL.
11. Problems on SF and BMD for cantilever beams subjected to UVL.
12. Problems on SF and BMD for cantilever beams subjected to UVL.

Unit – IV

1. Theory of simple bending, assumptions in simple bending.
2. Relationship between bending stresses and radius of curvature, relationship between bending moment and radius of curvature, section modulus, moment of resistance of a section.
3. Bending stresses in beams of uniform section and **I** section problems.
4. Shearing stresses in **T** section problems.
5. Introduction and different methods to determine the deflection in beams.
6. Relation between slope, deflection and radius of curvature.
7. Macaulay's method for simply supported beams with point load.
8. Problems on simply supported beams with point load.
9. Problems on simply supported beams with point load.
10. Problems on simply supported beams with UDL.

Unit – V

1. Types of cylinder, stresses in thin cylinder (Hoop's and longitudinal stress).
2. Changes in dimensions of cylinder (diameter, length, volume).
3. Problems.
4. Introduction to torsion, pure torsion, assumptions, derivation of torsion equation.
5. Problems.
6. Polar modulus, torsion rigidity, and torque transmitted by solid and hallow circular shafts.
7. Problems.
8. Introduction to Columns, Euler theory for axially loaded elastic long columns.
9. Euler equation for columns with both ends hinged.
10. Problems.

Course Code :P13ME45	**Semester : IV**	**L - T - P : 4 - 0 - 0**
Course Title : Fluid Mechanics		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Engineering Mathematics – I & II (P13MA11/21) Engineering Mechanics (P13CV13)		

Course Learning Objectives

1. **Explain** fluid properties like density, weight density, specific volume, specific gravity, viscosity and surface tension. **Solve** problems on viscosity and surface tension.
2. **Derive** Pascal's law and fundamental law of hydrostatics and **Explain** buoyancy and centre of buoyancy.
3. **Describe** the types of fluid flow and **solve** problems on continuity equation, Euler's equation of motion and Bernoulli's equation.
4. **Explain** boundary layer concept and **define** hydraulic gradient line and total energy line.
5. **Derive** Hagen-Poiseuille equation and **apply** dimensional analysis technique to obtain dimensionless relations.

Course Content

Unit –I

Properties of fluids: Introduction, properties of fluids, viscosity, Newton's law of viscosity. Surface tension, capillarity, vapor pressure and cavitations. Pascal's law, Fluid pressure at a point, pressure variation in a static fluid, absolute, gauge , atmospheric & vacuum pressures, General energy and momentum equations, and Navier-Stokes equations of motion. **11 hrs**

Unit -II

Fluid statistics (with buoyancy):, Simple manometers, differential manometers, total pressure, centre of pressure , inclined plane surfaces and curved surfaces submerged in liquid, Buoyancy, Buoyant force, centre of buoyancy, meta centre and meta centric height (analytical method only), stability of submerged and floating bodies **10 hrs**

Unit -III

Fluid kinematics and dynamics: Types of Fluid flow, continuity equation in three dimensions (Cartesian co-ordinate system only) and velocity and acceleration, velocity potential function, stream function and flow net.

Fluid Dynamics: Euler's equation of motion, Bernoulli's equation derived from fundamental principles & Euler's equation, Bernoulli's equation for real fluids. Fluid Flow measurements: Venturimeter, Orifice meter and Pitot tube. **10 hrs**

Unit -IV

Flow past immersed bodies: Drag, lift, expression for lift and drag, pressure drag and friction drag, boundary layer concept, displacement thickness, momentum thickness and energy thickness.

Flow Through Pipes: Frictional losses in pipe flow, Darcy and Chezy equations for loss of head due to friction in pipes, hydraulic gradient & total energy line. **10 hrs**

Course Articulation Matrix (CAM)												
Course Outcome (CO)	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
Explain the various mechanisms, **calculate** the degrees of freedom, **explain** the various inversions of four bar chain, single and double slider crank chain.	√	√	√									
Determine velocity by relative velocity method, Velocity of different mechanism, Instantaneous centers and velocity analysis by Instantaneous centre method. **Determine** the acceleration of four bar mechanisms, slider-crank mechanisms.	√	√	√							√		
Classify different types of gears, **Explain** Spur Gear terminology, law of gearing, interference and Back lash. **Derive and calculate** expressions for Path of contact, arc of contact, contact ratio.	√	√	√									
Explain Simple, Compound and Epicyclic gear trains, **Calculate** velocity ratio, tooth load and torque in epicyclic gear trains. **Explain** and **calculate** ratio of belt tensions, effect of slip, initial and centrifugal belt tension and power transmitted.	√	√	√									
Explain cam and follower types, **Explain** different follower Motions, **Construct** the cam profile.	√	√	√							√		

Course Articulation Matrix (CAM)												
Course Outcome (CO)	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
Classify different types of stresses, strain and deformation induced in the mechanical components due to external loads.	√	√	√									
Determine thermal stresses and **calculate** principal stresses in simple 2D elements.	√	√	√									
Draw SFD and BMD for different types of loads and support conditions.	√	√	√									
Compute and analyze stresses induced in basic mechanical components.	√	√	√									
Analyze buckling and bending phenomenon in columns and beams respectively	√	√	√									

Course Code :P13ME34	Semester : III	L - T - P : 4 - 0 - 0
Course Title : Manufacturing processes - I		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Elements of Mechanical Engineering (**P13ME14/24)**		

Course Learning Objectives

1. **Classify** various manufacturing processes
2. **Explain** the steps involved in casting processes
3. **Distinguish** between various casting processes
4. **Explain** arc welding and other special types of welding processes.
5. **Explain** metallurgical aspects and defects in welding

Course Content

Unit –I

Introduction: Concept of Manufacturing process, its importance, Classification of Manufacturing processes. Selection of a process for a production.

Casting process: Introduction, Steps involved, Varieties of components produced by casting process, Advantages & Limitations of casting process. Classification of furnaces, Constructional features & working principle of Electric Arc Furnace, Cupola furnace**.** **12hrs**

Unit –II

Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns. Binder: Definition, Types of binders used in moulding sand. Additives: need, types of additives used.

Sand Moulding: Types of sand moulds, ingredients of moulding sand and Properties, core sands, ingredients properties, Core making, Core baking – Dielectric baking of cores, Principles of Gating: Elements of gating system, types of gates, gating ratio, function of risers, types of risers – open and blind risers. Types of defects in Castings, Causes and remedies. **10 hrs**

Unit –III

Special Moulding Process : CO_2 moulding, Shell moulding, Investment casting, permanent mould casting : Gravity die-casting, Pressure die casting, centrifugal casting, Injection moulding, Squeeze Casting, Slush casting, Thixocasting and continuous casting processes **10 hrs**

Unit - IV

Welding Process: Arc Welding: Principle, Flux Shielded Metal Arc Welding (FSMAW), Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW) and Atomic Hydrogen Welding processes (AHW).

Special Types of Welding: Resistance welding - principles, Seam welding, Thermit welding, Spot welding, projection welding. Friction welding and Explosive welding **10 hrs**

Unit -V

1. Types of cams and followers.
2. Follower Motions- SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.
3. Follower Motions- uniform acceleration and retardation and Cycloidal motion.
4. Displacement, Velocity and acceleration curves for cam profiles.
5. Construction of the cam profile for disc cam with reciprocating follower having knife-edge follower.
6. Construction of the cam profile for disc cam with reciprocating follower having roller follower.
7. Construction of the cam profile for disc cam with reciprocating follower having flat –faced follower.
8. Construction of the cam profile for disc cam with reciprocating follower having knife-edge offset follower.
9. Construction of the cam profile for disc cam with reciprocating follower having roller offset follower.
10. Construction of the cam profile.

Unit -II

1. Introduction to Absolute and relative motions, vectors, addition and subtraction of vectors and Motion of a link.
2. Analysis Velocity by relative velocity method, Velocity of four-link mechanism.
3. Velocity of slider-crank mechanism, crank and slotted lever mechanism.
4. Instantaneous centre and number of I- centres, Kennedy's theorem and analysis.
5. Locating I-centers for four bar chain and slider crank chain.
6. Velocity analysis using I-centre method.
7. Acceleration and Angular acceleration of links.
8. Angular acceleration of links and acceleration of intermediate and offset points.
9. Problems solving.
10. Analysis and calculation of acceleration for four bar mechanisms.
11. Analysis and calculation acceleration for slider-crank mechanism.
12. Problems solving.

Unit -III

1. Different types of gears and its application.
2. Spur Gear terminology.
3. Gear tooth profiles and law of gearing.
4. Derivation of expression for Path of contact.
5. Derivation of expression for arc of contact and contact ratio.
6. Problems solving.
7. Interference in involute gears and under cutting.
8. Problems solving.
9. Various Methods of avoiding interference and back lash.
10. Problems solving.

Unit -IV

1. Simple gear trains, Compound gear trains and Epicyclic gear trains.
2. Tabular method of finding velocity ratio of epicyclic gear trains.
3. Solving problems on the velocity ratio of epicyclic gear trains using tabular method.
4. Tooth load and torque calculations in epicyclic gear trains.
5. Problems solving.
6. Introduction to belt drive and classification of belt drive, Velocity ratio, effect of slip, ratio of belt tensions, effect of centrifugal tension.
7. Introduction to power transmitted and effect of initial belt tension, Derivation of expressions for ratio of belt tensions, centrifugal tension, Condition for maximum power transmission.
8. Derivation of expressions for ratio of power transmitted and initial belt tension related to flat belt and Problems solving.
9. Derivation of expressions for ratio of belt tensions and power transmitted in V-belt.
10. Solving problem on ratio of belt tensions and power transmitted in V-belt.

Unit –V

Metallurgical Aspect In Welding: Structure of welds, Formation of different zones during welding, Heat affected zone (HAZ), Parameters affecting HAZ, Shrinkage in welds & Residual stresses. Weldability and Weldability testing, Welding defects – Detection, causes and remedy. **10 hrs**

Text books

1. P.N.Rao **"Manufacturing & Technology: Foundry Forming and Welding"** 2nd Ed., Tata McGraw Hill, 2003
2. Dr.K.Radhakrishna **"Manufacturing Process-I",** 5th Ed ,Sapna Book House, 2006

References

1. Serope Kalpakjian & Steven R Schmid **"Manufacturing Engineering and Technology",** Pearson Education Asia, 4th Ed. 2002
2. Roy A Lindberg "**Process and Materials of Manufacturin**g", 4th Ed. Pearson Edu.

Course Outcomes

1. **Classify** various manufacturing processes
2. **Explain** the steps involved in casting processes
3. **Distinguish** between various casting processes
4. **Explain** arc welding and other special types of welding processes.
5. **Explain** metallurgical aspects and defects in welding

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. **Classify** the manufacturing processes
2. **Determine** the selection process for production
3. **Explain** casting processes and steps involving in casting
4. **List out** advantages and limitations of casting process
5. **Explain** working principle of cupola and electric arc furnace

After learning all the topics of Unit-II, the student is able to

1. **Explain** patternsfunctions and materials used for patterns
2. **Analyse** the pattern allowances and importance
3. **Explain** the functions of binders and additives
4. **Explain** ingredient of moulding sand and core sand
5. **Discuss** about gating system, types of gates and gating ratio
6. **Distinguish** open and blind risers

After learning all the topics of Unit-III, the student is able to

1. **Explain** co2 moulding process.
2. **Discuss** on shell and investment casting
3. **Explain** method of pressure die and thixo casting

After learning all the topics of Unit-IV, the student is able to

1. **Discuss** on principle of arc welding process.
2. **Explain** TIG & MIG welding processes
3. **Explain** resistance, friction and explosive welding process

After learning all the topics of Unit-V, the student is able to

1. **Analyze** the welding parameters
2. **Tabulate** the welding defects, their causes & remedy
3. **Explain** different zones in welding
4. **Discuss** on HAZ and parameters affecting on HAZ

Review Questions

1. Classify the Manufacturing processes
2. With neat sketch explain working of Cupola furnace
3. Explain Casting process & steps involved in it
4. List out various pattern allowances and their importance
5. Write short note on pattern materials
6. Explain different Types of sand moulds
7. With neat sketch explain Principles of Gating system
8. Explain defects in Castings, Causes for defects0 and remedies
9. With neat sketch explain Thixocasting and continuous casting processes
10. With neat sketch explain TIG & MIG Welding process
11. Explain Principle of Arc Welding & Explosive welding process
12. Write short note on Heat affected zone (HAZ) & Parameters affecting HAZ
13. Explain different Welding defects ,causes & remedy.

Lesson Plan

Unit – I

1. Introduction on Manufacturing process and classification
2. Selection of a process for a production
3. importance of Manufacturing process
4. Introduction on furnace ,Classification of furnaces
5. Constructional features & working principle of Electric Arc Furnace
6. Advantages and limitation of Electric Arc Furnace
7. Constructional features & working principle of Cupola furnace
8. Advantages and limitation of cupola Furnace
9. Introduction to Casting process
10. steps involved in Casting process
11. Varieties of components produced by casting process
12. Advantages & Limitations of casting process

After learning all the topics of Unit-V, the student is able to

1. **Classify** types of cams and followers.
2. **Explain** the Follower Motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion..
3. **Explain** the Displacement, Velocity and acceleration curves for cam profiles.
4. **Determine/Construction** of the cam profile for various follower motion.

Review Questions

1. Define the following: i) Higher pair, ii) Kinematic chain, iii) Mechanism, iv) Machine, v) Inversion.
2. Determine the mobility of the four bar chain and single slider crank chain.
3. Explain with the help of neat sketches: a) Beam engine, b) Elliptical trammel, (c) Pantograph mechanism.
4. Explain with the help of neat sketches: a) Whit worth quick return motion mechanism, b) Peaucellier's mechanism, c) Ackermann steering mechanism.
5. Locate all the instantaneous centre for a four bar mechanism.
6. State and prove Kennedy's theorem of instantaneous centre.
7. State and prove law of gearing.
8. With a neat sketch explain spur gear terminology.
9. Derive an expression for Path of contact and contact ratio.
10. Explain with sketch Simple gear trains, Compound gear trains and Epicyclic gear trains.
11. Explain the terms slip, creep, initial tension and centrifugal tension.
12. Derive an expression for ratio of tensions for a flat belt passing over a pulley.
13. Classify types of cams and followers.
14. Explain the Follower Motions SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.

Lesson Plan

Unit -I

1. Introduction to link, rigid, resistant bodies, kinematic pair, degrees of freedom, Kinematic chain, mechanism, stricture, machines.
2. Inversion of mechanism, types of motion, Grubler's criterion and mobility of mechanism.
3. Degrees of freedom of different mechanisms and Problems solving.
4. Inversions of four bar chain.
5. Inversions of single slider crank chain.
6. Inversions of double slider crank chain.
7. Analysis of Quick return motion mechanisms-Whitworth mechanisms, Crank and slotted lever mechanisms.
8. Analysis of Intermittent motion mechanisms- Geneva mechanism and Ratchet and pawl mechanism.
9. Analysis of Toggle mechanism and Pantograph.
10. Analysis of Ackerman and Davis steering mechanism.

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. **Define** link, rigid and resistant bodies, kinematic pair, degrees of freedom, Kinematic chain, mechanism, structure, machines.
2. **Explain** the inversion, types of motion, Grubler's criterion and mobility of mechanism.,**Calculate** the degrees of freedom of different mechanisms
3. **Explain** various inversions of four bar chain, single slider crank chain and double slider crank chain
4. **Explain** the Quick return motion mechanisms and Intermittent motion mechanisms
5. Explain the various mechanisms like Toggle mechanism, Pantograph, Ackerman steering mechanism, Davis steering gear mechanism.

After learning all the topics of Unit-II, the student is able to

1. **Define** Absolute and relative motions, vectors, addition and subtraction of vectors and Motion of a link. **Explain** velocity by relative velocity method.
2. **Calculate** the Velocity of four-link mechanism, slider-crank mechanism and crank and slotted lever mechanism.
3. **Explain** the definitions of Instantaneous centre, number of I- centres and
4. Kennedy's theorem.
5. **Calculate** by locating I-centres for four bar chain, slider crank chain and
6. the velocity using I-centre method.
7. **Define** Acceleration and Angular acceleration of links,
8. **Determine** angular acceleration of links and acceleration of intermediate, offset points and acceleration for four bar mechanisms,and slider-crank mechanism

After learning all the topics of Unit-III, the student is able to

1. **Classify** different types of gears and its application.
2. **Explain** Spur Gear terminology, gear tooth profiles and law of gearing.
3. **Derive** an expression for Path of contact, arc of contact, contact ratio.
4. **Explain** the interference in involute gears, under cutting and various Methods of avoiding interference.
5. **Determine** Path of contact, arc of contact and contact ratio.

After learning all the topics of Unit-IV, the student is able to

1. **Explain** Simple gear trains, Compound gear trains and Epicyclic gear trains.
2. **Calculate** the velocity ratio of epicyclic gear trains using Tabular methods and
3. Tooth load and torque in epicyclic gear trains.
4. **Explain** belt drive, velocity ratio, effect of slip, ratio of belt tensions, Effect of centrifugal tension, power transmitted, effect of initial belt tension and **Classify** different types of belt drive.
5. **Drive** the expression for ratio of flat belt tension, V- belt tension and power transmitted
6. **Calculate** the velocity ratio, slip, ratio of belt tensions, centrifugal tension, power transmitted, effect of initial belt tension related to flat belt and V-belt tensions, and power transmitted

Unit II

1. Definition, functions, Materials used for pattern
2. Various pattern allowances and their importance
3. Classification of patterns
4. Definition, Types of binders used in moulding sand
5. Binder. Additives: need, types of additives used.
6. Types of sand moulds, Ingredients of moulding sand and Properties.
7. Core sands, ingredients properties Core making, Core baking – Dielectric baking of cores
8. Principles of Gating: Elements of gating system
9. Types of gates, gating ratio, function of risers, types of risers – open and blind risers.
10. Types of defects in Castings, Causes and remedies.

Unit III

1. Introduction to Moulding processes
2. CO2 moulding process
3. Shell moulding process
4. Investment casting,
5. Permanent mould casting
6. Gravity die-casting,
7. Pressure die casting
8. Centrifugal casting
9. Squeeze Casting and Slush casting
10. Thixocasting and continuous casting processes

Unit IV

1. Working principle of Arc Welding process
2. Working principle of Flux Shielded Metal Arc Welding (FSMAW)
3. Working principle of TIG Welding process
4. Working principle of MIG Welding process
5. Working principle of Submerged Arc Welding (SAW)
6. Working principle of Atomic Hydrogen Welding processes (AHW).
7. Working principle of Principle of Resistance welding
8. Working principle of Seam welding, and Thermit welding
9. Working principle of Spot welding and projection welding
10. Working principle of Friction welding and Explosive welding

Unit V

1. Introduction to weld Structure
2. Formation of different zones during welding
3. Heat affected zone (HAZ)
4. Parameters affecting on HAZ
5. Shrinkage in welds
6. Residual stresses in welding
7. Introduction to Weldability
8. Weldability testing
9. Welding defects – Detection
10. Causes for Welding defects & remedy.

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Classify various manufacturing processes	✓											
Explain the steps involved in casting processes	✓	✓										
Distinguish between various casting processes	✓	✓	✓									
Explain arc welding and other special types of welding processes.	✓	✓	✓									
Explain metallurgical aspects and defects in welding	✓	✓	✓									

Unit –III

Gears: Classification & application of different types of gears, Spur Gear terminology, law of gearing, gear tooth profiles, Path of contact, Arc of contact, Contact ratio, Interference in involute gears and under cutting. Methods of avoiding interference and Back lash. **10 hrs**

Unit –IV

Gear trains and belt drive: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Tabular method of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains.**Belt drive:** Introduction, classification, **(derivation of length of belt not included)** velocity ratio, effect of slip, ratio of belt tensions, effect of centrifugal tension, power transmitted, effect of initial belt tension. V-belts – ratio of belt tensions, power transmitted. **10 hrs**

Unit –V

Cams: Types of cams, types of followers, Follower Motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion. Displacement, Velocity and acceleration curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat –faced follower. **10 hrs**

Text books

1. S.S. Rattan **"Theory of Machines"** Tata McGraw-Hill, New Delhi and 2nd edition 2005.
2. Sadhu Singh "**Theory of Machines"** Person Eduction (Singapore) Pvt. Ltd Indian Branch, New Delhi, 2nd Edi.2006.

References

1. J.V. Shigley and J.J.Uickers "**Theory of Machines & Mechanisms"** OXFORD University Press.2004.
2. R.S.Khurmi and J.K.Gupta "**Theory of Machines"** S.Chand and Co.
3. P.L. Ballaney "**Theory of Machines"** Khanna Publishers
4. Dr. R.K. Bansal "**Theory of Machines"** Laxmi Publications.
5. J.B.K.Das "**Theory of Machines-1"** Sapna book house

Course Outcomes

1. **Explain** the various mechanisms, **calculate** the degrees of freedom, **explain** the various inversions of four bar chain, single and double slider crank chain.
2. **Determine** velocity by relative velocity method, Velocity of different mechanisms, Instantaneous centers and velocity analysis by Instantaneous centre method. **Determine** the acceleration of four bar mechanisms, slider-crank mechanisms.
3. **Classify** different types of gears, **Explain** Spur Gear terminology, law of gearing, interference and Back lash. **Derive** expressions for **and calculate** Path of contact, arc of contact, contact ratio.
4. **Explain** Simple, Compound and Epicyclic gear trains, **Calculate** velocity ratio, tooth load and torque in epicyclic gear trains. **Explain** and **calculate** ratio of belt tensions, effect of slip, initial and centrifugal belt tension and power transmitted.
5. **Explain** cam and follower types, **Explain** different follower Motions, **Construct** the cam profile.

Course Code :P13ME44	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : Kinematics of Machines		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Engineering Mathematics-I (P13MA11) Engineering Mechanics (P13CV13) Mechanics of Materials (P13ME33)		

Course Learning Objectives

1. **Explain** the various mechanisms, **calculate** the degrees of freedom, **explain** the various inversions of four bar chain, single and double slider crank chain.
2. **Determine** velocity by relative velocity method, Velocity of different mechanisms, Instantaneous centers and velocity analysis by Instantaneous centre method. **Determine** the acceleration of four bar mechanisms, slider-crank mechanisms.
3. **Classify** different types of gears, **Explain** Spur Gear terminology, law of gearing, interference and Back lash. **Derive** expressions for **and calculate** Path of contact, arc of contact, contact ratio.
4. **Explain** Simple, Compound and Epicyclic gear trains, **Calculate** velocity ratio, tooth load and torque in epicyclic gear trains. **Explain** and **calculate** ratio of belt tensions, effect of slip, initial and centrifugal belt tension and power transmitted.
5. **Explain** cam and follower types, **Explain** different follower Motions, **Construct** the cam profile.

Course Content

Unit –I

Introduction to Mechanisms: Introduction, Rigid and Resistant bodies, kinematic pairs, degrees of freedom, Grubler's criterion, Kinematic chain, mechanism, machine and structure. Mobility of Mechanism, inversion, Inversions of Four bar chain, Single slider crank chain and Double slider crank chain.

SimplE MechanismS: Quick return motion mechanisms-Whitworth mechanisms, Crank and slotted lever mechanisms. Intermittent motion mechanisms-Geneva mechanism and Ratchet and pawl mechanism. Peaucelliar's Straight line mechanism. Toggle mechanism, Pantograph, Ackerman steering mechanism, Davis steering gear mechanism. **10 hrs**

Unit –II

Velocity analysis of mechanisms: Introduction, absolute and relative motions, vectors, addition and subtraction of vectors, motion of a link, velocity analysis by relative velocity method, four-link mechanism, slider-crank mechanism, crank and slotted lever mechanism. Instantaneous centre, number of I-centres, Kennedy's theorem, locating I-centres, velocity analysis by I-centre method. **Acceleration anasyis of mechanisms:** Acceleration, Angular acceleration of links, Acceleration of intermediate and offset points, four bar mechanisms, slider-crank mechanism. **12 hrs**

Course Code :P13ME35	Semester : III	L - T - P : 4 - 0 - 0
Course Title : Basic Thermodynamics		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Engineering Physics (P13PH12) Engineering Mathematics-I (P13MA11)		

Course Learning Objectives

1. **Understand** the concepts of Energy in general and Heat and Work in particular.
2. **Apply** the laws of thermodynamics to various real life systems and the concepts of thermodynamics to basic energy systems.
3. **Understand** the concept of entropy and its applications to pure substances and gases
4. **Understand** the fundamentals of quantification and grade of energy
5. **Distinguish** between quality and quantity of energy, heat and work, enthalpy and entropy

Course Content

Unit – I

Fundamental Concepts & Definitions: Definition of Thermodynamics. Microscopic and Macroscopic approaches to the study of thermodynamics. Definitions of System (closed system) and Control Volume (open system) with examples. Definition of thermodynamic property, Intensive and extensive properties, thermodynamic state, process, quasi-static process, thermodynamic cycle. Thermodynamic equilibrium; definitions of thermal, chemical and mechanical equilibrium. Zeroth law of thermodynamics, Concept of Temperature. Thermodynamic definition of work, sign convention and examples to illustrate the definition of work. Work done at the system boundary, process equation and expressions for work done in different processes.

Definition of heat and its sign convention. Comparison of work and heat. Simple numerical problems on work and heat transfer only. **11 hrs**

Unit –II

First Law of Thermodynamics: Statement of the First law of thermodynamics for a closed system undergoing a cyclic process. First law of thermodynamics for a change of state of the system and concept of energy. Energy as a property of the system and its significance. Internal Energy, Enthalpy and Specific heats. Simple numerical problems on systems undergoing closed process.

Steady flow process, First law applied to steady flow process, derivation of steady flow energy equation and its applications. Simple numerical problems on systems undergoing steady flow process. **10 hrs**

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Explain measurement, metrology, various standards of measurements and elements of measurement systems.	√	√		√								
Calculate tolerances and **design** plug and ring guages	√	√										
Explain different types of comparators, angle measuring devices and **derive** expressions for finding effective diameter of screw threads.	√	√		√								
Explain sensor transducers, signal conditioning and terminating devices with associated parameters.	√	√		√								
Explain basic principles and devices involved in measuring strain, force, torque, pressure and temperature.	√	√		√								

7. Introduction to gauges and classification, Basic concept of design of gauges (Taylor's principles)
8. **Unit -**Types of gauges -plain plug gauge, ring gauge, snap gauge, gauge materials
9. Numerical Problems
10. Numerical Problems

Unit -III

1. Introduction to comparator and characteristics of comparator, Classification of comparator, Mechanical comparators
2. Optical comparators, Electronics
3. Electrical comparators, Pneumatic comparators
4. Principle and use of Sine bar, Sine center, Angle gauge
5. Numerical Problems
6. Surface roughness terminology, Methods of measuring surface roughness
7. Taylor-Hobson talysurf, Analysis of surface traces,
8. Measurement of basic elements of thread, Measurement of major diameter, minor diameter, pitch, angles
9. Effective diameter of screw threads by 2-wire and 3-wire methods and, Best size wire
10. Toolmakers' microscope, Use of gear tooth Vernier caliper and gear tooth micrometer
11. Profile projector, Principle of interferometry
12. Autocollimator, optical flats.

Unit—IV

1. Transducer and its efficiency, primary and secondary transducer
2. Classification of transducers with examples
3. Classification of transducers with examples
4. Signal Conditioning, Mechanical systems,
5. Electrical intermediate modifying devices, Modulated and unmodulated signals
6. Input circuitry-simple current sensitive circuit, Electronic amplifiers
7. Electronic amplifiers
8. Filters, Types of filters, telemetry
9. Terminating devices, Cathode Ray Oscilloscope,
10. Oscillographs, X-Y Plotters

Unit -V

1. Introduction to strain measurement, Methods of strain measurement
2. Strain gauges
3. Guage factor, preparation and mounting of strain gauges
4. Measurement of force - proving ring.
5. Torque measurement- Hydraulic dynamometer
6. Pressure measurement- Use of elastic members
7. Bridgeman gauge, Mcleod gauge and Pirani gauge
8. Temperature measurement- resistance thermometer, thermocouple
9. Laws of thermocouple, materials used for construction
10. Pyrometers, Optical pyrometer

Unit –III

Pure substances: Definition of pure substance, two-property rule applied to pure substance. Temperature-Volume diagram, definitions of Sub-cooled liquid, saturated liquid, mixture, saturated vapor and superheated vapor. Pressure-Temperature diagram. Definitions of triple point and critical point. Enthalpy of changes of a pure substance, temperature- Enthalpy diagram, definition of sensible heat, latent heat and super heat. Two phase mixture, quality of steam and definition of Dryness faction. Measurement of dryness fraction using bucket calorimeter, throttling calorimeter, separating calorimeter and throttling and separating calorimeter. Use of Steam tables, Simple problems on measurement of dryness fraction. **10 hrs**

Unit –IV

Second Law of Thermodynamics: Thermal reservoir. Source and sink. Heat engine, heat pump and refrigerator. Efficiency and coefficient of performance. Kelvin – Planck and Clausius statement of the Second law of thermodynamics and equivalence of the two Statements. Definition of perpetual motion machines of II kind with example. Reversible and Irreversible processes, factors that makes a process irreversible. Reversible heat engine - Carnot Cycle and expression for efficiency of Carnot cycle. Simple numerical problems on heat engines and heat pumps. **10 hrs**

Unit –V

Entropy: Clausius Inequality: Statement, and proof. Entropy: Definition, entropy as a property of the system. Principle of increase of entropy. Entropy as a quantitative test for irreversibility. Expression for entropy using T-dS relations, Calculation of entropy changes in different thermodynamic cyclic process. Equation of state, internal energy and enthalpy. Universal and characteristic gas constants, specific heats. Simple numerical problems based on heat, work, internal energy, enthalpy and entropy change in various processes.

11 hrs

Text books

1. P .K. Nag **"Basic and Applied Thermodynamics"** Tata McGraw Hill, 3rd Edi. 2006
2. R K Rajput "**Engineering Thermodynamics"** Laxmi Publications Pvt Ltd
3. Mahesh M Rathore "**Thermal Engineering**" Tata McGraw Hill

References

1. Spalding and Cole "**Engineering Thermodynamics"** ELBS edition.
2. Yunus A. Cenegal "**Thermodynamics – An engineering approach"** Tata McGraw Hill
3. Van and Wylen "**Fundamentals of Classical Thermodynamics"** Wiley Eastern limited
4. Domkundwar,kothandaraman"**A course in Thermal Engineering**"Dhanpat Rai & Co.

Course Outcomes

1. **Understand** the concepts of Energy in general and Heat and Work in particular.
2. **Apply** the laws of thermodynamics to various real life systems and the concepts of thermodynamics to basic energy systems.
3. **Understand** the concept of entropy and its applications to pure substances and gases
4. **Understand** the fundamentals of quantification and grade of energy
5. **Distinguish** between quality and quantity of energy, heat and work, enthalpy and entropy

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. **understand** the classical and the statistical approaches to thermodynamics
2. **understand** the basic concepts of thermodynamic such as temperature, pressure, system, properties process, state, cycles and equilibrium
3. **define** energy transfer through mass, heat and work for closed and control volume systems
4. **identify** the properties of substances on property diagrams and **describe** system behavior in terms of thermodynamic properties and processes
5. **identify** an appropriate system boundary and **describe** the interactions between the system and its surroundings
6. **Review** concepts of temperature, temperature scales and **State** Zeroth law of thermodynamics

After learning all the topics of Unit-II, the student is able to

1. **Define** FLTD for cyclic and non cyclic process
2. **Show** that energy as a property of system
3. **Apply** first law of thermodynamics to open and closed systems
4. **Define** reversible and irreversible processes
5. **Solve** problems based on open and closed systems

After learning all the topics of Unit-III, the student is able to

1. **Introduce** the concept of a pure substance.
2. **Discuss** the physics of phase-change processes.
3. **Illustrate** the P-v, T-v, and P-T property diagrams and P-v-T surfaces of pure substances.
4. **Demonstrate** the procedures for determining thermodynamic properties of pure substances from tables of property data.
5. **Determine** the quality of steam using different calorimeters

Review Questions

1. Sketch and explain imperial standard yard and international prototype meter.
2. Explain with sketch wringing phenomenon with respect to slip guages.
3. Explain with a block diagram the generalised measurement system.
4. Define error in measurement. List and explain different types of errors in measurement.
5. Define accuracy, precision and sensitivity.
6. Write a note on input circuitry.
7. State different terminating devices and explain any one.
8. Explain the working of a CRO.
9. Distinguish between tolerance and allowance.
10. Explain the principle of interchangeability and selective assembly.
11. With a sketch explain the 'hole basis' and 'shaft basis' system of fits.
12. Sketch and explain (a) Zeiss optimeter (b) Solex comparator.
13. With a neat figure, explain the principle of sine bar.
14. Explain the three wire method of measuring effective diameter of a screw thread.
15. Briefly explain the working of tool maker's microscope.
16. Discuss the working of McLeod guage.
17. What is a thermocouple? State and explain the laws of thermocouple.
18. What is a strain guage?

Lesson Plan

Unit -I

1. Definition and significance of measurement, Generalized measurement system, Signal Types, Modes of operation
2. Performance characteristics of measuring instruments
3. Inaccuracy of Measurements
4. Definition and objectives of metrology. Standards, Subdivision of standards
5. Line and end standard, Imperial standard yard, Wave length standard, International Prototype meter
6. Transfer from line to end standard. Calibration of end bars
7. Numerical Problems
8. Numerical Problems
9. Slip gauges, Wringing phenomena
10. Numerical Problems

Unit -II

1. Introduction to limits, fits and tolerance, Principles of interchangeability and selective assembly
2. Concept of limits of size and tolerances, Compound tolerances, accumulation of tolerances.
3. Definition of fits, types of fits. Hole basis system and shaft basis system
4. Numerical Problems
5. Numerical Problems
6. Geometric dimensioning and tolerancing

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. **Define** metrology and **state** its objectives.
2. **Explain** measuring system and significance of measurement.
3. **Define** the concepts of accuracy, precision, calibration, sensitivity, repeatability and linearity.
4. **Explain** static performance characteristics of measuring instruments and errors in measurement.
5. **Define** various standards used in metrology and **calibrate** end bars using slip guages.

After learning all the topics of Unit-II, the student is able to

1. **Define** limits, fits and tolerance and **explain** their significance.
2. **Explain** different types of tolerance and fits.
3. **Define** gauges and **explain** classification of gauges.
4. **Explain** geometric dimensioning and tolerancing.
5. **Calculate** tolerances and **design** plug and ring guages.

After learning all the topics of Unit-III, the student is able to

1. **Explain** working of mechanical, electrical, optical and pneumatic comparators.
2. **Explain** the working principle of Sine bar and Sine center.
3. **Explain** surface roughness terminology and **analyse** different types of surface traces.
4. **Explain** measurement of major diameter minor diameter, pitch angle of screw thread.
5. **Explain** two wire and three wire method of measuring effective diameter and **derive** expressions for the same.
6. **Explain** measurement of gear tooth parameters and application of gear tooth vernier caliper.
7. **Explain** principle of interferometry autocollimator, optical flats.

After learning all the topics of Unit-IV, the student is able to

1. **Explain** transducers and their classification.
2. **Explain** inherent problems in mechanical signal conditioning system.
3. **Explain** electrical signal conditioning systems.
4. **Explain** terminating devices.

After learning all the topics of Unit-V, the student is able to

1. **Explain** principle of strain gauge and **derive** an expression for gauge factor.
2. **Explain** the preparation and mounting of strain gauges.
3. **Explain** measurement of force using proving ring and torque using hydraulic dynamometer.
4. **Explain** measurement of pressure using elastic members, Bridgeman gauge, Mcleod gauge and Pirani gauge.
5. **Explain** the measurement of temperature using resistance thermometers, thermocouple and pyrometers.

After learning all the topics of Unit-IV, the student is able to

1. **Understand** the limitations of FLTD and **Introduce** the second law of thermodynamics.
2. **Discuss** thermal energy reservoirs, reversible and irreversible processes, heat engines, refrigerators, and heat pumps.
3. **Describe** the Kelvin–Planck and Clausius statements of the second law of thermodynamics.
4. **Discuss** the concepts of perpetual-motion machines.
5. **Apply** the second law of thermodynamics to cycles and cyclic devices.
6. **Apply** the second law to develop the absolute thermodynamic temperature scale.
7. **Describe** the Carnot cycle. Examine the Carnot principles, idealized Carnot heat engines, refrigerators, and heat pumps

After learning all the topics of Unit-V, the student is able to

1. **Define** entropy to quantify the second-law effects.
2. **Establish** the increase of entropy principle.
3. **Establish** the clausius inequality theorem
4. **Prove** entropy as a property of system
5. **Calculate** the entropy changes that take place during processes for pure substances, incompressible substances, and ideal gases.
6. **Examine** a special class of idealized processes, called isentropic processes, and develop the property relations for these processes.

Review Questions

1. What is the difference between the classical and the statistical approaches to thermodynamics
2. Explain the following concepts:
   - System, boundary, and surroundings
   - Closed system (control mass) and open system (control volume)
   - Adiabatic and isolated system
3. Distinguish clearly between intensive and extensive properties? Give three examples of each type
4. What is a quasi-equilibrium process? What is its importance in engineering?
5. What is the zeroth law of thermodynamics
6. Differentiate between path function and point functions with examples
7. Define Mechanical and thermodynamics modes of work
8. Derive an expression for displacement work for different thermodynamic process
9. Define FLTD for cyclic and non cyclic process and Show that energy as a property of system
10. Write down the SFEE and indicate clearly the meaning of each term in it
11. Apply SFEE for different thermodynamic devices like turbine. Compressor, nozzle, boiler
12. define pure substance and give some examples with a neat diagram explain PVT surface

13. explain formation of steam at constant pressure with PT diagram
14. define dryness fraction and with neat sketch explain the most accurate method of measuring it
15. State Kelvin – Planck and Clausius statement of the Second law of thermodynamics and show that they are equivalent
16. Prove that all reversible engines operating between same temperature limits have same efficiency
17. Prove that a reversible engine will have more efficiency than an irreversible engine operating between the same temperature limits
18. Mention the factors which render a process irreversible
19. State and prove Clausius Inequality
20. State and prove principle of increase of entropy
21. Show that entropy is a property of system
22. Using T ds relation obtain expression for change in entropy of an ideal gas

Lesson Plan

Unit – I

1. Definitions of system, system boundary and the interactions between the system and its surroundings.
2. Microscopic and macroscopic approaches description of matter
3. Thermodynamic properties, state, path and process
4. Thermodynamic equilibrium – mechanical, thermal and chemical equilibrium
5. Zeroth law of thermodynamics, temperature scales
6. Mechanical and thermodynamics definition of work with examples and sign convention
7. Different types of thermodynamic process and process equation.
8. Displacement work, expressions for displacement work in different thermodynamic processes.
9. Definition of heat, its units and sign convention. Comparison between work with heat.
10. Numerical problems on work and heat.
11. Numerical problems on work and heat.

Unit - II

1. Equivalence of heat and work - Joule's experiment. Statement of the First law of thermodynamics for a closed system under going cyclic process.
2. First law thermodynamics for a change of state of the system
3.
4. Energy as a property of the system
5. Numerical problems on closed system
6. Numerical problems on closed system
7. First law for an open System (control volume). Steady flow energy equation
8. Application of SFEE to different thermodynamic devices
9. Numerical problems on steady flow thermodynamic systems.
10. Numerical problems on steady flow thermodynamic systems
11. Numerical problems on steady flow thermodynamic systems

Surface roughness and Metrology of Screw Thread and Gears: Surface roughness terminology, Methods of measuring surface roughness, Taylor-Hobson talysurf, Analysis of surface traces, Measurement of basic elements of thread, worked examples. Measurement of major diameter, minor diameter, pitch, angles and effective diameter of screw threads by 2-wire and 3-wire methods, Best size wire. Toolmakers' microscope, Use of gear tooth Vernier caliper and gear tooth micrometer, Profile projector.**Interferometry:** Principle of interferometry, autocollimator, optical flats. **12 hrs**

Unit -IV

Sensor Transducers: Transfer efficiency, Loading effect, Primary and Secondary transducers, classification of transducers with examples. Advantages of each type transducers. **Signal Conditioning:** Mechanical systems, Electrical intermediate modifying devices, Input circuitry-simple current sensitive circuit, Electronic amplifiers, Filters, Types of filters, telemetry. **Terminiting devices:** Cathode Ray Oscilloscope, Oscillographs, X-Y Plotters. **10 hrs**

Unit –V

Strain Measurement: Methods of strain measurement, Strain gauges, Preparation and mounting of strain gauges, Gauge factor. **Measurement of Force:** Introduction, Proving ring **Measurement of Torque:** Introduction, Hydraulic dynamometer. **Measurement of Pressure**: Introduction, Use of elastic members, Bridgeman gauge, Mc Leod gauge, Pirani Gauge **Temperature Measurement**: Resistance thermometers, Thermocouple, Laws of thermocouple, Thermocouple materials, Pyrometers, Optical Pyrometer. **10 hrs**

Text books

1. R.K.Jain **"Engineering Metrology"** Khanna Publishers, 20th Ed.
2. R.S.Sirohi and H.C.RadhaKrishna **"Mechanical Measurements"** New Age International, 3rd Ed.

References

1. Thomas G. Beckwith, Roy D. Marangoni & John H. Lienhard **"Mechanical Measurements"** Pearson Education. Inc.
2. I.C.Gupta **"Engineering Metrology"** Dhanpat Rai Publications.
3. Alsutko & Jerry D.Faulk **"Industrial Instrumentation"** Thompson Asia Pvt. Ltd.
4. Doblin **"Mechanical measurements"** Tata McGraw Hill, Special Indian edition, 2007.

Course Outcomes

1. **Explain** measurement, metrology, various standards of measurements and elements of measurement systems.
2. **Calculate** tolerances and **design** plug and ring gauges.
3. **Explain** different types of comparators, angle measuring devices and **derive** expressions for finding effective diameter of screw threads.
4. **Explain** sensor transducers, signal conditioning and terminating devices with associated parameters.
5. **Explain** basic principles and devices involved in measuring strain, force, torque, pressure and temperature.

Course Code :P13ME43	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : Mechanical Measurements & Metrology		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Engineering Physics (P13PH12) Basic Electrical Engineering (P13EE15)		

Course Learning Objectives

1. **Explain** measurement, metrology, various standards of measurements and elements of measurement systems.
2. **Calculate** tolerances and **design** plug and ring gauges.
3. **Explain** different types of comparators, angle measuring devices and **derive** expressions for finding effective diameter of screw threads.
4. **Explain** sensor transducers, signal conditioning and terminating devices with associated parameters.
5. **Explain** basic principles and devices involved in measuring strain, force, torque, pressure and temperature.

Course Content

Unit –I

Basic Concepts of Measurement and Metrology: Definition and significance of measurement, Generalized measurement system, Signal Types, Modes of operation, Performance characteristics of measuring instruments (Only static characteristics), Inaccuracy of Measurements, Definition and objectives of metrology. Standards, Subdivision of standards, Line and end standard, Imperial standard yard, Wave length standard, International Prototype meter, Transfer from line to end standard. Calibration of end bars, Slip gauges, Wringing phenomena, Numerical problems on building of slip gauges. **10 hrs**

Unit –II

System of Limits, Fits, Tolerances and Gauging: Definition of tolerance, specification in assembly, Principle of inter changeability and selective assembly. Concept of limits of size and tolerances, Compound tolerances, accumulation of tolerances. Definition of fits, types of fits. Hole basis system and shaft basis system, Geometric dimensioning and tolerancing.Classification of gauges, Basic concept of design of gauges (Taylor's principles), wear allowance on gauges. Types of gauges -plain plug gauge, ring gauge, snap gauge, gauge materials. Gauge Design and numerical problems. **10 hrs**

Unit –III

Comparators: Characteristics and classification of comparators. Mechanical comparators-Johnson Mikrokator, Sigma Comparators, Optical Comparators - principles, Zeiss ultra optimeter, Electric and Electronic Comparators, LVDT, Pneumatic Comparators, Solex Comparator. Back Pressure gauges, **Angular Measurements:** Principle and use of Sine bars, Sine center, Angle gauges.

Unit -III

1. Definition, Two property Rule, Pressure - Temperature and Temperature –Volume diagrams, triple point and critical points.
2. Sub- cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapor, with water as example.
3. Temperature-Enthalpy diagram, change of phase (Latent heat) and Dryness fraction (quality of steam). T-S and H-S diagrams for water and representation of various processes on these diagrams,
4. Two phase mixture, quality of steam and definition of Dryness faction
5. Bucket Calorimeter, Separating calorimeter, Throttling calorimeter,
6. combined separating and throttling calorimeter
7. Steam tables, Mollier chart and its use.
8. numerical problems
9. numerical problems
10. numerical problems

Unit -IV

1. Thermal reservoir. source and sink. Devices converting heat to work in a thermodynamic cycle, heat engine, heat pump and refrigerator,
2. schematic representation, efficiency and coefficient of performance.
3. Kelvin – Planck and Clausius statement of the Second law of thermodynamics
4. Equivalence of the two Statements of second law.
5. Definition of perpetual motion machines of I and II kind. Reversible and Irreversible processes, factors that make a process irreversible,
6. reversible heat engine-Carnot Cycle.
7. expression for efficiency of Carnot cycle
8. Simple numerical problems on heat engines and heat pumps
9. Simple numerical problems on heat engines and heat pumps.
10. Simple numerical problems on heat engines and heat pumps

Unit -V

1. Clausius Inequality: Statement, proof and application to a reversible cycle. Entropy: Definition,
2. Entropy as a property of the system
3. Universal and characteristic gas constants, specific heats.
4. Principle of increase of entropy
5. Entropy as a quantitative test for irreversibility, isolated system
6. Calculation of entropy changes for different thermodynamic process.
7. Expression for entropy using T dS relations.
8. Simple numerical problems
9. Simple numerical problems
10. Simple numerical problems
11. Simple numerical problems

Course Articulation Matrix (CAM)												
Course Outcome (CO)	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
Understand the concepts of Energy in general and Heat and Work in particular.	✓	✓		✓								
Apply the laws of thermodynamics to various real life systems and the concepts of thermodynamics to basic energy systems.	✓	✓	✓	✓								
Understand the concept of entropy and its applications to pure substances and gases	✓	✓	✓	✓								
Understand the fundamentals of quantification and grade of energy	✓	✓	✓	✓								
Distinguish between quality and quantity of energy, heat and work, enthalpy and entropy	✓	✓	✓	✓								

Course Articulation Matrix (CAM)												
Course Outcome (CO)	**Program Outcomes**											
	1	2	3	4	5	6	7	8	9	10	11	12
Learn and **understand** necessity of applied thermodynamics and basics of I.C. Engines.	✓	✓		✓								
Explain the concept of air standard cycle and vapor power cycle	✓	✓		✓								
Explain and **calculate** the performance characteristics of reciprocating air compressor.	✓	✓		✓	✓							
Explain the different types of refrigerating systems and and **Apply** the knowledge of psychometrics chart.	✓	✓		✓	✓							
Calculate the performance characteristics of I.C. Engines	✓	✓		✓	✓							

Unit III

1. Operation of a single stage reciprocating air compressors,
2. Work input using p-v diagram and steady state flow analysis,
3. Effect of clearance and volumetric efficiency,
4. Adiabatic, isothermal and mechanical efficiencies,
5. Multistage compressors saving in work, expression for optimum intermediate pressure.
6. Imperfect inter cooling.
7. Numerical problems
8. Numerical problems
9. Numerical problems
10. Numerical problems

Unit -IV

1. Introduction, Heat Engines and Heat Pumps, Pressure- enthalpy diagram
2. Vapour compression refrigeration systems, description, analysis
3. refrigerating effect, capacity, power required, units of refrigeration, and COP
4. Numerical problems
5. Numerical problems
6. **Properties of atmospheric air:** Dry Air, Relative Humidity,Specific humidity, degree of saturation,
7. dry bulb and wet bulb temperature
8. Psychometric Chart.
9. Psychometric Process: Sensible heating or cooling, cooling and
10. dehumidification, heating and humidification
11. adiabatic mixing of two streams
12.

Unit -V

1. Testing of two-stroke and four strokes SI and CI engines.
2. Performance Factors and Performance characteristics.
3. Indicated Power, Friction Power: Willan's line method, Morse Test Motoring test and Retardation test
4. Brake Power: principle of Dynamometer, Porny Brake, Rope brake, Hydraulic Dynamometer and eddy current dynamometer.
5. Brake Power: principle of Dynamometer, Porny Brake, Rope brake, Hydraulic Dynamometer and eddy current dynamometer.
6. Fuel consumption: volumetric type. Air consumption: Air Box Method
7. Heat balance
8. Numerical problems
9. Numerical problems
10. Numerical problems

Course Code :P13ME36	Semester : III	L - T - P : 0 - 0 - 6
Course Title : Computer Aided Machine Drawing		
Contact Period: Lecture: 78 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Computer Aided Engineering Drawing (P13ME14/24)		

Course Learning Objectives

1. **Solve** problems on sections of regular solids.
2. **Convert** pictorial views to orthographic views.
3. **Draw** 2D views of simple machine elements
4. Assemble the components of mechanical systems in 3D environment

Course Content

Unit –I

INTRODUCTION: Review of basic sketching commands and navigational commands. **SECTIONS OF SOLIDS**: Sections of Pyramids, Prisms, Cube, Tetrahedron, Cone and Cylinder resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.
ORTHOGRAPHIC VIEWS: Conversion of pictorial views into orthographic projections of simple machine parts with and without section. (Bureau of Indian standards conventions are to be followed for the drawings), Line conventions. **12 hrs**

Unit –II

THREAD FORMS: Thread terminology, sectional view of threads. ISO Metric (Internal & External), BSW (Internal & External), square and Acme threads, Buttress thread, Sellers thread, American Standard thread.
FASTENERS: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. **12 hrs**

Unit –III

RIVETED JOINTS: Single and Double riveted lap joints, butt joints with single/ double cover straps (chain and Zigzag, using snap head rivets). **12 hrs**

Unit –IV

KEYS & JOINTS: Study of keys: Parallel key, Taper key, feather key, Gibhead key and Woodruff key.
Joints: cotter joint (socket and spigot), knuckle joint (pin joint), Universal joint.
COUPLINGS: Protected type flanged coupling, pin (bush) type flexible coupling, Muff coupling. **15 hrs**

7. Explain the effect of clearance volume in compressor
8. Derive an expression for intermediate pressure which gives minimum power in a two stage compressor with perfect intercooling
9. Explain the effect of increasing delivery pressure on the volume of air delivered
10. Define refrigeration, COP, and tons of refrigeration
11. Describe a simple vapour compression refrigeration system giving clearly its flow diagram
12. Distinguish between dry bulb and wet bulb temperature
13. Discuss Sensible heating or cooling, cooling and dehumidification,
14. Describe the method commonly used for measuring the air supplied to an IC engines
15. Describe the method commonly used for measuring the frictional power of an IC engines

Lesson Plan

Unit—I

1. Description about Carnot Cycle, Otto Cycle, and Diesel Cycle
2. Expression for efficiencies and definition of mean effective pressures for Otto cycles
3. Expression for efficiencies and definition of mean effective pressures for Diesel cycles
4. Comparison of Otto and Diesel cycles
5. Description Brayton cycle for a gas turbine power plants, open and closed type
6. Brayton cycle with Regeneration.
7. Brayton cycle with reheating
8. Brayton cycle with Inter-cooling
9. Numerical problems
10. Numerical problems
11. Numerical problems

Unit -II

1. Analysis of Carnot vapour power cycle
2. Simple Rankine cycle, description, T-s diagram, and Expression for efficiency.
3. Comparison of Carnot and Rankine cycles.
4. Effects of pressure and temperature on the performance Rankine cycle.
5. Analysis of Reheat Cycle
6. Ideal regenerative cycle,
7. practical regenerative with cycles open and closed type feed water heaters
8. Numerical problems
9. Numerical problems
10. Numerical problems

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. **Evaluate** the performance of gas power cycles for which the working fluid remains a gas throughout the entire cycle
2. **Develop** simplifying assumptions applicable to gas power cycles.
3. **Solve** problems based on the Otto, Diesel cycles.
4. **Solve** problems based on the Brayton cycle, Brayton cycle with intercooling, reheating, and regeneration

After learning all the topics of Unit-II, the student is able to

1. **Analyze** vapor power cycles in which the working fluid is alternately vaporized and condensed.
2. **Investigate** ways to **modify** the basic Rankine vapor power cycle to increase the cycle thermal efficiency.
3. **Analyze** the reheat and regenerative vapor power cycles.
4. **Analyze** the effects of pressure and temperature on the performance Rankine cycle.

After learning all the topics of Unit-III, the student is able to

1. **Gain** knowledge about the reciprocating air compressor and their application
2. **Understand** the working principle of single and multi stage compressors
3. **Understand** the effect of clearance and intercooling

After learning all the topics of Unit-IV, the student is able to

1. **Introduce** the concepts of refrigerators and heat pumps and the measure of their performance
2. **Analyze** the ideal vapor-compression refrigeration cycle.
3. **Discuss** the operation of refrigeration and heat pump systems..
4. **Evaluate** the performance of vapor-compression refrigeration systems
5. **demonstrate** the knowledge of psychometrics chart

After learning all the topics of Unit-V, the student is able to

Understand the working principle of IC engines and different types of I.C. Engines

Understand the working of different types of measurement of Brake power, frictional power, fuel consumption and Air consumption

Evaluate the performance of IC engines

Review Questions

1. What is a cycle? what is the difference between an ideal and actual cycle
2. Derive an expression for thermal efficiency of Otto and Diesel cycles
3. With sketches explain gas turbine cycles with Regenerator, reheating and Inter-cooling.
4. Discuss the effects of pressure and temperature on Rankine cycle
5. Explain Rankine cycle with super heat
6. Explain regenerative cycle with closed feed water heater

Unit –V

ASSEMBLY DRAWINGS

Assembly drawing of following machine parts (3D parts to be created and assemble and then getting 2D drawing with required views, including part drawing).

Introduction to geometrical dimensioning and tolerance.

1. Screw Jack
2. I.C. Engine Connecting Rod
3. Machine Vice
4. Plummer Block
5. Fuel Injector **27 hrs**

Text books

1. N.D. Bhat & V.M.Panchal "**Machine Drawing"**
2. N. Siddeshwar, P. Kannaiah, V.V.S. Sastri "**Machine Drawing"** published by Tata Mc. GrawHill, 2006
3. Tryambaka Murthy **"Machine Drawing"**

References

1. K.R. Gopala Krishna **"Machine Drawing"**, Subhash Publication.

Course Outcomes

1. **Solve** problems on sections of regular solids.
2. **Convert** pictorial views to orthographic views.
3. **Draw** 2D views of simple machine elements
4. Assemble the components of mechanical systems in 3D environment

Topic Learning Objectives

After learning all the topics of Unit-I, the student is able to

1. Solve problems on sections of solids.
2. Convert pictorial views to orthographic views.

After learning all the topics of Unit-II, the student is able to

1. Explain thread terminology and different forms of thread.
2. Draw proportionate drawing of bolts with washers

After learning all the topics of Unit-III, the student is able to

1. Draw proportionate drawing of riveted lap joints with single/double cover straps (chain and Zigzag, using snap head rivets)
2. Draw proportionate drawing of riveted butt joints with single/double cover straps (chain and Zigzag, using snap head rivets)

After learning all the topics of Unit-IV, the student is able to

1. Draw proportionate drawing of keys
2. Draw proportionate drawing of joints.
3. Draw proportionate drawing of couplings.

After learning all the topics of Unit-V, the student is able to

1. Assemble the components of mechanical systems in 3D environment.

Lesson Plan

Unit – I

1. Review of basic sketching commands and navigational commands. **(3Hrs)**
2. Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases. True shape of sections. **(3 Hrs)**
3. Conversion of pictorial views into orthographic projections of simple machine parts with and without section. Line conventions. **(3 Hrs)**
4. Conversion of pictorial views into orthographic projections of simple machine parts with and without section. Line conventions. **(3 Hrs)**

Unit -II

1. Thread terminology and sectional view of threads **(3 Hrs)**
2. Hexagonal headed bolt and nut with washer (assembly), **(3 Hrs)**
3. Square headed bolt and nut with washer (assembly) **(3 Hrs)**
4. Simple assembly using stud bolts with nut and lock nut. **(3 Hrs)**

Unit -III

1. Single riveted lap joints single/double cover straps (chain and Zigzag, using snap head rivets). **(3 Hrs)**
2. Double riveted lap joints single/double cover straps(chain and Zigzag, using snap head rivets). **(3 Hrs)**
3. Single riveted butt joints single/double cover straps(chain and Zigzag, using snap head rivets). **(3 Hrs)**
4. Double riveted butt joints single/double cover straps(chain and Zigzag, using snap head rivets). **(3 Hrs)**

Unit -IV

1. Keys & Joints **(6 Hrs)**
2. Joints **(6 Hrs)**
3. Couplings **(3 Hrs)**

Unit -V

1. Screw Jack **(6 Hrs)**
2. I.C. Engine Connecting Rod **(6 Hrs)**
3. Machine Vice **(6 Hrs)**
4. Plummer Block **(6 Hrs)**
5. Fuel Injector **(3 Hrs)**

and Psychometric Process: Sensible heating or cooling, cooling and dehumidification, heating and humidification and adiabatic mixing of two streams (No numerical problems). **11 hrs**

Unit –V

TESTING OF I.C. ENGINES: Testing of two-stroke and four strokes SI and CI engines. Performance Factors and Performance characteristics. Indicated Power, Friction Power: Willan's line method, Morse Test, Motoring test and Retardation test. Brake Power: principle of Dynamometer, Prony Brake, Rope brake, Hydraulic Dynamometer and eddy current dynamometer. Fuel consumption: volumetric type. Air consumption: Air Box Method. Heat balance and related numerical problems. **10 hrs**

Text books

1.P .K. Nag **"Basic and Applied Thermodynamics"** Tata McGraw Hill, 3rd Edi. 2006
2.R K Rajput "**Engineering Thermodynamics"** Laxmi Publications Pvt Ltd
3.V Ganeshan "Internal Combustion Engines"
4.Mahesh M Rathore "Thermal Engineering" Tata McGraw Hill

References

1.Spalding and Cole "**Engineering Thermodynamics"** ELBS edition.
2.Yunus A. Cenegal "**Thermodynamics – An engineering approach"** Tata McGraw Hill
3.Van and Wylen "**Fundamentals of Classical Thermodynamics" ,**Wiley Eastern limited
4.Domkundwar,kothandaraman"**A course in Thermal Engineering**",Dhanpat Rai & Co
5.M.L.Mathur and R.P.Sharma "**Internal Combustion Engines**", Dhanpat Rai & Co

Course Outcomes

1. **Learn** and **understand** necessity of applied thermodynamics and basics of I.C. Engines.
2. **Explain** the concept of air standard cycle and vapor power cycle
3. **Explain** and **calculate** the performance characteristics of reciprocating air compressor.
4. **Explain** the different types of refrigerating systems and and **Apply** the knowledge of psychometrics chart.
5. **Calculate** the performance characteristics of I.C. Engines

Course Code :P13ME42	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : Applied Thermodynamics		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Basic Thermodynamics (P13ME35)		

Course Learning Objectives

1. **Learn** and **understand** necessity of applied thermodynamics and basics of I.C. Engines.
2. **Explain** the concept of air standard cycle and vapor power cycle
3. **Explain** and **calculate** the performance characteristics of reciprocating air compressor.
4. **Explain** the different types of refrigerating systems and and **Apply** the knowledge of psychometrics chart.
5. **Calculate** the performance characteristics of I.C. Engines

Course Content

Unit –I

AIR STANDARD CYCLES: Carnot Cycle, Otto Cycle and Diesel Cycle, their PV and T-S diagrams, description, expression for efficiencies and definition of mean effective pressures. Comparison of Otto and Diesel cycles. Brayton cycle for a gas turbine power plants, open and closed type. Deviations of practical gas turbine cycles from ideal cycles. Variations of Brayton cycle like Regeneration, reheating and Inter-cooling. **11 hrs**

Unit –II

VAPOUR POWER CYCLES: Carnot vapour power cycle, its analysis for performance and drawbacks, Simple Rankine cycle, description, T-S diagram, and Expression for efficiency. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on the performance Rankine cycle. Analysis of Reheat Cycle, Ideal regenerative cycle, practical regenerative cycles with open and closed type feed water heaters. **10 hrs**

Unit –III

RECIPROCATING AIR COMPRESSORS: Working of single stage reciprocating air compressors, Work input using PV diagram and steady flow analysis. Effect of clearance and volumetric efficiency, isothermal and mechanical efficiencies, Multistage compressors, saving in work, expression for optimum intermediate pressure. Imperfect inter cooling. **10 hrs**

Unit –IV

REFRIGERATION AND AIR CONDITIONING: Introduction, Heat Engines and Heat Pumps, Pressure- enthalpy diagram. Vapour compression refrigeration systems, description, analysis, refrigerating effect, capacity, power required, units of refrigeration, and COP (Simple numerical problems).

Properties of atmospheric air: Dry Air, Relative Humidity, Specific humidity, degree of saturation, dry bulb and wet bulb temperature. Psychometric Chart

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Solve problems on sections of solids.			√		√					√		
Convert pictorial views to orthographic views.			√		√					√		
Draw 2D views of simple machine elements			√		√					√		
Assemble the components of mechanical systems in 3D environment.			√		√					√		

Course Code : P13MEL37	Semester : III	L - T - P : 0 - 0 - 3
Course Title : Metallography And Material Testing Laboratory		
Contact Period: Lecture: 36Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Materials Science and Metallurgy (P13ME32) Mechanics of Materials (P13ME33)		

Course Learning Objectives

1. **Determine** the mechanical properties of material specimen.
2. **Prepare** material specimen for metallographic studies and **recognize** the micro structural features of material.
3. **Demonstrate** heat treatment of metal specimens.
4. **Demonstrate** 4 point bending fatigue test.

Course Content

Part -A

Exp-1

Tensile, Compression, Shear and Torsion tests on mild steel specimens using a Universal Testing Machine **6Hrs**

Exp-2

Bending Test on mild steel, wooden specimens. **3Hrs**

Exp-3

Preparation of specimen for metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, grey CI, SG iron, Brass, Bronze and composites. **6Hrs**

Part -B

Exp-4

Impact Tests: Izod and Charpy tests on mild steel specimens. **3Hrs**

Exp-5

Hardness tests: Brinnell, Rockwell and Vickers's Hardness tests. **3Hrs**

Exp-6

Heat treatment: Annealing, Normalizing, Hardening and Tempering of Ferrous alloys and study their Rock well's hardness. **6Hrs**

Exp-7

Fatigue test- 4 point bending (Demonstration only) **3Hrs**

Seminar **3Hrs**

Test **3Hrs**

References

1. P.N.Rao **"Manufacturing & Technology: Foundry Forming and Welding"** 2nd Ed., Tata McGraw Hill, 2003
2. Serope Kalpakjian & Steven R Schmid **"Manufacturing Engineering and Technology",** Pearson Education Asia, 4th Ed. 2002

Course Outcomes

1. **Prepare** casting moulds using foundry sand.
2. **Prepare** simple cast components using Aluminium/Cast Iron.
3. **Calculate** the material requirement for forging.
4. **Prepare** simple forged components.

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Prepare casting moulds using foundry sand.			√		√							
Prepare simple cast components using Aluminium/Cast Iron.			√	√	√	√			√			
Calculate the material requirement for forging.			√		√							
Prepare simple forged components.			√		√				√			

Course Code : P13MEL38	Semester : III	L - T - P : 0 - 0 - 3
Course Title : Foundry and Forging Laboratory		
Contact Period: Lecture: 36Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Materials Science and Metallurgy (P13ME32) Manufacturing Process-I (P13ME34)		

Course Learning Objectives

1. **Prepare** casting moulds using foundry sand.
2. **Prepare** simple cast components using Aluminium/Cast Iron.
3. **Calculate** the material requirement for forging.
4. **Prepare** simple forged components.

Course Content

Part -A

Exp-1

Use of foundry tools and equipments. **3Hrs**

Exp-2

Preparation of moulds using two boxes,
Use of patterns : split pattern, match plate pattern and cores **6Hrs**

Exp-3

Preparation of casting;
Aluminium or cast iron (demonstration only) **6Hrs**

Part -B

Exp-4

Use of forging tools and equipments. **3Hrs**

Exp-5

Preparing minimum three models involving upsetting, drawing and bending operations, along with length and volume calculations. **12Hrs**

Seminar **3Hrs**

Test **3Hrs**

References

1. William D. Callister "**Materials Science and Engineering"** Wiley India Pvt. Ltd
2. Sidney Avner, "I**ntroduction to Physical Metallurgy"** Tata McGraw Hill Education Private Limited

Course Outcomes

1. **Determine** the mechanical properties of material specimen.
2. **Prepare** material specimen for metallographic studies and **recognize** the micro structural features of material.
3. **Demonstrate** heat treatment of metal specimens.
4. **Demonstrate** 4 point bending fatigue test.

Course Articulation Matrix (CAM)

Course Outcome (CO)	Program Outcomes											
	1	2	3	4	5	6	7	8	9	10	11	12
Determine the mechanical properties of material specimen.		√		√	√				√			
Prepare material specimen for metallographic studies and **recognize** the micro structural features of material.				√	√				√			
Demonstrate heat treatment of metal specimens.			√	√		√			√			
Demonstrate 4 point bending fatigue test.		√		√					√			