Evaluation Scheme

CIE Scheme

Assessment	Weightage in Marks
Calculations	20
Evaluation of models	20
Record writing	10
Total	**50**

SEE Scheme

Semester End Examination (SEE) is a practical examination of three hours duration of 50 marks.

Sl. No.	Marks allotment		
1	Procedure and Conduction	ONE Question from part A	25
		ONE Question from part B	15
2	Viva Voce		10
Total Marks			**50**

Syllabus

Out Come Based Education

III & IV Semester
Bachelor Degree
in
Industrial and Production Engineering

2013-14

P.E.S. College of Engineering

Mandya - 571 401. Karnataka

(An Autonomous Institution Affiliated to VTU Belgaum)

Grant -in- Aid Institution

(Government of Karnataka)

Accredited by NBA, New Delhi

Approved by AICTE, New Delhi.

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

Sl No	Course Code	Course Title	Teaching Dept.	Hrs/ week L:T:P: H	Credit	Examination Marks		
						CIE	SEE	Total Marks
1.	P13MA31	Engineering Maths - III.	Maths	4:0:0: 4	4	50	50	100
2.	P13IP32	Engineering Metrology.	IP	4:0:0:4	4	50	50	100
3.	P13IP33	Mechanical Measurements.	IP	4:0:0:4	4	50	50	100
4.	P13IP34	Mechanics of Materials.	IP	3:1:0:4	4	50	50	100
5.	P13IP35	Production Technology - I.	IP	3:0:0:3	3	50	50	100
6.	P13IP36	Fluid Mechanics and Machinery.	IP	3:1:0:4	4	50	50	100
7	P13IPL37	Mechanical Measurements and Metrology Lab	IP	0:0:3:3	1.5	50	50	100
8.	P13IPL38	Foundry and Forging Lab.	IP	0:0:3:3	1.5	50	50	100
9	P13HU39	Aptitude Competence and Professional Augmentation – I (ACPA- I)	HS&M	2:0:0:2	0	(50)	--	--
10	P13IPL310	Industry Interaction - I	IP	0:0:1:1	0	(50)	--	--
11	P13HM311	Constitution of India & Professional Ethics	H & S	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 Code : P13IPL48	**Semester : IV**	**L - T - P : 0 - 0 - 1.5**
Course Title : Machine Shop Practice.		
Contact Period: Lecture: 36 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	

Prerequisites : The student should have studied Elements of Mechanical Engineering - P13ME14/24

Course Learning Objectives: At the end of the Course the students should be,

1. Student should be able to understand different machine tools like Lathe, Milling, Drilling, Grinding and Shaping machines
2. Student will learn different operations of lathe; Facing, Plain turning, step turning, taper turning thread cutting and knurling- at least three models.
3. Student will able to do calculations of taper turning, thread cutting.
4. Student will able to do operations on Drilling machine.
5. Student will able to do operations on Shaping machine for two models.
6. Student will learn different operation on milling machine for gear cutting.

Course Content

Part – A

1. Introduction to cutting tools, Machine tools and preparing the layout of machine shop.
2. Preparation of models on lathe involving Facing, Plain turning, Taper turning, Step turning.
3. Thread cutting, Knurling.
4. Boring and Reaming operations.
5. Drilling operations.
6. Eccentric turning.

Part – B

1. Machining V Groove Rectangular groove using Shaping machine
2. Gear Teeth Cutting using Milling Machine

PART – B

1.Non-destructive test experiments

(a). Ultrasonic flaw detection

(b). Magnetic crack detection

(c). Dye penetration testing, to study the defects of Casted and Welded Specimens

2. Demonstrations of the following;

(a) Preparation of specimen for metallographic examination of different engineering materials and to identify the microstructures.

(b) Hardness studies of heat treated samples.

SEE Scheme

Semester End Examination (SEE) is a practical examination of three hours duration of 50 marks.

Sl. No.	Marks allotment		
1	Procedure and Conduction	ONE Question from part A	25
		ONE Question from part B	15
2	Viva Voce		10
Total Marks			**50**

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

Sl No.	Course Code	Course Title	Teaching Dept.	Hrs/ week L:T:P:H	Credit	Examination Marks		
						CIE	SEE	Total Marks
1.	P13MA41	Engineering Maths - IV.	Maths	4:0:0:4	4	50	50	100
2.	P13IP42	Material Science and Metallurgy	IP	4:0:0:4	4	50	50	100
3.	P13IP43	Engineering Thermodynamics	IP	3:1:0:4	4	50	50	100
4.	P13IP44	Theory of Machines	IP	3:1:0:4	4	50	50	100
5.	P13IP45	Production Technology - II	IP	4:0:0:4	4	50	50	100
6.	P13IP46	Computer Aided Machine Drawing	IP	0:0:6:6	3	50	50	100
7.	P13IPL47	Material Testing Lab	IP	0:0:3:3	1.5	50	50	100
8.	P13IPL48	Machine Shop	IP	0:0:3:3	1.5	50	50	100
9	P13HU49	Aptitude Competence and Professional Augmentation – Ii (ACPA- II)	HS&M	2:0:0:2	0	(50)	--	--
10	P13IPL410	Mini Project- I	IP	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

+ Common to BE (AU, CV, ME and I&PE) ++ Common to BE (E&C, E&E, CS&E and IS&E)

L: Lecture, T: Tutorial, P: Practicals, , H: Hrs/week, CIE: Continuous Internal Evaluation, SEE: Semester End Examination

* Additional Mathematics-II & Environmental Studies : Lateral entry students shall have to pass these mandatory learning courses before completion of VI- Semester

** ACPA- II : All students shall have to pass this mandatory learning courses before completion of VI- 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 : P13IPL47	Semester : IV	L - T - P : 0 - 0 - 1.5
Course Title : Metallography and Material Testing Lab.		
Contact Period: Lecture: 36 Hr, Exam: 3 Hr	Weightage: CIE:50; SEE:50	

Prerequisites : Students should have the knowledge of mechanical properties of materials such as aluminium, brass, plain carbon steel, tool steel, gray cast iron and mild steel.

Course Learning Objectives: At the end of the Course the students should be,

1. Learn the preparation of the specimen of different engineering materials for indentifying the microstructures.
2. Learn hardness of the heat treated materials.
3. Learn few non-destructive test experiments for detection of Ultrasonic flaw, magnetic crack, dry penetration and also know the defects of casted and welded materials.
4. Learn different material testing machines which are used for testing.

Course Content

PART –A

1. Tensile test of metallic specimen using Universal Testing Machine.
2. Single shear and double shear using Universal Testing Machine.
3. Compression test on metallic specimen using a Universal Testing Machine.
4. Bending Test on wood using a Universal Testing Machine.
5. Izod and Charpy tests on M.S. Specimen.
6. Brinell, Rockwell and Vickers’s Hardness test.

Course Code : P13IP32	Semester : III	L - T - P : 4 - 0 - 0
Course Title : Engineering Metrology		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	Weightage: CIE:50; SEE:50	

Prerequisites : Students should have the knowledge of using Scale, compass, inside & outside calipers, Spirit level, Tri square, Micrometer, Vernier Caliper, etc., knowledge of reading Least Count of various instruments is essential.

Course Learning Objectives:

1. The aim of the course is to provide the students an opportunity to gain the knowledge in the field of Metrology.
2. Apply the fundamental concepts of gauging principal and to solve the gauging problems.
3. To demonstrate the operation principles, advantages, applications, limitations of the various comparators.
4. Impart knowledge to students about the various surface measurements technique and their application.
5. To gain the knowledge for various optical measuring instruments.
6. The students gain the knowledge of different screw threads and gears terminology.
7. The students understands the different methods of Non destructive testing.
8. Develop the skill to apply, analyze basic of NDT methods.

Course Content

Unit-I

GENERAL MEASUREMENT CONCEPTS AND PRINCIPLES :Definition of accuracy and precision, estimating accuracy and precision, Line and End measurements, Subdivisions of Standards , Different types of length standards: Imperial standard yard, International yard, International prototype meter, Light wave (optical) length standard , Airy Points. Limits ,fits and tolerance, Hole basis system and shaft basis system (problems) . 12 Hrs

Unit-II

GAUGES : Classification of gauges, Brief concept of designing of gauges (Taylor's principle for Go and NoGo) wear allowance on gauges. Three basic types of gauges, Problems on designing of gauges. Types of gauges- plain plug gauge, ring gauge, snap gauge, thread gauge, screw pitch gauge, feeler gauge, wire gauge, slip gauge **.**

MEASUREMENT AND CHECKING USING DIFFERENT INSTRUMENTS :

Straightness, Flatness, Squareness, Combination Set, Sine bars- Sine center construction and working principle. 10 Hrs

Text books :

1. 'A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum.
2. N.D.Bhat&V.M.Panchal,'Machine Drawing'.

Reference Books :

1. S. Trymbaka Murthy, 'A Text Book of Computer Aided Machine Drawing', CBS Publishers, New Delhi, 2007
2. K.R. Gopala Krishna, 'Machine Drawing', Subhash Publications.
3. GoutamPohit&GouthamGhosh, 'Machine Drawing with Auto CAD', Pearson Education, 1st Indian Print, 2005.

Note :

Internal assessment: 50 Marks

All the sheets should be drawn in the class using software. Sheet sizes should be A3/A4. All sheets must be submitted at the end of the class by taking printouts.

Scheme of Examination

Two questions to be set from each Part-A, Part-B and Part-C. Student has to answer one question each from Part-A and Part-B for 20 marks each. And one question from Part-C for 60 marks.

PART-A 1x20	=	20 Marks
PART-B 1x20	=	20 Marks
PART-C 1x60	=	60 Marks
Total	=	100 Marks

Unit II :

Thread forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. 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. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw. **08 Hours**

PART – B

Unit III :

Keys &Joints : Parallel key, Taper key, Feather key, Gibhead key and Woodruff key, Riveted Joints:single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. **08 Hours**

Unit IV :

Couplings : Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint) **08 Hours**

PART – C

Unit V :

Assembly Drawings (Part drawings should be given) **18 Hours**

1. Plummer block (Pedestal Bearing)
2. Screw jack (Bottle type)
3. Machine vice
4. Petrol Engine piston
5. I.C. Engine connecting rod
6. Tailstock of lathe
7. Tool Head of a shaper

Unit-III

COMPARATORS: Need for a comparator, Mechanical, Optical, Pneumatic, Electrical and Electronic Comparator- Construction, working principle. Applications, advantage, disadvantage of the various comparators.

OPTICAL MEASURING INSTRUMENTS : Interference of light, Arrangement for producing interference pattern, Optical flats, Laser interferometer, Construction and Principle of Tool Maker's Microscope, Optical projectors, Autocollimators. 10 Hrs

Unit-IV

SURFACE FINISH MEASUREMENT: Definition, Elements of surface finish: Ra, R_{max}, Rt, Rz, Rpk, Symbols used, Different Methods of surface measurement, Instruments such as Tomlinson's Surface meter, Taylor – Hobson's Talysurf.

MEASUREMENT OF SCREW THREADS and GEARS: Terminology of screw threads, Best wire size method, Two and three wires method, Bench micrometer, Measurement of Major and Minor diameter. Gear terminol-ogy, Measurement of run-out, pitch, and profile, Parkinson Gear Tester 10 Hrs

Unit-V

MACHINE TOOL TESTING: Instruments required for alignment test, Alignment tests on Lathe, drilling machine and Milling machine.

NON DESTRUCTIVE TESTING: Comparison of Destructive and Non destructive testing methods, Introduction to NDT Methods: Magnetic Particle Inspection, Ultrasonic Testing, Eddy Current testing, Radiography, Acoustic emission Testing. 10 Hrs

Text Book :

1) R.K. JAIN,**Engineering Metrology** - Khanna Publishers
2) I.C. GUPTA,**Engineering Precision Metrology**–DhanpatRai Publications

Reference Books :

1. K. J. Hume, Engineering Metrology, Kalyani Publishers, Third Edition.
2. Shobont and Bolt, Engineering Metrology. ASTME – Hand book of Industrila Metrology - PHI

Course Outcomes

1. The students should learn and understand necessity of Metrology and basic of Non destructive testing.
2. Demonstrate ability to make use of different gauges.
3. Students will be able to use different type's comparators.
4. The students get exposure to different types of surface measurements methods.
5. Students should be able to demonstrate the knowledge of various screw threads and gear terminology.
6. Students will be able to demonstrate the need of Non destructive testing

Topic Learning Objectives

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

1. Describe general measurement in metrology (L1).
2. Describe limits, fits and tolerance (L1).
3. Describe Different types of length standards (L1).
4. Explain Airy Points through calculation (L2).
5. Compare Hole basis and Shaft basis system, terminologies used (L4).
6. Explain Line and End measurements (L2).
7. Compare Interchangeability and selective assembly (L4).
8. Explain accuracy and precision (L2)
9. Explain ways of expressing tolerance (L2).

After learning all the topics of unit – II, the student is able to,

1. Describe Classification of gauges in metrology (L1).
2. Describe Brief concept of designing of gauges (L1).
3. Describe Types of gauges (L1).
4. Use of ring gauge, snap gauge, srew pitch gauge, feeler gauge (L3).
5. Compare Sine bars- Sine center construction and working principle (L4).
6. Explain designing of gauges (L2).
7. Compare **S**traightness, Flatness, Squareness Interchangeability (L4).
8. Explain Combination Set (L2)
9. Explain measurement and checking using different instruments (L2).

After learning all the topics of unit – III, the student is able to

1. Describe need for a comparator (L1).
2. Describe Interference of light (L1).
3. Use Mechanical, Optical, Pneumatic, Electrical & Electronic Comparator for inspection (L3).
4. Explain Optical flats (L2).
5. Compare Tool Maker's Microscope and Optical projectors (L4).
6. Explain arrangement for producing interference pattern (L2).
7. Compare Mechanical, Optical, Pneumatic and Electrical comprator (L4).
8. Explain Laser interferometer (L2).
9. Explain Construction and Principle of Autocollimators (L2).
10. Use autocollimators for measurement of straightness (L3).

After learning all the topics of unit – IV, the student is able to

1. Describe surface finish measurement (L1).
2. Describe Ra, RMS, Rt, Rz, Rp (L1).
3. Describe Methods of surface measurement (L1).
4. Explain Elements of surface finish (L2).
5. Compare Tomlinson's Surface meter, Taylor – Hobson's Talysurf (L4).
6. Explain Best wire size (L2).
7. Explain Parkinson Gear Tester (L2).
8. Explain Terminology of screw threads (L2)
9. Explain Gear terminol-ogy (L2).

Course Code : P13IP46	Semester : IV	L - T - P : 2 - 1 - 0
Course Title : Computer Aided Machine Drawing.		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	

Prerequisites : The students should have undergone the course on Computer aided Engineering drawing.

Course Learning Objectives: At the end of the Course the students should be,

1. Able to produce computer-aided mechanical drawings of components and assemblies of machine parts and other mechanical equipments.
2. Visualizing and applying basic drafting fundamentals.
3. Preparing and editing engineering drawings,
4. Interpreting and applying drafting standards,
5. Using software for CAD such as Solid Edge V19,
6. Drawing sectional views and Assembly drawings.

Course Content

Introduction: Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing.Drawing units, grid and snap.

02 Hours

PART – A

Unit I :

Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders 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 or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions.Precedence of lines. **08 Hours**

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
The students should learn and understand necessity in the field of manufacturing process.	L 1	**M**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Demonstrate ability to make use of the fundamental concepts, constructions and principal of machine parts.	L 3	**L**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Students will be able to use different type's machines	L 3	**H**	**M**	**H**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**
The students get exposure to different types of attachments, and Work holding devices their application.	L 3	**H**	**M**	**M**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
The students should learn and understand necessity in the field of manufacturing process.	L 1	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Demonstrate ability to make use of the fundamental concepts, constructions and principal of machine parts.	L 3	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Students will be able to use different type's machines	L 3	**3**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
The students get exposure to different types of attachments, and Work holding devices their application.	L 3	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**

1 – Low, 2 – Moderate and 3 – High

After learning all the topics of unit – IV, the student is able to

1. Describe Instruments required for alignment test (L1).
2. Describe alignment tests on lathe, drilling machine and milling machine (L1).
3. Describe non destructive testing (L1).
4. Explain NDT Method (L2).
5. Compare Magnetic Particle Inspection andRadiography (L4).
6. Explain Ultrasonic Testing (L2).
7. Compare Destructive and Non destructive testing method (L4).
8. Explain Eddy Current testing (L2)
9. Explain Acoustic emission Testing (L2).

Review Questions

1 Define Accuracy and precision and measurements its importance
2 How do you estimate Accuracy and precision?
3 What are line standers?
4 What are end standers?
5 What is the various subdivision of yard?
6 Write notes on international photo type meter
7 What are Airy Points?
8 Define limits
9 Explain various types of fits
10 What is Hole base system and shaft basis system?
11 What is a gauge?
12 Write about importance of gauge
13 What are the basic concepts in design of gauges?
14 What are GO and NOGO gauges
15 What is wear allowance to the principle gauge?
16 What is the use of plain plug gauge?
17 What is the list of ring gauge?
18 How do measure the straightness and flatness
19 Design the sine center construction
20 Design the working principle of sine center
21 What is the purpose of a comparator?
22 Mention various types of comparators
23 Sketch and explain Mechanical and pneumatic
24 Explain the constructions of Electrical comparators
25 Explain the constructions of Electronic comparators
26 Write notes on constructions of optical comparators
27 Write notes on laser interferometer
28 Write about the constructions and waviness principle of Tomlinson surface meter
29 What are the optical projectors?
30 Write notes on constructions working of auto coulometer

Unit – IV

1. Milling machines:
2. Classification,
3. constructional features,
4. milling cutters nomenclature, milling operations,
5. up milling and down milling concepts.
6. Indexing:
7. Simple,
8. compound,
9. differential and
10. angular indexing calculations.

Unit – V

1. Grinding machines:
2. Types of abrasives,
3. bonding process,
4. classification,
5. constructional features (surface grinding), and
6. types of surface grinding, selection of grinding wheel.
7. Laping, Honing and Super Finishing machines:
8. Principles of operation,
9. construction,
10. applications.

Lesson Plan

Unit – I

1. Introduction,
2. Functions of lathe types of lathes,
3. parts of lathes,
4. specification of lathe,
5. operation of lathe,
6. lathe accessories and attachments. capstan and turret lathe,
7. Capstan and turret lathe mechanisms,
8. tool holding devices,
9. capstan and turret lathe operation,
10. turret tooling layout(Production of an hexagonal bolt)
11. cutting speed ,
12. feed and depth of cut.

Unit – II

1. Shaping and planning machines::Introduction,
2. Constructional features of shaper ,
3. Constructional features of shaper,
4. Constructional features of planer;
5. Constructional features of planer,
6. drive Mechanism of shaper
7. Drive mechanism of planer,
8. Different mechanisms,
9. cutting speed,
10. feed and depth of cut.

Unit – III

1. Drilling machines: Introduction,
2. classification,
3. constructional features,
4. Working principles,
5. drilling Machine & drilling operations,
6. Different operations performed,
7. types of drill,
8. drill bit nomenclature,
9. Drill bit nomenuclature,
10. drill materials.

31Difine the surface finish
32 What are the elements of surface finish?
33 How is surface finish represented?
34 What is the symbol used for surface finish
35 What are the different methods of surface measurements?
36 Draw the sketch of Tomlinson surface meter
37 Write notes on Tomlinson surface meter
38 How is Taylor –Hobson's Talysurf used for surface measurements
39 Writes a notes on best-3 wire method
40 Write notes on Parkinson gear tester
41 Why do use need to do alignment test
42 What are the instruments need for drilling alignment test
43 How are alignment test for Lathe
44 How are alignment test for milling machine
45 What are destructive and non destructive test
46 Write notes on Magnetic particle inspector
47 Sketch and explain ultraistic testing producer
48 Explain radiography test with neat sketch
49 Write notes on Acoustic emission testing
50 Write few advantages of non destructive testing methods

Lesson Plan

Unit – I

1. Introduction to Power Semiconductor devices
2. Applications of Power electronics and power semiconductor devices
3. Control characteristics of power semiconductor devices
4. Types of Power electronic circuits
5. Peripheral effects of power electronic circuits
6. Power Transistors : BJT's
7. Steady state characteristics Switching characteristics and Switching limits
8. Power MOSFET's switching Steady state characteristics and IGBT's
9. The concepts of di/dt and dv /dt limitations
10. Isolation of gate and base drives

Unit – II

1. Thyristors : Introduction
2. Characteristics of thyristor
3. Two transistor models
4. Turn on and turn off times of an SCR
5. Thyristor types
6. The di /dt Protection for thyristor circuits
7. The dv /dt Protection for thyristor circuits
8. Thyristor types – series and parallel operation of SCR
9. Problems on series and parallel operation of SCR
10. Thyristor firing circuits

Unit – III

1. AC Voltage Controllers: Introduction
2. Principles of ON– OFF control
3. Principles of Phase control
4. Single Phase bi directional controllers with resistive and inductive loads
5. Problems on Single Phase bi directional controllers with resistive and inductive loads
6. Controlled Rectifiers: Introduction
7. Principles of phase controlled converter operation
8. Single phase with problems
9. Full converter with problems
10. Dual converter (constant current operation mode only) with problems

35. With a neat sketch explain the nomenuclature of Milling cutter.
36. Mention the different operations performed in milling machine.
37. Explain Indexing.
38. With a neat sketch explain Simple Indexing.
39. With a neat sketch explain Compount Indexing.
40. With a neat sketch explain Differential Indexing.
41. With a neat sketch explain Angular Indexing.
42. Define Grinding Process.
43. With a block diagram explain the working principle of Grinding machine.
44. Mention the different types of Grinding machines.
45. With a neat sketch explain the grinding wheel.
46. With a neat sketch explain centerless grinding process.
47. With a neat sketch explain the constructional features of Surface Grinding.
48. Mention the different types of Surface Grinding.
49. Briefly explain selection of grinding wheel.
50. Briefly explain Lapping, Honning and Super Finishing Machines.

1. With a neat sketch describe the centre less grinding process.(L2)
2. Explain the different types of bonding materials used to make the grinding wheels.(L3)
3. State the precautions to be taken during mounting of grinding wheels.(L3)
4. Explain super finishing operation with a sketch. .(L2)
5. Explain the difference between honing and lapping. .(L4)

Review Questions

1. With a block diagram explain the different parts of Lathe.
2. Briefly explain the functions of Lathe.
3. Explain the working principle of Lathe.
4. Mention the specifications of Lathe.
5. With a neat sketch explain the different operations of Lathe.
6. With a neat sketch explain the different Lathe attachments.
7. Explain the working principle of Capstan and Turret Lathe.
8. Briefly explain the mechanism of obtaining a Production of Hexagonal Bolt.
9. Define Cutting Speed, Feed and Depth of cut.
10. Simple Problems.
11. With a neat diagram explain the working principle of Shaper.
12. With a neat diagram explain the constructional features of Shaper.
13. Explain briefly the different parts of Shaper.
14. With a neat diagram explain the working principle of Planer.
15. Mention the Different mechanisms of Shaper.
16. Mention the different mechanisms of Planer.
17. With a neat sketch explain briefly any one mechanism of Planer.
18. With a neat sketch explain briefly any one mechanism of Shaper.
19. Define Cutting Speed, Feed and Depth of cut.
20. Simple problems.
21. Explain drilling operation.
22. With a block diagram explain the working principle of Radial Drilling Machine.
23. With a block diagram explain the constructional features of Drilling Machine.
24. Mention the classification of Drilling Machine.
25. Mention the different operations performed in a Drilling Machine.
26. With a block diagram explain Drill Bit.
27. Mention the nomenuclature of Drill Bit.
28. Mention the different material used in drilling operatiions
29. With a neat sketch explain Boring process.
30. With a neat sketch explain Reaming process.
31. With a neat sketch explain Reamer.
32. With a block diagram explain the working principle of Milling machine.
33. Mention the classification of Milling machines.
34. With a neat sketch explain Up Milling and Down Milling.

Unit – IV

1. DC to DC Converter: Introduction
2. Principles of step–down operation
3. Step–down converter with RL load
4. Problems on step down converter
5. Principle of step–up converter
6. Step–up converter with Resistive load
7. Performance parameters of choppers
8. Converter classification
9. Differences between step–down and step–up operation
10. Problems on step–up converter

Unit – V

1. Inverters: Introduction
2. Principles of operation of inverters
3. Performance parameters for inverters
4. Single phase bridge inverters
5. Voltage control of single phase inverters
6. Current source inverter
7. Power supplies: Introduction
8. DC power supplies
9. AC power Supplies
10. Differences between DC and AC power supplies

Course Articulation Matrix (CAM)												
Course Outcome (CO)		**Program Outcome** (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
The students should learn and understand necessity of Metrology and basic of Non destructive testing.	L 1	**M**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Demonstrate ability to make use of different gauges.	L 4	**L**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Students will be able to use different type's comparators.	L 1	**H**	**M**	**H**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**
The students get exposure to different types of surface measurements methods.	L 5	**H**	**M**	**M**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**
Students should be able to demonstrate the knowledge of various screw threads and gear terminology.	L 4	**H**	**H**	**M**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**
L- Low, M- Moderate, H-High												
Course Assessment Matrix (CAM)												
Course Outcome (CO)		**Program Outcome** (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
The students should learn and understand necessity of Metrology and basic of Non destructive testing.	L 1	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Demonstrate ability to make use of different gauges.	L 4	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Students will be able to use different type's comparators.	L 1	**3**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
The students get exposure to different types of surface measurements methods.	L 5	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
Students should be able to demonstrate the knowledge of various screw threads and gear terminology.	L 4	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
1 – Low, 2 – Moderate and 3 – High												

Course Outcomes

1. The students should learn and understand necessity in the field of manufacturing process.
2. Demonstrate ability to make use of the fundamental concepts, constructions and principal of machine parts.
3. Students will be able to use different type's machines
4. The students get exposure to different types of attachments, and Work holding devices their application.

Topic Learning Objectives

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

1. Draw a neat diagram of centre lathe and name its various parts. (L2).
2. Describe the working of a three jaw self centering chuck and combination Chuck. (L2).
3. Give the specification of a lathe (L3).
4. Describe the constructional features of a turret lathe (L3).
5. Draw a tool layout for hexagonal headed bolt in a capstan lathe (L4).
7. Compare capstan lathe and turret lathe (L3).

After learning all the topics of unit – II, the student is able to,

1. Describe Classification of planning machines (L1).
3. Describe Types of woke holding devices (L1).
4. Describe the constructional features of a Shaping machine (L3).).
5. Compare planning machine and Shaping machine (L4).
6. Explain the drive Mechanism of shaper and planer (L2).

After learning all the topics of unit – III, the student is able to,

1. Describe need for a Drilling machines (L1).
2. Describe Radial drilling machine (L2).
3. Explain with neat sketches nomenclature of the Twist Drill (L2).
4. Explain with neat sketches Gang Drilling machine(L2).

After learning all the topics of unit – IV, the student is able to,

1. Explain with neat sketch working of column and knee type milling machine. (L2).
2. Differentiate up milling and down milling. Show the chip cross-section with figures. (L3)
3. Differentiate simple indexing and differential indexing (L3)
4. Explain with neat sketch nomenclature of milling cutter (L2)

After learning all the topics of unit – V, the student is able to,

Unit – III

Drilling machines: Classification, constructional features, drilling Machine & drilling operations, types of drill & drill bit nomenclature, drill materials.

10 hrs

Unit – IV

Milling machines: Classification, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concepts.

Indexing: Simple, compound, differential and angular indexing calculations.

10 Hours

Unit – V

Grinding machines: Types of abrasives, bonding process, classification, constructional features (surface grinding), and types of surface grinding, selection of grinding wheel.

Laping, Honing and Super Finishing machines: Principles of operation, construction, applications. **11 Hours**

Text Books:

1. HazaraChoudhry**, "Workshop Technology :** Vol-II", Media Promoters& Publishers Pvt. Ltd. 2004.

2. R.K.Jain**, "Production Technology"**, Khanna Publications, 2003.

Reference Books:

1. AmitabhaGhosh and Mallik, "**Manufacturing Science"**, affiliated EastWest Press, 2003.

2. G.Boothroyd, **"Fundamentals of Metal Machining and Machine Tools"**, McGraw Hill, 2000.

Course Code : P13IP33	Semester : III	L - T - P : 4 - 0 - 0
Course Title : MACHANICAL MEARSUREMENTS		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	Weightage: CIE:50; SEE:50	

Prerequisites : Students should have the knowledge of pressure sensitive elements, Bourdon tube pressure gage, sliding contact devices, LVDT, Telemetry, Mechanical counters, CRO, Oscillographs, Proving ring, Dynamometers, Strain gauges, McLeod gage, Thermocouple, Radiation Pyrometers, etc., knowledge of reading various instruments is essential.

Course Learning Objectives:

1. The aim of the course is to provide the students an opportunity to gain the knowledge in the field of Measurements.
2. Apply the fundamental concepts of instrumentsprincipal and to solve the constructional problems.
3. To demonstrate the operation principles, advantages, applications, limitations of the various of instruments
4. To gain the knowledge for various measuring instruments andpressure sensitive elements.
5. The students gain the knowledge of different Oscillographs
6. The students understands the different methods of Dynamometers,
7. Develop the skill to apply, analyze basic of Radiation Pyrometers methods.

Course Content

Unit-I

BASIC DETECTOR TRANSDUCERS: Mechanical members as primary detectors. Electric transducers - sliding contact devices. Secondary transducers - differential transformer, piezoelectric effect, Ionization transducer.
INTERMEDIATE MODIFYING SYSTEMS Mechanical systems, kinematics linearity, Mechanical amplifications, reflected frictional amplifications, reflected inertial amplifications,-temperature problems, methods for limiting temperature errors, Telemetry. **11 Hrs**

Unit-II

TERMINATING DEVICES AND METHODS: The generalized system. Vacuum tube voltmeter. Mechanical counters. CRO recording techniques, oscillographs,
MEASUREMENT OF FORCE, TORQUE: Methods of force and torque measurements, elastic transducers, Hydraulic, pneumatic transmission dynamometers. **11 Hrs**

Course Code : P13IP45	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : Production Technology – II		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	Weightage: CIE:50; SEE:50	

Prerequisites : Students should have the knowledge of Lathes, Drilling machines ,Milling machines, Shaping machine, Planning machines, Grinding machines Lapping, Honing, Super finishing process etc. knowledge of reading different types attachments and Work holding devices.

Course Learning Objectives: At the end of the Course the students should be,

1. The aim of the course is to provide the students an opportunity to gain the knowledge in the field of manufacturing process.
2. Apply the fundamental concepts, constructions and principal of machine and parts.
3. To demonstrate the operation principles, advantages, applications, limitations of the various machines
4. Impart knowledge to students about the different type's attachments, and Work holding devices their application.

Course Content

Unit– I

The Lathe: Introduction, Functions of lathe types of lathes, parts of lathes, specification of lathe, operation of lathe, lathe accessories and attachments. capstan and turret lathe, Capstan and turret lathe mechanisms, tool holding devices, capstan and turret lathe operation, turret tooling layout(Production of an hexagonal bolt) cutting speed , feed and depth of cut. **12 Hours**

Unit – II

Shaping and planning machines: Introduction, Constructional features of shaper and planer; drive Mechanism of shaper and planer, cutting speed, feed and depth of cut. **10 Hours**

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Link or element, Kinematic pairs, degrees of freedom, kinematic chain and mechanisms,	L 1	M	L	-	-	-	-	-	-	-	-	-
Mechanisms – quick return motion, whitworth and crank and slotted lever mechanism,	L 3	L	M	-	-	-	-	-	-	-	-	-
Spur gears – terminology and law of gearing,	L 3	H	M	H	-	H	-	-	-	-	-	-
Belt drives – ratio of belt tensions, centrifugal tension, power transmitted and v-belt.	L 3	H	M	M	-	M	-	-	-	-	-	-
CAMS – Types, types of followers, displacement, velocity and acceleration,	L 1	H	H	M	-	H	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Link or element, Kinematic pairs, degrees of freedom, kinematic chain and mechanisms,	L 1	2	1	-	-	-	-	-	-	-	-	-
Mechanisms – quick return motion, whitworth and crank and slotted lever mechanism,	L 3	1	2	-	-	-	-	-	-	-	-	-
Spur gears – terminology and law of gearing,	L 3	3	2	3	-	3	-	-	-	-	-	-
Belt drives – ratio of belt tensions, centrifugal tension, power transmitted and v-belt.	L 3	3	2	2	-	2	-	-	-	-	-	-
CAMS – Types, types of followers, displacement, velocity and acceleration,	L 1	3	3	2	-	3	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

Unit-III

STRAIN MEASUREMENTS: Types of electrical resistance- strain gauges, principle of operation, gauge material, gauge factor, mounting Techniques, moisture proofing, calibration circuits, strain measurement on static and rotary shafts proper orientation of gauges, commercial strain measuring systems. **10 Hrs**

Unit-IV

MEASUREMENT OF PRESSURE: Pressure measuring systems, pressure measuring transducers, elastic transducers, elastic diagrams, strain gauge pressure cell, measurement of high and low pressures. **10 Hrs**

Unit-V

TEMPERATURE MEASUREMENT: Thermal expansion methods, bimetallic thermometers, liquid-in glass thermometers, pressure thermometers, thermo electric sensors (thermo couples), and common thermo couples. Reference junc-tion considerations, electrical resistance sensors- semiconductor sources – Radiation methods - pyrometers. **10 Hrs**

Text Book :

1. D.S.KUMAR, **Mechanical Measurements and Control** - Metropolitan Publishers.
2. BECKWITH, BUCK & MARAN-GONI, **Mechanical Measurements**– Narosa publishing House.

Course Outcomes

1. The students learn and understand necessity of Mechanical Measurements.
2. Demonstrate ability to make use of various measuring instruments.
3. Students will be able to use different typesof Dynamometers
4. The students get exposure to different types of measurements methods.
5. Students should be able to demonstrate the knowledge of various Mechanical measuring instruments
6. Students will be able to demonstrate the need of Radiation Pyrometers methods

Topic Learning Objectives

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

1. Discuses the various mechanical types of pressure sensitive elements. (L5)
2. Explain the types of transducer elements (L5)
3. Describe the different types of resistive transducer (L5).
4. With sketch explain piezoelectrictransducer (L2).
5. With sketch explain LVDT?(L2)
6. Explain the construction and working of an ionization transducer(L2)
7. Discuss reflected frictional and reflected inertial amplification(L5)
8. Discuss kinematic linearity of mechanical intermediate modifying system(L5)
9. What are the methods of limiting temperature errors?(L4)
10. With sketch and explain a general telemetry system.L2

After learning all the topics of unit – II, the student is able to,

1. Explain VTVM with a neat sketch (L2)
2. Explain the working principle of CRO.(L2)
3. With sketch and explain a stylus type oscillographs.(L2)
4. With sketch and explain the magnetic tape recorder/reproducer(L2)
5 What is the working principle of a platform balance? Explain.(L2)
6. With a sketch explain the working of proving ring.(L2)
8. Explain hydraulic dynamometer with a neat sketch.(L4)
9. With a sketch explain the working of mechanical dynamometer. (L4)
10. With a sketch explain the working of transmission dynamometer. (L4)
11. What is the working principle of an Analytical balance? Explain (L2)

After learning all the topics of unit – III, the student is able to

1. Explain with a neat sketch a mechanical type strain gauge. (L2)
2. Explain with a neat sketch Tuckerman optical extensometer.(L5)
3. With a sketch explain the working of bounded type resistance strain gauge (L2)
4. With a sketch explain the working of unbounded type resistance strain gauge(L2)
5. Explain with a neat sketch piezoresistive type strain gauge(L2)
6. Write a short note on bonding materials of strain gauge (L2)

After learning all the topics of unit – IV, the student is able to

1. Describe with a neat sketch a bulk modulus pressure gage. (L2)
2. Explain with a neat sketch a flattened-tube pressure cell. (L2)
3. Explain with a neat sketch a pirani type thermal conductivity gage.(L2)
4. Describe with a neat sketch a McLeod pressure gage.(L2)
5. Explain with a neat sketch a cylindrical strain gauge pressure cell.(L2)

Unit – IV

1. CAMS : Introduction – Types of Cams.
2. Types of followers.
3. Displacement and velocity.
4. Acceleration time curves for cam profiles.
5. Problems.
6. Problems.
7. Disc cam with reciprocating follower having knife-edge.
8. Roller and flat-faced follower.
9. Follower motions including Uniform velocity.
10. Follower motions including Simple Harmonic motion and uniform acceleration and retardation.

Unit – V

1. Balancing of Machinery : Introduction.
2. Static and dynamic balancing.
3. Balancing of single rotating mass in same plane and in different planes.
4. Balancing of several rotating in same plane and in different planes.
5. Problems on above concepts.
6. Problems on above concepts.
7. Governors : Introduction.
8. Types of governors.
9. Force analysis of porter.
10. Controlling force, stability and sensitiveness.
11. Problems on above concepts.

Lesson Plan

Unit – I

1. Introduction : Definitions – Link or element, Kinematic pairs.
2. Degrees of freedom, Kinematic chain, mechanism, structure.
3. Mobility of mechanism, Inversion.
4. Machine. Kinematic chains and Inversions.
5. Inversions of Four bar chain, Single slider crank chain and double slider crank chain.
6. Mechanisms : Quick return motion mechanisms.
7. Whitworth mechanism and Crank and slotted lever mechanism.
8. Intermittent motion mechanism.
9. Geneva mechanism.
10. Ratchet and pawl mechanism.
11. Problems.

Unit – II

1. Spur gears : Introduction – Gear Terminology.
2. Characteristics of Involute action.
3. Path of contact and arc of contact.
4. Contact ratio.
5. Interference in involute gears and methods of avoiding interference.
6. Gear Trains : Introduction.
7. Simple Gear trains, compound gear trains.
8. Compound gear trains for large speed reduction.
9. Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclical gear trains.
10. Problems.

Unit – III

1. Friction : Introduction – Definitions.
2. Laws of Solid friction.
3. Belt drives.
4. Ratio of belt tensions.
5. Centrifugal tension.
6. Power transmitted.
7. Effect of centrifugal tension on power transmitted.
8. V-belt drives.
9. Problems.
10. Problems.

After learning all the topics of unit – V, the student is able to

1. Explain the laws of thermocouples.(L2)
2. Explain the types of thermocouple (L2)
3. List the desirable properties of a thermocouples material.(L2)
4. List the advantages and disadvantages of thermocouples(L3)
5. Describe the construction and working of any one total radiation pyrometer.(L6)
6. Describe the construction and working of optical pyrometer.(L6)

Review Questions

1. Write a note on Basic detector Transducers.
2. Mention the different mechanical members which are used as primary detectors.
3. Explain with a neat sketch Sliding Contact devices.
4. With a neat sketch Explain differential transformer.
5. Explain piezoelectric effect.
6. With a neat sketch explain Ionization transducer.
7. Define Mechanical systems and Kinematic linearity.
8. Explain mechanical amplifications.
9. Explain reflected frictional amplifications.
10. Explain reflected inertial amplifications.
11. Explain the different methods used for limiting temperature errors.
12. Explain telemetry.
13. Briefly explain the Generalized system.
14. With a neat sketch explain Vacuum tube voltmeter.
15. With a neat sketch explain mechanical counters.
16. With a neat sketch Explain the working of CRO.
17. Mention the different techniques of recording in CRO.
18. With a neat sketch explain Oscillographs.
19. Explain force and Torque.
20. Mention the different methods used for measurement of Force and Torque.
21. Explain Elastic Transducers.
22. With a neat sketch explain Hydraulic Transmission dynamometers.
23. With a neat sketch explain Pneumatic Transmission dynamometers.
24. Define Strain.
25. Mention the different methods of Strain Measurements.
26. With a neat sketch explain Strain Gauges.
27. With the principle of operation of Strain Gauge.
28. Mention the different gauge materials and the concept of Gauge factor.
29. With a neat sketch explain the mounting of Strain gauges.
30. Explain moisture proofing.
31. With a block diagram explain Calibration circuits.
32. With a neat sketch explain the strain measurement on Static and Rotary shafts.
33. Describe the concept of proper orientation of gauges.
34. Explain commercial strain measuring systems.
35. With a block diagram explain Pressure Measuring Systems.
36. Write a note on Pressure measuring transducers.
37. Explain Elastic Transducers.
38. Explain Working of Elastic transducers.
39. Write a note on elastic diagrams.
40. Explain Strain gauge pressure cell.
41. Explain the measurement of high pressure.
42. Explain the measurement of low pressure.
43. Explain Temperature Measurement concept.
44. Mention the different methods of temperature measurements.

sure angle increases.

48. Derive an expression for the length of the arc of contact in a pair of meshed spur gears.

49. What do you understand by the term ‘interference’ as applied to gears?

50. Derive an expression for the minimum number of teeth required on the pinion in order to avoid interference in involute gear teeth when it meshes with wheel.

35. Draw the acceleration diagram of a slider crank mechanism.
36. Explain how the coriolis component of acceleration arises when a point is rotating about some other fixed point and at the same time its distance from the fixed point varies.
37. Derive an expression for the magnitude and direction of coriolis component of acceleration.
38. Sketch a quick return motion of the crank and slotted lever type and explain the procedure of drawing the velocity and acceleration diagram, for any given configuration of the mechanism.
39. In a pin jointed four bar mechanism *ABCD*, the lengths of various links are as follows: *AB* = 25 mm ; *BC* = 87.5 mm ; *CD* = 50 mm and *AD* = 80 mm. The link *AD* is fixed and the angle *BAD* = 135°. If the velocity of *B* is 1.8 m/s in the clockwise direction, find 1. velocity and acceleration of the mid point of *BC*, and 2. angular velocity and angular acceleration of link *CB* and *CD*.
40. In a four bar chain *ABCD* , link *AD* is fixed and the crank *AB* rotates at 10 radians per second clockwise. Lengths of the links are *AB* = 60 mm ; *BC* = *CD* = 70 mm ; *DA* = 120 mm. When angle *DAB* = 60° and both *B* and *C* lie on the same side of *AD*, find 1. angular velocities (magnitude and direction) of *BC* and *CD* ; and 2. angular acceleration of *BC* and *CD*.
41. In a given mechanism , the link *AB* rotates with a uniform angular velocity of 30 rad/s. The lengths of various links are : *AB* = 100 mm ; *BC* = 300 mm ; *BD* = 150 mm ; *DE* = 250 mm ; *EF* = 200 mm ; *DG* = 165 mm. Determine the velocity and acceleration of *G* for the given configuration.
42. The suction valve of a four stroke petrol engine is operated by a circular arc cam with a flat faced follower. The lift of the follower is 10 mm ; base circle diameter of the cam is 40 mm and the nose radius is 2.5 mm. The crank angle when suction valve opens is 4° after top dead centre and when the suction valve closes, the crank angle is 50° after bottom dead centre. If the cam shaft rotates at 600 r.p.m., determine: 1. maximum velocity of the valve, and 2. maximum acceleration and retardation of the valve.
43. The following particulars relate to a symmetrical circular cam operating a flat-faced follower : Least radius = 25 mm ; nose radius = 8 mm, lift of the valve = 10 mm, angle of action of cam = 120°, cam shaft speed = 1000 r.p.m. Determine the flank radius and the maximum velocity, acceleration and retardation of the follower. If the mass of the follower and valve with which it is in contact is 4 kg, find the minimum force to be exerted by the spring to overcome inertia of the valve parts.
44. Explain the terms : **(*i*)** Module, **(*ii*)** Pressure angle, and **(*iii*)** Addendum.
State and prove the law of gearing. Show that involute profile satisfies the conditions for correct gearing.

45. Derive an expression for the velocity of sliding between a pair of involute teeth. State the advantages of involute profile as a gear tooth profile.
46. Prove that the velocity of sliding is proportional to the distance of the point of contact from the pitch point.
47. Prove that for two involute gear wheels in mesh, the angular velocity ratio does not change if the centre distance is increased within limits, but the pres-

45. Explain Thermal Explain method with a neat sketch.
46. Explain reference junction considerations.
47. Explain electrical resistance sensors.
48. Explain semiconductor sources.
49. Explain Pyrometers.
50. Describe radiation methods.

Lesson Plan

Unit – I

1. BASIC DETECTOR TRANSDUCERS: Introduction
2. Mechanical members as primary detectors.
3. Electric transducers - sliding contact devices.
4. Secondary transducers -
5. differential transformer,
6. piezoelectric effect, Ionization transducer.
7. INTERMEDIATE MODIFYING SYSTEMS
8. Mechanical systems, kinematics linearity,
9. Mechanical amplifications, reflected frictional amplifications,
10. reflected inertial amplifications,-temperature problems,
11. methods for limiting temperature errors, Telemetry.

Unit – II

1. TERMINATING DEVICES AND METHODS: Introduction
2. The generalized system.
3. Vacuum tube voltmeter.
4. Mechanical counters.
5. CRO recording techniques,
6. oscillographs,
7. MEASUREMENT OF FORCE, TORQUE: Introduction
8. Methods of force and torque measurements,
9. elastic transducers,
10. Hydraulic,
11. pneumatic transmission dynamometers.

Unit – III

1. STRAIN MEASUREMENTS: Introduction
2. Types of electrical resistance-
3. strain gauges,
4. principle of operation,
5. gauge material, gauge factor,
6. mounting Techniques, moisture proofing,
7. calibration circuits,
8. strain measurement on static and rotary shafts
9. proper orientation of gauges,
10. commercial strain measuring systems.

whose free end is connected to the ram by a connecting link. Find the ratio of time of cutting to time of return.

20. Describe the method to find the velocity of a point on a link whose direction (or path) is known and the velocity of some other point on the same link in magnitude and direction is given.
21. Explain how the velocities of a slider and the connecting rod are obtained in a slider crank mechanism.
22. Define rubbing velocity at a pin joint. What will be the rubbing velocity at pin joint when the two links move in the same and opposite directions ?
23. What is the difference between ideal mechanical advantage and actual mechanical advantage
24. In a slider crank mechanism, the length of crank *OB* and connecting rod *AB* are 125 mm and 500 mm respectively. The centre of gravity *G* of the connecting rod is 275 mm from the slider *A*. The crank speed is 600 r.p.m. clockwise. When the crank has turned 45° from the inner dead centre position, determine: 1. velocity of the slider *A*, 2. velocity of the point *G*, and 3. angular velocity of the connecting rod *AB*.
25. In a link work, as shown in Fig. 7.34, the crank *AB* rotates about *A* at a uniform speed of 150 r.p.m. The lever *DC* oscillates about the fixed point *D*, being connected to *AB* by the connecting link *BC*. The block *F* moves, in horizontal guides being driven by the link *EF*, when the crank *AB* is at 30°. The dimensions of the various links are : *AB* = 150 mm ; *BC* = 450 mm ; *CE* = 300 mm ; *DE* = 150 mm ; and *EF* = 350 mm. Find, for the given configuration, 1. velocity of slider *F*, 2. angular velocity of *DC*, and 3. Rubbing speed at pin *C* which is 50 mm in diameter.
26. In a Whitworth quick return motion mechanism, as shown in Fig. 7.39, the dimensions of various links are as follows : *OQ* = 100 mm ; *OA* = 200 mm ; *BQ* = 150 mm and *BP* = 500 mm. If the crank *OA* turns at 120 r.p.m. in clockwise direction and makes an angle of 120° with *OQ*, Find : 1. velocity of the block *P*, and 2. angular velocity of the slotted link *BQ*.
27. What do you understand by the instantaneous centre of rotation (centro) in kinematic of machines? Answer briefly.
28. Explain, with the help of a neat sketch, the space centrode and body centrode.
29. Explain with sketch the instantaneous centre method for determination of velocities of links and mechanisms.
30. Write the relation between the number of instantaneous centres and the number of links in a mechanism.
31. Discuss the three types of instantaneous centres for a mechanism.
32. State and prove the 'Aronhold Kennedy's Theorem' of three instantaneous centres.
33. A mechanism, as shown in Fig. 6.31, has the following dimensions : *O*1 *A* = 60 mm ; *AB* = 180 mm ; *O*2 *B* = 100 mm ; *O*2 *C* = 180 mm and *CD* = 270 mm. The crank *O*1 *A* rotates clockwise at a uniform speed of 120 r.p.m. The block *D* moves in vertical guides. Find, by instantaneous centre method, the velocity of *D* and the angular velocity of *CD*.
34. Explain how the acceleration of a point on a link (whose direction is known) is obtained when the acceleration of some other point on the same link is given in magnitude and direction.

Review Questions

1. Explain the term kinematic link. Give the classification of kinematic link.
2. What is a machine ? Giving example, differentiate between a machine and a structure.
3. Write notes on complete and incomplete constraints in lower and higher pairs, illustrating your answer with neat sketches.
4. Explain different kinds of kinematic pairs giving example for each one of them.
5. Explain the terms : 1. Lower pair, 2. Higher pair, 3. Kinematic chain, and 4. Inversion.
6. In what way a mechanism differ from a machine ?
7. What is the significance of degrees of freedom of a kinematic chain when it functions as a mechanism? Give examples.
8. Explain Grubler's criterion for determining degree of freedom for mechanisms.
9. Using Grubler's criterion for plane mechanism, prove that the minimum number of binary links in a constrained mechanism with simple hinges is four.
10. Sketch and explain the various inversions of a slider crank chain.
11. Sketch and describe the four bar chain mechanism. Why it is considered to be the basic chain?
12. Show that slider crank mechanism is a modification of the basic four bar mechanism.
13. Sketch slider crank chain and its various inversions, stating actual machines in which these are used in practice.
14. Sketch and describe the working of two different types of quick return mechanisms. Give examples of their applications. Derive an expression for the ratio of times taken in forward and return stroke for one of these mechanisms.
15. Sketch and explain any two inversions of a double slider crank chain.
16. Identify the kinematic chains to which the following mechanisms belong :. Steam engine mechanism ;. Beam engine ; . Whitworth quick return motion mechanism; Elliptical trammels.
17. In a crank and slotted lever quick return mechanism, the distance between the fixed centres is 150 mm and the driving crank is 75 mm long. Determine the ratio of the time taken on the cutting and return strokes.
18. In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres *O* and *C* is 200 mm. The driving crank *CP* is 75 mm long. The pin *Q* on the slotted lever, 360 mm from the fulcrum *O*, is connected by a link *QR* 100 mm long, to a pin *R* on the ram. The line of stroke of *R* is perpendicular to *OC* and intersects *OC* produced at a point 150 mm from *C*. Determine the ratio of times taken on the cutting and return strokes.
19. The Whitworth quick return motion mechanism has the driving crank 150 mm long. The distance between fixed centres is 100 mm. The line of stroke of the ram passes through the centre of rotation of the slotted lever

Unit – IV

1. MEASUREMENT OF PRESSURE: Introduction
2. Pressure measuring systems,
3. Working principles,
4. pressure measuring transducers,
5. elastic transducers,
6. Elastic transducers,
7. elastic diagrams,
8. strain gauge pressure cell,
9. measurement of high pressure
10. Measurement of low pressures.

Unit – V

1. TEMPERATURE MEASUREMENT: Introduction,
2. Thermal expansion methods,
3. bimetallic thermometers,
4. liquid-in glass thermometers,
5. pressure thermometers,
6. thermo electric sensors (thermo couples), and common thermo couples.
7. Reference junc-tion considerations,
8. electrical resistance sensors- semiconductor sources –
9. Radiation methods - pyrometers.
10. Revision.

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
The students learn and understand necessity of Mechanical Measurements.	L 1	**M**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Demonstrate ability to make use of different gauges.	L 4	**L**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Demonstrate ability to make use of various measuring instruments.	L 1	**H**	**M**	**H**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**
The students get exposure to different types of measurements methods.	L 5	**H**	**M**	**M**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**
Students should be able to demonstrate the knowledge of various Mechanical measuring instruments	L 4	**H**	**H**	**M**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**
L- Low, M- Moderate, H-High												

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
The students learn and understand necessity of Mechanical Measurements.	L 1	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Demonstrate ability to make use of various measuring instruments.	L 4	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Students will be able to use different typesof Dynamometers	L 1	**3**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
The students get exposure to different types of measurements methods.	L 5	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
Students should be able to demonstrate the knowledge of various Mechanical measuring instruments	L 4	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
1 – Low, 2 – Moderate and 3 – High												

Topic Learning Objectives

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

1. Define the basic definitions such as link, kinematic chains, mechanism, etc., [L1].
2. Define the different mechanisms – quick return motion, whitworth and crank and slotted lever mechanisms [L1].
3. Define the Geneva mechanism [L1].
4. Identify the different methods of avoiding interference [L1].

After learning all the topics of unit – II, the student is able to,

1. Describe or identify the gear terminology – Spur Gear [L1].
2. Define the law of gearing [L1].
3. Solve the algebraic and tabular methods of finding the velocity ratio of epicyclical gear trains [L3].

After learning all the topics of unit – III, the student is able to,

1. Define the terminology of belt drives [L1].
2. Define the effect of centrifugal tension of power transmitted and v-belt drive [L1].
3. Solve the problems on belt drives [L3].

After learning all the topics of unit – IV, the student is able to,

1. Define the concept of CAMS and followers [L1].
2. Define the different types of CAM followers.[L1].
3. Solve the problems on CAMS [L3].

After learning all the topics of unit – V, the student is able to,

1. Define the theory of Balancing of machinery – Static and dynamic balancing [L1].
2. Solve the problems based balancing of single rotating mass in same and different planes [L3].
3. Define the different types of governors [L1].
4. Define the force analysis of porter, controlling forces, stability and sensitiveness [L4].

Course Outcomes

By the end of the course students should be able to understand the concept of,

1. Link or element, Kinematic pairs, degrees of freedom, kinematic chain and mechanisms,
2. Mechanisms – quick return motion, whitworth and crank and slotted lever mechanism,
3. Spur gears – terminology and law of gearing,
4. Gear Trains – Simple and Compound gear trains,
5. Belt drives – ratio of belt tensions, centrifugal tension, power transmitted and v-belt.
6. CAMS – Types, types of followers, displacement, velocity and acceleration,
7. Balancing and Governors.

Course Code : P13IP34	Semester : III	L - T - P : 3 - 1 - 0
Course Title : Mechanics of Materials.		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	

Prerequisites : The students should have undergone the course on basic concept on stress and strain in Elements of Mechanical Engineering.

Course Learning Objectives:

1. Able to define the concept Stress, Strain, deflections, Hooke's law and Poisson's ratio.
2. Able to derive an expression of deflections, bars with cross sections varying in steps.
3. Able to solve the problems on principle of superposition.
4. Able to solve the problems on composite sections, temperature stresses, etc.,
5. Able to understand the concept of Thick and thin cylinders.
6. Able to understand the concept of bending and shear force.
7. Able to solve the problems on bending moment and shear force diagram.

Course Content

Unit-I

Simple stress and strain: Introduction, stress, strain, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular) Principle of super position.

Stress in composite section: Volumetric strain, expression for volumetric strain, elastic constants. 11Hrs

Unit-II

Compound Bars and Temperature Stresses: Temperature stresses (including compound bars).

Compound Stresses: Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress. 11 Hrs

UNIT – III

Thick and thin cylinders: Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume), Thick cylinders subjected to internal and external pressures (Lame's equation), (compound cylinders not included).

Bending moment and Shear force in beams: Introduction, Types of beams, shear forces and bending moments, sign conventions, relationship between shear force and bending moment, shear force and bending moment diagrams for Simply Supported beams subjected to concentrated loads and uniform distributed load (udl). 11Hrs

UNIT - IV

Bending and shear stresses in beams: Introduction, theory of simple bending, assumptions in simple bending, relationship between bending stresses and radius of curvature, relationship between bending moment and radius of curvature, moment carrying capacity of a section, Bending stresses in beams of Uniform cross section, shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections (composite / fletched beams not included). 10Hrs

UNIT –V

Deflection of beams: Introduction, differential equation for deflection, equations for deflections, slope and moments, Macaulay's method.

Torsion of circular shafts and Elastic stability of columns: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity. Introduction to columns, Euler's theory for axially loaded elastic long columns, derivation of Euler's load for various end conditions, Rankine's formula. 10 Hrs

Text Book :

1. Hibbeler, **"Mechanics of Materials",** Practice Hall, PersonEdu., 2005.
2. James. M. Gere, **"Mechanics of Materials",** Thomson, Fifth Edition, 2004.

Reference Books :

1. S.S. Bhavikatti, **"Strength of Materials",**Vikas Publications House Pvt. Ltd., 2nd Edition, 2006.
2. Dr. R. K. Bansal, **"Strength of Materials",** Laxmi Publications (P) Ltd, New Delhi, 3rd Edition 1996.
3. R. S. Khurmi, **"Strength of Materials",** S. Chand & Company Ltd, New Delhi, 10th Edition, 2007.

Course Outcomes

After the end of the course students should learn and understand,

1. Engineering Stress, Strain, Hooke's law and Poisson's ratio,
2. Composite section – Volumetric strain, expression for volumetric strain, elastic constants.
3. Temperature stresses and compound stresses.
4. Thick and Thin cylinders – Problems.
5. Bending moment and shear force diagrams.
6. Deflection of beams – differential equation for deflection.
7. Torsion of circular shafts and elastic stability of columns – Euler's theory and problems.

Unit – III

Friction: Definition, Laws of Static and Dynamic Co-efficient of Friction : Belt drives, ratio of belt tensions, centrifugal tension, power transmitted. Effect of centrifugal tension on power transmitted and V-Belt Drives. **10 hrs**

Unit – IV

CAMS: Types of cams, Types of followers, Displacement, Velocity and Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-faced follower, Follower motions including Uniform velocity, Simple Harmonic Motion, Uniform acceleration and retardation. **10 Hours**

Unit – V

Balancing of Machinery: Static and dynamic balancing, Balancing of single rotating mass in same plane and in different planes. Balancing of several rotating in same plane and in different planes.

Governors: Types of governors; force analysis of porter Governor, controlling force, stability and sensitiveness.

11 Hours

Text Books:

1. Rattan S.S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd edition -2005.
2. Thomas ,Bevan , "Theory of Machines", CBS Publications.

Reference books:

1. Shigley. J. V. and Uickers, J.J., "Theory of Machines & Mechanisms" , OXFORD University press - 2004
2. R.K Bansal, "Theory of Machines".
3. R.S.Khurmi, "Theory of Machines".

Course Code : P13IP44	Semester : IV	L - T - P : 3 - 1 - 0
Course Title : Theory of Machines		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : The students should have undergone the course on basic concept on mechanisms and Elements of Mechanical Engineering.		

Course Learning Objectives: At the end of the Course the students should be,

1. Able to define link, kinematic pairs, degrees of freedom, kinematic chains and mechanisms.
2. Able to Understand the kinematic chains and Inversions – Four bar chain and single slider crank chain and double slider crank chain.
3. Able to Understand the quick return motion mechanisms and whitworth mechanisms..
4. Able to define the gear terminology – Spur gears.
5. Able to understand the concept Friction.

Course Content

Unit– I

Introduction: Definitions - Link or element, kinematic pairs, degrees of freedom, Kinematic chain, Mechanism, structure, Mobility of Mechanism, Inversion, Machine. KINEMATIC CHAINS AND INVERSIONS: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain.

Mechanisms: Quick return motion mechanisms Whitworth mechanism and Crank and slotted lever Mechanism. Intermittent Motion mechanisms – Geneva mechanism and Ratchet and Pawl mechanism.Ackerman steering gear mechanism. **11 Hours**

Unit – II

Spur Gears: Gear terminology, law of gearing, Characteristics of involute action, Path of contact, Arc of contact, Contact ratio, Interference in involute gears, Methods of avoiding interference.

Gear Trains: Simple gear trains, Compound gear trains for large speed reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclical gear trains. **10 Hours**

Topic Learning Objectives

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

1. Define the concept of Simple stress and strain [L1].
2. Define the equations for Linear Elasticity, Hooke's Law and Poisson's ratio [L1].
3. Solve the different types of problems on Engineering stress, strain and Young's modulus concept [L3].
4. Define the equations for deflection and bars on continuously varying cross sections [L1].
5. Define the principle of Superposition [L1].

After learning all the topics of unit – II, the student is able to,

1. Define the concept of temperature stresses and compound stresses [L1].
2. Define the concepts of principle stresses and maximum shear stresses [L1].
3. Solve the problems on temperature stresses and compound stresses [L3].
4. Describe the concept of Mohr's circle for plane stress [L1].

After learning all the topics of unit – III, the student is able to,

1. Define stresses in thin cylinders [L1].
2. Solve the problems on change in dimensions of cylinders [L3].
3. Solve the problems on thick cylinders subjected to internal and external pressures [L1].
4. Define the concept of bending moment and shear force diagrams [L1].
5. Solve and draw the bending moment and shear force diagrams [L3].

After learning all the topics of unit – IV, the student is able to,

1. Define the theory of simple bending [L1].
2. Explain the assumptions in bending, relationship between bending stresses and radius of curvature [L1].
3. Solve the problems on above concepts [L3].

After learning all the topics of unit – V, the student is able to,

1. Define the concept of deflection of beams [L1].
2. Define the differential equation for deflection, equations for deflections. [L1].
3. Solve the problems based on deflection of beams [L3].
4. Define the assumptions and derivation for torsional equations [L1].
5. Solve the problems based on torsion of circular shafts and elastic stability of columns [L4].

Review Questions

1. Define Nominal stress, Elasticity and principle of Super positions.
2. A specimen of steel 25 mm diameter with a gauge length of 200 mm is tested to destruction. It has on extension of 0.16 mm under a load of 80 KN. The total extension of fracture is 56 mm and the diameter at neck is 18 mm. Find, Young's modulus, Percentage elongation and Percentage reduction of area.
3. State Hooke' Law.
4. Explain clearly the different types of stresses and strains.
5. Define the terms : Elasticity, Elastic limit, Young's modulus and modulus of rigidity.
6. An axial pull of 40000 N is acting on a bar consisting of three sections of length 30 cm, 25 cm and 20 cm and of diameters 2 cm, 4 cm and 5 cm. if the $E=2x10^5$ N/mm^2, determine : stress in each section and total extension of bar.
7. Define bulk modulus and temperature stresses.
8. A bar of 20 mm diameter is tested in tension. It is observed that when a load of 37.7 KN is applied, the extension measured over a gauge length of 200 mm is 0.12 mm and contraction in diameter is 0.0036 mm. find Poisson's ratio and Young's modulus.
9. Define a composite bar. How will you find the stresses and load carried by each member of a composite bar.
10. What is principal planes and principal stresses.
11. What is the procedure of finding thermal stresses in a composite bar.
12. What do you mean by a bar of uniform strength.
13. A thick cylindrical pipe outside diameter 300 mm and internal diameter 200 mm is subjected to an internal fluid pressure of 14 N/mm2. Determine the maximum hoop stress developed in the cross section. Sketch the variation of hoop stress across the thickness of the pipe.
14. What are the types of beams and types of loads.
15. Derive an expression for the maximum deflection in a cantilever beam subjected to a concentrated load at its free end.

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Steam power plants, IC engines, Domestic Refrigerator, Room Air conditioner.	L 1	**M**	**L**	-	-	-	-	-	-	-	-	-
Macroscopic and Microscopic view points, Thermodynamic system and Properties like equilibrium, Quasistatic process, Zeroth law of thermodynamics.	L 3	**L**	**M**	-	-	-	-	-	-	-	-	-
Second law of Thermodynamics, Heat engine and Heat pump and Carnot cycle and Carnot Theorem.	L 3	**H**	**M**	**H**	-	**H**	-	-	-	-	-	-
Air standard cycles – Otto, Diesel, Dual cycles, P-v and T-s diagrams.	L 3	**H**	**M**	**M**	-	**M**	-	-	-	-	-	-
L- Low, M- Moderate, H-High												

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Steam power plants, IC engines, Domestic Refrigerator, Room Air conditioner.	L 1	**2**	**1**	-	-	-	-	-	-	-	-	-
Macroscopic and Microscopic view points, Thermodynamic system and Properties like equilibrium, Quasistatic process, Zeroth law of thermodynamics.	L 3	**1**	**2**	-	-	-	-	-	-	-	-	-
Second law of Thermodynamics, Heat engine and Heat pump and Carnot cycle and Carnot Theorem.	L 3	**3**	**2**	**3**	-	**3**	-	-	-	-	-	-
Air standard cycles – Otto, Diesel, Dual cycles, P-v and T-s diagrams.	L 3	**3**	**2**	**2**	-	**2**	-	-	-	-	-	-
1 – Low, 2 – Moderate and 3 – High												

Unit – IV

1. Vapour power cycles – Carnot cycle, Rankine cycle, Efficiency,
2. Steam rate and heat rate, actual vapour cycle process, comparison of Rankine and Carnot cycle,
3. Mean Temperature of Heat addition, Effect of pressure and temperature on Rankine cycle performance.
4. Reheat and Regenerative cycles.
5. Simple problems.
6. Gas power cycles: Air standard cycles – Otto cycles. P-v and T-s diagrams, Description, efficiencies and Mean effective pressures (MEP), (no derivation for MEP).
7. Diesel, P-v and T-s diagrams, Description, efficiencies and Mean effective pressures (MEP)
8. Dual cycles, P-v and T-s diagrams, Description, efficiencies and Mean effective pressures (MEP),
9. Comparison of Otto, Diesel and Dual cycles. (No derivation for MEP).
10. Problems.

Unit – V

1. Gas turbine cycle: Brayton cycle, efficiency,
2. Methods to improve the efficiency of Brayton cycle using regeneration, intercooling & reheating.
3. Methods to improve the efficiency of Brayton cycle using regeneration, intercooling & reheating.
4. Simple problems.
5. Air Compressors: Operation of a single stage reciprocating compressor,
6. Work input equation through P-v diagram and steady state, steady flow analysis,
7. Effect of clearance and Volumetric efficiency, Adiabatic, Isothermal and Mechanical efficiencies
8. Multistage compressor, saving in work, Optimum intermediate pressure,
9. Minimum work for compression
10. Simple problems.

16. What are the assumptions made in deriving torsional equation.
17. Define and explain Longitudinal strain, lateral strain and poisson's ratio.
18. Prove that the volumetric strain of a cylindrical rod which is subjected to an axial tensile load is equal to strain in the length minus twice the strain of diameter.
19. What is a bulk modulus? Derive an expression for Young's modulus in terms of bulk modulus and Poisson's ratio.
20. State the principle of shear stress.
21. derive an expression between modulus of elasticity and modulus of rigidity.
22. Determine the changes in length, breadth and thickness of a steel bar which is 5 m long, 40 mm wide and 30 mm thick and is subjected to an axial pull of 35 KN in the direction of its length. Take $E=2x10^5$ N/mm^2 and Poisson's ratio=0.32.
23. For the above problem, determine the volumetric strain and the final volume of the given steel bar.
24. Define and explain Shear force, Bending moment, shear force diagram and bending moment diagram.
25. What are the different types of beams? Differentiate between a cantilever and a simply supported beam.
26. Draw the S.F and B.M diagram for a cantilever of length L carrying a point load W at the free end.
27. A cantilever beam of length 2 m carries a point load of 1 kN at its free end, and another load of 2 kN at a distance of 1 m from the free end. Draw the Shear force and Bending moment diagrams.
28. A simply supported beam of length 8 m carries point load of 4 kN and 6 kN at a distance of 2 m and 4 m from the left end. Draw the S.F and B.M diagram for the beam.
29. A simply supported beam of length 5 m, carries a uniformly distributed load of 100 N/m extending from the left end to a point 2 m away. There is also a clockwise couple of 1500 Nm applied at the center of the beam. Draw the S.F and B.M diagrams for the beam and find the maximum bending moment.

30. Define thin cylinders. Name the stresses set up in a thin cylinder subjected to internal fluid pressure.
31. Show that in thin cylinder shells subjected to internal fluid pressure, the circumferential stress is twice the longitudinal vessel.
32. Find the expression for circumferential stress and longitudinal stress for a longitudinal joint and circumferential joint.
33. A cylindrical shell is subjected to internal fluid pressure, find an expression for change in diameter and change in length of the cylinder.
34. A cylindrical pipe of diameter 2 m and thickness 2 cm is subjected to an internal fluid pressure of 1.5 N/mm2, determine, longitudinal stress and circumferential stress developed in the pipe material.
35. a cylinder of internal diameter 0.6 m contains air at a pressure of 7.5 N/mm2. if the maximum permissible stress induced in the material is 75 N/mm2, find the thickness of the cylinder.
36. A thin spherical shell of 1.2 m internal diameter is subjected to an internal pressure of 1.6 N/mm2. if the permissible stress in the plate material is 80 N/mm2 and joint efficiency is 75%, find the minimum thickness.
37. Differentiate between thick cylinder and thin cylinders.
38. Find an expression for the radial pressure and hoop stress at any point in case of a thick cylinder.
39. What do you mean by a thick compound cylinder.
40. How will you determine the hoop stresses in a thick compound cylinder.
41. Derive an expression for the radial pressure and hoop stress for a thick spherical shell.
42. What do you mean by Lame's equations. How will you derive these equations.
43. Define the terms, Torsion, Torsional rigidity and polar moment of inertia.
44. Derive an expression for the shear stress produced in a circular shaft which is subjected to torsion. What are the assumptions made in the derivation.
45. Derive the relation for a circular shaft subjected to torsion.
46. When a circular shaft is subjected to torsion, show that the shear stress varies linearly from the axis to the surface.
47. Find the expression for the torque transmitted by a hollow circular shaft of external diameter and internal diameter.
48. Derive an expression for cantilever subjected to a varying load.
49. derive an expression for cantilever subjected to udl.
50. A solid shaft of 20 cm diameter is used to transmit torque. Find the maximum torque transmitted by the shaft if the maximum shear stress induced in the shaft is 50 N/mm2.

Lesson Plan

Unit – I

1. Definition –Practical examples; Simple steam power plants,
2. IC engines, Domestic Refrigerator, Room Air conditioner,
3. Macroscopic and Microscopic view points, Thermodynamic system and control volume,
4. Thermodynamic Properties, Processes and Cycles,
5. Thermodynamic equilibrium, Quasistatic process,
6. Force, Pressure, Specific Volume Density, Energy, Power, Temperature, Thermal equilibrium,
7. Zeroth law of thermodynamics, simple problems,
8. Work transfer, Thermodynamic definition of work, sign convention,
9. P-dv work or displacement work, Path and Point functions,
10. Expression for P-dv work in various Quasistatic processes,
11. Heat transfer – a path function,
12. Specific heat and latent heat, points to remember about work and heat transfer.

Unit – II

1. Define 1st law of TD, First law for closed system undergoing a cycle, First law for a closed system undergoing a change of state,
2. Energy – a property of the system, different form of energies, specific heat at constant volume, Enthalpy , Specific heat at constant pressure, PMMI,
3. First law applied to a flow process,
4. Second law of Thermodynamics, Heat engine and efficiency, Heat pump and COP, Energy reservoirs,
5. Kelvin Planck and Clausius Statements of Second law of thermodynamics, PMM II,
6. Reversible and Irreversible processes, Carnot cycle,
7. Carnot Theorem, Entropy – Clausius inequality, showing cyclic integral of $\delta Q/T$ is independent of path. (No problems on entropy)
8. Problems
9. Problems
10. Problems

Unit – III

1. Introduction to pure substances, P-T and P-v diagrams, Triple point and critical points,
2. Sub cooled liquid, saturated liquid, Mixture of saturated liquid and vapours, saturated vapour
3. Superheated vapour states of a pure substance with water as an example,
4. Enthalpy of change of phase (latent heat), dryness fraction (Quality), steam tables and its use
5. Charts of thermodynamic properties, T-s and h-s diagrams with constant Property lines,
6. Simple problems.
7. The Perfect Gas: The equation of state of a perfect gas, specific heats, internal energy
8. Enthalpy of an Ideal gas, Reversible adiabatic process,
9. Reversible Isothermal Process,
10. Polytropic process

27. What are disadvantages of single stage sir compressor? Explain how these disadvantages are overcome by multi stage air compressor.
28. Problems in air standard cycles
29. Problems in Reciprocating air compressor.
30. Define the following,
    a)COP b)1 ton of refrigeration
31. With help of simple sketch explain the working of a vapour compression refrigeration.
32. Analyse vapour compression cycle with T-S and P-H charts.
33. What are the desirable properties of refrigerants to be used in a vapour compression refrigeration cycle?
34.Explain the working of ammonia vapour absorption refrigeration.
35. .Describe the morse test ,what are the assumption made in this test.
36. Explain Gas power Cycles.
37. Explain Otto-cycle and write P-V and T-S diagrams.
38. Draw P-V and T-S diagrams for Diesel Cycles.
39. Draw P-V and T-S diagrams for Dual Cycles.
40. Differential between Otto, diesel and Dual cycles.
41. Simple Problems.
42. Explain Brayton cycle and efficiency of Gas turbine cycle.
43. Explain the different methods of improving the efficiency of Brayton cycle using regeneration intercooling and reheating.
44. Problems.
45. Problems.
46. Explain Air compressor.
47. With a neat sketch explain the operation of single stage reciprocating compressor.
48. Explain work input equation through P-V diagram and steady state and steady flow analysis.
49. Explain the effect of clearance and volumetric efficiency.
50. Explain with a neat sketch multistage compressor.

Lesson Plan

Unit – I

1. Introduction, Concept of Stress and Strain.
2. Equations for Linear elasticity, hooke's law and poisson's ratio.
3. Problems on Stress and Strain concepts.
4. Stress Strain relationship.
5. Extension / Shortening of a bar, bars with cross sections varying in steps.
6. Bars with continuously varying cross sections (circular and rectangular).
7. Principle of Superposition.
8. Stress in composite section : Introduction, Volumetric strain.
9. Expression for volumetric strain and elastic constants.
10. Problems on above concepts.
11. Problems on the above concepts.

Unit – II

1. Compound bars : Introduction.
2. Temperature stresses including compound bars.
3. Problems on Temperature stresses.
4. Compound Stresses : Introduction.
5. Plane stresses, problems on plane stresses.
6. Stresses on inclined sections, problems on inclined sections.
7. Principal stresses ad maximum shear stresses.
8. Problems on principal stresses and maximum shear stresses.
9. Mohr's circle for plane stresses.
10. Problems on mohr's circle for plane stresses.

Unit – III

1. Thick and Thin cylinders : Introduction, stresses in thin cylinders.
2. Changes in dimensions of cylinder (diameter, length and volume).
3. Problems on thin cylinders.
4. Thick cylinders subjected to internal and external pressures (Lame's equation).
5. Problems on Lame's equation.
6. Bending Moment and Shear force in beams : Introduction.
7. Types of beams, Shear forces and bending moments.
8. Sign conversions, relationship between shear force and bending moment.
9. Shear force and bending moment diagrams for Simply supported beams subjected to concentrated loads.
10. Simply supported beams subjected to uniform distributed loads.
11. Problems on above concepts.

Unit – IV

1. Bending and Shear stresses in beams : Introduction.
2. Theory of simple bending, assumptions in simple bending.
3. Relationship between bending stresses and radius of curvature.
4. Problems on above concepts.
5. Problems on bending stresses and radius of curvature.
6. Moment carrying capacity of a section.
7. Bending stresses in beams of uniform cross section.
8. Shearing stresses in beams, shear stress across rectangular and circular sections.
9. Shear stress across symmetrical I and T sections.
10. Problems on the above concepts.

Unit – V

1. Deflection of beams : Introduction.
2. Differential equation for deflection – Problems.
3. Equations for deflections, Slope and moments.
4. Macaulay's method – Problems.
5. Problems on above concepts.
6. Torsion of circular shafts and Elastic stability of columns : Introduction.
7. Pure torsion, assumptions.
8. Derivation of torsional equations.
9. Polar modulus, torsional rigidity, columns – Euler's theory for axially loaded elastic long columns.
10. Derivation of Euler's load for various end conditions, Rankine's formula – Simple problems.

20. What are air standard cycles? State the assumption made in the analysis of air standard cycles.
21. Obtain an expression for the thermal efficiency of diesel cycles in terms of compression ration and cut off ratio.
22. Obtain an expression for the thermal efficiency of otto cycles in terms of compression ration
23. For same state of air before compression and same maximum pressure and temperature in both the cycles, using appropriate P-V T-s diagrams, compare the performances of air standard otto and diesel cycles.
24. Derive an expression for the volumetric efficiency of reciprocating air compressors.
25. Derive an expression for the isothermal work done by the reciprocating compressor of single stage, neglecting clearance volume.
26. What are advantages of multistage compressors? obtain the condition for minimum work of compression in a two stage reciprocating air compressor with perfect inter cooling.

After learning all the topics of unit – V, the student is able to,

1. Explain the working principal of gas turbine cycle [L1].
2. Various methods to improve the efficiency of Brayton cycle [L1].
3. Solve the problems on gas turbine and Brayton cycle [L3].
4. Define and classify the air compressor [L1].
5. Derive the expression for the work input for the air compressor with and without clearance volume [L3].
6. Expression for the Minimum work required to compress unit mass of air in multi stage compression [L3].
7. Solve the problem on single and multi-stage air compressor with and without clearance volume [L3].

Review Questions

1.What is the difference between the classical and the statistical approaches to thermodynamics
2.Explain the following concepts:
A. System, boundary, and surroundings
B. Closed system (control mass) and open system (control volume)
C. Adiabatic and isolated system
3. Explain the meaning of the following terms: property, specific property, state, path, process, cycle
4. Distinguish clearly between intensive and extensive properties? Give three examples of each type.
5. What is a quasi-equilibrium process? What is its importance in engineering?
6. What is the zeroth law of thermodynamics
7. Differentiate between path function and point functions with examples
8. Define Mechanical and thermodynamics modes of work
9. Derive an expression for displacement work for different thermodynamic process
10. Write the Comparison between work with heat
10 a. Define FLTD for cyclic and non cyclic process
11. Show that energy as a property of system
12. .Write down the SFEE and indicate clearly the meaning of each term in it
13. Apply SFEE for different thermodynamic devices like turbine. Compressor, nozzle, boiler
14. Define the following
refrigeration effect , COP, heat pump, thermal reservoir, PMM
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. With the help of P V diagram explain the Carnot cycle
19. Mention the factors which render a process irreversible

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Study of Engineering Stress, Strain, Hooke's law and Poisson's ratio	L 1	M	L	-	-	-	-	-	-	-	-	-
Composite section – Volumetric strain, expression for volumetric strain, elastic constants.	L 3	L	M	-	-	-	-	-	-	-	-	-
Temperature stresses and compound stresses.	L 3	H	M	H	-	H	-	-	-	-	-	-
Bending moment and shear force diagrams.	L 3	H	M	M	-	M	-	-	-	-	-	-
Deflection of beams – differential equation for deflection.	L 1	H	H	M	-	H	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Study of Engineering Stress, Strain, Hooke's law and Poisson's ratio	L 1	2	1	-	-	-	-	-	-	-	-	-
Composite section – Volumetric strain, expression for volumetric strain, elastic constants.	L 3	1	2	-	-	-	-	-	-	-	-	-
Temperature stresses and compound stresses.	L 3	3	2	3	-	3	-	-	-	-	-	-
Bending moment and shear force diagrams.	L 3	3	2	2	-	2	-	-	-	-	-	-
Deflection of beams – differential equation for deflection.	L 1	3	3	2	-	3	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

Course Code : P13IP35	Semester : III	L - T - P : 3 - 0 - 0
Course Title : Production Technology—I		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	Weightage: CIE:50; SEE:50	

Prerequisites : The students should have undergone the course on Elements of Mechanical Engineering.

Course Learning Objectives:

1. Able to define the concept of Manufacturing processes and the classification of the process.
2. Able to understand the functions and materials used for the preparation of Patterns.
3. Able to define the concept and methods used in Sand moulding techniques.
4. Able to understand the classification and constructional features of furnaces.
5. Able to understand principle, classification and applications of welding process.
6. Able to understand the different types of welding process.
7. Able to understand the principles of Soldering and Brazing process.

Course Content

Unit – I

Casting Process :

Introduction: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Varieties of components produced by casting process.Advantages& Limitations of casting process.
Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns.
Binder: Definition, Types of binder used in moulding sand.
Additives: Need, Types of additives used.

Sand Moulding: Types of base sand, requirement of base sand. Types of sand moulds.
Sand moulds: Moulding sand mixture ingredients (base sand, binder &additives) for different sand mixtures. Method used for sand moulding.
Cores: Definition, Need, Types, Method of making cores, binders used. Concept of Gating &Risering. Principle involved and types, Fettling and cleaning of castings. Basic steps involved. Casting defects causes, features and remedies. **11 Hours**

Topic Learning Objectives

After learning all the topics of Unit—I, the student is able to,
1. Concepts of Practical examples like Simple steam power plants, IC engines, Domestic Refrigerator, Room Air conditioner [L1].
2. Different types of thermodynamic systems and micro and macroscopic viewpoints [L1].
3. Thermodynamic properties, equilibrium and quasi-static process and zeroth law of TD [L4].
4. State the different types of energies (work and heat) their p-dv work [L1].
5. Expression for P-dv work in various Quasistatic processes [L1].
6. Define Specific heat and latent hea [L1].

After learning all the topics of unit – II, the student is able to,
1. Define 1st law of TD, for a cycle and for a change of state [L1].
2. Deriving the equation for First law applied to a flow process [L1].
3. Define 2nd law of TD and the concept of heat engine and heat pump [L3].
4. Define Kelvin Planck and Clausius Statements of Second law of thermodynamics [L1].
5. Working principal of Carnot cycle [L2]
6. Problems on 2nd law of TD.

After learning all the topics of unit – III, the student is able to,
1. Define the pure substances, P-T and P-v diagrams, Triple point and critical points [L1].
2. Explain superheated vapour states of a pure substance with water as an example [L1].
3. Define quality of steam use of steam table and charts (T-s and h-s diagrams) [L1].
4. Solve the related problems [L3].
5. Solve the different types of problems related to an alloy system [L3].
6. Define Perfect Gas, specific heats, internal energy, Enthalpy of an Ideal gas [L1],
7. Explanation of Reversible adiabatic process [L1],
8. Explain Reversible Isothermal Process, Polytropic process [L1].

After learning all the topics of unit – IV, the student is able to,
1. Define Carnot cycle, Rankine cycle and their Efficiencies [L1].
2. Derive the Efficiencies Carnot cycle, Rankine cycle [L3].
3. Effect of heat addition, pressure, temperature on Rankine cycle [L1].
4. Working principal of reheat and regenerative cycles [L1].
5. Derive an air standard efficiency of Otto, Diesel, Duel cycles [L3].
6. Calculations of mean effective pressure (MEP) [L3].
7. Comparison of Otto, Diesel, Duel cycle with same temperature and pressure [L2].
8. Solve the problems on Otto, Diesel, Duel cycle [L3].

Text Books:

1. P.K.Nag, “Basic and Applied Thermodynamics”, Tata McGraw Hill, 3rd Edi. 2005
2. Yunus A. Cenegal and Michael A.Boles,“Thermodynamics an engineering approach”, Tata McGraw hill pub. 2008.

Reference Books:

1. J.B.Jones and G.A.Hawkins, “Engineering Thermodynamics: an Introductory, John Wiley and sons.2ndEdn. 2009
2. Y.V.C. Rao, “An Introduction to Thermodynamics”,, University press 2009.
3. R.K.Rajput, “A text book of Engineering Thermodynamics” by, Laxmi Publications, Pvt Ltd, 4thEdn, 2010.

Course Outcomes

By the end of the course students should be able to understand the concept of,

1. Steam power plants, IC engines, Domestic Refrigerator, Room Air conditioner.
2. Macroscopic and Microscopic view points, Thermodynamic system and Properties like equilibrium, Quasistatic process, Zeroth law of thermodynamics.
3. Thermodynamic definition of work, displacement work, Path and Point functions, expression for P-dv work in various Quasistatic processes and heat transfer
4. First law for closed system undergoing a cycle and a change of state, Enthalpy , Specific heat at constant pressure, PMMI, First law applied to a flow process.
5. Second law of Thermodynamics, Heat engine and Heat pump and Carnot cycle and Carnot Theorem.
6. Pure Substance and Perfect Gas:P-T and P-v diagrams, dryness fraction (Quality), steam tables and its use, charts of thermodynamic properties, T -s and h-s.
7. Vapour power cycles – Carnot cycle, Rankine cycle, Efficiency, Effect of pressure and temperature on Rankine cycle, Reheat and Regenerative cycles
8. Air standard cycles – Otto, Diesel, Dual cycles, P-v and T-s diagrams.
9. Brayton cycle, efficiency, methods to improve the efficiency.
10. Operation of a single stage reciprocating compressor, Effect of clearance and Multistage compressor.

Unit - II

Moulding machines: Jolt type, Squeeze type, Jolt & Squeeze type and Sand-slinger.

Special moulding Process: Study of important moulding processesGreen sand, Core sand, Dry sand, Sweep mould, CO2 mould, Shell mould and Investment mould.

Metal moulds: Gravity die-casting, Pressure die casting, centrifugal casting, Squeeze Casting, Slush casting, and continuous casting processes.

09 Hours

Unit - III

Melting Furnaces: Classification of furnaces. Constructional features & working principle of Gas fired pit furnace, Resistance furnace, Coreless Induction furnace, Electric Arc Furnace, Cupola furnace.

Welding Process :

Welding Process: Definition, Principles, Classification, Application, Advantages & limitations of welding.

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

10 Hours

Unit - IV

Gas Welding: Principle, Oxy–Acetylene welding, Reaction in Gas welding, Flame characteristics, Gas torch construction & working. Forward and backward welding.

Special type of welding: Resistance welding - principles, Seam welding, Butt welding, Spot welding and projection welding. Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding.

11 Hours

Unit – V

Metallurgical aspects in welding: Structure of welds, Formation of different zones during welding. Heat affected zone **(HAZ),**Parametersaffecting **HAZ**. Effect of carbon content on structure and properties of steel.Shrinkage in welds & Residual stresses.Concept of electrodes, Filler rod and fluxes.Welding defects – Detection causes & remedy.

Principles of soldering &brazing: Parameters involved & Mechanism. Different Types of Soldering & Brazing Methods. *Inspection Methods*– Methods used for Inspection of casting and welding. Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection. **11 Hours**

Text Books:

1. **P. N. Ro, "Manufacturing & Technology**: Foundry Forming and Welding", Tata McGraw Hill, 2nd Ed., 2003.

Dr. K. Radhakrishna, "Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book House, 2nd Edition, 2007.

Reference Books:

1. SeropeKalpakjain, Steuen.R.Sechmid **"Manufacturing Technology**", Pearson Education Asia, 5th Ed. 2006.

Roy A Lindberg, **"Process and Materials of Manufacturing**", Pearson Edu, 4th Edition, 2006.

Course Outcomes

By the end of the course students should be able to understand the concept of,

1. Patterns : Functions, Materials used for pattern, various pattern allowances,
2. Different types of Sand Moulds,
3. Methods of making a Cores,
4. Different types of furnaces, constructional features and working principles of Gas fired fit furnaces,
5. Principles, Classification and Applications of Welding process,
6. Metallurgical aspects of Welding and principles of Soldering and Brazing.

Unit – III

Pure Substance and Perfect Gas: P-T and P-v diagrams, Triple point and critical points, subcooled liquid, saturated liquid, Mixture of saturated liquid and vapours saturated vapour and superheated vapour states of a pure substance with water as an example, enthalpy of change of phase (latent heat), dryness fraction (Quality), steam tables and its use, charts of thermodynamic properties, T-s and h-s diagrams with constant Property lines, simple problems.

The Perfect Gas: The equation of state of a perfect gas, specific heats, internal energy and enthalpy of an Ideal gas, Reversible adiabatic process, Reversible Isothermal Process, Polytropic process. **10 hrs**

Unit – IV

Power Cycles: Vapour power cycles – Carnot cycle, Rankine cycle, Efficiency, Steam rate and heat rate, actual vapour cycle process, comparison of Rankine and carnot cycle, Mean Temperature of Heat addition, Effect of pressure and temperature on Rankine cycle performance, Reheat and Regenerative cycles(simple problems)

Gas power cycles: Air standard cycles – Otto, Diesel, Dual cycles, P-v and T -s diagrams, Description, efficiencies and Mean effective pressures (MEP),comparison of Otto, Diesel and Dual cycles.(no derivation for MEP).
10 hrs

Unit – V

Gas turbine cycle: Brayton cycle, efficiency, methods to improve the efficiency of Brayton cycle using regeneration, intercooling & reheating (simple problems).

Air Compressors: Operation of a single stage reciprocating compressor, Work input equation through P-v diagram and steady state, steady flow analysis, Effect of clearance and Volumetric efficiency, Adiabatic, Isothermal and Mechanical efficiencies, Multistage compressor, Saving in work, Optimum intermediate pressure, Minimum work for compression.(simple problems).

10 hrs

Course Code : P13IP43	Semester : IV	L - T - P : 3 - 1 - 0
Course Title : Engineering Thermodynamics.		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : The students should have undergone the course on **Engineering Thermodynamics**.		

Course Learning Objectives: At the end of the Course the students should be,

1. Apply the basic principles of thermodynamics in solving engineering problems knowing the real world engineering examples.
2. Define thermodynamic system, process, cycle, equilibrium, properties, work and heat transfer in thermodynamic context, laws of thermodynamics and properties of pure substances and perfect gases.
3. Explain basic constructional features of energy producing cycles like Rankine cycle, Air standard cycle and gas turbine cycles.
4. Explain the basic principles of energy absorbing device like Air compressor.

Course Content

Unit – I

Introduction: Definition – Engineering Thermodynamics – some practical examples; Simple steam power plants, IC engines, Domestic Refrigerator, Room Air conditioner, Macroscopic and Microscopic view points, Thermodynamic system and control volume, Thermodynamic Properties, Processes and Cycles, Thermodynamic equilibrium, Quasistatic process, units and dimensions, Force, Pressure, Specific Volume and Density, Energy, Power, Temperature, Thermal equilibrium, Zeroth law of thermodynamics, simple problems.

Work and Heat transfer: Work transfer, Thermodynamic definition of work, sign convention, P-dv work or displacement work, Path and Point functions, expression for P-dv work in various Quasistatic processes, heat transfer – a path function, Specific heat and latent heat, points to remember about work and heat transfer. **12 hrs**

Unit – II

Laws of thermodynamics: First law for closed system undergoing a cycle, First law for a closed system undergoing a change of state, Energy – a property of the system, different form of energies, specific heat at constant volume, Enthalpy , Specific heat at constant pressure, PMMI, First law applied to a flow process, Second law of Thermodynamics, Heat engine and efficiency, Heat pump and CoP, Energy reservoirs, Kelvin Planck and Clausius Statements of Second law of thermodynamics, PMM II, Reversible and Irreversible processes, Carnot cycle, Carnot Theorem, Entropy – Clausius inequality, showing cyclic integral of $\delta Q/T$ is independent of path. (No problems on entropy) **10 hrs**

Topic Learning Objectives

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

1. Define the manufacturing process and its importance [L1].
2. State the Casting process and the different methods involved in the process [L1].
3. State the Importance of various pattern allowances [L1].
4. Describe the diffusion process occuring in a solid materials [L1].
5. Define the methods used for Sand moulding technique [L1].

After learning all the topics of unit – II, the student is able to,

1. Define the different types of Moulding machines [L1].
2. Explain the different types of Special Moulding process such as Green Sand, Core Sand, etc., [L2].
3. Describe the different types Metal moulds such as Gravity die-casting, Pressure die-casting, centrifugal casting, etc., [L1].

After learning all the topics of unit – III, the student is able to,

1. Identify the different types of Melting furnaces [L1].
2. Explain the constructional features and working principle of different types of furnaces [L2].
3. State the principles, classification and application of welding process [L1].
4. Describe the principle of different types of Arc welding process [L1].

After learning all the topics of unit – IV, the student is able to,

1. Define principle of Gas welding and types of welding processes [L1].
2. Explain the reaction in Gas welding and characteristics of Flame [L1].
3. Describe the constructional features of Gas torch [L1].
4. Define the principle of Special welding process like resistance welding, seam welding, etc., [L1].
5. Differentiate between the different methods of Special type of welding processes L4].

After learning all the topics of unit – V, the student is able to,

1. Define the different zones of welding [L1].
2. State the factors affecting heat affected zone [L1].
3. Identify the effect of carbon content on structure and properties of steel [L1].
4. Define the different methods used for Inspection of casting and welding [L1].

Review Questions

1. Write about concept and importance of Manufacturing process
2. Classifying the Manufacturing Process
3. Write about the steps involved in Manufacturing process
4. Explain in detail various patters allowance
5. Write notes on characteristics of moulding sands
6. Write about various methods used for moulding
7. Define a Core
8. What is the purpose of a Core
9. Write notes on concepts of gating and raising
10. Write notes on Casting defects
11. With a neat sketch explain Jolt type moulding machine
12. With a neat sketch Jolt and squeeze type moulding machine
13. Write notes on CO_2 Moulding procedure
14. Write notes on investment moulding
15. Explain the procedure of gravity die casting
16. Explain in detail centrifugal casting
17. Write notes Squeeze Casting
18. Write notes sketch Casting
19. What are the use of metal moulds
20. Write notes on continuous casting
21. How are melting furnace classified
22. With neat sketch, explain the working principle of gas
23. With neat sketch, explain working of resistance furnaces
24. Write notes sketch of Electric Arc furnace
25. What is purpose of Cupola
26. Draw a neat sketch of Cupola
27. Explain the working principle of cupola
28. Define welding process and classify them
29. Draw a neat sketch of TIG and MIG welding process? explain
30. Explain the submerged Arc welding and Atomic hydrogen welding

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Study Internal Structure of the materials and their properties	L 1	M	L	-	-	-	-	-	-	-	-	-
Investigates the relationship between the Internal Structure and its properties,	L 3	L	M	-	-	-	-	-	-	-	-	-
Different methods used for Testing the properties of materials,	L 3	H	M	H	-	H	-	-	-	-	-	-
Different methods of failures of materials (Fracture, Fatigue and Creep),	L 3	H	M	M	-	M	-	-	-	-	-	-
Preparation of Alloys and study of their compositions,	L 1	H	H	M	-	H	-	-	-	-	-	-
Different Engineering materials, Corrosion and its preventions methods.	L 3	M	M	-	-	-	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Study Internal Structure of the materials and their properties	L 1	2	1	-	-	-	-	-	-	-	-	-
Investigates the relationship between the Internal Structure and its properties,	L 3	1	2	-	-	-	-	-	-	-	-	-
Different methods used for Testing the properties of materials,	L 3	3	2	3	-	3	-	-	-	-	-	-
Different methods of failures of materials (Fracture, Fatigue and Creep),	L 3	3	2	2	-	2	-	-	-	-	-	-
Preparation of Alloys and study of their compositions,	L 1	3	3	2	-	3	-	-	-	-	-	-
Different Engineering materials, Corrosion and its preventions methods.	L 3	2	2	-	-	-	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

Unit – IV

1. Heat Treatment : Process, Purpose and Types of Heat Treatment process.
2. Annealing, Types of Annealing and Normalizing process.
3. Hardening : Jominy End-Quench Test.
4. Tempering : Low tempr, Middle Tempr and Higher Temperature Tempering.
5. Austempering and Martempering.
6. Surface Hardening : Introduction, different types of Surface hardening.
7. Carburizing, Cyaniding methods of Surface hardening.
8. Nitriding, Induction Hardening and Age or Precipitation Hardening methods.
9. Corrosion : Introduction, Process and Galvanic Cell.
10. The Electrode Potentials, Polarization, Passivation.

Unit – V

1. Types of Corrosion Mechanisms.
2. General methods of Corrosion Prevention.
3. Engineering Alloys : Introduction, Properties, Composition and uses of low carbon.
4. Effect of alloying elements on Properties of Steel.
5. Carbon Steels and Alloy steels.
6. Steel Designation and Cast Iron.
7. Aluminium Alloys and Temper designation of Wrought Aluminium alloys.
8. Titanium alloys.
9. Copper and its alloys.
10. Revision.

process with a neat sketch

31. What is the working principle of Gas welding
32. Write about the characteristics procedure of gas torch
33. Write a notes on various flame characteristics
34. Write about various reaction zones in gas welding
35. Write notes on forward and back ward welding technique
36. Mention the principle of resistance welding
37. Write a detailed notes on SPOT and SEAM welding
38. Write notes on Friction welding and Explosive welding
39. Write notes on Thermit welding
40. Write notes on Laser welding
41. Sketch the structure of a weld joint
42. What are the various zones present in HAZ
43. What parameters effect HAZ
44. What is the effect of carbon content on structure and property
45. Write notes on weld defects
46. What is principle of Soldering and Brazing
47. What are inspects procedure of casting and welding
48. How is radiography test conducted on welding process
49. How is Eddy current test carried on welded structure
50. How is ultrasonic testing procedure conducts on welding part

Lesson Plan

Unit – I

1. Introduction (Concept of Manufacturing process, types, etc.,.)
2. Importance and Classification of Manufacturing process.
3. Casting process : Steps involved in the process.
4. Advantages and Limitations of Casting process.
5. Pattern : Definition, Functions, Materials used for Pattern.
6. Various pattern allowances and their importance and Classification of Patterns.
7. Binders : Definition, Types of binder used in moulding sand.
8. Additives : Need and types of additives used.
9. Sand Moulding : Types of base sand, requirements and types of Sand Moulds.
10. Sand Moulds : Moulding sand mixture ingredients for different sand mixtures.
11. Cores : Need, types and methods of making cores, Steps involved and casting defects.

Unit – II

1. Moulding machines : Jot Type.
2. Moulding machines : Squeeze type, Jolt and Squeeze type.
3. Moulding machines : Sandslinger type.
4. Special moulding process : Study of important moulding process.
5. Green Sand, Core Sand, Dry Sand and Sweep mould..
6. CO2 mould, shell mould and investment mould.
7. Metal moulds : Gravity die-casting.
8. Pressure die-casting, Centrifugal casting.
9. Squeeze casting, Slush casting and continuous casting processes.

Unit – III

1. Melting Furnaces : Introduction, Classification of furnaces.
2. Constructional features and Working principle of Gas fired pit furnace,
3. Resistance furnace, coreless induction furnace, electric arc furnace and cupola furnace.
4. Welding process : Definition, principles, classification,
5. Application, Advantages and limitations of Welding process.
6. Arc Welding : Introduction, Principle.
7. Metal Arc Welding, Flux Shielded Metal Arc Welding.
8. Inert Gas Welding (TIG and MIG),
9. Submerged Arc Welding.
10. Atomic Hydrogen Welding processes.

Lesson Plan

Unit – I

1. Introduction (Concept of Atoms, arrangements, materials, types of materials, etc.,.)
2. Fundamental Concepts of Lattice, Space Lattice and Bravis Space Lattice.
3. Concept of Stacking of Layers of atoms, CN and APF.
4. Calculation of APF for Simple Cubic and BCC Structure.
5. Calculation of APF for FCC and HCP Structure.
6. Problems on above Concepts.
7. Crystal Imperfections : Introduction, Types.
8. Zero, One, Two and Three dimensional defects of a crystal.
9. Diffusion : Fundamental Concepts, Factors affecting Diffusion.
10. Fick's First and Second Law of Diffusion and Review.

Unit – II

1. Stress, Strain and Tensile Properties.
2. Tensile Properties – Properties in Elastic and Plastic Region.
3. Stress – Strain Curve for different materials : Brittle and Ductile Behaviour.
4. Hardness – Types of Hardness measurements.
5. Critically Resolved Shear Stress – Derivation.
6. Problems on fundamental Concepts.
7. Fracture types : Definition, Different types of Fracture.
8. Ductile to Brittle Transition, Griffith's Theory for Brittle Fracture.
9. Fatigue – Fatigue Test, Factors affecting Fatigue Life.
10. Fatigue Protection methods.
11. Creep – Creep Test, Creep Cure and Mechanism of Creep.
12. Creep – Resistant materials.

Unit – III

1. Solid Solutions : Definition, Types and Rules governing the formation of Solid Solutions.
2. Phase Diagrams : Basic terms, Phase Rule and Cooling Curves.
3. Construction and Interpretation of Phase diagrams.
4. Types of Phase diagrams, Lever Rule and Problems.
5. Problems on different types of Phase diagrams.
6. Iron Carbon Equilibrium diagram : Definition, Phases in the diagram.
7. Invariant reactions, Critical Temperatures and Comments on Fe-C diagram.
8. Microstructure of slowly cooled steels, effect of alloying elements on diagram.
9. TTT diagram, Construction, effect of alloying elements.
10. Continuous cooling diagram and difference between TTT diagram and Fe-C diagram.

ing.

33. What is the purpose of case hardening? Discuss the different methods of case hardening.

34. Distinguish between the hardness and hardenability of steel. State the factors, which affect hardenabilty and how this is measured.
35. State and explain the difference between hardening and case hardening.
36. What is the purpose of surface hardening treatment? What types of steel can be surface hardened and how?
37. With the help of a neat sketch explain induction hardening flame hardening process
38. What is age-hardening? What are its requirements?
39. Explain in detail the factors affecting the hardening process of steels.
40. Define hardenability. Describe a test to determine hardenability of steels.

41. Write a note on ·Classification of steel as per Bureau of Indian standards

42. State the properties and uses of grey cast iron, malleable cast iron, spheroidal cast iron and white cast iron.
43. Distinguish between α and (α+β) brasses with respect to composition, properties and applications.
44. Discuss the suitability of steel utilization in vehicle body construction highlighting their properties
45. Explain how Aluminum alloy is able to find place in body construction.
46. Explain corrosion and mention the different types of corrosion prevention mechanisms.
47. With a neat sketch explain the corrosion mechanisms.
48. Write a steel designation.
49. Write a note on effect of alloying elements on properties of steel.
50. Write a note on Titanium alloys and Copper and its alloys.

Unit – IV

1. Gas Welding : Introduction, Oxy-welding,
2. Reaction in Gas Welding,
3. Flame characteristics,
4. Gas torch construction and working,
5. Forward and backward welding,
6. Special type of Welding : Introduction,
7. Resistance welding – principles,
8. Seam welding, Butt welding,
9. Spot Welding and projection welding,
10. Friction welding, Explosive welding, Thermit welding,
11. Laser welding and Electron beam welding.

Unit – V

1. Metallurgical aspects in welding : Introduction, Structure of welds,
2. Formation of different zones during welding.
3. Heat affected zone, parameters affecting HAZ.
4. Effect of carbon content on structure and properties of steel.
5. Shrinkage in welds and residual stresses. Concept of electrodes.
6. Filler rod and fluxes, welding defects – detection causes and remedy.
7. Principles of Soldering and brazing : Parameters involved and mechanism.
8. Different types of Soldering and Brazing methods.
9. Inspection methods – Methods used for Inspection of casting and welding - visual.
10. Magnetic particle, Fluorescent particle.
11. Ultrasonic, radiography, eddy current, holography methods of Inspection.

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Patterns : Functions, Materials used for pattern, various pattern allowances,	L 1	**M**	**L**	-	-	-	-	-	-	-	-	-
Different types of Sand Moulds,	L 3	**L**	**M**	-	-	-	-	-	-	-	-	-
Methods of making a Cores,	L 3	**H**	**M**	**H**	-	**H**	-	-	-	-	-	-
Different types of furnaces, constructional features and working principles of Gas fired fit furnaces,	L 3	**H**	**M**	**M**	-	**M**	-	-	-	-	-	-
Principles, Classification and Applications of Welding process,	L 1	**H**	**H**	**M**	-	**H**	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Patterns : Functions, Materials used for pattern, various pattern allowances,	L 1	**2**	**1**	-	-	-	-	-	-	-	-	-
Different types of Sand Moulds,	L 3	**1**	**2**	-	-	-	-	-	-	-	-	-
Methods of making a Cores,	L 3	**3**	**2**	**3**	-	**3**	-	-	-	-	-	-
Different types of furnaces, constructional features and working principles of Gas fired fit furnaces,	L 3	**3**	**2**	**2**	-	**2**	-	-	-	-	-	-
Principles, Classification and Applications of Welding process,	L 1	**3**	**3**	**2**	-	**3**	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

63.9 mm. Calculate the 0.2% proof stress, tensile strength, percentage elongation, the percentage reduction in area & Engineering stress at fracture.

14.Define fracture of a material. Describe different types of fracture.

15.What is S-N diagram? Explain its importance with the example of mild steel and aluminum

16.What is meant by creep? With the help of creep curve, explain different stages of creep.

17.List the factors affecting fatigue life of a material.

18.Discuss the solidification mechanism in pure metals. How do you distinguish homogeneous and heterogeneous nucleation?

19.What is solid solution? Distinguish substitutional solid solution and interstitial solid solution.

20.Explain Hume Rothery rules for formation of substitutional solid solution.

21.Explain the construction of isomorphous phase diagram with the help of cooling curve .

22.Describe Gibbs phase rule. Also explain modified Gibbs phase rule.

26. Explain the following binary phase diagrams with a suitable example.
a) Eutectic system; b) Eutectoid system

27. Two metals A and 8 are used to form an alloy containing 75% A and 25% B. 'A' melts at 600°C and '8' at 400°C. When alloyed together, these metals form no compounds or solid solutions but form eutectic at 40% A and 60% B. Assume Jhat the liquidus lines are straight. The eutectic solidifies at 250°C. The specific gravity of A is 2.0 and that of B is 6.0. Find. (a). The temperature at which the alloy will begin to crystallize from the melt and at which the melt will be completely solid; (b) The % of eutectic in the alloy at room temperature & % of solid in the alloy at 300°C.

28. Draw a neat sketch of Fe-C phase diagram and mention all the phases present at different temperatures.

With the help of a neat sketch of Fe-C phase diagram explain different invariant reactions.

30. With the help of a neat sketch explain the construction of TTT diagram

31. What do you mean by heat treatment? Why is it necessary? Explain annealing & normalizing.

32. Describe and distinguish normalizing, full annealing and process anneal-

After learning all the topics of unit – V, the student is able to,

1. Define the different methods of Corrosion [L1].
2. List the different methods of prevention of corrosion of engineering metals or alloys [L1].
3. Identify the different types of engineering materials [L1].
4. Select the different materials for different purpose [L4].
5. Differentiate the different types of Engineering alloys or metals [L4].

Review questions

1. What are the types of structures found in different materials? How are these formed? Give some examples.

2. Define atomic packing factor. Prove that the APF for FCC is higher than BCC.

3. What is meant by crystal imperfections? State the effects of their presence in materials.

4. Discuss the principal types of point defects found in crystals. Explain their significance.

5. Differentiate between edge and screw dislocation. What is a stacking fault?

6. The BCC iron has lattice constant of 2.861 nm and atomic mass number 55.85 g/mol. Calculate the density of pure element iron.

7. Aluminum has atomic radius of 0.143 nm. Assuming the atoms of aluminum to be in spherical shape which touch each other along the face diagonal of the unit cell, calculate the density of aluminum. The atomic mass of aluminum is 26.98g/mol.

8. Titanium has HCP structure with the Lattice constant a = 0.2950 nm and c=0.4683 nm. Calculate· the volume of titanium crystal and mass of the unit cell. The atomic mass of titanium is 47.90 g/mol

9. State Fick's second law of diffusion and state the assumptions.

10. Calculate the self-diffusivity for copper in copper if the diffusion coefficient of copper in copper is $20x10^{-6}$ m^2 I sec at 1000°C and activation energy for diffusion of copper in this system is 197 KJ/mol. Take universal gas constant R=8.314 J/mollK. (LO 14)

11. What is engineering stress and strain, true stress and strain? State where each of them are particularly used and suitable.

12. Draw a stress strain diagram for a low carbon steel specimen indicating the proportional limit, elastic limit, yield point, the point of maximum loading and rupture. Explain the above data.

13.A 15mm diameter tensile bar of an aluminum alloy is pulled in tension. It has a gauge length of 60mm. The load corresponding to 0.2 percent offset is 37500 and the maximum load is 45000 N. Fracture takes place at 44220 N. The diameter after fracture is 14.5mm and gauge length at fracture is

Course Code : P13IP36	**Semester : III**	**L - T - P : 3 - 1 - 0**
Course Title : Fluid Mechanics and Hydraulic Machines.		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr		**Weightage: CIE:50; SEE:50**

Prerequisites : The students should have undergone the course on **Fluid mechanics and Hydraulics machines**.

Course Learning Objectives:

1. Recall the basic principles involved in fluid behavior and equipment's involving fluid flow, thus preparing themselves for an advanced course on hydraulic drives.
2. Define the properties of fluids, fluid statics, fluid kinematics involving flow and the basic principles of dimensional analysis.
3. Explain the equations of motion and demonstrate fluid flow measurement and energy losses in pipe flow.
4. Explain the operation of energy producing devices like turbines through velocity triangles knowing fully the principles of impact of jets on valves.
5. Define the velocity triangles for energy absorbing devices like centrifugal pumps and the working principle of reciprocating pump.

Course Content

Unit – I

Properties of Fluids: Introduction, properties of fluids, density, specific weight, specific gravity, viscosity, thermodynamic properties, surface tension and Capillarity, Vapor pressure and Cavitation. **Fluid Statics:** Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers, differential manometers **10 Hrs**

Unit – II

Fluid Statics. Total pressure and center of pressure for vertical, Horizontal, inclined and curved plane surfaces submerged in liquid. Buoyancy – center of buoyancy, Archimedes principle metacenter and metacentric height, conditions of equilibrium of floating and submerged bodies. **Fluid Kinematics:**: Introduction, Types of fluid flow, continuity equation, continuity equation in three dimensions (Cartesian co-ordinate system only). Velocity and acceleration, velocity potential function and stream function. **10 Hrs**

Unit - III

Dimensional Analysis: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Buckingham's p theorem, Rayleigh's method, dimensionless numbers, similitude, types of similitudes.

Fluid Dynamics: Introduction, equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and Euler's equation, Bernoulli's equation for real fluids. **10 Hrs**

Unit –IV

Fluid flow measurement: Introduction, venturimeter, orifice meter, Pitot tube.
Flow through pipes: Frictional loss in pipe flow, Darcy &Chezy's equation for loss of head due to friction in pipes, minor energy losses, hydraulic gradient and total energy lines.

Turbines: classification of Hydraulic turbines, Impulse and reaction turbines, work done and efficiency of pelton wheel and reaction turbine, velocity diagrams, Francis turbine, workdone and efficiency of Francis turbine, draft tube, Kaplan turbine. Impact of jets: Force exerted by the jet on a stationery vertical plate, Force exerted by the jet on a curved plate moving in the direction of the jet. (Simple problems only). **12 Hrs**

Unit –V

Pumps
Reciprocating pumps: Types, workdone by reciprocating pump, single acting and double acting, coefficient of discharge, Percentage slip, effect of acceleration on piston, Air vessels.
Centrifugual pump: Advantages of centrifugual pump over Reciprocating pump, working of C/F pump, work done by the impeller, losses & efficiency, specific speed, multistage pump. (Simple problems only). **10 Hrs**

Topic Learning Objectives

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

1. Define how the atoms or molecules are arranged in a 3 Dimensional Space [L1].
2. Compare the properties of the materials based on Coordination Number and APF [L4].
3. State the different imperfections of the crystals [L1].
4. Describe the diffusion process occuring in a solid materials [L1].
5. Define the mechanism of diffusion process [L1].

After learning all the topics of unit – II, the student is able to,

1. Define Stress, Strain, Fracture, Fatigue and Creep Concepts [L1].
2. Define the different Tensileproperties of materials [L1].
3. Demonstrate the different types of hardness measuring methods [L3].
4. Describe the different types of Fractures [L1].

After learning all the topics of unit – III, the student is able to,

1. Define Solid Solutions, Phase diagram concepts [L1].
2. Explain the Hume – Rothery's Rule for the formation of Substitutional Solid Solutions [L2].
3. State the different types of Solid Solutions [L1].
4. Describe the Construction of different types of phase diagrams [L1].
5. Solve the different types of problems related to an alloy system [L3].
6. Describe the Iron Carbon Equilibrium phase diagram L1].
7. Interpret the different phases of an Iron Carbon Equilibrium diagram and TTT diagram [L6].

After learning all the topics of unit – IV, the student is able to,

1. Define stages involved in the Heat Treatment process [L1].
2. Explain the different types of Heat Treatment process [L1].
3. List the purpose and uses of heat treatment process [L1].
4. Define the corrosion process [L1].
5. Differentiate between the different methods of Heat Treatment process L4].

Text Books :

1. William. D. CallisterJr**,"Material Science and Engineering – An Introduction",**. Wiley India Pvt. Ltd., New Delhi, 6th Edition, 2006.
2. Donald. R. Askeland, Pradeep. P**,"Essentials of Materials for Science and Engineering",**Phule Thomson – Engineering, 2006.

Reference Books :

1. James. F. ShackelFord**,"Introduction to Material Science for Engineering",**Pearson Prentice Hall, New Jersy, 6th Edition., 2006.
2. V. Raghavan**,"Physical Metallury, Principles and Practices",**, PHI, New Delhi, 2nd Edition 2006.
3. Smith**, "Foundation of Material Science and Engineering",** McGraw Hill, 3rd Edition, 1997.

Course Outcomes

By the end of the course students should be able to understand the concept of,

1. Internal Structure of the materials and their properties,
2. Investigates the relationship between the Internal Structure and its properties,
3. Different methods used for Testing the properties of materials,
4. Different methods of failures of materials (Fracture, Fatigue and Creep),
5. Preparation of Alloys and study of their compositions,
6. Different Engineering materials, Corrosion and its preventions methods.

Text Books:

1. Dr. Bansal.R.K**, Fluid Mechanics & Hydraulic machines**, Lakshmi Publications,9th edition 2005.
2. Mode and Seth, **Hydraulics and Fluid Mechanics**.

References:

1. Yunus A, **"Essentials of Fluid Mechanics: Fundamental & applications"**, Cenegel, John M,Cimbala, Tata MacGraw Hill, 2007.
2. John F.Douglas, Janul and M.Gasiosek and john A. Swaffield, **"Fluid Mechanics**", Pearson Education Asia, 5th ed., 2008
3. Kumar.D.S,Kataria and Sons., **"Fluid Mechanics and Fluid Power Engineering",** 7th edition, 2010.

Course Outcomes

By the end of the course students should be able to understand the concept of,

1. Properties of fluids like density, specific weight, specific gravity, viscosity, surface tension and Capillarity.
2. Pascal's law, hydrostatic law and relation between various pressures and different manometers,
3. Fluid Statics, Archimedes principle and fuid Kinematics types of fluid flow and related equation.
4. Dimensions of physical quantities, Buckingham's pie theorem, Rayleigh's method, dimensionless numbers, similitude, types of similitudes. Fluid Dynamics to analyse different equation of motion.
5. Fluid flow measurement using venturimeter, orifice meter, Pitot tube.
6. Frictional loss in pipe flow by various equations for loss of head from Darcy & Chezy's equation.
7. Turbines like Impulse and reaction turbines, Francis turbine, Kaplan turbine to find work done, efficiency, velocity diagrams.
8. Hydraulic Machines Impact of jets: Force exerted by the jet on a stationery vertical plate, curved plate, unsymmetrical moving curved plate.
9. Reciprocating pumps, Types, work done by single acting and double acting reciprocating pumps
10. Centrifugual pump: Advantages of centrifugual pump over Reciprocating pump, working of C/F pump.

Topic Learning Objectives

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

1. Define fluid mechanics, density, specific weight, specific gravity, Viscosity [L1].
2. Define surface tension and Capillarity their formula [L1].
3. Explain Vapour pressure and Cavitation [L1].
4. Explain Fluid pressure at a point, Pascal's law, Hydrostatic law [L1],
5. Relationship between Absolute, gauge, atmospheric and vacuum pressures [L3],
6. Working principal of Simple and differential manometers [L1].
7. Solve the problem on fluid properties and manometers [L4].

After learning all the topics of unit – II, the student is able to,

1. Define fluid Statics.[L1]
2. Derive the expression for the Total pressure and center of pressure for vertical and horizontal plane surfaces submerged in liquid [L3].
3. Derive the expression for the Total pressure and center of pressure for Inclined and curved plane surfaces submerged in liquid [L3].
4. Solve the problems on vertical, horizontal, inclined and curved surfaces [L1].
5. Define Buoyancy, center of buoyancy, Archimedes principle [L1].
6. Conditions of equilibrium of floating and submerged bodies [L3].
7. Define fluid kinematics and explain different types of flow [L1].
8. Derive the continuity equation for in three dimensions [L3]

After learning all the topics of unit – III, the student is able to,

1. What is Dimensional Analysis and different derived quantities [L1].
2. Explain Buckingham's pie theorem and Rayleigh's method [L1].
3. Define fluid Dynamics and derive the equation of motion [L1].
4. Derive the Euler's equation of motion [L1].
5. Derive the Bernoulli's equation from first principles [L1].
6. Application of Euler's equation and Bernoulli's equation for real fluids [L3].
7. Solve the problems on dimensional analysis and fluid dynamics [L3].

Unit – III

Solid Solutions and Phase Diagram : Solid solutions - Types, Rules governing the formation of solids solutions. Phase diagrams - Basic terms, phase rule, cooling curves, construction of phase diagrams, interpretation of equilibriums diagrams, Types of phase diagrams. Lever rule.

Iron Carbon Equilibrium Diagram : Phases in the Fe–C system, Invariant reactions, critical temperatures, Microstructure of slowly cooled steels, effect of alloying elements on the Fe-C diagram, ferrite & Austenite stabilizers. The TTT diagram, drawing of TTT diagram, TTT diagram for hypo & hypereutectoid steels, effect of alloying elements, CCT diagram. **10 Hours**

Unit – IV

Heat Treatment: Annealing, and its types, Normalizing, Hardening, Tempering, Martempering, Austempering, Surface hardening like Case hardening, Carburizing, Cyaniding, Nitriding Induction hardening. Hardenabilty :Jominy - End quench test, Age hardening of Al & Cu alloys.

Corrosion : Galvanic Cell, The Electrode Potentials, Polarization, Passivation. **10 Hours**

Unit – V

Corrosion Prevention : General methods of Corrosion Prevention, Cathodic Protection, Coatings, Corrosion Prevention by Alloying, Stress Corrosion Cracking.

Engineering Alloys : Properties, Composition and uses of low carbon, mild, medium & high carbon steels. Steel designation & AISI – SAE designation. Cast irons, gray CI, white CI, malleable CI, SC iron. Microstructures of cast iron. The light alloys, Al & Mg & Titanium alloys. Copper & its alloys : brasses & bronzes. **10 Hours**

Course Code : P13IP42	Semester : IV	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 : The students should have undergone the course on Elements of Mechanical Engineering.

Course Learning Objectives: At the end of the Course the students should be,

1. Able to define the concept of Unit cell, Space Lattice, Atomic Packing Factor, Coordination Number and different types of Crystal Imperfections.
2. Able to understand the concept of Mechanical Properties of the materials.
3. Able to define the concept and mechanism of Fracture, Fatigue and Creep.
4. Able to construct and analyse the different types of Solid Solutions.
5. Able to understand the properties, composition and uses of Engineering alloys.
6. Able to understand the different heat treatment techniques to improve the specific properties of the engineering materials.
7. Able to understand the concept of corrosion and different prevention methods of corrosion.

Course Content

Unit – I

Structure of Crystalline Solids : Fundamental concepts of Unit cell, Space lattice, Bravis Space lattice, Unit cells for cubic structure & HCP, study of stacking of layers of atoms in cubic structure & HCP, calculations of radius, Coordination Number and Atomic Packing Factor for different cubic structures. Crystal imperfections - Point, line, Surface & Volume defects.Diffusion, Diffusion Mechanism, Fick's laws of diffusion. **10Hours**

Unit – II

Concepts of Stress &Strain : Tensile properties, True Stress & Strain, Hardness, Rockwell, Vickers &Brinell Hardness Testing. Plastic deformation - Slip & Twinning.

Fracture, Fatigue &Creep : Fracture: Types, Stages in Cup & Cone fracture, Griffith's Criterion. Fatigue : Fatigue tests, S-N curves, Factors affecting fatigue life and protection methods. Creep : The Creep curves, Mechanisms of Creep : Creep - resistant materials. **12 Hours**

After learning all the topics of unit – IV, the student is able to,

1. What is fluid flow measurement [L1]
2. Explain the working principal of venturimeter, Orifice meter and Pitot tube. [L1].
3. Explain the frictional loss in pipe flow [L1],
4. Derive Darcy & Chezy's equation for loss of head due to friction in pipes [L3]
5. List the Minor energy losses and explain hydraulic gradient and total energy lines [L1].
6. Classification of Hydraulic turbines [L3]
7. What is the Work done and efficiency of pelton wheel with velocity diagrams [L1]
8. What is the Work done and efficiency of reaction turbine with velocity diagrams [L1]
9. Explain the working principal of Francis turbine [L1]
10. Expression for work done and efficiency of Francis turbine [L3]
11. Explain the Kaplan turbine [L1]

After learning all the topics of unit – V, the student is able to,

1. Describe the Hydraulic Machines [L1]
2. Find the Force exerted by the jet on a stationery vertical plate [3]
3. Find the Force exerted by the jet on a curved plate moving in the direction of the jet [3]
4. Find the Force exerted by the jet of water on an unsymmetrical moving curved plate when the jet strikes tangentially at one of the tips. [L3].
5. Explain the classification of Reciprocating pumps [L1]
6. Find out the work done by reciprocating pump [L3]
7. Explain the Single acting and double acting reciprocating pump [L1]
8. Define coefficient of discharge, Percentage slip [L1]
9. Advantages of centrifugal pump over Reciprocating pump [L2]
10. Working of C/F pump, expression for work done by the impeller [L1]
11. Problems.

Review Questions

1. List and define various properties of fluid?
2. What is Newton's law of viscosity?
3. Differentiate between Newtonian and non-Newtonian fluid, ideal and real fluid.
4. Calculate specific weight, mass density, specific volume and specific gravity of a liquid having a volume of 4m3 and weighing 29.43 kN. Assume missing data suitably.
5. Two large surfaces are 2.5 cm apart. This space is filled with glycerin of absolute viscosity 0.82 NS/m2. Find what force is required to drag a plate of area 0.5m2 between the two surfaces at a speed of 0.6m/s. (i) When the plate is equidistant from the surfaces, (ii) when the plate is at 1cm from one of the surfaces.
6. What is capillarity Derive Expression for capillary rise?
7. What do you mean by surface tension? Derive Expression for the same.
8. What is the pressure inside the droplet of water 0.05mm in diameter at 200C, if the pressure outside the droplet is 103 kPa Take σ = 0.0736 N/m at 200C
9. Calculate capillary rise in a glass tube when immersed in Hg at 200c. Assume σ for Hg at 200c as 0.51N/m. The diameter of the tube is 5mm. θ = 1300c.
10. How fluids are classified? How do classify various fluid flows?
11. State the importance of the dimensions and units.
12. State and prove Pascal's law for a static fluid.
13. Explain fluid pressure at a point (hydrostatic law) & pr. variation in a static fluid.
14. Derive the hydrostatic law in an incompressible fluid at rest.
15. Calculate intensity of pressure due to a column of 0.3m of (a)water (b) Mercury (c) Oil of specific gravity-0.8.
16. Relate the terms absolute pressure, gauge pressure, vacuum pressure and atmospheric pressures.
17. Explain various kinds of instrumentation used for measuring fluid pressure.
18. Classify the different types of manometers
19. Determine the pressure at a desired point in a fluid using suitable manometer.
20. Define total pressure and center of pressure for different submerged surfaces.
21. Obtain an expression for Hydrostatic force on submerged plane & curved surfaces.
22. Solve problems on hydrostatic force on submerged plane and curved surfaces.
23. Define buoyancy and centre of buoyancy.
24. Compute the horizontal & vertical components of the total force acting on a curved surface AB, which is in the form of a quadrant of a circle of radius 2m as shown in figure. Take the width of the gate as unity.
25. A trapezoidal channel 2m wide at the bottom & 1m deep has side slopes 1:1. determine: (i)total pr., & (ii) the centre of pr. On vertical gate closing

Evaluation Scheme

CIE Scheme

Assessment	Weightage in Marks
Calculations	20
Evaluation of models	20
Record writing	10
Total	**50**

SEE Scheme

Semester End Examination (SEE) is a practical examination of three hours duration of 50 marks.

Sl. No.	Marks allotment		
1	Procedure and Conduction	ONE Question from part A	25
		ONE Question from part B	15
2	Viva Voce		10
Total Marks			**50**

Course Code : P13IPL38	Semester : III	L - T - P : 0 - 0 - 1.5
Course Title : Foundry and Forging Lab.		
Contact Period: Lecture: 36 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : The student should have studied Production Engineering - I - P13IP35.		

Course Learning Objectives: By learning this course students should be,

1. able to understand different types of sand moulds.
2. Able to learn operations of smith and forging.
3. able to do calculations for the preparation of given models both in moulding and forging.

PART – A

1. Testing of Moulding sand and Core sand

Preparation of sand specimens and conduction of the following tests:

1 Compression, Shear and Tensile tests on Universal Sand Testing Machine. Permeability test

3 Core hardness & Mould hardness tests.

4 Grain fineness number test (Sieve Analysis test)

5 Clay content test.

6 Moisture content test.

2. Foundry Practice

Use of foundry tools and other equipments.

Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).

3. Demonstration

Preparation of casting: Aluminum or cast iron depending upon availability

PART – B

Forging Operations

Preparing minimum three models involving upsetting, drawing and bending operations.

the channel when it is full of water.

26. Compute the force of buoyancy and meta-centric height of a partially or fully submerged body.
27. Derive an analytical expression for the metacentric height of a floating body.
28. Explain the procedure to determine the metacentric height by experimental method.
29. Identify the states of equilibrium for a floating body.
30. A body having the dimensions of 1.5m ×1.0m× 3.0m weighs 1962N in water. Find its weight in air. What will be its specific gravity?
31. A wooden cylinder having a specific gravity of 0.6 is required to float in an oil of specific gravity 0.8. If the diameter of cylinder is 'd' and length is 'L', show that 'L' cannot exceed 0.817d for the cylinder to float with its longitudinal axis vertical.
32. Define the concept of different fluid flows.
33. Derive an expression for continuity equation for a three-dimensional flow.
34. Define velocity potential and stream function.
35. Compute velocity potential and stream function for the fluid flow.
36. Explain the significance of momentum equation.
37. Explain the various forces causing the flow.
38. A 40cm diameter pipe conveying water branches into two pipes of diameters 30cm and 20cm respectively. If the average velocity in the 40cm diameter pipe is 3m/s., find the discharge in this pipe. Also, determine the velocity in 20cm diameter pipe if the average velocity in 30cm diameter pipe is 2m/s.
39. The fluid flow field is given by V=x2yi+y2zj-(2xyz+yz2)k . Prove that this is a case of a possible steady incompressible flow field.
40. The stream function for a 2-D flow is given by ψ = 2xy. Calculate the velocity at the point P (2,3) and velocity function (Φ).
41. Derive Euler's equation of motion for a two-dimensional steady flow of an incompressible fluid and extend it for three-dimensional viscous flow.
42. Obtain the Bernoulli's equation of motion along a streamline by integrating the Euler's equation of motion under appropriate conditions.
43. Describe the working principle of various devices used to measure the rate of fluid flow.
44. Obtain the discharge through a pipe by employing a venturimeter or an orifice meter.
45. Explain the working of Pitot tube which is used for measuring the velocity of flow at any point in a pipe.
46. **State** Bernoulli's theorem for steady flow of an incompressible fluid. **Derive** an expression for Bernoulli's Equation from first principle & State the **assumptions** made for such derivation
47. Water flows through a pipe AB 1.2m diameter at 3m/s & then passes through a pipe BC 1.5m diameter. At C, pipe branches. Branch CD is 0.8m in diameter & carries one third of the flow in AB. The flow velocity in branch CE is 2.5m/s. *find the volume rate of flow in AB, the velocity in BC, the velocity in CD & the diameter of CE.*
48. A 30cm 15cm Venturimeter is provided in a vertical pipe line carrying

oil of sp. gr.0.9, the flow being upwards. The difference in elevation of the throat section & entrance section of the venturimeter is 30cm. The differential U-tube mercury manometer shows a gauge deflection of 25cm. Calculate (i) the discharge of oil & (ii) the pr. difference between the entrance section & the throat section.Take the co-efficient of meter as 0.98 & sp. gr. of mercury as 13.6.

49. Derive an equation for Laminar flow through circular pipe-Hagen poiseulle's equation.
50. Derive an equation for Laminar flow between parallel stationery plates.

- Measurements on Universal length measuring machine
- Measurements of gear tooth profile using gear tooth Vernier /gear tooth micrometer.
- Measurements of straightness, flatness, squareness using straight edges / Autocollimator
- Measurement of flatness using Interferometer & Optical Flats
- Measurements of Surface roughness using roughness tester (demo)

Note: Atleast 60% of the above experiments should be conducted depending upon the availability of the instruments.

Scheme of Examination:

ONE question from Metrology (part -A) 20 Marks
ONE question from Instrumentation (part -B) 20 Marks
Viva –Voce 10 Marks **Total 50 Marks**

Evaluation Scheme

CIE Scheme

Assessment	Weightage in Marks
Calculations	20
Evaluation of models	20
Record writing	10
Total	**50**

SEE Scheme

Semester End Examination (SEE) is a practical examination of three hours duration of 50 marks.

Sl. No.	Marks allotment		
1	Procedure and Conduction	ONE Question from part A	25
		ONE Question from part B	15
2	Viva Voce		10
Total Marks			**50**

Course Code : P13IPL37	Semester : III	L - T - P : 0 - 0 - 1.5
Course Title : Mechanical Measurements and Metrology Lab.		
Contact Period: Lecture: 36 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : P13IP32 Mechanical Measurements and Metrology or equivalent.		

Course Learning Objectives:

The course covers the different areas of measurements. The objective is to provide basic knowledge in the field of industrial metrology through the use of traditional and state of the art instruments, how to select and handle precision measuring tools etc.

Part – A

Mechanical Measurements

Calibration of Pressure gauge.
Calibration of Thermocouple
Calibration of LVDT.
Calibration of Load cell.
Determination of modulus of elasticity of a mild steel specimen using strain gauges.

Part – B

Metrology.

Introduction to Metrological instruments like gauges and commonly using instruments.

- Calibration of instruments: Micrometer, Vernier Caliper, Dial Gauges
- Measurements using Micrometer, Vernier Caliper, Dial Gauges, Height gauges
- Measurements of angle using Sine Center / Sine bar / Roller set
- Measurements using Profile Projector.
- Measurements using Toolmaker Microscope/ Vision measuring instrument
- Measurements of Screw Thread Parameters using thread measuring machine / micrometer.

Lesson Plan

Unit – I

1. Introduction, properties of fluids, density, specific weight, specific gravity,
2. Viscosity, thermodynamic properties,
3. surface tension and Capillarity,
4. Vapour pressure and Cavitation.
5. Fluid Statics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid,
6. Absolute, gauge, atmospheric and vacuum pressures,
7. Simple manometers,
8. Differential manometers
9. Problems
10. Problems

Unit – II

1. Fluid Statics. Total pressure and center of pressure for vertical and horizontal plane surfaces,
2. Total pressure and center of pressure for Inclined and curved plane surfaces submerged in liquid.
3. Problems
4. Problems
5. Buoyancy – center of buoyancy, Archimedes principle
6. Metacenter and metacentric height, conditions of equilibrium of floating and submerged bodies.
7. Fluid Kinematics: Introduction, Types of fluid flow,
8. Continuity equation: continuity equation in three dimensions (Cartesian coordinate system only).
9. Velocity and acceleration, velocity potential function and stream function.
10. Problems

Unit – III

1. Dimensional Analysis: Introduction, derived quantities,
2. Dimensions of physical quantities, dimensional homogeneity,
3. Buckingham's pie theorem, Rayleigh's method,
4. Dimensionless numbers,
5. Similitude, types of similitudes.
6. Fluid Dynamics: Introduction, equation of motion,
7. Euler's equation of motion, Bernoulli's equation from first principles
8. Euler's equation, Bernoulli's equation for real fluids.
9. Problems.
10. Problems

Unit – IV

1. Fluid flow measurement: Introduction, venturimeter,
2. Orifice meter, Pitot tube.
3. Flow through pipes: Frictional loss in pipe flow, Darcy & Chezy's equation for loss of head due to friction in pipes,
4. Minor energy losses, hydraulic gradient and total energy lines.
5. Turbines: classification of Hydraulic turbines, Impulse and reaction turbines,
6. Work done and efficiency of pelton wheel, velocity diagrams.
7. Work done and efficiency of reaction turbine, velocity diagrams,
8. Francis turbine, work done and efficiency of Francis turbine, draft tube,
9. Kaplan turbine
10. Simple problems.

Unit – V

1. Hydraulic Machines: Introduction
2. Impact of jets: Force exerted by the jet on a stationery vertical plate,
3. Force exerted by the jet on a curved plate moving in the direction of the jet,
4. Force exerted by the jet of water on an unsymmetrical moving curved plate when the jet strikes tangentially at one of the tips.
5. Pumps: Reciprocating pumps: Types, workdone by reciprocating pump,
6. Single acting and double acting, coefficient of discharge, Percentage slip,
7. Effect of acceleration on piston, Air vessels.
8. Centrifugual pump: Advantages of centrifugal pump over reciprocating pump,
9. Working of C/F pump, work done by the impeller,
10. Losses & efficiency, specific speed, multistage pump.
11. Simple problems only.
12. Simple problems only.

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Properties of fluids like density, specific weight, specific gravity, viscosity, surface tension and Capillarity.	L 1	**M**	**L**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Pascal's law, hydrostatic law and relation between various pressures and different manometers,	L 3	**L**	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Fluid Statics, Archimedes principle and fuid Kinematics types of fluid flow and related equation.	L 3	**H**	**M**	**H**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**
Fluid flow measurement using venturimeter, orifice meter, Pitot tube.	L 3	**H**	**M**	**M**	**-**	**M**	**-**	**-**	**-**	**-**	**-**	**-**
Frictional loss in pipe flow by various equations for loss of head from Darcy & Chezy's equation.	L 1	**H**	**H**	**M**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Properties of fluids like density, specific weight, specific gravity, viscosity, surface tension and Capillarity.	L 1	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Pascal's law, hydrostatic law and relation between various pressures and different manometers,	L 3	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Fluid Statics, Archimedes principle and fuid Kinematics types of fluid flow and related equation.	L 3	**3**	**2**	**3**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
Fluid flow measurement using venturimeter, orifice meter, Pitot tube.	L 3	**3**	**2**	**2**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**-**
Frictional loss in pipe flow by various equations for loss of head from Darcy & Chezy's equation.	L 1	**3**	**3**	**2**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**

1 – Low, 2 – Moderate and 3 – High