Syllabus

Out Come Based Education

III & IV Semester
Bachelor Degree
in
Automobile 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.

Ph : 08232- 220043

Fax : 08232 - 222075

Web : www.pescemandya.org

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

III Semester B.E. (AUTOMOBILE ENGINEERING)

Sl No	Course Code	Course Title	Teaching Dept.	Hrs / Week L:T:P:H	Credits	Examination Marks		
						CIE	SEE	Total Marks
1.	P13MAT31	Course I - Engineering Mathematics-III	Maths	4:0:0: 4	4	50	50	100
2.	P13AU32	Mechanics of Materials	Auto	4:0:0: 4	4	50	50	100
3.	P13AU33	Thermodynamics	Auto	4:0:0: 4	4	50	50	100
4.	P13AU34	Material Science & Metallurgy	Auto	4:0:0: 4	4	50	50	100
5.	P13AU35	Manufacturing Technology-I	Auto	2:2:0: 4	3	50	50	100
6.	P13AU36	Fluid Mechanics	Auto	4:0:0: 4	4	50	50	100
7.	P13AUL37	Metallography & Material Testing Lab	Auto	0:0:3: 3	1.5	50	50	100
8.	P13AUL38	Foundry and Forging Lab	Auto	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	P13HUL310	Industry Interaction – I	Auto	0:0:1: 1	0	(50)	--	--
	P13HM311	Constitution of India & Professional Ethics	Human& Science	2:0:0: 2	0	(50)	---	---
11	P13HUDIP39	English & Persona Evolution#	HS&M	4:0:0:4	[2]#	[50]#	[50]#	[100]#
12	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
#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.
ACPA- **I** All students shall have to pass this mandatory learning courses before completion of V - Semester

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		Total Marks
1	Procedure and Conduction	ONE Question from part A ONE Question from part B	25 15
2	Viva Voce		10
			50

Course Code : P13AUL48	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

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

Sl No	Course Code	Course Title	Teaching Dept.	Hrs / Week L:T:P: H	Cred-its	Examination Marks		
						CIE	SEE	Total Marks
1.	P13MAAC41/ P13MAES41+	Course I - Engineering Mathematics-IV	Maths	4:0:0: 4	4	50	50	100
2.	P13AU42	Measurements and Metrology	Auto	4:0:0: 4	4	50	50	100
3.	P13AU43	Manufacturing Technology-II	Auto	2:2:0: 4	3	50	50	100
4.	P13AU44	Theory of Machines-I	Auto	4:0:0: 4	4	50	50	100
5.	P13AU45	Computer Aided M/c Drawing	Auto	0:0:6: 6	4	50	50	100
6.	P13AU46	Automotive Engines and Components	Auto	4:0:0: 4	4	50	50	100
7.	P13AUL47	Engines and Components Lab	Auto	0:0:3: 3	1.5	50	50	100
8.	P13AUL48	M/c shop Practice	Auto	0:0:3: 3	1.5	50	50	100
9	P13HU49	Aptitude Competence and Professional Aug-mentation – II (ACPA- II)	HS&M	2:0:0: 2	0	(50)	--	--
10	P13xxL410	Mini Project- I	Auto	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				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, **CIE:** Continuous Internal Evaluation, **SEE:** Semester End Examination, **C**: Credits

- Additional Mathematics-I & 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**				
CIE	50%	50	**Test I**	**Test II**	**Quiz I**	**Quiz II**	**Assign-ment**
			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 Articulation Matrix												
Course Outcomes (Cos)		Program Outcome - * (General)										
		a	b	c	d	e	f	g	h	i	j	k
Explain about function & application of various hand tools used in auto-motive workshop/ laboratory.	L 3 & L 1							M		M	M	
Predict about various Troubles encountered with engine components and to overcome the same.	L 3					M		M		M	M	M
Practice to, dismantle & assemble SI and CI engines(	L 3							M		M	M	
Inspect engine compo-nents for wear and tear and damage	L 4					M		M		M	M	M
Assess the condition of the engines by Conduct-ing compression test, vacuum test on diesel and petrol engines	L 3					M		M		M	M	M
Know about Fuel sys-tems, cooling systems, lubrication systems and turbo-chargers used in engines	L 3					M		M		M	M	M
Measure power, SFC, speed, etc of any given engine.	L 5					M		M		M	M	M

Lesson Plan

1.Study of hand tools- sketching, materials used and their applications.
2.Trouble shooting charts for all engine components.
3.Specifications of given engines and component standard dimensions.
4.Dismantling & assembling of Two engine

a) two stroke SI engine
b) b) four stroke SI engine
   i)Enfield and hero Honda engine
c) Four stroke multi cylinder SI engine
   i)Four cylinder engine
   ii)Three cylinder MPFI maruti engine
d) four stroke multi cylinder CI engine
   i) Six cylinder tata and ashok Leyland engine r

5.Conducting compression test, vacuum test on diesel and petrol engines.r
6. Study (Dismantling & assembly): Different carburetors, fuel injection pumps, injectors, fuel tanks, fuel filters, fuel pumps, turbo-chargers, cooling systems and lubricating systems.
Identify location of above components in a vehicle and note their functions along with the brand names.
7. Conduct performance test on single cylinder SI engine
8. Conduct performance test on multi cylinder SI engine

Course Code : P13AU32	Semester : III	L - T - P : 4 - 0 - 0
Course Title : Mechanics of Materials		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	Weightage: CIE:50; SEE:50	

Course Learning Objectives (CLOs)

This course aims to

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

Course Content

Unit – I

Simple stresses and strains: Stress, types of stresses, Strain, Saint Venant's principle, stress-strain diagram for mild steel, working stress, proof stress, factor of safety, Hooke's law, modulus of elasticity, strain energy due to gradually applied load, proof resilience, longitudinal strain, lateral strain, poison ratio, stress strain analysis of bars of uniform cross section, stepped bars, bars with continuously varying section, principle of superposition. Modulus of rigidity, volumetric strain, expression for volumetric strain, bulk modulus, relation among elastic constants **12 Hrs**

Unit – II

Compound bars: Stress analysis of composite bars. Thermal stresses in uniform and compound bars. **Compound stresses**: Principal planes and stresses, planes of maximum shear stress in general two dimensional systems, Mohr's circle diagram. **10 Hrs**

Unit – III

Shear force and Bending moment diagrams: Types of beams, loads and supports. Shear forces and bending moments, sign conventions, relationship between load intensity, shear force and bending moment. Shear force and bending moment diagrams for different beams subjected to concentrated loads, UDL, UVL and couple. **10 Hrs**

Unit – IV

Bending and shear stresses in Beams: Theory of simple bending, assumptions in simple bending, relationship between bending stresses and radius of curvature, relationship between bending moment and radius of curvature, section modulus, moment of resistance of a section. Bending stresses in beams of uniform section. Shearing stresses in beams, shear stress across square, rectangular, circular, I and T

sections. **(*Composite beams are not included and moment of inertia to be supplied for numerical problems*).**

Deflection of Beams: Introduction, relation between slope, deflection and radius of curvature. Macaulay's method for cantilever and simply supported beams with point load and UDL. **10 Hrs**

Unit – V

Thin and thick cylinders: Types of cylinder, stresses in thin cylinder – Hoop stress and longitudinal stress, changes in dimensions of cylinder (diameter, length, volume). Thick cylinders subjected to internal and external pressures (circumferential and radial stress). (***Compound cylinders not included***).

Torsional stresses: Introduction to torsion, pure torsion, assumptions, derivation of torsional equation, polar modulus, torsional rigidity, and torque transmitted by solid and hollow circular shafts. C**olumns and struts:** Introduction to Columns, Euler's theory for axially loaded elastic long columns, Euler's equation for columns with different end conditions, Rankine's formula **10 Hrs**

Text Book:

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

Reference Books:

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

Course Outcomes

After learning all the units of the course, the student is able to

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

Topic Learning Objectives

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

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

***Topic Learning objectives (TLO's)*:**

At the end of this lab, student should be able to:

1.Sketch and **define** about function & application of various hand tools used in automotive

workshop/laboratory.

2.Review about various Troubles encountered with engine components and to overcome the

same.

3.Know and C**ompare** Specifications of given engines and components standard dimensions

4.**Practice** to, dismantle & assemble engines,

5.Identify the major components of engines,

6..Know the functions & materials used.

7.C**ompare** major engine components dimension with standard specifications.

8.Inspect engine components for wear and tear and damage

9.Assess the working condition of the engines.

10.**Assess** the condition of the engines by Conducting compression test, vacuum test on diesel and petrol engines.

11.**Know** about Fuel supply systems, cooling systems, lubrication systems and turbo-chargers used in engines.

12.Conduct performance test on any given engine

Review questions

1.name the different tools used in automobile w/s and also their material
2. what are all the parameters required to specify an engineering
3. write dismantling procedure for two stroke SI engineering
4. write dismantling procedure for four stroke SI engineering
5. write dismantling procedure for multi cylinder SI engineering
6. write dismantling procedure for multi cylinder CI engineering
7.what is the purpose of conducting the comprn. test in SI and CI engines
8. what are the different ways through which the gases leaks from an IC engine
9.List the probable troubles in SI engines fuel supply system
10. List the probable troubles in CI engines fuel supply system
11.List the probable troubles in cooling system
12.List the probable troubles in lubricating system
13.conduct the performance test on given two stroke SI engineering
14. conduct the performance test on given four stroke SI engineering
15.conduct the performance test on given multi cylinder SI engineering
16.define the terms IHP,BHP,SFC, thermal, mechanical , heat balance

4.Dismantling & assembling of engines.

[Note: Procedure of dismantling & assembly; identify the major components, noting their functions & materials used. Measurement & comparison of major components dimension with standard specifications. Inspection for wear and tear, crack and breakdown] and run the same

a) two stroke SI engine
b) four stroke SI engine
   i)Enfield and hero Honda engine
c) Four stroke multi cylinder SI engine
   i)Four cylinder engine
   ii)Three cylinder MPFI maruti engine
d) four stroke multi cylinder CI engine
   i) Six cylinder tata and ashok Leyland engine

5.Conducting compression test, vacuum test on diesel and petrol engines.

6. Study (Dismantling & assembly): Different carburetors, fuel injection pumps, injectors,
fuel tanks, fuel filters, fuel pumps, turbo-chargers, cooling systems and lubricating systems.

Identify location of above components in a vehicle and note their functions along with the
brand names.

7. Conduct performance test on single cylinder SI engine
8. Conduct performance test on multi cylinder SI engine

Text books

1.Dr. N K Giri, Automobile mechanics, Khanna publications 2012
2.Dr. Kirpal singh, automobile engineering, standard publishers distributors 2011

References:

1.Vehicle manufacturers manual
2.Tools catalog
3.Lab manual#

Course outcomes

After learning all the units of the course, the student is able to

1.Explain about function & application of various hand tools used in automotive workshop/laboratory.(L3 & L1).

2. Predict about various Troubles encountered with engine components and to overcome the same. (L3)

3. Practice to, dismantle & assemble SI and CI engines(L3)

4.Inspect engine components for wear and tear and damage (L4)

5.Assess the condition of the engines by Conducting compression test, vacuum test on diesel and petrol engines (L3).

6.Know about Fuel systems, cooling systems, lubrication systems and turbo -chargers used in engines (L1).

7.**Measure** power, SFC, speed, etc of any given engine. (L5)

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

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

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

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

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

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

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

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

Review Questions

1. Define the following stress, strain, shear strain, modulus of elasticity, lateral strain.
2. With the help of stress-strain diagram explain the behavior of the following (i) Mild steel in tension (ii) Mild steel in compression (iii) Cast iron in tension (iv) Aluminum in tension.
3. A circular bar of diameter 25 mm is subjected to an axial force of 20 kN. Find the stresses on a plane making 30° to the plane of axial stresses and also on the plane which has maximum shear stress.
4. Define Thermal stresses, principal planes, principal stresses, Mohr's circle.
5. Classify types of beams and types of loads.
6. Derive the relation between load intensity, shear force and bending moment.
7. Derive the relation between bending moment and radius of curvature section modulus, moment of resistance of a section.
8. Derive the expression for simple bending.

9. Derive the relation between slope, deflection and radius of curvature.
10. List the assumptions in simple bending.
11. Define the cylinder and types of cylinder.
12. Derive the expressions for Hoop and Longitudinal stress in thin cylinders, circumferential and radial stress in thick cylinders.
13. Derive the torsion equation for solid and hollow shafts.
14. Derive Euler's equation.

Lesson Plan

Unit – I

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

Unit – II

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

Unit – III

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

Course Title: **Engines and components lab**	*Course Code*: P13AUL47
Total Contact Hours: 36	*Duration of Exam*: **3 Hrs**
CIE marks: **50**	SEE marks: **50**

***Prerequisites*:**

Subject requires student to know about

Basic of Heat Engines and their classification
Components of IC Engines.
Classification of IC Engines.
Basics working Principle of Different Types IC Engines

Course learning objectives (CLO's):

At the end of the course the student should be able to,

1. **Sketch** and **define** about function & application of various hand tools used in automotive workshop/laboratory.(L3 & L1).
2. **Review** about various Troubles encountered with engine components and to overcome the same. (L3)
3. **Practice** (L3) to, dismantle & assemble SI and CI engines,
4. **Identify** (L1) the major components of engines,
5. **Know** (L1) the functions & materials used.
6. C**ompare** (L2) major engine components dimension with standard specifications.
7. **Inspect** (L4) engine components for wear and tear and damage
8. **Assess** (L5)the working condition of the engines.
9. **Assess** the condition of the engines by Conducting compression test, vacuum test on diesel and petrol engines (L3).
10. **Know** about Fuel systems, cooling systems, lubrication systems and turbo-chargers used in engines (L1).
11. **Conduct** performance test on any given engine.

Course Content

Engines and components lab

1.Study of hand tools- sketching, materials used and their applications.
2.Trouble shooting charts for all engine components.
3.Specifications of given engines and component standard dimensions.

Course Assessment Matrix (CAM)												
Course Outcomes (COS)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Define heat engines and their Classification. **Define** Basic Engine Components & Nomenclature. **Define** the working principle, types and construction details of Reciprocating Four stroke and two stroke SI and CI engines. **Compare** Four stroke and two stroke engines, SI and CI engines. **Draw** valve/port timing diagrams of Reciprocating Four stroke and two stroke engines.	L1, L2	-	2	-	-	2	-	-	-	2	2	2
Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like cylinder block, crank case & cylinder heads etc…. Compute the major dimensions of the same	L2, L3	2	2	2	-	2	-	-	-	2	2	2
Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like piston, piston rings, piston pin and Compute the major dimensions of the same	L1, L2, L3	2	2	2	-	2	-	-	-	2	2	2
Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like connecting rod crank shaft and Compute the major dimensions of the same	L2, L3	2	2	2	-	2	-	-	-	2	2	2
Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like valve and valve mechanism and Compute the major dimensions of the same. Numerical problems pertaining to Testing of two-stroke and four strokes SI and CI engines heat balance, Morse test.	L2, L3	2	2	2	-	2	-	-	-	2	2	2
1 – Low, 2 – 2oderate, 3 – High												

8. Problems on SF and BMD for cantilever beams subjected to concentrated loads.
9. Problems on SF and BMD for cantilever beams subjected to UDL.
10. Problems on SF and BMD for cantilever beams subjected to UVL.
11. Problems on SF and BMD for cantilever beams subjected to concentrated loads, UDL, UVL and Couple.
12. Problems on SF and BMD for overhanging beams subjected to concentrated loads and UDL.

Unit – IV

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

Unit – V

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

Course Articulation Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Classify different types of stresses, strain and deformation induced in the mechanical components due to external loads.	L1	M	L	M			-	-	-	-	-	-
Determine the bending moment, shear force and distribution of various stresses in the mechanical elements such as beams, shafts etc.	L2	L	M	M			-	-	-	-	-	-
Draw SFD and BMD for different types of loads and support conditions.	L5	H	M	H		H	-	-	-	-	-	-
Compute and analyze stresses induced in basic mechanical components.	L5	H	M	M		M	-	-	-	-	-	-
Determine stresses in thin and thick cylinders, torsional stresses, and **Analyze** buckling phenomenon in columns.	L3	√H	H	M		H	-	-	-	-	-	-

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcoms (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Classify different types of stresses, strain and deformation induced in the mechanical components due to external loads.	L1	2	1	2	-	-	-	-	-	-	-	-
Determine the bending moment, shear force and distribution of various stresses in the mechanical elements such as beams, shafts etc.	L2	1	2	-2	-	-	-	-	-	-	-	-
Draw SFD and BMD for different types of loads and support conditions.	L5	3	2	3	-	3	-	-	-	-	-	-
Compute and analyze stresses induced in basic mechanical components.	L5	3	2	2	-	2	-	-	-	-	-	-
Determine stresses in thin and thick cylinders, torsional stresses, and **Analyze** buckling phenomenon in columns.	L3	3	3	2	-	3	-	-	-	-	-	-

1 – Low, 2 – Moderate and 3 – High

Course Articulation Matrix (CAM)

Course Outcome (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Define heat engines and their Classification. **Define** Basic Engine Components & Nomenclature. **Define** the working principle, types and construction details of Reciprocating Four stroke and two stroke SI and CI engines. **Compare** Four stroke and two stroke engines, SI and CI engines. **Draw** valve/port timing diagrams of Reciprocating Four stroke and two stroke engines.	L1, L2	-	M	-	-	M	-	-	-	M	M	M
Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like cylinder block, crank case & cylinder heads etc…. Compute the major dimensions of the same	L2, L3	M	M	M	-	M	-	-	-	M	M	M
Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like piston, piston rings, piston pin and Compute the major dimensions of the same	L1, L2, L3	M	M	M	-	M	-	-	-	M	M	M
Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like connecting rod crank shaft and Compute the major dimensions of the same	L2, L3	M	M	M	-	M	-	-	-	M	M	M
Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like valve and valve mechanism and Compute the major dimensions of the same. Numerical problems pertaining to Testing of two-stroke and four strokes SI and CI engines heat balance, Morse test.	L2, L3	M	M	M	-	M	-	-	-	M	M	M

L – Low, M – Moderate, H - High

8. Determination of major dimensions of Piston, Piston Rings, Piston Pin by means of Numerical calculations
9. Determination of major dimensions of Piston, Piston Rings, Piston Pin by means of Numerical calculations
10. Numerical - Practice

Unit-IV

1. Types, function, materials,construction details, manufacturing, Fastening of Conn Rod Piston and Piston Pin
2. Length of rod, Cross section, Buckling, Drilled connecting rods, piston pin bearing, Offset connecting rods, effects of whipping, Bearing materials, lubrication Troubles & Remedies
3. Determination of major dimensions based on Rankine Gardon Formulae Numerical Problems
4. Numerical Problems – Practice
5. Definition of Crank shaft, Types, Materials used, Manufacturing.
6. Bearing Pressures**,** Stresses, Balance Weights, Local Balance, Empirical Rules for Crankshaft Dimensions, Six and Eight Cylinders, Oil holes in Crankshafts, Balancing Crankshaft,
7. Analysis of Center Crank shaft, Crank at Dead Center, Crank at angle of maximum Twisting Moment, Analysis of side Crank Shaft, Crank at Dead Center, Crank at angle of maximum Twisting Moment,
8. Vibration dampers, firing order, bearings, lubrication.
9. Design Procedure, Design Calculations, Numerical
10. Numerical Problems – Practice

Unit-V

1. **Valve and Valve Mechanism-**Types**,** Angle of seat, Operating Conditions,
2. operating temperatures, valve cooling, Sodium cooled valves,Valve rotators, valve seats, valve guides, valve springs, valve clearance, Valve timing,
3. OHV, OHC, dual valves, types of valve operating mechanisms, Valve train component details,
4. Numerical Practice
5. **Camshaft**,-drives of cams, cam types, tappets,-automatic zero clearance tappets, push rods, rocker arms & Shaft.
6. Testing of two-stroke and four strokes SI and CI engines.
7. Performance related numerical problems.
8. heat balance calculations
9. Performance related numerical problems
8. Morse test.

Course Code : P13AU33	**Semester : III**	**L - T - P : 4 - 0 - 0**
Course Title : THERMODYNAMICS		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	

Course Learning Objectives (CLOs)

This course aims to

1. Define and understand the concepts of Energy in general and Heat and Work in particular
2. Apply the concepts of thermodynamics to steady and unsteady flow processes.
3. Understand the basics of heat engine and heat pumps and second law of thermodynamics and corollaries.
4. learn and understand necessity of applied thermodynamics and air standard cycles and Demonstrate ability to make use of air standard cycle and able to use reciprocating air compressor Students will be able to use reciprocating air compressor.
5. Get exposure to different types of refrigerants and their desirable properties and vapor absorption and vapor compression refrigeration, use of charts.

Course Content

Unit – I

FUNDAMENTAL CONCEPTS & DEFINITIONS:

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

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

Unit – II

FIRST LAW OF THERMODYNAMICS:

Statement of the First law of thermodynamics for a closed system undergoing a cyclic process. First law thermodynamics for a change of state of the system and concept of energy. Energy as a property of the system and its significance. Internal Energy, Enthalpy and Specific heats. Simple numerical problems on systems undergoing closed process. Steady flow process, First law applied to steady flow process, derivation of steady flow energy equation and its applications to steady flow process. Simple numerical problems on systems undergoing steady flow process. **10 Hrs**

Unit – III

SECOND LAW OF THERMODYNAMICS:

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

Unit – IV

AIR STANDARD CYCLES: Carnot Cycle, Otto Cycle, Diesel & Dual Cycle, their p-v and T-S diagrams, description, expression for efficiencies and definition of mean effective pressures. Comparison of Otto and Diesel cycles.

RECIPROCATING AIR COMPRESSORS: Operation of a single stage reciprocating air compressors, Work input using p-v diagram and steady state flow analysis, Effect of clearance and volumetric efficiency, Adiabatic, isothermal and mechanical efficiencies, Multistage compressors, saving in work, expression for optimum intermediate pressure **10 Hrs**

Unit – V

REFRIGERATION AND AIR CONDITIONING: Introduction, Heat Engines and Heat Pumps, Pressure- enthalpy diagram. Vapour compression refrigeration systems, Vapour absorption refrigeration systems description, analysis, refrigerating effect, capacity, power required, units of refrigeration, and COP. Properties of atmospheric air: Dry Air, Relative Humidity, Specific humidity, degree of saturation, dry bulb and wet bulb temperature. Psychometric Chart. and Psychometric Process: Sensible heating or cooling, cooling and dehumidification, heating and humidification and adiabatic mixing of two streams.

11Hrs

Text Books:

1. P .K. Nag , Basic and Applied Thermodynamics, Tata McGraw Hill, 3rd Edi. 2006

2. R K Rajput , Engineering Thermodynamics by, Laxmi Publications Pvt Ltd

Reference Books:

1. Spalding and Cole ,Engineering Thermodynamics , ELBS edition.

2. Prakash and Gupt, Engineering Thermodynamics Thermodynamics – An engineering approach by Yunus A. Cenegal Tata McGraw Hill

Course Outcomes

After learning all the units of the course, the student is able to

1. Define and understand the concepts of Energy in general and Heat and Work in particular
2. Apply the concepts of thermodynamics to steady and unsteady flow processes.
3. Understand the basics of heat engine and heat pumps and second law of thermodynamics and corollaries.

Lesson Plan

Unit-1

1. Historical development of automobiles,
2. Heat Engines & their classification, merits/demerits, application
3. Reciprocating IC Engines, Classification of I C engines, Basic Engine Components & Nomenclature,
4. Principle of engine operation, Comparison of SI & CI Engines, , applications of IC Engines
5. **Four stroke engines** - Principles of engine operation (SI & CI), Ideal Valve timing
6. Actual Valve timing - mechanical and dynamic factors, Relative merits & demerits of petrol & diesel engines.
7. **Two stroke engines -** Principles of engine operation (SI & CI),.
8. Types - Three port engine, Separate pumps or blowers, Symmetrical & unsymmetrical timing, Cross flow, loop flow & uniflow type Scavenging systems.
9. Scavenging Process – Pre blow down, Blow down, Scavenging, Additional Charging.
10. Theoretical Scavenging processes, Comparison of Different Scavenging Systems;
11. Scavenging parameters, port design, scavenging pumps.
12. Relative merits & demerits of petrol & diesel engines. Comparison of Two Stroke & Four Stroke Engines. Port timing diagrams

Unit-II

1. **Cylinder Block, Cylinder heads**, Gaskets, cylinder wear, water jacket, Cylinder liners
2. Numerical
3. Numerical Practice
4. **Crank Case** – General form of crank case, oil sumps and cooling features,
5. Flywheel mountings, Engine mountings, Front & Rear mountings.
6. Production of engine blocks
7. **Manifolds and Mufflers** - inlet and exhaust manifolds, mixture distribution, heating by exhaust gas, dual manifolds,
8. General Design of Manifolds
9. Effect of firing order, Mufflers,
10. General design of Mufflers.

Unit-III

1. Piston - Types, function, materials, construction details, manufacturing,
2. Piston Rings, function, materials, construction details, manufacturing,
3. Forms of gap, stresses in piston rings, ring collapse, heat treatment, piston ring selection & shape.
4. Piston Pin Types, function, materials, construction details, manufacturing, locking of piston pins and length of piston
5. Piston Temperatures, piston slap, compensation for thermal expansion in pistons,
6. Design considerations for calculation of piston crown thickness by strength and by heat dissipation.
7. Determination of major dimensions of Piston, Piston Rings, Piston Pin by means of Numerical calculations

52. Design a connecting rod for four stroke petrol engine with the following data: Diameter of piston = 88mm; Stroke 125mm; Weight of reciprocating parts 15.696N, Length of connecting rod centre to centre=300mm;Speed = 2200 rpm with possible over speed of 3000, Compression ratio=6.8: 1, Probable maximum explosion pressure (assumed shortly after dead centre, say when , ϕ =3°)=3.4335N/mm^2
53. Explain the Functions, Types, constructional details of Crank Shaft.
54. What are the materials of Crank Shaft & Explain manufacturing process of Crank Shaft.
55. Discuss Troubles & Remedies of Crank Shaft.
56. Briefly explain, how to Calculate the major dimensions of Crank Shaft.
57. Write a note on Balance weights, local balance, Crankshaft proportions, and drilled oil holes in crank shafts.
58. Explain balancing of crank shafts
59. How torsional vibration analysis is made on crank shafts
60. Sketch and explain vibration dampers
61. What do you mean firing order? What are factors on which firing order depend?
62. Write a note on bearings and Crank Shaft lubrication.
63. Design an overhung crank pin for an engine having the following particulars:

Cylinder diameter =300mm
Stroke =500mm
Maximum explosion pressure in the cylinder=1.8MPa
Engine Speed =200rpm
Permissible bending stress for pin =1000MPa
42Permissible Bending stress =85MPa

64. Design a plain carbon steel centre crankshaft for a single acting four stroke single cylinder engine for the following data: Bore = 400 mm; Stroke = 600 mm; Engine speed = 200 rpm.; Mean effective pressure = 0.5 N/mm^2; Maximum combustion pressure = 2.5 M/mm^2; Weight of flywheel used a pulley = 50 kN; Total belt pull = 6.5 kN. When the crack has turned through 35^0 from the top dead centre, the pressure on the piston is 1N/mm^2 and the torque on the crank is maximum. The ratio of the connecting rod length to the crank radius is 5. Assume any other date required for the design.

65. What is Sodium cooled valves? Explain with neat sketches
66. What is the difference between OHC and OHV? Explain
67. Determine the valve lift and valve dimensions of an engine from the following data:
68. Max. Gas pressure=5N/mm^2, Cylinder bore diameter=80mm, Gas velocity=1500m/min, Mean Piston speed=300m/min, Allowable Stress=42N/mm^2, Valve seat angle=30^0.
69. What are different drives of cams? Explain with neat sketch.
70. What do you mean automatic zero clearance tappets?

4.learn and understand necessity of applied thermodynamics and air standard cycles and Demonstrate ability to make use of air standard cycle and able to use reciprocating air compressor Students will be able to use reciprocating air compressor.
5.Get exposure to different types of refrigerants and their desirable properties and vapor absorption and vapor compression refrigeration, use of charts.

Topic Learning Objectives

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

1. This unit mainly deals with fundamental definition and meaning each definition.
2. The term we come across in this unit will be use full for entire thermodynamics.
3. Students will know the definition of zeroth law of thermodynamics and understand the application of the law.
4. Students will know the temperature measurement and construction of temperature scale.
5. Students will know the definition and measurement of work both in mechanics and thermodynamics method
6. Students will know the definition and measurement of work
7. Students will able to do various types problems involved in work and heat.

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

1. Learn and understand the first law of thermodynamics for a closed system under going cyclic process.
2. Understand the concept of energy -PE,KE,INTERNAL ENERGY ENTHALPY
3. do simple problems for a closed system
4. Understand steady flow energy equation and apply the equation to the various practical problems.

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

1. understand the drawback of first law of thermodynamics, define heat pump and heat engines
2. Understand the second law of thermodynamics, corollary and PMMs.
3. understand the reversible and irreversible process
4. to find efficiency of ideal Carnot cycle , and at the end learn problems involved in heat pump and heat engines.

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

1.To make use of air standard cycle ie,Otto cycle, diesel cycle and its efficiency ,comparison of Otto and diesel cycles. problems on Otto and diesel cycles
2.understand the students basic behavior of IC engines
3.understand the working principle of reciprocating air compressor,work done equation,single stage and multistage compressor and problems relating to compressor

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

1.Application of second law of thermodynamics,ie**.,**heat pump,and heat engines. To understand vapor compression refrigeration.,units of regeneration,,cop and properties of air,Psychometric chart.

2.Students have already learn the air standard cycles ,now in this unit to understand actual petrol and diesel cycles efficiencies and different performance parameter like mechanical efficiency ,thermal efficiency,etc.At the end they will b able to do performance analysis of IC Engines.

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
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
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

23. Draw Porte timing diagram for the following details:
IPO at 30^0 Bbdc and IPC at 40^0 Abdc: Spark Occurs at 15^0 BTDC
EPO at 40^0 BbDC and EPC at 30^0 Abdc
What is its significance of this type of Port Timing? Explain
24. Sketch and Explain different types of Cylinder heads duly mentioning their merits and demerits.
25. What are the reasons for cylinder wear? Explain with neat sketch
26. Sketch and explain different types of Cylinder liners
27. A vertical 4 stroke CI Engine has the following specifications: BP=4.5kW, Speed=1200rpm, imep=0.35N/mm^2, η_{mech}=0.80, Determine the dimensions of the cylinder
28. Sketch and explain oil sumps with cooling features.
29. Sketch and explain different types of exhaust manifolds duly mentioning significance of each one of them
30. What is Effect of firing order on arrangement of exhaust manifolds?
31. Explain the Functions, Types, constructional details of Piston, Piston Rings, Piston Pin.
32. Describe materials & manufacturing process of Piston, Piston Rings, Piston Pin.
33. Discuss Troubles & Remedies of Piston, Piston Rings, Piston Pin.
34. Interpret Piston Temperatures and piston slap.
35. What is Compensation for thermal expansion in pistons?
36. What are different forms of gap in Piston Rings
37. What are stresses in piston rings? Explain.
38. What is ring collapse? Explain.
39. How do you lock piston pins with Piston
40. How do You Calculate the major dimensions of Piston, Piston Rings, Piston Pin.
41. Design a cast iron piston for a 4-stroke single acting engine from the following data. Cylinder bore dia = 100 mm (D), Stroke length = 120 mm (L), Gas pressure = 5 Mpa, (p), BMEP = 0.5 MPa, Fuel consumption = 0.15 Kg / BP (W), Speed = 2200 rpm. (N)
42. Explain the Functions, Types, constructional details of Connecting Rod.
43. Describe materials & manufacturing process of Connecting Rod.
44. What are the Troubles & Remedies of Connecting Rod?
45. Explain the procedure to Calculate the major dimensions of Connecting Rod.
46. Write a note on Length of rod, Cross section, Buckling of Connecting Rod.
47. What are Drilled connecting rods?
48. Describe piston pin bearing in Connecting Rod and offset connecting rods.
49. What is effects of whipping in Connecting Rod?
50. What are the bearing materials for Connecting Rod and briefly explain lubrication in Connecting Rods.
51. Design a connecting rod for a petrol engine for the following data, Diameter of the piston (d)= 110 mm, Length of the connecting rod(2L) = 325 mm, Stroke length (L) = 150 mm, Speed (n) = 1500 rpm, Over speed = 2500 rpm, Compression ratio = 4 : 1, Maximum explosion pressure = 2.5 MPa, weight of the reciprocating mass = 2kg

7. Explain the Functions, Types, constructional details of Crank Shaft.(L2)
8. Describe materials & manufacturing process of Crank Shaft. (L2)
9. Discuss Troubles & Remedies of Crank Shaft. (L2)
10. Calculate the major dimensions of Crank Shaft. (L3)
11. Describe Balance weights, local balance, Crankshaft proportions, oil holes drilled in crank shafts.(L2)
12. Explain balancing and torsional vibration analysis, vibration dampers, firing order, bearings, and Crank Shaft lubrication.(L2)

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

1. Explain the Functions, Types, constructional details of Valve & Valve Mechanism. (L2)
2. Describe materials & manufacturing process of Valve and Valve Mechanism. (L2)
3. Discuss Troubles & Remedies of Valve and Valve Mechanism. (L2)
4. Calculate the major dimensions of Valves and ports. (L3)
5. Explain valve seats….(L2)
6. Describe Valve & Valve operating Mechanism and Valve train component.(L2)
7. Explain Engine Camshafts, drives of cams, cam types, tappets….(L2)

Review Questions

1. Write a note on Historical development of automobiles.
2. What are Heat Engines & How do you classify Heat Engines?
3. Sketch and explain the Basic working principle Reciprocating IC Engines.
4. How do you Classify IC Engines?
5. Describe about the Basic Engine Components & their Nomenclature.
6. How SI & CI Engines Compared?
7. What are the applications of IC Engines?
8. Sketch and Explain the Principles of working of SI Four Stroke engine.
9. Sketch and Explain the Principles of working of CI Four Stroke engine.
10. What is the difference between Ideal & Actual Valve timing considering mechanical and dynamic factors?
11. Draw Valve timing diagram for the following details:

IVO at 10^0 Btdc and IVC at 20^0 Abdc: Spark Occurs at 15^0 BTDC:
EVO at 15^0 BbDC and EVC at 20^0 Atdc
What is the valve overlap period in above arrangement? And what is its significance? explain

12. Compare merits & demerits of petrol & diesel engines.
13. Compare two Stroke & Four Stroke engines.
14. Explain Principles of operation of SI & CI Two Stroke engines.
15. Explain Port timing diagrams for SI & CI. Two Stroke Engines.
16. Explain different Types of Two Stroke engines and scavenging pumps. (L2)
17. Explain Typical Scavenging Process in two stroke engines.
18. Explain Scavenging parameters.
19. Explain Theoretical Scavenging processes.
20. Compare Different Scavenging Systems.
21. Explain theoretical approach of port design in two stroke engines.
22. Compare merits & demerits of petrol & diesel Two Stroke & Four Stroke Engines.

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.
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.

Lesson Plan

Unit – I

1.Definition of Thermodynamics. Microscopic and Macroscopic approaches to the study of thermodynamics. Definitions of System (closed system) and Control Volume (open system) with examples.
2.Definition of thermodynamic property, Intensive and extensive properties,
3.Thermodynamic state, process, quasi-static process, thermodynamic cycle.
4.Thermodynamic equilibrium; definitions of thermal, chemical and mechanical equilibrium.
5.Zeroth law of thermodynamics,
6.Concept of Temperature, types commonly used of temperature scales and relation between them.
7.Thermodynamic definition of work, sign convention and examples to illustrate the definition of work.
8.Work done at the system boundary, process equation
9.Expressions for work done in different processes.
10.Definition of heat and sign convention. Comparison of work and heat.
*11.*Simple numerical problems on work and heat transfer only

Unit – II

1.Statement of the First law of thermodynamics for a closed system undergoing a cyclic process.
2First law thermodynamics for a change of state of the system and concept of energy.
3.Energy as a property of the system and its significance. Internal Energy, Enthalpy and Specific heats.
4Simple numerical problems on systems undergoing closed process.
5.Simple numerical problems on systems undergoing closed process.
6Steady flow process, First law applied to steady flow process,
7derivation of steady flow energy equation
8its applications to steady flow process. like nozzle,compressor etc
9 its applications to steady flow process like nozzle,compressor et
10 Simple numerical problems on systems undergoing steady flow process.

Unit – III

1.Second Law of Thermodynamics: Thermal reservoir. Source and sink.
2.Heat engine, heat pump and refrigerator, their: schematic representation,
3.efficiency and coefficient of performance.
4. Kelvin – Planck and Clausius statement of the Second law of thermodynamics
5.and equivalence of the two Statements of second law.
6.Definition of perpetual motion machines of I,II, III kind with example.
7. Reversible and Irreversible processes, factors that make a process irreversible.
8.Reversible heat engine-
9.Carnot Cycle and expression for efficiency of Carnot cycle.
10. Simple numerical problems on heat engines and heat pumps.

Unit – IV

1. Carnot Cycle, Otto Cycle, and
2. Diesel Cycle, their p-v and T-S diagrams, description,
3. expression for efficiencies and definition of mean effective pressures.
4. Comparison of Otto and Diesel cycles.
5. Simple numerical problems
6. RECIPROCATING AIR COMPRESSORS:Operation of a single stage reciprocating air compressors,
7. Work input using p-v diagram and steady state flow analysis,
8. Effect of clearance and volumetric efficiency,
9. Simple numerical problems
10. Simple numerical problems

Unit – V

1. Introduction, Heat Engines and Heat Pumps,
2. Pressure- enthalpy diagram.
3. Vapour compression refrigeration systems, description, analysis,
4. Refrigerating effect, capacity, power required, units of refrigeration, and COP.

13. Explain (SI & CI), Port timing diagrams. (L2)
14. Explain different Types of Two Stroke engines and scavenging pumps. (L2)
15. Explain Scavenging Process & parameters and Theoretical Scavenging processes.. (L2)
16. Compare Different Scavenging Systems. (L2)
17. Explain theoretical approach of port design. (L2)
18. Compare merits & demerits of petrol & diesel Two Stroke & Four Stroke Engines. (L2)

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

1. Explain the Functions, Types, constructional details of Cylinder Blocks, Cylinder liners, Cylinder heads, Gaskets, Crank Case Manifolds, Mufflers. (L2)
2. Describe materials & manufacturing process of Cylinder Blocks Cylinder heads, Gaskets, Crank Case Manifolds, Mufflers. (L2)
3. Discuss Troubles & Remedies of Cylinder Blocks Cylinder heads, Gaskets, Crank Case Manifolds, Mufflers. (L2)
4. Calculate the major dimensions of Cylinder bore, Cylinder heads. (L3)
5. Explain cylinder wear, water jackets, valve seats….(L2)
6. Explain General form of Engine crank case, flywheel mountings, Engine mountings, Front & Rear mountings. (L2)
7. Explain oil sumps and cooling features. (L2)
8. Describe Production of engine blocks. (L2)
9. Describe inlet and exhaust manifolds, mixture distribution, heating by exhaust gas, dual manifolds and effect of firing order. (L2)
10. Explain General Design of Manifolds & Mufflers. (L2)

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

1. Explain the Functions, Types, constructional details of Piston, Piston Rings, Piston Pin.(L2)
2. Describe materials & manufacturing process of Piston, Piston Rings, Piston Pin(L2)
3. Discuss Troubles & Remedies of Piston, Piston Rings, Piston Pin(L2)
4. Calculate the major dimensions of Piston, Piston Rings, Piston Pin(L3)
5. Interpret Piston Temperatures, piston slap, compensation for thermal expansion in pistons. (L2)
6. Identify & Understand Piston Rings, forms of gap, stresses in piston rings, ring collapse, heat treatment, piston ring selection & shape. (L1)
7. Identify & Understand Piston pin, locking of piston pins and length of piston. (L1)

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

1. Explain the Functions, Types, constructional details of Connecting Rod.(L2)
2. Describe materials & manufacturing process of Connecting Rod. (L2)
3. Discuss Troubles & Remedies of Connecting Rod. (L2)
4. Calculate the major dimensions of Connecting Rod. (L3)
5. Describe Length of rod, Cross section, Buckling of Connecting Rod, Drilled connecting rods. (L2)

6.Describe piston pin bearing in Connecting Rod, offset connecting rods, effects of whipping in Connecting Rod, bearing materials for Connecting Rod and lubrication in Connecting Rod. (L2)

TEXT BOOKS:

P.M.Heldt, High Speed Engines -, Oxford & IBH, 1932

R.B Gupta, Auto Design –, Satyapraksh, New Delhi, 2000

Mathur & Sharma , A course in I.C. Engine - Dhanpat Rai & Sons, Delhi, 1999

REFERENCE BOOKS:

Kirpal Singh Vol. II , Automobile Engineering -, Standard publications, New Delhi, 2003

J.B.Heywood, Fundamentals of I.C.Engines, McGraw Hill International Edition, 1988

P.C. Sharma & D.K. Aggarwal, Machine design - S.K Kataria & sons, Delhi, 2012

Course Outcomes

After learning all the units of the course, the student is able to

1. Define heat engines and their Classification. Define Basic Engine Components & Nomenclature. Define the working principle, types and construction details of Reciprocating Four stroke and two stroke SI and CI engines. Compare Four stroke and two stroke engines, SI and CI engines. Draw valve/ port timing diagrams of Reciprocating Four stroke and two stroke engines.
2. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like cylinder block, crank case & cylinder heads etc…. Compute the major dimensions of the same
3. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like piston, piston rings, piston pin and Compute the major dimensions of the same
4. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like connecting rod crank shaft and Compute the major dimensions of the same
5. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like valve and valve mechanism and Compute the major dimensions of the same. Numerical problems pertaining to Testing of two-stroke and four strokes SI and CI engines heat balance, Morse test.

Topic Learning objectives

After learning all the units of Unit-1, the student is able to

1. Describe Historical development of automobiles. (L2)
2. Define about Heat Engines & their classification.(L1)
3. Describe the Basic working principle Reciprocating IC Engines. (L2)
4. Classify IC Engines. (L2)
5. Describe the Basic Engine Components & their Nomenclature. (L2)
6. Compare SI & CI Engines. (L2)
7. Describe the applications of IC Engines. (L2)
8. Explain Principles of SI & CI Four Stroke engine operation. (L2)
9. Interpret Ideal & Actual Valve timing considering mechanical and dynamic factors. (L2)
10. Draw Ideal and Actual Valve timing diagrams for SI & CI Engines(L1)
11. Compare merits & demerits of petrol & diesel, two Stroke & Four Stroke engines. (L2)
12. Explain Principles of SI & CI Two Stroke engine operation. (L2)

5. Properties of atmospheric air: Dry Air, Relative Humidity, Specific humidity,
6. Degree of saturation, dry bulb and wet bulb temperature.
7. Psychometric Chart. and Psychometric Process: Sensible heating or cooling, cooling and dehumidification,
8. Heating and humidification and adiabatic mixing of two streams.
9. Simple numerical problems.
10. Simple numerical problems
11. Simple numerical problems

Course Articulation Matrix (CAM)

Course Outcome (CO)		**Program Outcome** (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Define and understand the concepts of Energy in general and Heat and Work in particular	L2	**M**	**L**	-	**-**	**M**	**-**	**-**	**-**	**M**	**-**	**-**
Apply the concepts of thermodynamics to steady and unsteady flow processes.	L3	**H**	-	**-**	**-**	**H**	**-**	**-**	**-**	**-**	**-**	**-**
Understand the basics of heat engine and heat pumps and second law of thermodynamics and corollaries.	L2	**M**	**-**	**-**	**-**	**-**	**-**	**-**	**L**	**M**	**-**	**-**
learn and understand necessity of applied thermodynamics and air standard cycles and Demonstrate ability to make use of air standard cycle and able to use reciprocating air compressor	L4	**M**	**L**	**-**	**-**	**M**	**-**	**-**	**-**	**M**	**M**	**L**
get exposure to different types of refrigerants and their desirable properties and vapor absorption and vapor compression refrigeration, use of charts.	L4	**H**	**-**	**-**	**-**	**H**	**-**	**-**	**-**	**-**	**H**	**-**

L- Low, M- Moderate, H-High

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**
Define and understand the concepts of Energy in general and Heat and Work in particular	L2	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**-**	**-**
Apply the concepts of thermodynamics to steady and unsteady flow processes.	L3	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**-**	**-**
Understand the basics of heat engine and heat pumps and second law of thermodynamics and corollaries.	L2	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**2**	**-**	**-**
learn and understand necessity of applied thermodynamics and air standard cycles and Demonstrate ability to make use of air standard cycle and able to use reciprocating air compressor	L4	**2**	**1**	**-**	**-**	**2**	**-**	**-**	**-**	**2**	**2**	**1**
get exposure to different types of refrigerants and their desirable properties and vapor absorption and vapor compression refrigeration, use of charts.	L4	**3**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**3**	**-**
Describe the inverter operation and its application.	L2											
1 – Low, 2 – Moderate and 3 – High												

Four stroke engines - Principles of engine operation (SI & CI), Actual Valve timing - mechanical and dynamic factors, Relative merits & demerits of petrol & diesel engines.

Two stroke engines - Principles of engine operation (SI & CI), Types, Port timing diagrams. Scavenging systems. Scavenging Process: Comparison of Different Scavenging Systems; port design, Relative merits & demerits of petrol & diesel engines. Comparison of Two Stroke & Four Stroke Engines.

12 Hrs.

ENGINE COMPONENTS (Units-II to V)

Types, function, materials, construction details, manufacturing, Troubles & Remedies and Design of major dimensions of the following engine components

UNIT-II

Cylinder Block, Cylinder heads, Gaskets, cylinder wear, water jacket, Cylinder liners, and valve seats.

Crank Case – General form of crank case, oil sumps and cooling features, flywheel mountings, Engine mountings, Front & Rear mountings.

Production of engine blocks

Manifolds and Mufflers - inlet and exhaust manifolds, mixture distribution, heating by exhaust gas, dual manifolds, General Design of Manifolds, effect of firing order, Mufflers, general design. **10 Hrs.**

UNIT-III

Piston - Piston Temperatures, piston slap, compensation for thermal expansion in pistons.

Piston Rings - forms of gap, stresses in piston rings, ring collapse, heat treatment, piston ring selection, shape.

Piston pin - locking of piston pins, length of piston. **10 Hrs.**

UNIT-IV

Connecting Rod

Length of rod, Cross section, Buckling, Drilled connecting rods, piston pin bearing, offset connecting rods, effects of whipping, bearing materials, lubrication.

Crank Shaft

Balance weights, local balance, Crankshaft proportions, oil holes drilled in crank shafts, balancing and torsional vibration analysis, vibration dampers, firing order, bearings, lubrication. **10 Hrs.**

UNIT-V

Valve and Valve Mechanism

Angle of seat, Operating Conditions, operating temperatures, valve cooling, Sodium cooled valves, Valve rotators, valve seats, valve guides, , valve springs, valve clearance, valve timing, OHV, OHC, dual valves, types of valve operating mechanisms. Valve train component details, **Camshaft**-drives of cams, cam types, tappets,-automatic zero clearance tappets, push rods, rocker arms & rocker Shaft.

Testing Of I.C. Engines: Testing of two-stroke and four strokes SI and CI engines. Performance related numerical problems. heat balance, Morse test.

10 Hrs.

Course Code: P13AU46	**Semester: IV**	L – T – P : 4 – 0 - 0
Course Title: **Automotive Engines and Components**		
Contact Period - Lecture:52Hr.; Exam: 3 Hr.	*Weightage: CIE:50 Marks; SEE:50 Marks*	

***Prerequisites*:** Basics of Engineering Mathematics and Basics of I.C. Engines. Simple , Numerical problems regarding determination of performance parameters.

Course Learning Objectives (CLOs)

This Course aims to

1. Define heat engines and their Classification. Define Basic Engine Components & Nomenclature. Define the working principle, types and construction details of Reciprocating Four stroke SI and CI engines. Draw valve timing diagrams of Reciprocating Four stroke engines.
2. Define the working principle, types and construction details of Reciprocating two stroke SI and CI engines. Compare Four stroke and two stroke engines, SI and CI engines. Draw port timing diagrams of Reciprocating two stroke engines.
3. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like cylinder block, crank case & cylinder heads etc…. Compute the major dimensions of the same.
4. Learn about Production of engine blocks, inlet and exhaust manifolds and Mufflers, General Design of Manifolds and Mufflers .
5. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like piston, Compute the major dimensions of the same
6. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like piston rings, piston pin and Compute the major dimensions of the same
7. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like connecting rod and Compute the major dimensions of the same
8. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like crank shaft and Compute the major dimensions of the same
9. Define types, function, materials, construction details, manufacturing, Troubles & Remedies of engine components like valve and valve mechanism and Compute the major dimensions of the same.
10. Numerical problems pertaining to Testing of two-stroke and four strokes SI and CI engines heat balance, Morse test.

Course Content

UNIT-I

INTRODUCTION

Historical development of automobiles, Heat Engines & their classification. Reciprocating IC Engines - Basic Engine Components & Nomenclature, Principle of engine operation, Comparison of SI & CI Engines, Classification of I C engines, applications of IC Engines

Course Code : P13AU34	**Semester : III**	**L - T - P : 4 - 0 - 0**
Course Title : Material Science and Metallurgy		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Nil		

Course Learning Objectives (CLOs)

This course aims to

1. Explain the different crystalline structure of the metals and imperfection associated with them.
2. Explain the laws governing the diffusion phenomena and factors affecting them.
3. Explain the behavior of the materials when subjected to mechanical forces.
4. Describe the phenomena of fatigue and creep in metals
5. Describe the solidification process in metal casting
6. Explain the concept of phase transformation due to temperature in alloys.
7. Explain physical properties and microstructures of iron based on percentage of carbon present
8. Explain the types of heat treatment methods for metals and its affect on the mechanical properties
9. Explain the different alloys, their properties, compositions and uses.
10. Discuss different types of composite materials (PMC,MMC and CMC), their properties and applications,

Course Content

Unit – I

Introduction and Crystal Structure: Historical perspective of Material Science, Fundamental concepts of Unit cell, space lattice, Bravais Lattices, Unit cells for cubic structures and HCP. Study of stacking of layers of atoms in cubic structure and HCP, calculations of radius, co-ordination number and Atomic Packing Factor for different cubic structures, Crystal imperfections – point, line, surface & volume defects, Diffusion – diffusion mechanism, Fick's laws of diffusion, problems **12 Hrs**

Unit – II

Mechanical Behavior: Stress-strain diagram to show ductile and brittle behavior of materials, linear and non linear elastic behavior and properties, mechanical properties in plastic range, yield strength, offset yield strength, ductility, ultimate tensile strength, toughness, true stress & true strain, Plastic deformation of single crystal by slip and twinning, work hardening, recovery, recrystallisation and grain growth.

Fracture, fatigue and Creep: Fracture type, Stages in cup and cone fracture, Griffith's criterion, Fatigue, Crack initiation and propagation, SN Curves, Factors affecting fatigue life and protection methods. Mechanism of Creep, Generalized creep behavior of materials, Parameters affecting creep, Creep resistant materials. **10 Hrs**

Unit – III

Solidification & Phase diagrams: Mechanism of solidification, Homogenous and heterogeneous nucleation, Crystal growth, Cast metal structures. Solid solutions Hume Rothary rules- substitutional, and interstitial solid solutions, intermediate phases, Gibbs phase rule, construction of equilibrium diagrams, equilibrium diagrams involving complete and partial solubility, lever rule**.**

Iron-Carbon Phase Diagram: phases in the Fe-C system, Invariant reactions, critical temperatures, Microstructures of slowly cooled steels, effect of alloying elements on the Fe-C diagram, ferrite and austenite stabilizers. The TTT diagram, drawing of TTT diagram, TTT diagram for hypo & hyper eutectoid steels, effect of alloying elements on CCT diagram. **10 Hrs**

Unit- IV

Heat treatment of metals: Definition and aims of heat treatment – Annealing and its types, normalizing, hardening, tempering, austempering, martempering with microstructure changes

Surface treatment – Diffusion methods – Carburizing, Nitriding, Cyaniding Thermal methods – flame hardening, induction hardening **10 Hrs**

Unit V

Engineering alloys: Properties, composition and uses of low Carbon, medium and high carbon steels, Steel designation AISI and SAE designation; Cats Irons – gray CI, White CI, Malleable CI & SG CI; Microstructures of CI. The light alloys Al, Mg and Ti alloys; Copper and its alloys, Brasses & Bronzes, Glass, Corrosion prevention materials

Advanced Materials: Composite materials-definition, classification, types ofmatrix materials & reinforcements, fundamentals of production of FRP's and MMC's, advantages and application of composites**.** **10 Hrs**

Text books:

1. William D. Callister Jr. "Materials Science & Engineering- An Introduction**"**, Wiley India Pvt. Ltd. 6th Edition, 2006, New Delhi.
2. Donald R. Askland, Predeep P. Phule Thomson, "Essentials of Materials for Science and Engineering", Thomson Engineering, 2006

Reference Books:

1.V. Raghavan, "Physical Metallurgy, Principles & Practices**"**,. PHI 2nd Edition 2006, New Delhi

2.Murthy, Structure and properties of engineering Materials - TATA McGraw hill, 2003

3.Smith**,** "Foundation of Materials Science & Engineeering**",** , 3rd Edition McGraw Hill, 1997.

C A M DF	
Assessment	**Weightage in Marks**
Part - A	25
Part - B	25
Part - C	50
Total	**100**

Evaluation Scheme

CIE Scheme

Assessment	Weightage of Marks	
TEST 1	10	
QUIZ 1	5	
TEST 2	10	
QUIZ 2	5	
		SEE
ASSIGNMENTS	20	
Total	**50**	

Scheme

Semester End Examination (SEE) is a written examination of three hours duration of 100 marks with 50% weightage.Course Unitization for Tests and Semester End Examination

Examination	Portions to be covered	Maximum Marks
CIE - I	40% of the syllabus	50
CIE - II	40% of the syllabus	50
SEE	Complete Syllabus	100

SCHEME FOR SEMESTER END EXAMINATION:

Semester End Examination (SEE) is a written examination of three hours duration of 100 marks with 50% weightage.

Two question to be set from each Part - A, Part – B, Part – C students has to answer one question each from Part- A and Part – B for 25 marks each and one question from Part –C for 50 marks.

Course Outcomes

After learning all the units of the course, the student is able to

1. Explain the different crystalline structure of the metals, imperfection associated with them and laws governing the diffusion phenomena.
2. Apply the knowledge of mechanical behavior to select appropriate material for given automotive component and the Griffith's criterion for fracture, fatigue tests and mechanism of creep.
3. Study the construction and analysis of phase diagram and Iron-carbon equilibrium diagram.
4. Apply the heat treatment process knowledge for improving physical and mechanical properties of different types of engineering materials.
5. Discuss different alloys and composite materials (PMC, MMC & CMC), their properties and application in automobiles with economic and social concerns.

Topic learning objectives (TLOs)

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

1. Identify the importance and applications of the materials science (L1 & L2)
2. Sketch different unit cells(L2)
3. Describe the properties of various materials according to its crystal structures(L2)
4. Demonstrate different unit cell structures (L3)
5. Calculate different parameters of the unit cells (L3)
6. Describe various defects in crystal structures (L2)
7. Explain different diffusion mechanisms (L2)
8. State Fick's First and Second Law of Diffusion(L2)
9. Derive the Diffusion equations (L2)
10. Calculate Diffusion parameters for different applications of materials (L3)

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

1. Define different properties of material under different loading conditions (L1 & L2)
2. Calculate different mechanical properties of materials (L3)
3. Distinguish between linear and non linear elastic behavior and properties of materials (L2)
4. Calculate the True stress and true strain (L3)
5. Describe different types of fracture of the materials and the testing procedure (L2)
6. Explain Griffith's theory of brittle fracture. (L2)
7. List different parameters affecting fracture (L2)
8. Explain the different types of fatigue loading. (L2)
9. Explain the fatigue mechanism of the materials and the testing procedure (L2)
10. Describe the mechanism of creep and the testing procedure (L2)

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

1.Explain the mechanism of solidification in pure metals and alloys. (L2)
2.Distinguish between homogeneous and heterogeneous nucleation. (L2)
3.Utilize the Gibbs Phase Rule to calculate equilibrium number of phases for any given
4.temperature, pressure and number of independent components. (L3)
5.Examine solubility limits in terms of the Hume-Rothery rules. (L3)
6.Calculate mole fraction and weight fraction of a phase using the lever rule. (L3)
7.Construct a phase diagram from phase composition data as well as from cooling curves. (L3)
8.Given a binary phase diagram, the composition of alloy, its temperature and assuming that the alloy
9. Is at equilibrium, determine what phases are present, the composition of the phases, the mass
10. Fraction of phase (L3)
11.Understand the importance and phase regions of Iron-carbon phase diagram (L 1)
12.9. Explain the various micro constituents-of Iron and Steel. (L2)
10.Explain Fe-C equilibrium diagram and T- T- T diagram. (L2)

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

1.Learn the importance of the processing-properties-performance relationships in heat treatable materials. (L2)
2.Describe the classification of heat treatment processes. (L2)
3.Explain the stages of heat treatment process. (L2)
4.Learn how to identify practical materials engineering problems in the technologies of the heat treatment of ferrous and non-ferrous alloys. (L3)
5.Learn of current and emerging heat treatable materials and heat treating processes (L3)
6.Describe the hardening process. (L2)
7.Define hardenability; describe the factors affecting hardenability. (L2)
8.Distinguish between the different methods to determine hardenability. (L2)
9.Explain case hardening and surface heat treatment. (L2)
10.Explain the concept of age hardening and how it contributes to the improvement of mechanical properties. (L3)

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

1. Describe the Classification of Engineering materials. (L2)
2. Identify the physical properties of different steel alloys, aluminum alloys based on the chemical composition. (L 1)
3. Identify the physical properties of different cast irons on the chemical composition. (L 1)
4. Understand the classification general characteristics, use, and composition of Non-ferrous alloys. (L2)
5. Analyze the suitability of steel or aluminum alloy as material to be used to design a particular automobile structural component. (L2)
6. Explain the necessity of corrosion prevention materials body construction. (L2)
7. Identify the main divisions of composite materials and explain the

Course Assessment Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Sketch 2D and 3D drawings manually & using drawing software. **Solve** Problems on Sections of Solids resting on their bases and **sketch** true shape of sections **Interpret** Pictorial views of simple machine parts & **Sketch** Orthographic Projections of the same.	L1, L3			2		2		2	2	2	2	2
Distinguish and **Sketch** Various Thread forms and Fasteners as per the standard dimensions.	L1, L3	-	-	2	-	2	-	2	2	2	2	2
Sketch Various Keys, Couplings and Riveted joints as per the standard dimensions.	L1, L3	-	-	2	-	2	-	3	2	2	2	2
Sketch Proportionate / to scale Automotive Engine components.	L1, L3	-	-	2	-	2	-	3	2	2	2	2
Sketch and create 2D & 3D part drawings of different of Machine components, then **assemble** the same to **Create** an Assembled view of the complete Machine component and 2D drawings of Assembled view with required views along with 3D drawings.	L1, L3, L6	-	-	2	-	3	-	2	2	2	2	2
1 – Low, 2 – Moderate, 3 – High												

Course Articulation Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Sketch 2D and 3D drawings manually & using drawing software. **Solve** Problems on Sections of Solids resting on their bases and **sketch** true shape of sections **Interpret** Pictorial views of simple machine parts & **Sketch** Orthographic Projections of the same.	L1, L3			M		M		M	M	M	M	M
Distinguish and **Sketch** Various Thread forms and Fasteners as per the standard dimensions.	L1, L3	-	-	M	-	M	-	M	M	M	M	M
Sketch Various Keys, Couplings and Riveted joints as per the standard dimensions.	L1, L3	-	-	M	-	M	-	H	M	M	M	M
Sketch Proportionate / to scale Automotive Engine components.	L1, L3	-	-	M	-	M	-	H	M	M	M	M
Sketch and create 2D & 3D part drawings of different of Machine components, then **assemble** the same to **Create** an Assembled view of the complete Machine component and 2D drawings of Assembled view with required views along with 3D drawings.	L1, L3, L6	-	-	M	-	H	-	M	M	M	M	M
L – Low, M – Moderate, H - High												

8. features of each. (L2)
9. Describe the classification and manufacture of Fiber Reinforced Plastics. (L2)
10. Explain the production of Metal Matrix Composites. (L2)
11. Identify and explain the role of each of the constituents in a composite material. (L 1 & L2)

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/molK. (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.Explain the linear and non linear behavior of materials and properties in plastic range.
14.Explain Yield point phenomena with a neat sketch.
15.The tensile specimen of magnesium 600 mm long is pulled until it breaks. The percentage elongation of magnesium alloy is 12% and if the deformation is uniform during this process. What is the final length of the bar?
16.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 63.9 mm. Calculate the 0.2% proof stress, tensile strength, percentage elongation, the percentage reduction in area & Engineering stress at fracture.

17Define fracture of a material. Describe different types of fracture.
18What is S-N diagram? Explain its importance with the example of mild steel and aluminum
19What is meant by creep? With the help of creep curve, explain different stages of creep.
20List the factors affecting fatigue life of a material.
21Discuss the solidification mechanism in pure metals. How do you distinguish homogeneous and heterogeneous nucleation?
22What is solid solution? Distinguish substitutional solid solution and interstitial solid solution.
23Explain Hume Rothery rules for formation of substitutional solid solution.
24Explain the construction of isomorphous phase diagram with the help of cooling curve .
25Describe 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.
29. 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 annealing.
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.

7. Draw the two views of a Protected type flanged coupling. Indicate all proportions with dimensions
8. Draw sectional front view and side view of a S I Engine - Spark plug. Indicate all proportions with dimensions.
9. Figure shows the details of an I. C. Engine Connecting rod. Assemble the parts and draw the following views. Dimension the drawings.

Front view (2D) with top half in section.Top view (2D) & An Assembled 3D View

Lesson Plan

UNIT-I

1. **Introduction**: Review of graphic interface of the software…, Introduction to Sections of Solids Sections of Pyramids, Prisms
2. Sections of Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases. True shape of sections.
3. Orthographic views - Conversion of pictorial views into orthographic projections of simple machine parts with or without section

UNIT-II

1. Thread Forms: Thread terminology, Conventional representations of threads.
2. Fasteners **-** Hexagonal & Square headed bolt and nut with washer (assembly),
3. Types of Bolt heads, special types of nuts, locking of nuts, Studs, set screws, grub screws.

UNIT-III

1. Keys, Cotter and knuckle Joints - Types of Keys, Cotter and knuckle Joints,
2. Riveted Joints - Chain and Zigzag, using snap head rivets
3. Keys, Cotter and knuckle Joints/Riveted Joints…

UNIT-IV

1. Couplings
2. Automotive Components
3. Couplings/Automotive Components

UNIT-V

1. Plummer block - Assembly drawing of machine parts (with or without section) - 2D drawing with required views, along with 3D view
2. Petrol Engine piston - Assembly drawing of machine parts (with or without section) - 2D drawing with required views, along with 3D view
3. I.C. Engine connecting rod - Assembly drawing of machine parts (with or without section) - 2D drawing with required views, along with 3D view
4. Screw jack - Assembly drawing of machine parts (with or without section) - 2D drawing with required views, along with 3D view
5. Fuel Injector - Assembly drawing of machine parts (with or without section) - 2D drawing with required views, along with 3D view
6. Clutches - Assembly drawing of machine parts (with or without section) - 2D drawing with required views, along with 3D view

Topic Learning objectives

After learning all the units of Unit-1, the student is able to

1. Sketch 2D drawings manually & using drawing software. (L1 & L3)
2. Solve Problems on Sections of Solids resting on their bases and sketch true shape of sections. (L3)
3. Interpret Pictorial views of simple machine parts and Sketch Orthographic Projections of the same. (L3)

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

1. Sketch 2D drawings manually & using drawing software. (L1 & L3)
2. Distinguish and Sketch Various Thread forms and Fasteners as per the standard dimensions. (L3)

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

1. Sketch 2D drawings manually & using drawing software. (L1 & L3)
2. Distinguish and Sketch Various Keys, Various Couplings and Riveted joints as per the standard dimensions. (L3)

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

1. Sketch 2D drawings manually & using drawing software. (L1 & L3)
2. Sketch Proportionate/to scale Automotive Engine components. (L3)
3. **After learning all the units of Unit-V, the student is able to**
4. Sketch 2D & 3D drawings manually & using drawing software. (L1 & L3)
5. Sketch and create 2D & 3D part drawings of different of Machine components. (L3)
6. Assemble the parts created to build an Assembled view (3D) of the complete Machine component. (L6)
7. Create Assembled 2D drawings of required views along with 3D drawings. (L6)

Review Questions

1. A cylinder 60 mm diameter and 80 mm long stands with its circular base on HP. A section plane perpendicular to VP and inclined at 60 degree to HP cuts the axis at a point 28 mm below its top end. Draw sectional top and right views and true shape of the section.

2. Figure shows a machine component. Draw the following views: Front view, Top view, Side view
3. Draw two views of hexagonal headed bolt with nut for a 20 mm diameter bolt and thread length of 50mm. Take length of the bolt equal to 100mm
4. Draw to indicate conventional representation of the following.

ISO metric thread having pitch of 40 mm, Square thread having pitch of 40 mm. show at least three threads in section.

5. Draw the following views of a SOCKET and SPIGOT COTTER JOINT used for joining two rods of diameter 30 mm: Sectional front view, A view looking from socket end.
6. Draw the top view and sectional front view of single riveted butt joint with double cover plate. The thickness of the plate is 9 mm. show at least three rivets. Indicate all the dimensions. Use snap headed rivets and show all calculation on the answer sheet

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. What is composite material? Classify the composite materials based on the type of reinforcement and type of matrix.
47. Explain applications of composite materials
48. What are the factors that determine the performance of fiber reinforced composites?
49. Explain the squeeze casting technique of producing Metal Matrix Composites
50. Discuss the' applications of composites

Lesson Plan

Unit – I

1.Historical perspective of Materials Science. Classification materials
2.Unit cell, space lattice, Bravaias lattice
3.Unit cells for cubic structure and HCP
4.Atomic packing factor for different cubic structure
5.Study of stacking of layers of atoms in cubic structures and HCP
6.Calculation of radius, co-ordination number and atomic packing factors for different cubic structures.
7.Calculation of radius, co-ordination number and atomic packing factors for different cubic structures
8.Crystal imperfections
9.point, line, surface and volume defects
10.Atomic diffusion, Diffusion Mechanisms
11.Fick's laws of diffusion
12.Work out of problems

Unit – II

1. Concepts of stress and strain, linear and non linear elastic behavior and properties
2. Mechanical properties in plastic range, Plastic deformation of single crystal by slip and twinning, work hardening, recovery, recrystallisation and grain growth
3. True stress and true strain
4. plastic deformation - slip and twinning
5. Fracture type, stages in Cup &Cone fracture
6. Griffith's criterion
7. Fatigue test, S-N curves
8. factors affecting fatigue life and protection methods
9. The creep curves
10. Mechanism of creep, creep resistant materials

Unit – III

1. Mechanism of solidification, Homogenous and heterogeneous nucleation,
2. Crystal growth, Cast metal structures
3. Solid solutions, Hume Rothary rules- substitutional, and interstitial solid solutions

Unit – III

1. Mechanism of solidification, Homogenous and heterogeneous nucleation,
2. Crystal growth, Cast metal structures
3. Solid solutions, Hume Rothary rules- substitutional, and interstitial solid solutions
4. Gibbs phase rule, construction of equilibrium diagrams, equilibrium diagrams involving complete and partial solubility, lever rule**.**
5. Problems on interpretation of binary phase diagrams
6. Definition of phases present in Fe-C system at different temperatures
7. Description of invariant reactions and critical temperature lines and slow cooling of steels
8. Effect of alloying elements on the Fe-C diagram, ferrite and austenite stabilizers.
9. Importance of TTT diagram, construction of TTT diagram.
10. TTT diagram of eutectoid steel, definition of phases like banite and martensite. effect of alloying elements on CCT diagram

Unit – IV

1. Introduction to heat treatment process, types of heat treatment: Annealing and its types.
2. Normalizing, hardening and its types
3. Temmpering - Austempering, Martempering
4. Surface treatment- methods of surface hardening, carburizing types
5. Nitriding and Cyaniding.
6. Hardenability, Jominy end quench test,
7. Need for doing surface treatment of materials. Carburizing,
8. Cyaniding & Nitriding surface heat treatment process
9. Explanation with sketches of Induction and flame hardening process
10. Age hardening of AI & Cu alloys

Unit – V

1. Introduction to ferrous and non - ferrous alloys, classification of ferrous metals and alloys.
2. AISI and SIS designation of steels, types of Cast iron properties and applications.
3. Non ferrous alloys - composition, properties and applications
4. Different types of glasses
5. Corrosion prevention materials.
6. Introduction to advanced materials, plastic material- characteristics, types and molding methods; Ceramic materials - types - clay products, glasses, glass ceramics.
7. Composite materials- An overview, classification, types of matrix materials & reinforcements
8. Fundamentals of production of FRP's
9. Fundamentals of production of MMC's
10. Advantages & application of composites

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly). Types of Bolt heads, special types of nuts, locking of nuts, Studs, set screws, grub screws. **8 Hrs**

Part-B

UNIT-III(2D Only)

Keys and Couplings: Types of Keys, Split Muff coupling, flanged coupling (un-Protected and Protected type), Pin type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)

Riveted Joints: lap joints- single and double riveted lap joints, butt joints with single/ double cover straps (Chain and Zigzag, using snap head rivets).. **9 Hrs**

UNIT-IV(2D Only)

Automotive Components: Clutch lever, Spark plug, IC Engine valve, Valve tappet lever, crank lever, rocker arm, Cylinder liner, Cylinder and Cylinder head of two stroke petrol engine, Crank shaft and cam shaft, stub axle. **8 Hrs**

Part-C

UNIT-V(2D and 3D)

Assembly Drawings

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

1. Plummer block (Pedestal Bearing) 2. Piston, 3. Connecting rod
4. Screw jack 5. Fuel Injector 6. Clutches (Single and multi Plate) **18 Hrs**

Text books:

1. K.R. Gopala Krishna Machine Drawing, Subhash Publication, 2013
2. R.B.Gupta, Automobile Engineering Drawing, , Satya Prakashan, New Delhi, 2000.
3. N.D.Bhat & V.M.Panchal Machine Drawing, 2011

Reference Books

1. VTU, A Primer on Computer Aided Machine Drawing', Published by, Belgaum, 2007
2. S. Trymbaka Murthy, A Text Book of Computer Aided Machine Drawing, , CBS Publishers, New Delhi, 2007
3. Sidheshwar, Machine Drawing, Tata McGraw-Hill,New Delhi, 2001

Course Outcomes

After learning all the units of the course, the student is able to

1. **Sketch** 2D and 3D drawings manually & using drawing software. **Solve** Problems on Sections of Solids resting on their bases and **sketch** true shape of sections. **Interpret** Pictorial views of simple machine parts & **Sketch** Orthographic Projections of the same.
2. **Distinguish** and **Sketch** Various Thread forms and Fasteners as per the standard dimensions.
3. **Sketch** Various Keys, Couplings and Riveted joints as per the standard dimensions
4. **Sketch** Proportionate/to scale Automotive Engine components.
5. **Sketch** and create 2D & 3D part drawings of different of Machine components, then **assemble** the same to **Create** an Assembled view of the complete Machine component and 2D drawings of Assembled view with required views along with 3D drawings.

Course Code: **P13AU45**	**Semester:IV**	L – T – P : 2 – 2 - 0
Course Title: **Computer Aided Machine Drawing**		
Contact Period - Lecture:36 Hr.; Exam:3 Hr.	Weightage: CIE:50 Marks; SEE:50 Marks	

Prerequisites: Basics of Engineering Graphics, Drawing conventions, Sketching,Navigation Commands, Graphic interface of Software, Starting New Drawing Sheet, Sheet Sizes, Naming a Drawing, Drawing Units….

Course Learning Objectives (CLOs)

This Course aims to

1. **Sketch** 2D and 3D drawings manually & using drawing software. **Solve** Problems on Sections of Solids resting on their bases and **sketch** true shape of sections.
2. **Interpret** Pictorial views of simple machine parts & **Sketch** Orthographic Projections of the same.
3. **Distinguish** and **Sketch** Various Thread forms as per the standard dimensions.
4. **Distinguish** and **Sketch** Various Fasteners as per the standard dimensions.
5. **Sketch** Various Keys, Couplings as per the standard dimensions
6. **Sketch** Various Riveted joints as per the standard dimensions
7. **Sketch** Proportionate/to scale Automotive Engine components.
8. **Sketch** and create 2D & 3D part drawings of different of Machine components,
9. then **assemble** the 3D part drawings to **Create** an Assembled view of the complete Machine component and
10. Create 2D drawings of Assembled view with required views along with 3D drawings

Course Content

Part-A

UNIT-I(2D Only)

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.
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 (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.
9 Hrs

UNIT-II(2D Only)

Thread Forms: Thread terminology, forms of threads – BSW Thread, Sellers thread, ISO Metric thread, square and Acme thread. Conventional representations of threads.

Course Articulation Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Explain the different crystalline structure of the metals, imperfection associated with them and laws governing the diffusion phenomena.	L2	**M**				**M**		**L**				
Apply the knowledge of mechanical behavior to select appropriate material for given automotive component and the Griffith's criterion for fracture, fatigue tests and mechanism of creep.	L3	**M**	**L**			**M**		**L**	**L**			
Study the construction and analysis of phase diagram and Iron-carbon equilibrium diagram	L4	**M**	**L**						**L**			
Apply the heat treatment process knowledge for improving physical and mechanical properties of different types of engineering materials.	L3	**L**	**L**			**M**	**L**		**L**	**L**		
Discuss different alloys and composite materials (PMC, MMC & CMC), their properties and application in automobiles with economic and social concerns	L2	**L**	**L**	**M**			**L**		**L**			

L- Low, M- Moderate, H-High

Course Assessment Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Explain the different crystalline structure of the metals, imperfection associated with them and laws governing the diffusion phenomena.	L2	**2**				**2**		**1**				
Apply the knowledge of mechanical behavior to select appropriate material for given automotive component and the Griffith's criterion for fracture, fatigue tests and mechanism of creep.	L3	**2**	**1**			**2**		**1**	**1**	**1**		
Study the construction and analysis of phase diagram and Iron-carbon equilibrium diagram	L4	**2**	**1**						**1**			
Apply the heat treatment process knowledge for improving physical and mechanical properties of different types of engineering materials.	L3	**1**	**1**			**2**	**1**		**1**			
Discuss different alloys and composite materials (PMC, MMC & CMC), their properties and application in automobiles with economic and social concerns	L2	**1**	**1**	**2**			**1**		**1**			

1 – Low, 2 – Moderate and 3 – High

Course Assessment Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Explain the various mechanisms, calculate the degrees of freedom, explain the various inversions of four bar chain, single and double slider crank chain.	L1, L2	2	2	2		1			2			1
Determine velocity by relative velocity method, Calculate the Velocity of different mechanism, Determine number of Instantaneous centres and velocity analysis by Instantaneous centre method.	L1 - L4	2	2	1		1			1			2
Study various Velocity components in a mechanism. Determine the different component of acceleration of various links, on different elements of four bar mechanisms, slider-crank mechanisms.	L1 - L4	2	2	1		1			1			2
Classify different types of gears, Explain Spur Gear terminology, law of gearing methods of avoiding interference and Back lash, Derive an expression for Path of contact, arc of contact, contact ratio.Calculate the Path of contact, arc of contact and contact ratio. Explain Simple, Compound and Epicyclic gear trains, Calculate velocity ratio, tooth load and torque in epicyclic gear trains	L1 - L4	2	2			2						2
Explain cam and follower types, Explain different follower Motions, Construction of the cam profile. Analysis of tangential cam with roller follower and circular arc cam with flat faced follower.	L1 - L4	2	2			2						2
1 – Low, 2 – Moderate, 3 – High												

Course Articulation Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k)) a	b	c	d	e	f	g	h	i	j	k
Explain the various mechanisms, calculate the degrees of freedom, explain the various inversions of four bar chain, single and double slider crank chain.	L1 - L2	M	M	M		L			M			L
Determine velocity by relative velocity method, Calculate the Velocity of different mechanism, Determine number of Instantaneous centres and velocity analysis by Instantaneous centre method.	L1 - L4	M	M	L		L			L			M
Study various Velocity components in a mechanism. Determine the different component of acceleration of various links, on different elements of four bar mechanisms, slider-crank mechanisms.	L1 - L4	M	M	L		L			L			M
Classify different types of gears, Explain Spur Gear terminology, law of gearing methods of avoiding interference and Back lash, Derive an expression for Path of contact, arc of contact, contact ratio.Calculate the Path of contact, arc of contact and contact ratio. Explain Simple, Compound and Epicyclic gear trains, Calculate velocity ratio, tooth load and torque in epicyclic gear trains	L1 - L4	M	M			M						M
Explain cam and follower types, Explain different follower Motions, Construction of the cam profile. Analysis of tangential cam with roller follower and circular arc cam with flat faced follower.	L1 - L4	M	M			M						M

L – Low, M – Moderate, H - High

Course Code : P13AU35	Semester : III	L - T - P : 4 - 0 - 0
Course Title : Manufacturing Technology - I		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Nil		

Course Learning Objectives (CLOs)

This course aims to

1. Classify various manufacturing processes.
2. Define pattern making. Classification, tools used and describe construction of pattern making. Explain foundry sands, sand preparation and testing.
3. Explain molding processes and Describe core making process.
4. Discuss different special molding process.
5. Classify furnaces. Describe working and construction features of electric arc furnace and Cupola.
6. Discuss steps involved in casting process. Explain principle of gating and risering.
7. Explain arc welding processes. Describe various welding processes.
8. Discuss special type of welding.
9. Summarize metallurgical aspect in welding.
10. Explain welding defects, causes and remedies.
11. Discuss different methods for inspection for casting and welding.

Course Content

Unit – I

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

PATTERNMAKING: Definition, functions, Materials and tools used for pattern, various pattern allowances and their importance. Classification of patterns. Construction of patterns,

FOUNDRY: Introduction, Tools and equipments, Moulding sands, Types of molding sands, Sand additives, Properties of Molding sand. Sand preparation, Sand testing, **11 Hrs**

Unit – II

Molding processes based on sand used and methods used Cores and Core makings, Core boxes, Typical molding problems.
Binder: Definition, Types of binders used in molding sand.
Additives: need, types of additives used.
SPECIAL MOULDING PROCESS : Study of Molding processes, CO2 molding, Shell mould, Investment casting, permanent mould casting : Gravity die-casting, Pressure die casting, centrifugal casting, Squeeze Casting, Slush casting, Thixocasting and continuous casting **11 Hrs**

Unit – III

MELTING FURNACES: Classification of furnaces, Constructional features & working principle of Electric Arc Furnace, Cupola furnace

CASTING PROCESS: Introduction to Casting process & steps involved, Varieties of Automotive components produced by casting process, Advantages & Limitations of casting process

Principles of Gating: Elements of gating system, types of gates, gating ratio, function of risers, types of risers – open and blind risers. Types of defects in Castings, Causes and remedies. **10 Hrs**

Unit – IV

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

SPECIAL TYPE OF WELDING: Resistance welding - principles, Seam welding, Thermit welding, Spot welding, projection welding. Friction welding and Explosive welding **10 Hrs**

Unit – V

METALLURGICAL ASPECT IN WELDING: Structure of welds, Formation of different zones during welding, Heat affected zone (HAZ), Parameters affecting HAZ, Shrinkage in welds & Residual stresses. Weldability and Weldability testing, Welding defects – Detection causes & remedy. Principle of Soldering, Brazing, different methods and its applications.

Inspection Methods: Methods used for Inspection of casting and welding. Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Holography methods of Inspection. **10 Hrs**

Text Book

1.S.K.Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy, "Elements of Workshop Technology"-Vol-I-Media Promoters & Publishers Pvt Ltd ,2006.
2.Dr.K.Radhakrishna, "Manufacturing Process-I", -Sapna Book House, 5th Ed, 2006

References:

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

2. Roy A Lindberg, "Process and Materials of Manufacturing" 4th Edn.- Pearson Edu. 2006.

Course Outcomes

After learning all the units of the course, the student is able to

1. Classify various manufacturing processes. Define pattern making. Classification, tools used and describe construction of pattern making. Explain foundry sands, sand preparation and testing.
2. Explain molding processes and Describe core making process. Discuss different special molding process.
3. Classify furnaces. Describe working and construction features of electric arc

6. Interference in involute gears
7. Problems solving
8. Problems solving
9. Study of different types of gear trains
10. Tabular method to find velocity ratio in epicyclic gear train
11. Problems solving
12. Problems solving

UNIT-V

1. Types of cams and followers
2. Follower Motions- SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.
3. Follower Motions- uniform acceleration and retardation and Cycloidal motion.
4. Construction of the cam profile for disc cam with reciprocating follower having knife-edge follower
5. Construction of the cam profile for disc cam with reciprocating follower having roller follower
6. Construction of the cam profile for disc cam with reciprocating follower having flat –faced follower
7. Practice of Construction of the cam profile in drawing class
8. Practice of Construction of the cam profile in drawing class
9. Analysis of tangential cam with roller follower
10. Analysis of circular arc cam with flat faced follower

Lesson Plan

UNIT-I

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

UNIT-II

1. Introduction to Absolute and relative motions, vectors, addition and subtraction of vectors and Motion of a link
2. Analysis Velocity by relative velocity method, Velocity of four-link mechanism
3. Velocity of slider-crank mechanism, crank and slotted lever mechanism
4. Problems solving by graphical method in drawing class
5. Problems solving by graphical method in drawing class
6. Instantaneous centre and number of I- centres, Kennedy's theorem
7. and analysis
8. locating I-centers for four bar chain and slider crank chain,
9. Velocity analysis using I-centre method
10. Problems solving by graphical method in drawing class
11. Problems solving by graphical method in drawing class

UNIT-III

1. Acceleration and Angular acceleration of links
2. Angular acceleration of links and acceleration of intermediate and offset points
3. Analysis and calculation of acceleration for four bar mechanisms
4. Analysis and calculation acceleration for slider-crank mechanism
5. Study of coriolis acceleration component
6. acceleration diagram for crank and slotted lever quick return motion mechanism
7. kliens construction to find velocity and acceleration in single slider crank mechanism
8. Problems solving by graphical method in drawing class
9. Problems solving by graphical method in drawing class
10. Problems solving by graphical method in drawing class

UNIT-IV

1. Different types of gears and its application
2. Spur Gear terminology
3. Gear tooth profiles and law of gearing
4. Derivation of expression for Path of contact
5. Derivation of expression for arc of contact and contact ratio

furnace and Cupola. Discuss steps involved in casting process. Explain principle of gating and risering.
4. Explain arc welding processes. Describe various welding processes. Discuss special type of welding.
5. Summarize metallurgical aspect in welding. Explain welding defects, causes and remedies. Discuss different methods for inspection for casting and welding.

Topic Learning Objectives

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

1. Define manufacturing, manufacturing process (L1).
2. Explain the term manufacturing and its role in the development of mankind (L2)
3. Classify manufacturing process and patterns (L2).
4. Define pattern making (L1).
5. Explain common materials and tools used for pattern making (L2).
6. Discuss common allowances provided on pattern (L2).
7. Describe different tools and equipments used in foundries (L2).
8. Discuss different types of molding sand (L2).
9. Explain properties of molding sand (L2).
10. Explain the process of sand preparation (L2).

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

1. Discuss molding processes based on sand used (L2).
2. Explain methods used for cores, core making and core boxes (L2).
3. Describe typical molding problems (L2).
4. Explain various types of clays used as binder (L2).
5. Explain various types of organic and inorganic additives used in molding sand (L2).
6. Explain CO_2 mould and shell mould (L2).
7. Explain how investment casting differs from conventional sand moulds (L2).
8. Explain various steps in gravity die casting, Also Explain the fundamentals of pressure die casting (L2).
9. Explain slush casting process and explain the principle of centrifugal casting (L2).

Explain squeeze casting technique and Thixocasting (L2).

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

1. Classify furnaces (L2).
2. Describe Working and construction of Electric Arc Furnace (L2).
3. Sketch and Explain the construction and working of Cupola furnace (L3)
4. Explain basic steps in casting process (L2).
5. Discuss varieties of automotive components produced by casting process (L2).

6. List the advantages and limitations of casting process (L1).
7. Discuss the principles of gating and risering (L2)
8. Explain types of gates and risers (L2).
9. Describe elements of gating system (L2).
10. Explain the types of defects, caused and remedies in castings (L2)

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

1. Classify various welding processes (L2).
2. Explain common types of welding joints (L2).
3. Explain MIG welding. List advantages, limitations and applications of MIG welding (L2).
4. Explain submerged arc welding process. Name its advantages, limitations and applications (L2).
5. Explain flux covered arc welding process. Name its advantages, limitations and applications (L2).
6. Explain process of atomic-hydrogen welding. Discuss its advantages, limitations and applications (L2).
7. Discuss special types of welding (L2).
8. Describe principle of resistance welding (L2)
9. Explain principles of Seam welding; Butt welding, Spot welding and projection welding (L2)
10. Explain friction welding, Laser welding, Electron beam welding and Thermit welding (L2)

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

1. Explain solidification of welds and their resulting structures (L2).
2. Describe various regions of HAZ in low carbon steel during welding L2)
3. Explain residual stresses can be controlled in welding (L2).
4. Explain different aspects associated with weldability (L2)
5. Describe various types of defects in welded joints (L2).
6. List methods used for inspection of casting and welding (L1).
7. Explain basic methods used for Inspection of casting and welding (L2)
8. Describe Ultrasonic inspection in welding (L2)
9. Explain X-ray radiography inspection (L2).
10. Describe the principle of Soldering, Brazing and its applications (L2)

Review Questions

1. Explain the term manufacturing and explain its role in the development of mankind.
2. Explain the various factors to be considered while selecting a process for a given production application.
3. Classify the various manufacturing processes.
4. List the different types of furnaces.

26. 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*.
27. 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*.
28. 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.
29. Explain the terms : **(*i*)** Module, **(*ii*)** Pressure angle, and **(*iii*)** Addendum.
30. State and prove the law of gearing. Show that involute profile satisfies the conditions for correct gearing.
31. 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.
32. Prove that the velocity of sliding is proportional to the distance of the point of contact from the pitch point.
33. 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 pressure angle increases.
34. Derive an expression for the length of the arc of contact in a pair of meshed spur gears.
35. What do you understand by the term 'interference' as applied to gears?
36. 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.
37. Derive an expression for minimum number of teeth required on a pinion to avoid interference when it gears with a rack.
38. Define (*i*) normal pitch, and (*ii*) axial pitch relating to helical gears.
39. Derive an expression for the centre distance of a pair of spiral gears.
40. Show that, in a pair of spiral gears connecting inclined shafts, the efficiency is maximum when the spiral angle of the driving wheel is half the sum of the shaft and friction angles.
41. Write short notes on cams and followers.
42. Explain with sketches the different types of cams and followers.
43. Why a roller follower is preferred to that of a knife-edged follower ?
44. Define the following terms as applied to cam with a neat sketch :-(*a*) Base circle, (*b*) Pitch circle, (*c*) Pressure angle, and (*d*) Stroke of the follower.
45. What are the different types of motion with which a follower can move ?
46. Draw the displacement, velocity and acceleration diagrams for a follower when it moves with simple harmonic motion. Derive the expression for velocity and acceleration during outstroke and return stroke of the follower.

11. 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.
12. Explain how the velocities of a slider and the connecting rod are obtained in a slider crank mechanism.
13. 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 ?
14. What is the difference between ideal mechanical advantage and actual mechanical advantage
15. 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*.
16. 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.
17. 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*.
18. What do you understand by the instantaneous centre of rotation (centro) in kinematic of machines? Answer briefly.
19. Explain, with the help of a neat sketch, the space centrode and body centrode.
20. Explain with sketch the instantaneous centre method for determination of velocities of links and mechanisms.
21. 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.
22. Draw the acceleration diagram of a slider crank mechanism.
23. 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.
24. Derive an expression for the magnitude and direction of coriolis component of acceleration.
25. 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.

Review Questions

5. Sketch and explain the constructional features of electric arc furnace.
6. Explain with sketch the principle and constructional features of a cupola.
7. Explain different steps involved in making sand casting.
8. List out the varieties of components produced by casting process.
9. List the advantages and limitations of casting process.
10. Define pattern. Explain the functions of patterns.
11. Discuss the various pattern allowances and their importance.
12. Classify patterns.
13. Differentiate between match plate pattern and cope and drag pattern. With neat sketches explain them.
14. Define a binder. Explain types of binders used in molding sand.
15. Explain the various additives used in molding sand with specific emphasis on improvement of properties of the sand.
16. Discuss the different sand mixes with respect to composition, properties, advantages, limitations and applications
i) Green sand ii) Dry sand iii) Loam sand iv) Core sand
17. Explain the desirable characteristics of any core in sand casting.
18. Define gating ratio.
19. Sketch and explain elements of a gating system.
20. Explain the functions of riser and its types.
21. Differentiate open and blind risers.
22. Explain the types of defects, causes and their remedies.
23. List the special molding process.
24. Explain briefly "CO_2" molding and shell molding process.
25. Sketch and explain i) Investment casting Process.
26. Explain with a sketch permanent mold casting
27. Explain in detail squeeze casting process and centrifugal casting.
28. Sketch and explain Slush casting.
29. Explain clearly Thixocasting process.
30. Explain with a sketch continuous casting process.
31. Define welding. Classify the various welding processes.
32. Explain the steps involved in preparation of base metal for welding.
33. Discuss in detail the different types of fluxes used in gas welding and arc welding.
34. Explain the principle and operation of TIG and MIG welding process with the help of neat sketches.
35. Differentiate MIG and TIG welding.
36. Explain submerged arc welding with a sketch.
37. Explain the process of Atomic-Hydrogen welding. Discuss its advantages, limitations and applications.
38. Sketch and explain the principle of resistance welding.
39.Sketch and explain the following types of welding i) Spot welding ii) Seam welding iii) Friction welding iv) projection welding v) Explosive welding vi) Butt welding
40. Sketch and explain Thermit welding.
41. Explain metallurgical aspects in welding.
42. Explain shrinkage and residual stresses in welds.
43. Explain how residual stresses can be controlled in weld.
44. Explain the welding characteristics of cast Iron and steels.

45. Sketch and explain the solidification of the weld and the resulting structure of low carbon steel.
46. Briefly explain the welding characteristics of i) Aluminum ii) Stainless steel
47. Define HAZ. Explain various regions of HAZ in low carbon steels.
48. Define weldability.List the factors affect the weld ability and mention the weld ability of metals in descending order.
49. Explain the various welding defects, its causes and remedies.
50. Explain soldering and brazing with examples.
51. Compare soldering and brazing.
52. Explain with sketches different methods of brazing.
53. Sketch and explain magnetic particle inspection.
54. Sketch and explain the ultrasonic testing method of NDT. Also list its advantages.
55. Explain with sketch radiography testing method.

Lesson Plan

Unit – I

1.INTRODUCTION: Concept of Manufacturing process, its importance,
2.Concept of Manufacturing process, its importance,
3. Classification of Manufacturing processes.
4. Selection of a process for a production
5. **PATTERNMAKING**: Definition, functions, Materials and tools used for pattern,
6. Various pattern allowances and their importance.
7. Classification of patterns. Construction of patterns,
8. **FOUNDRY**: Introduction, Tools and equipments,
9. Molding sands, Types of molding sands,
10. Sand additives, Properties of Molding sand.

Unit – II

1. Molding processes based on sand used,
2. methods used Cores and Core makings, Core boxes,
3. Typical molding problems. Binder: Definition, Types of binders used in molding sand
4. Additives: need, types of additives used.
5. **SPECIAL MOULDING PROCESS :** Study of Molding processes,
6. CO2 molding, Shell mould,
7. Investment casting, permanent mould casting,
8. Gravity die-casting, Pressure die casting,
9. Centrifugal casting, Squeeze Casting,
10.Slush casting, Thixocasting
11.Continuous casting and Review

Unit – III

1. **MELTING FURNACES:** Classification of furnaces,
2. Constructional features & working principle of Electric Arc Furnace, Cupola furnace.
3. **CASTING PROCESS:** Introduction to Casting process & steps involved,
4. Varieties of Automotive components produced by casting process,
5. Advantages & Limitations of casting process
6. Principles of Gating: Elements of gating system,
7. Types of gates, gating ratio, function of risers,

UNIT-II

VELOCITY ANALYSIS OF MECHANISMS

Introduction to Vectors, Absolute and relative motions, Motion of a link, velocity analysis by relative velocity method, four-link mechanism, slider-crank mechanism, crank and slotted lever mechanism. Instantaneous centre, number of I- centres, Kennedy's theorem , locating I-centres, velocity analysis by I-centre method. **10 hrs**

UNIT-III

ACCELERATION ANALYSIS OF MECHANISMS

Total acceleration of a link, acceleration of a point on a link, acceleration diagram for four bar mechanism, slider-crank mechanism, coriolis acceleration component, acceleration diagram for crank and slotted lever quick return motion mechanism, klien's construction to find velocity and acceleration in single slider crank mechanism. **10 hrs**

UNIT-IV

GEARS AND GEAR TRAINS

Classification & application of different types of gears, Spur Gear terminology, law of gearing, gear tooth profiles, Path of contact, Arc of contact, Contact ratio, Interference in involute gears.
Simple gear trains, Compound gear trains, Epicyclic gear trains, Tabular methods of finding velocity ratio of epicyclic gear trains. **12 hrs**

UNIT-V

CAMS

Types of cams, types of followers, Follower Motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion. Disc cam with reciprocating follower having knife edge, roller and flat faced follower. Disc cam with oscillating follower.
Analysis of tangential cam with roller follower and circular arc cam with flat faced follower. **10 hrs**

TEXT BOOKS :

Rattan S.S. "Theory of Machines" Tata McGraw-Hill Publishing Company Ltd. New Delhi and 2nd edition 2005.
V P Singh, "Theory of Machines" Publisher, Dhanpat Rai Publishing Company (P) Limited, 2004.

REFERENCE BOOKS :

Thomas Bevan, " Theory of Machines-I", CBS Publications, New Delhi.2010
Shigley. J.V. and Uickers, J. J., " Theory of Machines & Mechanisms" OXFORD University Press.2004
R.S.Khurmi and J.K.Gupta, Theory of Machines S.Chand and Co.2012

Course Code: P13AU44	**Semester: IV**	L – T – P : 4 – 0 - 0
Course Title: **Theory of machines-I**		
Contact Period - Lecture: 52 Hr.; Exam: 3 Hr.	Weightage: CIE: 50Marks; SEE: 50 Marks	
Prerequisites: Engineering Mechanics, Engineering Mathematics and Strength of material		

Course Learning Objectives (CLOs)

This Course aims to

1. **Explain** the various mechanisms, **calculate** the degrees of freedom,
2. **Explain** the various inversions of four bar chain, single and double slider crank chain.
3. **Determine** velocity by relative velocity method, **Calculate** the Velocity of different mechanism,
4. **Determine** number of Instantaneous centres and velocity analysis by Instantaneous centre method.
5. **Study** various Velocity components in a mechanism. **Determine** the different component of acceleration of various links**,** on different elements of four bar mechanisms,
6. **Study** klien's construction to find velocity and acceleration in slider-crank mechanisms.
7. **Classify** different types of gears, **Explain** Spur Gear terminology, law of gearing methods of avoiding interference and Back lash, **Derive** an expression for Path of contact, arc of contact, contact ratio.**Calculate** the Path of contact, arc of contact and contact ratio.
8. **Explain** Simple, Compound and Epicyclic gear trains, **Calculate** velocity ratio, tooth load and torque in epicyclic gear trains
9. **Explain** cam and follower types, **Explain** different follower Motions, **Construction** of the cam profile.
10. **Analysis** of tangential cam with roller follower and circular arc cam with flat faced follower.

Course Content

UNIT-I

INTRODUCTION TO MECHANISMS

Rigid and Resistant bodies, Link, kinematics pairs, degrees of freedom, Grubler's criterion, Kinematic chain, mechanism, structure, Mobility of Mechanism, inversion, Machine Inversions of Four bar chain, Single slider crank chain and Double slider crank chain.

Quick return motion mechanisms-whitworth mechanisms, Crank and slotted lever mechanisms. Principle of Straight line motion mechanism – Peaucelliers Mechanism, Engine Indicator, Intermittent motion mechanisms- Geneva mechanism and Ratchet and pawl mechanism. Toggle mechanism, Pantograph. **10 hrs**

UNIT-II

VELOCITY ANALYSIS OF MECHANISMS

Introduction to Vectors, Absolute and relative motions, Motion of a link, velocity analysis by relative velocity method, four-link mechanism, slider-crank mechanism, crank and slotted lever mechanism. Instantaneous centre, number of I-centres, Kennedy's theorem, locating I-centres, velocity analysis by I-centre method. **10 hrs**

8. Types of risers – open and blind risers.
9. Types of defects in Castings, Causes and remedies.
10. Review.

Unit – IV

1. **WELDING PROCESS:** Arc Welding: Principle,
2. Flux Shielded Metal Arc Welding (FSMAW),
3. Inert Gas Welding (TIG & MIG) Submerged Arc Welding (SAW)
4. Atomic Hydrogen Welding processes (AHW).
5. **SPECIAL TYPE OF WELDING:**
6. Resistance welding - principles
7. Seam welding, Thermit welding,
8. Spot welding, projection welding.
9. Friction welding and Explosive welding
10. Review.

Unit – V

1. **METALLURGICAL ASPECT IN WELDING:** Structure of welds,
2. Formation of different zones during welding,
3. Heat affected zone (HAZ),
4. Shrinkage in welds & Residual stresses.
5. Weldability and Weldability testing,
6. Welding defects – Detection causes & remedy.
7. Principle of Soldering and Brazing.
8. Different methods and its applications.
9. **Inspection Methods**: Methods used for Inspection of casting and welding. Visual, Magnetic particle,

Course Articulation Matrix (CAM)												
Course Outcomes (COs)		**Program Outcome** (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Classify various manufacturing processes. Define pattern making. Classification, tools used and describe construction of pattern making. Explain foundry sands, sand preparation and testing.	L 3	**M**						**M**		**M**		**M**
Explain molding processes and Describe core making process. Discuss different special molding process.	L 2	**M**						**M**		**M**		**M**
Classify furnaces. Describe working and construction features of electric arc furnace and Cupola. Discuss steps involved in casting process. Explain principle of gating and risering.	L 4	**M**						**M**		**M**		**M**
Explain arc welding processes. Describe various welding processes. Discuss special type of welding.	L 2	**M**						**M**		**M**		**M**
Summarize metallurgical aspect in welding. Explain welding defects, causes and remedies. Discuss different methods for inspection for casting and welding.	L 4	**M**						**M**		**M**	**L**	**M**
L- Low, M- Moderate, H-High												

Course Articulation Matrix - (CAM)												
Course Outcomes - COs	**Program Outcome – (General)**											
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Recognize appropriate parameters in metal cutting. Explain the Mechanism of chip formation; Merchants circle diagram and Cutting tool materials.	**L1**	**M**	**-**	**-**	**-**	**-**	**-**	**M**	**-**	**M**	**-**	**M**
Explain types and causes of tool wear, Estimate tool life, Explain Heat generation, Machinability and cutting fluids.	**L2**	**M**	-	-	-	-	-	**M**	-	M	-	M
Explain the working principles of Lathes, planning and shaping machines. Classification of Lathes, planning and shaping machines	**L2**	**M**	-	-	-	-	-	**M**	-	M	**L**	M
Classify and explain the working principles of drilling and grinding machines.	**L3**	**M**	-	-	-	-	-	**M**	-	M	**L**	M
Explain milling machines, Describe Non-traditional machining processes. Also Describe various Surface finishing processes.	**L2**	**M**	-	-	-	**-**	-	**M**	-	- M	**L**	M

Course Assessment Matrix - (CAM)												
Course Outcomes - COs	**Program Outcome – (General)**											
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Recognize appropriate parameters in metal cutting. Explain the Mechanism of chip formation; Merchants circle diagram and Cutting tool materials.	**L1**	2	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**2**	**-**	**2**
Explain types and causes of tool wear, Estimate tool life, Explain Heat generation, Machinability and cutting fluids.	**L2**	**2**	-	-	-	-	-	**2**	-	2	-	2
Explain the working principles of Lathes, planning and shaping machines. Classification of Lathes, planning and shaping machines	**L2**	**2**	-	-	-	-	-	**2**	-	2	**1**	2
Classify and explain the working principles of drilling and grinding machines.	**L3**	**2**	-	-	-	-	-	**2**	-	2	**1**	2
Explain milling machines, Describe Non-traditional machining processes. Also Describe various Surface finishing processes.	**L2**	**2**	-	-	-	**-**	-	**2**	-	2	**1**	2

Unit-V

1. **MILLING MACHINES:** Classification, constructional features,
2. milling cutters nomenclature, Fundamentals of the milling process,
3. milling machine operations, Indexing,
4. Simple, compound, Simple problems on simple and compound indexing.
5. **Non Traditional Machining Processes:** Principle and Operation,
6. LBM, Electro Chemical Machining,
7. AJM And Ultrasonic Machining.
8. **Surface finishing processes:** Introduction Lapping, honing,
9. Surface finishing, Polishing, buffing,
10. electroplating, hot dipping,
11. Galvanizing and metal spraying.
12. Review.

Course Assessment Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
Classify various manufacturing processes. Define pattern making. Classification, tools used and describe construction of pattern making. Explain foundry sands, sand preparation and testing.	L3	**2**						**2**			**2**	**2**
Explain molding processes and Describe core making process. Discuss different special molding process.	L2	**2**						**2**			**2**	**2**
Classify furnaces. Describe working and construction features of electric arc furnace and Cupola. Discuss steps involved in casting process. Explain principle of gating and risering.	L4	**2**						**2**			**2**	**2**
Explain arc welding processes. Describe various welding processes. Discuss special type of welding.	L2	**2**						**2**			**2**	**2**
Summarize metallurgical aspect in welding. Explain welding defects, causes and remedies. Discuss different methods for inspection for casting and welding.	L4	**2**						**2**		**1**	**2**	**2**
1 – Low, 2 – Moderate and 3 – High												

Course Code : P13AU36	Semester : III	L - T - P : 4 - 0 - 0
Course Title : Fluid Mechanics		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	
Prerequisites : Basics of Engineering Mathematics and Engineering mechanics		

Course Learning Objectives (CLOs)

This course aims to

1. Define the properties of fluids
2. Describe the phenomena associated with fluid static (Pressure and Measurement), Identify, formulate and solve engineering problems on fluid statics
3. Describe the phenomena associated with Hydrostatic forces. Identify, formulate and solve engineering problems in fluid statics
4. Describe the phenomena associated with fluid statics – Buoyancy. Identify, formulate and solve engineering problems in fluid statics
5. Explain and derive the conservation laws that govern fluid motion, Identify, formulate and solve engineering problems in Fluid Kinematics. Analyzing and solving engineering problems involving fluid flow
6. Explain and derive the conservation laws that govern fluid motion, Identify, formulate and solve engineering problems in Fluid dynamics and its applications. Analyzing and solving engineering problems involving fluid flow
7. Explain and derive for fluid motion for laminar flow and viscous effects.
8. Define, classify and compute the effect of compressible fluids in the practical scenario
9. Analyzing and solving engineering problems involving fluid flow considering major and minor energy losses.
10. Apply dimensional techniques (Buckingham PI Theorem) in fluid dynamic analysis

Course Content

Unit – I

Properties of Fluids: Introduction, properties of fluids, classifications, viscosity, thermodynamic properties, Surface tension and Capillarity, Vapour pressure and Cavitation

Fluid Statics - Pressure and its Measurement: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, Absolute, gauge, atmospheric and vacuum pressures, simple manometers, and differential manometers.

10 Hrs

Unit – II

Fluid Statics - Hydrostatic forces on surfaces: Total pressure and center of pressure, vertical plane surface submerged in liquid, horizontal plane surface submerged in liquid, inclined plane surface submerged in liquid, and curved surface submerged in liquid.

Buoyancy and floatation: Buoyancy center of buoyancy, meta-center and meta-centric height, conditions of equilibrium of floating and submerged bodies. **10 Hrs**

Ultrasonic machining.

68. What is LASER? Explain how LASER is utilized on machining materials

Lesson Plan

Unit-1

1. **THEORY OF METAL CUTTING**
2. Single point cutting tool nomenclature, geometry,
3. orthogonal and oblique cutting, mechanism of chip formation,
4. types of chips, Merchants circle diagram and analysis,
5. Ernst Merchant's solution, shear angle relationship
6. Problems of Merchant's analysis.
7. **CUTTING TOOL MATERIALS:** Desired properties,
8. types of cutting tool materials – HSS, carbides,
9. coated carbides CBN, PCD and ceramics
10. Review

Unit-II

1. **TOOL WEAR:** causes and types of tool wear,
2. Effects of cutting parameters on tool life, tool failure criteria,
3. Taylor's tool life equation,
4. Problems on tool life evaluation.
5. Heat generation in metal cutting, factors affecting heat generation,
6. Measurement of tool tip temperature.
7. Machinability and factors affecting machinability.
8. **CUTTING FLUIDS**: desired properties,
9. Types and selection.
10. Review

Unit-III

1. **PRODUCTION LATHES:** Introduction, principle and working,
2. part of centre lathe specification different operations,
3. definitions of speed, feed and depth of cut,
4. cutting time calculation, Calculation of change of gears in thread cutting,
5. Constructional features of turret and capstan lathes.
6. **SHAPING AND PLANNING MACHINES:** Classification,
7. Specification, constructional features, and driving mechanisms.
8. Shaping and planning operations.
9. Comparison between shaping and planning,
10. Problems on calculation of machining time.

Unit-IV

1. **DRILLING MACHINES:** Classification, Specification,
2. Constructional features,
3. Drilling & related operations,
4. Types of drill & drill bit nomenclature, machining time.
5. **GRINDING MACHINES:** Types of abrasives, bonding process,
6. Classification, constructional features of cylindrical
7. Surface grinding machines,
8. Tool and cutter grinder, specification of grinding wheel,
9. Selection of grinding wheel, balancing of grinding wheel.
10. Review

26. Describe in brief various parts of capstan and turret lathes.
27. Name the different work holding devices used in capstan and turret lathes explain them briefly.
28. What are the various collet chucks? Explain briefly.
29. List the various tool holding devices used in capstan and turret lathes
30. Name the different parts of a shaper, describe them in briefly.
31. What is shaper mechanism? Mention the different types of shaper mechanism, explain with suitable sketches
32. What are the advantages of hydraulic shaper over crank shaper? Discuss.
33. Define feed and depth of cut of shaper.
34. What is the fundamental difference between a planer and shaper?
35. List various mechanisms for table drive in planer. Explain with suitable sketches.
36. What types of operations can be performed efficiently by a planer? List and explain.
37. Sketch various planer tools and indicate their applications.
38. Sketch and explain radial drilling machine.
39. List the various drilling machine operations. Explain few briefly.
40. List the various types of drill
41. With suitable sketches explain twist drill nomenclature.
42. What is the function of grinding machine? How these function if similar or dissimilar with other machine tools?
43. What is center less grinding? Describe center less grinding operations.
44. What are the advantages of center less grinding?
45. Outline the nature and characteristics of abrasives used in grinding wheels.
46. What is the function of bonds in grinding wheel? Indicate bonding material and name their corresponding grinding wheel.
47. How grinding wheel is selected? What are the various factors influence its selection?
48. Why a grinding wheel is to be balanced? Explain.
49. Classify milling machines. How milling differs from turning and lathe?
50. Compare between plain and universal milling machine.
51. Name and explain the three different table feeds.
52. Name and describe the principle parts of a milling machine.
53. Classification of milling cutters. State material and features of each.
54. Describe various milling processes with neat sketches.
55. List various milling machine operations .Explain few briefly.
56. What is Indexing? How and why it is performed for gear manufacturing?
57. What are the different methods of indexing? Explain them briefly.
58. What is compound indexing? Write the procedure of determining the index circle.
59. Explain why surface finishing is important in manufacturing processes.
62. Write a short notes a) polishing) buffing c) electroplating d) Galvanizing e) Hot dipping
64. How do you classify the non-traditional machining processes?
65. Explain ultrasonic machining processes. Specify some of its process characteristics.
66. Explain with suitable sketches, the principle and operation of ECM and LBM .List their advantages and applications.
67. Explain with suitable sketches, the principle and operation of AJM and

Unit – III

Fluid Kinematics: Introduction, Types of fluid flow, continuity equation in one and three dimension (Cartesian co-ordinate system only), velocity and acceleration, velocity potential function and stream function for 2D flow and types of motion.
Fluid Dynamics: Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, Bernoulli's equation for real fluids. **Fluid flow measurements -** Venturimeter, Orifice meter, Pitot tube. **11 Hrs**

Unit – IV

Laminar flow and viscous effects: Reynold's number, critical reynold's number, Laminar flow through circular pipe-Hagen poiseulle's equation, Laminar flow between parallel stationery plates.
Introduction to compressible flow: Basic equations of compressible flow, Velocity of sound in a fluid, Mach number, Propagation of pressure waves in a compressible fluid, Sonic velocity **10 Hrs**

Unit – V

Flow through pipes: Introduction, loss of energy in pipes, Major Energy Losses, Darcy-Weisbach equation for loss of head due to friction in pipes, Chezy's equation for loss of head due to friction in pipes, Minor Energy Losses, hydraulic gradient and total energy line.
Dimensional Analysis: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Buckingham's ∏ theorem, Rayleigh's method, dimensionless numbers, similitude, types of similitude. **11 Hrs**

Text Books

1. Dr. Bansal.R.K, Fluid Mechanics by, Lakshmi Publications, 2005.
2. Dr. Jagadishlal, Fluid Mechanics and hydraulics,: Metropolitan Book Co-Ltd., 1997.

Reference books:

1. Yunus A, Cenegel, John M,Cimbala,Fluid Mechanics, Fundamental & applications, by Tata MacGraw Hill, 2006.
2. John F.Douglas, Janul and M.Gasiosek and john A. Swaffield, Fluid Mechanics Pearson Education Asia, 5th ed., 2006
3. Kumar.D.S, Fluid Mechanics and Fluid Power Engineering," Kataria and Sons.,2004.

Course Outcomes

After learning all the units of the course, the student is able to

1. Define the properties of fluids and Describe the phenomena associated with fluid static (Pressure and Measurement), Identify, formulate and solve engineering problems in fluid statics
2. Describe the phenomena associated with fluid static (Hydrostatic forces & Buoyancy), Identify, formulate and solve engineering problems in fluid statics

3.Explain and derive the conservation laws that govern fluid motion, Identify, formulate and solve engineering problems in Fluid Kinematics and dynamics, Analyzing and solving engineering problems involving fluid flow

4. Explain and derive for fluid motion for laminar flow and viscous effects. Define, classify and compute the effect of compressible fluids in the practical scenario
5. Analyzing and solving engineering problems involving fluid flow considering major and minor energy losses. Apply dimensional techniques (Buckingham PI Theorem) in fluid dynamic analysis

Topic Learning Objectives

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

1. Identify the different states of fluid and define a fluid, fluid mechanics- fluid statics, fluid dynamics (L1)
2. List the areas of application of fluid mechanics (L1)
3. List and define various properties of fluid (L1)
4. Apply the Newton's law of viscosity to simple engineering problems and analyze the fluid flow behavior. (L4)
5. Derive an equation for capillary rise (L2)
6. Classify fluids (L2)
7. Differentiate between Newtonian and non-Newtonian fluid, ideal and real fluid (L2)
8. Classify various fluid flows (L2)
9. State the importance of the dimensions and units (L1)
10. Solve problems on capillarity, surface tension etc. (L3)
11. State and prove Pascal's law for a static fluid. (L2)
12. Explain fluid pressure at a point (hydrostatic law) & pr. variation in a static fluid (L2)
13. Derive the hydrostatic law in an incompressible fluid at rest.(L2)
14. Relate the terms absolute pressure, gauge pressure, vacuum pressure and atmospheric pressures (L2)
15. Explain various kinds of instrumentation used for measuring fluid pressure. (L2)
16. Classify the different types of manometers (L2)
17. Determine the pressure at a desired point in a fluid using suitable manometer.(L3)
18. Solve numerical on measurement of fluid pressure using manometers. (L3)

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

1. Define total pressure and center of pressure for different submerged surfaces. (L1)
2. Obtain an expression for Hydrostatic force on submerged plane and curved surfaces (L2)
3. Solve problems on hydrostatic force on submerged plane and curved surfaces (L3)
4. Define buoyancy and centre of buoyancy. (L1)
5. Compute the force of buoyancy and meta-centric height of a partially or fully submerged body (L3)
6. Derive an analytical expression for the metacentric height of a floating body. (L3)

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

1. Classify milling machines (L2).
2. List out salient features of Column and Knee type milling machine (L2).
3. Classify milling cutters. State material features of each (L2).
4. Differentiate up-milling and down milling. Show the chip cross sections with sketch for both operations (L4).
5. Name the different methods of production of gears (L1).
6. Explain the method of simple and compound Indexing (L2).
7. Differentiate between simple and compound/differential indexing (L4)
8. Explain the working principles of LBM and Electro chemical machining (L2).
9. Explain the working principles of AJM and Ultrasonic machining (L2).
10. Explain different super finishing processes (L2)

Review Questions

1. Differentiate between orthogonal and oblique cutting
2. Derive the expression of chip reduction co-efficient in single point cutting. State the assumptions used.
3. Considering the various forces acting on the chip, draw merchant force diagram.
4. List and describe the various types of chips produced during metal cutting.
5. Sketch and explain the various types of chip breakers. Why they are used?
6. What do you understand by cutting tool nomenclature? Sketch and label the tool angle and nomenclature.
7. What are the desirable characteristics of cutting tool materials? Describe them in brief.
8. Name the various cutting tool materials. Briefly describe the important tool materials along with its Characteristics and usability.
9. What are the significant characteristics of HSS?
10. What are the common types of tool failures with suitable sketches explain
11. What are the factors affecting tool life?
12. Describe in brief how you measure tool life?
13. What is machinability and what is machinability index?
14. Explain heat generation in metal cutting.
15. Discuss the factors affecting heat generation in metal cutting
16. What are the purposes of cutting fluids?
17. What are the types and properties of cutting fluids?
18. What is the function of lathe? List various types of lathe.
19. Describe in brief the engine lathe.
20. Why checks are used? List various types of checks are used in lathes. Describe in briefly.
21. What is mandrel? Why they are used in lathes? List different types of mandrels.
22. What are the different machining operations performed on a lathe by holding work pieces between centers or chucks?
23. Define taper. How is the amount of taper expressed? Name the different methods of taper turning done on a lathe. Explain them briefly with suitable sketches.
24. Differentiate between a capstan, a turret and an engine lathe.
25. What are the differences between capstan and turret lathes?

Topic Learning Objectives

After learning all the topics of unit-1, the student is able to

1. Discuss types of cutting tools (L2).
2. Explain ISO tool nomenclature used in s single point cutting tool (L2).
3. Show different cutting angles of a single point cutting tool with a sketch (L3)
4. Compare orthogonal and oblique cutting systems (L4).
5. Describe mechanism of chip formation (L2).
6. Explain different types of chips that are formed during metal cutting (L2).
7. Sketch Merchant's circle diagram and explain different quantities involved (L3).
8. Discuss different cutting tool materials (L2).
9. Outline desirable properties of cutting tool materials (L1).
10. Explain different types of cutting tool materials (L2).

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

1. Explain briefly the mechanism of tool wear and types of tool wear (L2).
2. Describe effects of cutting parameters on tool life (L2).
3. Explain different types of tool failures (L2).
4. Define tool life (L1).
5. Outline the relation between tool life and cutting speed (L1).
6. Discuss the factors affecting heat generation in metal cutting (L2).
7. Explain measurement of tool tip temperature (L3).
8. Explain factors affecting the machinability of materials (L2).
9. Describe purposes of cutting fluids. List types of cutting fluids (L2).
10. Explain the desirable properties of cutting fluids (L2).

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

1. Classify different types of lathe and Bring out their salient features (L2).
2. Explain a Centre lathe and explain its various parts (L2).
3. Differentiate between capstan/turret and center lathe (L4).
4. Discuss briefly the feeding mechanism of a lathe (L2).
5. Classify shaper and planer machines (L2).
6. Define speed, feed and depth of cut in a shaper (L1).
7. Describe the principle of quick return mechanism as used in shapers (L2).
8. Explain different mechanisms in a shaper machine (L2).
9. Explain the different types of shaper and planer machines (L3).
10. Differentiate between a shaper and a planer (L4)

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

1. Name different types of drilling machines (L1).
2. Explain various types of drilling machines (L2).
3. Name different work holding devices of drilling machine (L1).
4. Explain the nomenclature of twist drill (L2).
5. List various grinding processes (L1)
6. Define a bond. Explain different bonding processes (L2).
7. Describe centre less grinding machines with a sketch (L2).
8. Explain the constructional features of cylindrical and surface grinding (L2)
9. Describe tool and cutter grinder (L2).
10. Discuss the factors influencing the selection of grinding wheels (L2).

7.Explain the procedure to determine the metacentric height by experimental method.(L2)
8.Identify the states of equilibrium for a floating body.(L2)

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

1.Define the concept of different fluid flows.(L1)
2.Derive an expression for continuity equation for a three-dimensional flow. (L2)
3.Define velocity potential and stream function.(L1)
4.Compute velocity potential and stream function for the fluid flow.(L3)
5.Explain the significance of momentum equation. (L2)
6.Explain the various forces causing the flow. (L2)
7.Derive Euler's equation of motion for a two-dimensional steady flow of an incompressible fluid and extend it for three-dimensional viscous flow. (L2)
8.Obtain the Bernoulli's equation of motion along a streamline by integrating the Euler's equation of motion under appropriate conditions. (L2)
9.Solve problems using Euler's equation and Bernoulli's equation of motion. (L3)
10.Describe the working principle of various devices used to measure the rate of fluid flow.(L2)
11.Obtain the discharge through a pipe by employing a venturimeter or an orifice meter.(L 3)
12.Explain the working of Pitot tube which is used for measuring the velocity of flow at any point in a pipe.(L2)
13.Solve problems on various flow measuring devices to determine discharge and velocity. (L3)

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

1.Derive an equation for Laminar flow through circular pipe-Hagen poiseulle's equation. (L2)
2.Derive an equation for Laminar flow between parallel stationery plates. (L2)
3.Solve problems pertaining to Laminar Flows.
4.Define Basic Equations of Compressible Flow. Sonic velocity, Velocity of sound in a fluid, Mach number, Propagation of pressure waves in a compress-ible fluid.(L2)
5.Solve Numerical to Determine velocity. .(L3)

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

1.Discuss various major and minor losses involved in fluid flow through pipes. (L2)
2.Derive an equation for frictional head loss in pipe flow (Darcy-Weisbach formula). (L2)
3.Derive an equation for frictional head loss in pipe flow (Chezy's formula). (L2)
4.Derive an equation for loss of head due to sudden Expansion, sudden con-traction & an obstruction in a pipe. (L2)
5.Solve problems to determine major and minor losses in pipes. (L3)
6.Explain the various methods of dimensional analysis.(L2)
7.Describe the Rayleigh's method for dimensional analysis.(L2)
8.State and apply Buckingham's ∏-theorem to arrange a set of given varia-bles into dimensionless groups.(L2)
9.Explain the significance of dimensionless numbers. (L2)
10. Apply dimensional techniques in fluid dynamic analyses.(L3)

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

Unit 4:

DRILLING MACHINES: Classification, Specification, constructional features, drilling & related operations, types of drill & drill bit nomenclature, machining time.

GRINDING MACHINES: Types of abrasives, bonding process, classification, constructional features of cylindrical and surface grinding machines, tool and cutter grinder, specification of grinding wheel, selection of grinding wheel, balancing of grinding wheel. **10 hrs**

Unit 5:

MILLING MACHINES: Classification, constructional features of Column and Knee type, types of milling cutters, milling cutters nomenclature, Fundamentals of the milling process, milling machine operations, Gear cutting methods, Indexing and Indexing methods, Simple problems on Indexing methods.

Non Traditional Machining Processes: Principle and Operation, LBM, Electro Chemical Machining, AJM And Ultrasonic Machining.

Surface finishing processes: Introduction Lapping, honing, Surface finishing, Polishing, buffing, electroplating, hot dipping, Galvanizing and metal spraying. **12 hrs**

Text Books

S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy,"Elements of Workshop Technology" Vol-II, -Media Promoters & Publishers Pvt. Ltd. 2007

R.K.Jain,"Production Technology" -Khanna Publications,New delhi, 2003.

REFERENCES:

Amitabha Ghosh and Mallik, "Manufacturing Science"- Affiliated East West Press, 2003.

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

A. Bhatta charya."Theory of Metal cutting & practice"

Course Outcomes

After learning all the units of the course, the student is able to

1. Recognize appropriate parameters in metal cutting. Explain the Mechanism of chip formation; Merchants circle diagram and Cutting tool materials.
2. Explain types and causes of tool wear, Estimate tool life, Explain Heat generation, Mach inability and cutting fluids.
3. Explain the working principles of Lathes, planning and shaping machines. Classification of Lathes, planning and shaping machines.
4. Classify and explain the working principles of drilling and grinding machines.
5. ***Explain milling machines, Describe Non-traditional machining processes. Also Describe various Surface finishing processes.***

Course Code:	P13AU43	Sem:	IV	L-T-P : 4-0-0
Course Title:	Manufacturing Technology- II			
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	Weightage: CIE:50; SEE:50			

Prerequisites: The student should have undergone the course on Elements of Mechanical Engineering (Code: P13ME46) Manufacturing process I (code: P13AU35)

Course Learning Objectives (CLO'S):

This course aims to:

1. Recognize appropriate parameters in metal cutting. Explain the Mechanism of chip formation; Merchants circle diagram and Cutting tool materials.
2. Explain types and causes of tool wear, Estimate tool life, Explain Heat generation, Mach inability and cutting fluids.
3. Explain the working principles of Lathes, planning and shaping machines. Classification of Lathes, planning and shaping machines.
4. Classify and explain the working principles of drilling and grinding machines.
5. ***Explain milling machines, Describe Non-traditional machining processes. Also Describe various Surface finishing processes.***

Course Content

Unit 1:

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

CUTTING TOOL MATERIALS: Desired properties, types of cutting tool materials – HSS, carbides, coated carbides CBN, PCD and ceramics **10 hrs**

Unit 2:

TOOL WEAR: causes and types of tool wear, effects of cutting parameters on tool life, tool failure criteria, Taylor's tool life equation, problems on tool life evaluation. Heat generation in metal cutting, factors affecting heat generation, measurement of tool tip temperature. Machinability and factors affecting machinability.

CUTTING FLUIDS: desired properties, types and selection. **10 hrs**

Unit 3:

PRODUCTION LATHES: Introduction, principle and working, part of centre lathe specification different operations, definitions of speed, feed and depth of cut, cutting time calculation, Calculation of change of gears in thread cutting, constructional features of turret and capstan lathes.

SHAPING AND PLANING MACHINES: Classification, specification, constructional features, and driving mechanisms. Shaping and planning operations. Comparison between shaping and planning, Problems on calculation of machining time. **10 hrs**

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.
51. Calculate the loss of head in a pipe having a diameter of 15cm and a length of 2km. It carries oil of specific gravity 0.85 and viscosity of 6 Stokes at the rate of 30.48 lps (Assume laminar flow).
52. Calculate the power required to maintain a laminar flow of an oil of viscosity 10P through a pipe of 100mm diameter at the rate of 10 lps if the length of the pipe is 1 km. (assume laminar flow) (1 Ns/m2 = 10 Poise)
53. Define Basic Equations of Compressible Flow. Sonic velocity, Velocity of sound in a fluid,

54. Define Mach number, Propagation of pressure waves in a compressible fluid.

55. Discuss various major and minor losses involved in fluid flow through pipes.
56. Derive an equation for frictional head loss in pipe flow (Darcy-Weisbach formula).
57. Derive an equation for frictional head loss in pipe flow (Chezy's formula)
58. Derive an equation for loss of head due to sudden Expansion, sudden contraction & an obstruction in a pipe.
59. A horizontal pipe line 40m long is connected to a water tank alone end & discharges freely into the atmosphere at the other end. For the first 25m of its length from the tank, the pipe is 150mm diameter & its diameter is suddenly enlarged to 300mm. the height of water level in the tank is 8m above the centre of the pipe. Considering all losses of head which occur, *determine the rate of flow*. Take f=0.01 for both sections of the pipe. *Draw the Hydraulic Gradient Line (H.G.L) & Total Energy Line (T.E.L)*
60. Explain the various methods of dimensional analysis.
61. Describe the Rayleigh's method for dimensional analysis.
62. State and apply Buckingham's ∏-theorem to arrange a set of given variables into dimensionless groups.
63. Explain the significance of dimensionless numbers.
64. Apply dimensional techniques in fluid dynamic analyses.

65. Using Buckingham's π-theorem, show that the discharge Q consumed by

Course Assesment Matrix (Cam)

Course Outcomes(Cos)	Program Outcome - * (General)										
	a	b	c	d	e	f	g	h	i	j	k
Describe various standards and measurements of fundamental quantities.	2	-	-	-	1	-	2	-	2	2	1
Explain and perform calibration of various measuring instruments like Comparators and Angular measuring Instruments.	2	-	-	-	2	-	2	-	2	2	2
Discuss transducers. Intermediate modifying devices and Interferometer	2	-	-	-	2	-	2	-	2	2	2
Explain the measurement of Force, Torque and terminating devices. Calibrate the instruments to measure force and torque,	2	-	-	-	2	-	2	-	2	2	2
Describe strain, pressure and temperature measurement. Calibrate the instruments to measure temperature and pressure.	2	-	-	-	2	-	2	-	2	2	2

Unit-V

1.Strain gauge, preparation and mounting of strain gauges,
2.Gauge factor, Methods of strain measurement,
3.Principle, use of elastic members, bridge man gauge,
4.Mc leod gauge, thermal conductivity gauge,
5.Pirani gauge and thermocouple vacuum gauge,
6.Ionization gauge, Resistance thermometers,
7.Thermocouple, law of thermocouple,
8.Thermocouple circuits, thermocouple materials,
9.Pyrometers, optical pyrometer
10.Review

Course Articulation Matrix (CAM)

Course Outcoms(Cos)	Program Outcome - * (General)										
	a	b	c	d	e	f	g	h	i	j	k
Describe various standards and measurements of fundamental quantities.	M	-	-	-	L	-	M	-	M	M	L
Explain and perform calibration of various measuring instruments like Comparators and Angular measuring Instruments.	M	-	-	-	M	-	M	-	M	M	M
Discuss transducers. Intermediate modifying devices and Interferometer	M	-	-	-	M	-	M	-	M	M	M
Explain the measurement of Force, Torque and terminating devices. Calibrate the instruments to measure force and torque,	M	-	-	-	M	-	M	-	M	M	M
Describe strain, pressure and temperature measurement. Calibrate the instruments to measure temperature and pressure.	M	-	-	-	M	-	M	-	M	M	M

$$Q = Nd^3\phi\left[\frac{\mu}{\rho Nd^2}, \frac{\sigma}{\rho N^2 d^3}, \frac{w}{\rho N^2 d}\right]$$

1. an oil ring is given by
where d is the internal diameter of the ring, N is rotational

Lesson Plan

Unit – I

1. **Properties of Fluids**: Introduction, properties of fluids,
2. Numericals
3. classifications, viscosity, thermodynamic properties, Numericals
4. Surface tension and Capillarity,
5. Vapour pressure and Cavitation
6. **Fluid Statics - Pressure and its Measurement**: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid,
7. Numericals, Absolute, gauge, atmospheric and vacuum pressures,
8. simple manometers, and Numericals
9. Differential manometers.
10. Numericals

Unit – II

1. **Fluid Statics - Hydrostatic forces on surfaces**: Total pressure and center of pressure, vertical plane surface submerged in liquid,
2. Numericals
3. horizontal plane surface submerged in liquid, inclined plane surface submerged in liquid, Numericals
4. Curved surface submerged in liquid.
5. Numericals
6. **Buoyancy and floatation**: Buoyancy center of buoyancy,
7. Numericals
8. metacenter and metacentric height,
9. Numericals
10. Conditions of equilibrium of floating and submerged bodies. Numericals

Unit – III

1. **Fluid Kinematics**: Introduction, Types of fluid flow, continuity equation in one and three dimension (Cartesian co-ordinate system only),
2. Numericals
3. velocity and acceleration, Numericals
4. velocity potential function and streamfunction for 2D flow and types of motion.
5. Numericals
6. **Fluid Dynamics**: Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation,
7. Numericals
8. Bernoulli's equation for real fluids. Numericals
9. **Fluid flow measurements**, venturimeter,
10. Numericals
11. orifice meter, Pitot tube Numericals

Unit – IV

1. **Laminar flow and viscous effects**: Reynold's number, critical reynold's number, Laminar flow through circular pipe-Hagen poiseulle's equation, Derivation
2. Numericals
3. Laminar flow between parallel stationery plates. Derivation
4. Numericals
5. **Introduction to compressible flow**: Sonic velocity, Velocity of sound in a fluid,
6. Numericals
7. Numericals
8. Mach number, Propagation of pressure waves in a compressible fluid.
9. Numericals
10. Numericals

Unit-V

1. Expression for loss of head due to friction in pipes, Major Energy Losses, Darcy-Weisbach equation.for loss of head due to friction in pipes, Chezy's equation for loss of head due to friction in pipes,
2. Numericals
3. Minor Energy Losses,
4. Numericals
5. Hydraulic gradient and total energy line. Numericals
6. **Dimensional Analysis**: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method
7. Numericals
8. Buckingham's ∏ theorem,
9. Numericals
10. Numericals
11. dimensionless numbers, similitude, types of similitudes

49. Define thermocouple. Explain the principle on which it works.
50. Sketch and explain Law of thermocouple and their industrial applications.

Lesson Plan

Unit-1

1.Definition, significance of measurement, generalized measurement system
2.definition and concept of accuracy, precision, sensitivity,
3.Calibration, threshold, hysteresis, repeatability,
4.Loading effect, linearity, system response, time delay,
5. Errors in measurement, classification of errors.
6.Definition and objectives of metrology,
7.Standard of length- International prototype meter, Imperial standard yard
8.Wave length standard, Subdivision of standards,
9.line and end standard, comparison, Transfer from line standard to end standard,
10.Calibration of end bars (Numerical)
11.Review

Unit-II

1.Introduction to Comparator, Characteristics,
2.Classification of Comparators, Sigma comparators,
3.Dial indicators, optical comparators, ,
4.Principles, ziess ultra optimeter,
5.Electric and electronic comparators –principles, LVDT,
6.Pneumatic comparators, back pressure gauges,
7. Solex comparators. Bevel protractor.
8.Sine principle, use of sine bars, sine centre,
9.Angle gauges (numerical on building of angles)
10.Review

Unit-III

1.Interferometer**,** Transfer efficiency,
2.primary and secondary transducers, Mechanical,
3. Mechanical transducers, advantages of each type of transducers.
4. Electrical, electronic transducers, advantages of each type of transducers.
5.Mechanical systems, inherent problems,
6.Electrical intermediate modifying devices, input circuitry,
7.signal transmission (hydraulic transmission)
8.signal transmission (magnetic transmission, electrical transmission)
9. Clinometers. Principle of inter-ferometry,
10.Autocollimator, optical flats
11.Review

Unit-IV

1.Measurement of Force, Torque, and terminating devices, Principle,
2.Analytical balance, platform balance,
3.proving ring, torque measurement,
4.Types of dynamometers prony brake,
5. Hydraulic dynamometer, Eddy current dynamometer.
6.Mechanical, digital read out devices,
7.ultra-violet recorders, servo-recorders,
8.cathode ray oscilloscope, Oscillographs,
9.X-Y plotters
10.Review

13. Sketch and explain the principle and working of LVDT.
14. Explain the working principles of Pneumatic comparators and back pressure gauges.
15. Briefly discuss the Advantages and Disadvantages of Electrical Comparators.
16. Explain the sine bars are used for measurements with the help of neat sketch.
17. Explain the principle of sine bar with a suitable example.
18. Define angle gauges. Give the combination of angle gauge to obtain the following angle, also sketch the arrangement of gauges i) $37^0$9'18'' ii) $57^0$34'9''
19. Illustrate the principle of interferometry with sketches.
20. Explain transfer efficiency.
21. Classify different types of transducers.
22. Sketch and explain a primary transducer and secondary transducer.
23. Distinguish between active and passive transducer.
24. List the advantages of electrical over mechanical transducer.
25. Sketch and explain the following a) Capacitance transducer b) Peizo-electric transducer
26. Explain the inherent problem present in mechanical intermediate modifying systems.
27. Sketch and explain the hydraulic data transmission system.
28. Explain the principle of inter-ferometry.
29. Expalain the following a) Clinometers b) Autocollimator c) Optical flats
30. Distinguish between force and torque
31. List the different principles on which force measurements are made.
32. List the different means normally used for torque measurement.
33. Sketch and explain the working principle of analytical and flat form balance.
34. Classify the dynamometers. What does a dynamometer measure?
35. Define the term brake tare as applied to prony brake dynamometer. How do you proceed to determine brake tare?
36. Sketch and explain the method of measuring power using a prony brake dynamometer.
37. Explain with sketches, Hydraulic dynamometer and Eddy current dynamometer.
38. Sketch and explain Cathode ray oscilloscope.
39. Sketch and explain stylus type oscillograph
40Explain the working of proving ring with a sketch
41. Explain the working principle of X-Y plotters with a block diagram.
42. Define strain gauge. List some practical situations where strain measurement becomes essential.
43. Name the various types of strain gauges for different applications.
44. List the steps to be taken in the preparation of the specimen and mounting of strain gauge.
45. Explain the preparation and mounting of strain gauges.
46. Explain null balance method of strain measurement with a circuit diagram.
47. Explain the working of Bridgeman gauge used to measure high pressure.
48. Explain with sketch the working and application of McLeod gauge.

Course Articulation Matrix (CAM)

Course Outcome (CO)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Define the properties of fluids and Describe the phenomena associated with fluid static (Pressure and Measurement)	L3	M	M	M	-	M	-	-	-	-	M	M
Describe the phenomena associated with fluid static (Hydrostatic forces & Buoyancy), Identify, formulate and solve engineering problems in fluid statics	L3	M	M	-	-	M	-	-	-	-	M	M
Explain and derive the conservation laws that govern fluid motion Identify, formulate and solve engineering problems in Fluid Kinematics and dynamics, Analyzing and solving engineering problems involving fluid flow	L3, L4	M	M	-	-	M	-	-	-	-	M	M
Explain and derive for fluid motion for laminar flow and viscous effects. Define, classify and compute the effect of compressible fluids in the practical scenario	L3	M	M	-	-	M	-	-	-	-	M	M
Analyzing and solving engineering problems involving fluid flow considering major and minor energy losses. Apply dimensional techniques (Buckingham PI Theorem) in fluid dynamic analysis Apply dimensional techniques (Buckingham PI Theorem) in fluid dynamic analysis	L3, L4	M	M	-	--	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
Define the properties of fluids and Describe the phenomena associated with fluid static (Pressure and Measurement)	L3	2	2	2	-	2	-	-	-	-	2	2
Describe the phenomena associated with fluid static (Hydrostatic forces & Buoyancy), Identify, formulate and solve engineering problems in fluid statics	L3	2	2	-	-	2	-	-	-	-	2	2
Explain and derive the conservation laws that govern fluid motion Identify, formulate and solve engineering problems in Fluid Kinematics and dynamics, Analyzing and solving engineering problems involving fluid flow	L3, L4	2	2	-	-	2	-	-	-	-	2	2
Explain and derive for fluid motion for laminar flow and viscous effects. Define, classify and compute the effect of compressible fluids in the practical scenario	L3	2	2	-	-	2	-	-	-	-	2	2
Analyzing and solving engineering problems involving fluid flow considering major and minor energy losses. Apply dimensional techniques (Buckingham PI Theorem) in fluid dynamic analysis Apply dimensional techniques (Buckingham PI Theorem) in fluid dynamic analysis	L3, L4	2	2	-	--	2	-	-	-	-	2	2
1 – Low, 2 – Moderate, 3 – High												

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

Define Acceleration and Angular acceleration of links,

1. **Determine** angular acceleration of links and acceleration of intermediate and offset points.
2. **Determine** acceleration for four bar mechanisms, slider-crank mechanism.
3. **Learn** coriolis acceleration component
4. **Determine** acceleration diagram for crank and slotted lever quick return motion mechanism
5. **Learn** kliens construction to find velocity and acceleration in single slider crank mechanism
6. **Draw** acceleration diagram for important mechanisms.

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

1. **Classify** different types of gears and its application.
2. **Explain** Spur Gear terminology, gear tooth profiles and law of gearing.
3. **Derive** an expression for Path of contact, arc of contact, contact ratio.
4. **Explain** the interference in involute gears and under cutting
5. **Describe** the various Methods of avoiding interference.
6. **Determine** Path of contact, arc of contact and contact ratio.
7. **Know** different types of gear trains
8. **Determine** velocity ratio of epicyclic gear trains by tabular method

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

1. **Classify** types of cams and followers.
2. **Explain** the Follower Motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion.
3. **Determine/Construction** of the cam profile for various follower motion.
4. **Determine** displacement, velocity and acceleration of tangential cam with roller follower
5. **Determine** displacement, velocity and acceleration of circular arc cam with flat faced follower.

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

Course Outcomes

After learning all the units of the course, the student is able to

1. **Explain** the various mechanisms, **calculate** the degrees of freedom, **explain** the various inversions of four bar chain, single and double slider crank chain.
2. **Determine** velocity by relative velocity method, **Calculate** the Velocity of different mechanism, **Determine** number of Instantaneous centres and velocity analysis by Instantaneous centre method.
3. **Study** various Velocity components in a mechanism. **Determine** the different component of acceleration of various links**,** on different elements **of** four bar mechanisms, slider-crank mechanisms.
4. **Classify** different types of gears, **Explain** Spur Gear terminology, law of gearing methods of avoiding interference and Back lash, **Derive** an expression for Path of contact, arc of contact, contact ratio.**Calculate** the Path of contact, arc of contact and contact ratio. **Explain** Simple, Compound and Epicyclic gear trains, **Calculate** velocity ratio, tooth load and torque in epicyclic gear trains
5. **Explain** cam and follower types, **Explain** different follower Motions, **Construction** of the cam profile. **Analysis** of tangential cam with roller follower and circular arc cam with flat faced follower.

Topic Learning objectives

After learning all the units of Unit-1, the student is able to

1. **Define** link, rigid and resistant bodies.
2. **Explain** the definitions of kinematic pair, degrees of freedom, Kinematic chain, mechanism, stricture, machines.
3. **Explain** the inversion, types of motion, Grubler's criterion and mobility of mechanism.
4. **Calculate** the degrees of freedom of different mechanisms.
5. **Explain** various inversions of four bar chain, single slider crank chain and double slider crank chain.
6. **Explain** the various mechanism and inversions.
7. **Explain** the Quick return motion mechanisms-whitworth mechanisms, Crank and slotted lever mechanisms.
8. **Explain** the Intermittent motion mechanisms- Geneva mechanism and Ratchet and pawl mechanism.
9. **Explain** the various mechanisms like Toggle mechanism, Pantograph.

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

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

Course Code : P13AUL37	**Semester : III**	**L - T - P : 0 - 0 –1.5**
Course Title : Metallography and Materials Testing lab		
Contact Period: Lecture: 36 Hr.; Exam: 3 Hr.		**Weightage: CIE:50; SEE:50**
Prerequisites : Chemical composition of the material. Physical and mechanical properties of the material. How these above properties can be changed by different heat treatment process?How inclusion of heat treatment affects the manufacturing flow chart? Selection of material for a given application.		

Course Learning Objectives (CLOs)

This Course aims to

1.Discuss Engineering and Manufacturing Roles, Types of Material Processes and get familiar to the Testing Laboratory.
2.Compute stresses, strains and various mechanical properties under different loading conditions, viz. tensile, compression, shear.
3.Predict the variation in characteristic properties with reference to ductility and brittleness of materials before and after heat treatment.
4.Determine the behaviour of the material subjected to high rate of sudden loading so as to find the energy required for the plastic deformation.
5.Determine the wear coefficient for the given material, and conclude the nature of wear.
6.Prepare the sample for microstructure examination, identify the structure and perform image analysis.

Course Content

PART- A

1. Preparation of specimen for Metallographic examination of engineering materials and study the microstructure of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze.

2. Study and demonstration of different Heat treatment: Annealing, normalizing, hardening and tempering of steel & to study their Rock-well hardness.

3. Study and demonstration of
   a) Fatigue test
   b). Ultrasonic flaw detector
   c). Magnetic crack detector
   d). Dye penetrate testing

PART-B

1. Tension test and compression test on mild steel and cast Iron
2. Bending Test on mild steel and timber
3. Torsion tests on circular sections
4. Hardness test on mild steel, cast iron, aluminium etc.,
5. Shear test on mild steel
6. Test on helical springs- Determination of spring modulus and rigidity modulus
7. Impact test (Charpy and Izod) on cast iron and mild steel
8. Experiment on wear study

Course Outcomes (COs)

At the end of the course the student is able to:

1. Prepare material specimen for metallographic studies and recognize the micro structural features of material.
2. Determine the mechanical properties of different materials
3. Determine the wear coefficient of material
4. Determine the variation in properties before and after heat treatment of metal specimens
5. Demonstrate fatigue test.

Topic Learning objectives

After learning all the topics of PART-A, the student is able to

1. Familiarization with the procedure for preparation of a material specimen for microscopic examination.
2. Familiarization with compound optical microscopes and metallography.
3. Examination of surface characteristics of engineering materials.
4. Grain size determination of metals.
5. Understand the relationship between hardness and the grain structure of the specimen.
6. Justify, hardness as a material property in the specimen.
7. Study on the furnaces, temperature control, quenching media.
8. Process flow of hardening and tempering (hardening and tempering temperatures, media of quenching for given steel)
9. Testing the hardness of materials
10. Differentiate the Destructive and Non Destructive testing methods
11. Recognize the importance of Destructive and Non destructive testing.

After learning all the topics of PART-B, the student is able to

1. Familiarization with a universal testing machine (UTM), standard tensile test and test procedure.
2. Observation of the tensile & compression behavior of metal.

8. Explain stylus type Oscillograph (L2)
9. Explain the working of X-Y plotters (L2)

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

1. Explain a mechanical type strain gauge. And list their advantages and disadvantages (L2).
2. Explain the necessary precautions to be taken while mounting strain gauges (L2)
3. Discuss in detail gauge factor (L2).
4. Sketch a neat diagram of a simple resistance bridge arrangement for strain measurement (L3)
5. Explain the types of pressure measuring devices (L2).
6. Explain the working and application of McLeod gauge (L3).
7. Explain pirani thermal conductivity gauge.(L2)
8. Explain electrical resistance thermometer (L3).
9. State and explain the laws of thermocouple (L1)
10. List the desirable properties of a thermocouple materials (L1)
11. Describe the construction and working of optical pyrometer (L2)

Review Questions

1. Define measurement and explain its significance in our day-to life and in various fields of engineering.

2. Explain the concept of generalized measurement system with block diagram.

3.Explain the following i) Accuracy ii) precision iii) Sensitivity iv) Speed of response v) Calibration, vi) Threshold, vii) Hysteresis, viii) Repeatability **ix)** Loading effect x) Linearity, xi) Time delay

4. Define error in measurement and describe the Classification of errors.

5. Define metrology. List out the major objectives of metrology.

6.Explain the following with sketches i) International prototype meter, ii) Imperial standard yard ,iii)Wave length standard.

7. State the important features of line standards and End standards.

8. Distinguish between line standards and End standards.

9. Three 100 mm end bars are measured on a level comparator by first wringing them together and comparing with a 300mm bar. The 300mm bar has a known error of +40µm and the three bars together measure 64µm less than the 300mm bar. Bar A is 18µm longer than bar B and 23µm longer than bar C. Find the actual length of each bar.

10. Four bars of length A, B, C and D of basic length 100mm each are to be calibrated length bar of 400mm was also found that length is 399.9992mm.It was also found that length of bars B, C and D are in comparison to A are 0.0002mm, +0.0004mm and -0.0001mm respectively and length of all above four bars put together in comparison to standard calibrated bar is +0.0003mm longer. Determine the actual dimension of all four bars.

11. Define a comparator. How does it differ from a measuring device? How they are classified?

12. Explain the comparators with sketches i) Sigma comparators ii) Zeiss Comparator (Optical)

iii) Solex Comparator (pneumatic), IV) Electric and electronic comparators.

Topic Learning Objectives

After learning all the topics of unit-1, the student is able to

1. Define measurement and metrology (L1).
2. Discuss generalized measurement system (L2)
3. Explain the various stages of a generalized measurement system (L2).
4. Explain i) Hysteresis ii) Threshold iii) Repeatability iv) Sensitivity v) Calibration (L2).
5. Discuss about errors (L2).
6. Describe "International Prototype Meter "and "Imperial Standard Yard" (L2).
7. Discuss i) Line Standard ii) Wave length standard iii) End standard (L2).
8. Distinguish between Line Standard and End Standard (L2).
9. Discuss the procedure for the calibration of End bars (L2).
10.

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

1. Define a Comparator. List out the Characteristics of comparator (L1).
2. Classify the various types of comparators (L2).
3. Describe the construction and working of Sigma comparator (L2).
4. Explain a dial indicator (L3).
5. Describe the construction and working of mechanical-optical comparator (L3).
6. Explain the working of a 'Solex pneumatic comparator'L3).
7. Explain vernier bevel protractor (L2).
8. Explain the principle of sine bar (L2).
9. Distinguish between sine bar and sine centre (L2).
10. Distinguish between angle gauges and slip gauges. (L2)

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

Define Transfer Efficiency (L1).

1. Explain with an example a primary and secondary transducer (L2).
2. List the electrical and mechanical transducers (L1).
3. Explain various types of mechanical transducer elements (L2).
4. Distinguish between active and passive transducers (L2).
5. Explain mechanical intermediate modifying systems (L2).
6. Explain a simple current-sensitive circuit (L2).
7. Describe in detail a ballast circuit (L2).
8. Explain the method of measuring included angle of two adjacent faces of a component using clinometers (L3).
9. Illustrate the principle of inter-ferometry (L3)
10. Explain the principle of Autocollimator and Optical flats (L2)

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

1. Explain the analytical balance (L2).
2. Explain the working principle of a platform balance (L3).
3. Explain the working of proving ring (L2).
4. Define a dynamometer. List all types of dynamometers (L1).
5. Explain the working principle of prony brake dynamometer. (L3)
6. Explain with examples the way terminating devices provide information (L2).
7. Explain the construction and important parts of a CRO (L3)

1. Determination of material properties from stress-strain curves obtained from tensile tests.
2. Predict the critical strength for the given structure under different loading conditions.
3. Prove the Bending moment equation through experimentation.
4. Conclude how bending moment in the structure decides shape of the structure.
5. Prove the torsion equation through experimentation.
6. Conclude how torsion in the structure decides shape of the structure.
7. Understand the relationship between hardness and the grain structure of the specimen.
8. To determine the Brinell Hardness Number,Rockwell Hardness Number and Vicker's hardness number of metal specimens.
9. To find the ultimate tensile strength of the metal specimens from the Brinell Hardness Number by using empirical relationships.
10. To compare the empirically obtained tensile strength of the metals with their actual ultimate tensile strength obtained from tensile test
11. Identify the Importance of the shear strength in the failure theories.
12. Predict the materials behavior under shear loading conditions.
13. Design how to carry out experiment to find spring characteristics
14. To find the energy absorbed in fracturing Mild Steel and Cast Iron specimens.
15. To compare the energy absorbed in fracturing cantilever beam and simply supported beam
16. Compute the impact strength
17. Predict the material behaviour under impact loading condition
18. Familiarize with methods for toughness measurement with impact tests
19. Know the importance of the wear parameters

Review Questions

1. Determine the grain size of the given specimen
2. Determine the hardness of the given material before and after heat treatment
3. Distinguish between destructive and non destructive testing methods
4. Determine the tensile properties of the given specimen and compare theempirically obtained tensile strength of the metals with their actual ultimate tensile strength obtained from tensile test

5. Determine the Compression properties of the given specimen To compare the empirically obtained tensile strength of the metals with their actual ultimate tensile strength obtained from tensile test
6. Determine the shear strength of the given specimen

7. Determine the torsional strength of the given specimen
8. Determine the Bending properties of the given specimen
9. Determine the charpy and Izode impact strength
10. Find the wear coefficient of given specimen

Lesson Plan
Part-A

1. Preparation of specimen for Metallographic examination of engineering materials and study the microstructure of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze.
2. Study and demonstration of different Heat treatment: Annealing, normalizing, hardening and tempering of steel & to study their Rock-well hardness.
3. Study and demonstration of
   a) Fatigue test
   b). Ultrasonic flaw detector
   c). Magnetic crack detector
d). Dye penetrate testing

Lesson Plan
Part-B

1. Tension test and compression test on mild steel and cast Iron
2. Bending Test on mild steel and timber
3. Torsion tests on circular sections
4. Hardness test on mild steel, cast iron, aluminium etc.,
5. Shear test on mild steel
6. Test on helical springs- Determination of spring modulus and rigidity modulus
7. Impact test (Charpy and Izod) on cast iron and mild steel
8. Experiment on wear study

UNIT-4. Measurement of Force, Torque, and terminating devices: Principle, analytical balance, platform balance proving ring, torque measurement, types of dynamometers prony brake, Hydraulic dynamometer, Eddy current dynamometer. Mechanical, digital read out devices, ultra-violet recorders, servo-recorders cathode ray oscilloscope, Oscillographs, X-Y plotters

10 Hrs

UNIT-5.Strain Measurement, Pressure Measurement and Temperature Measurement: Strain gauge, preparation and mounting of strain gauges, gauge factor, Methods of strain measurement Principle, use of elastic members, bridge man gauge, Mc leod gauge, thermal conductivity gauge, (pirani gauge and thermocouple vacuum gauge) ionization gauge, Resistance thermometers, thermocouple, law of thermocouple, thermocouple circuits, thermocouple materials, pyrometers, optical pyrometer.
10 Hrs

TEXT BOOKS:

1) R.K. JAIN, Engineering Metrology - Khanna Publishers, New Delhi.
2) R.C. GUPTA, Engineering Precision Metrology - Khanna Publishers, New Delhi.
3) D.S.KUMAR, Mechanical Measurements and Control - Metropolitan Book Co.Pvt.Ltd, New Delhi.

REFERENCES:

1) ASTME- Hand book of Industrial Metrology - PHI
2) K.J. HUME, Engineering Metrology - Third (metric) Edition - Kalyani publishers.
3) BECKWITH, BUCK & MARAN-GONI, Mechanical Measurements - Narosa publishing House.
4) DOEBELIN, Measurement systems - Application a Design, (4th Edition) - McGraw Hill.

Course Outcomes

After learning all the units of the course, the student is able to

- Facilitate students to calibrate various measuring instruments.
- Provide familiarization with the various gauges and measuring instruments generally used in industries.
- Familiarization with measurement systems and related concepts.
- Understanding the use of Instruments in measurement.
- Measurements & Metrology is a fundamental course in BE Automobile Engineering program, where student learn necessary and applications of measurement and metrology, different standards of measurement. The course gives the students an understanding of characteristics and fundamental elements of measuring system.
- The course gives the students an understanding of principles of various measurements like force, torque pressure temperature and strain.

Course Code : P13AU42	Semester : IV	L - T - P : 4 - 0 - 0
Course Title : Measurements and Metrology		
Contact Period: Lecture: 52 Hr, Exam: 3 Hr	**Weightage: CIE:50; SEE:50**	

Prerequisites : The student should have undergone the courses on Engineering Physics (code: P13PH12), Engineering Mechanics (code: P13CV13), Basic Electrical Engineering (code: P13EE15) and Engineering Mathematics (code: P13MA11)

Course Learning Objectives (CLOs)

This course aims to

1.Describe various standards and measurements of fundamental quantities.

2.Explain and perform calibration of various measuring instruments like Comparators and Angular measuring Instruments.

3.Discuss transducers. Intermediate modifying devices and Interferometer.

4.Explain the measurement of Force, Torque and terminating devices. Calibrate the instruments to measure force and torque,

5. Describe strain, pressure and temperature measurement. Calibrate the instruments to measure temperature and pressure.

Course Content

UNIT-1.Measurements, Measurement Systems and Standards of Measurement: Definition, significance of measurement, generalized measurement system, definition and concept of accuracy, precision, sensitivity, Calibration, threshold, hysteresis, repeatability, linearity, loading effect, system response, time delay, errors in measurement, classification of errors. Definition and objectives of metrology, Standard of length- International prototype meter, Imperial standard yard, Wave length standard, Subdivision of standards, line and end standard, comparison, Transfer from line standard to end standard, calibration of end bars (Numerical) 11 Hrs

UNIT-2. Comparators and Angular Measurements: Introduction to Comparator, Characteristics, Classification of Comparators, Sigma comparators, dial indicators, optical comparators, principles, ziess ultra optimeter, Electric and electronic comparators –principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Bevel protractor. Sine principle, use of sine bars, sine centre, angle gauges (numerical on building of angles) 10Hrs

UNIT-3. Transducers, Intermediate Modifying Devices and Interferometer: Transfer efficiency, primary and secondary transducers, Mechanical, electrical, electronic transducers, advantages of each type of transducers.Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, signal transmission (hydraulic transmission, magnetic transmission, electrical transmission) Clinometers. Principle of interferometry, autocollimator, optical flats 11 Hrs

Course Assessment Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Know and explain about, Preparation of sand specimens for conduction of various tests, various Testing of Moulding sand and Core sand and Use of Different foundry tools and other equipments and sketching of the same	L1, L2		2			2		2	3	2	2	2
Practice and prepare moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes) Apply the knowledge by preparing one casting (Aluminum or cast iron-Demonstration only)	L3	2	2			2		2	3	2	2	2
Know about Use of Different Forging tools and other equipments and explain, sketching of the same Practice and prepare minimum three forged models involving upsetting, drawing and bending operations. Apply the knowledge by preparing at least one forging model by using Power Hammer.	L1, L2, L3	2	2			2		2	3	2	2	2
1 – Low, 2 – Moderate, 3 – High												

Evaluation Scheme

CIE Scheme

Assessment	Weightage in Marks
TEST 1	20
TEST 2	20
RECORD	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 Chapter 1	10Marks
		ONE Question from Chapter 2	30Marks
		ONE Question from Chapter 3	
2	Viva		10 Marks
Total Marks			50 Marks

Evaluation Scheme

CIE Scheme

Assessment	Weightage in Marks
TEST 1	20
TEST 2	20
RECORD	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	10Marks
		Two Questions from part-B	30Marks
2	Viva		10 Marks
Total Marks			50 Marks

Course Code : P13AUL38	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 : Basics of Manufacturing Processes and their classification, like Sand Moulding, Sand and die Casting Forging and Forging process at smith's shop

Course Learning Objectives (CLOs)

This Course aims to

1. Know and explain about Preparation of sand specimens for conduction of various tests and sketching of the same – L1,L2
2. Know and explain about various Testing of Moulding sand and Core sand sketching of the same –L1,L2
3. Know about Use of Different foundry tools and other equipments and explain, sketching of the same –L1,L2
4. Practice and prepare moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes) – L3
5. Apply the knowledge by preparing one casting (Aluminum or cast iron-Demonstration only) – L3
6. Know about Use of Different Forging tools and other equipments and explain, sketching of the same –L1,L2
7. Practice and prepare minimum three forged models involving upsetting, drawing and bending operations – L3
8. Apply the knowledge by preparing at least one forging model by using Power Hammer – L3

Course Content

Part-A

Unit-1. Testing of Moulding sand and Core sand

Preparation of sand specimens and conduction of the following tests:
Compression, Shear and Tensile tests on Universal Sand Testing Machine.
Permeability test
Core hardness & Mould hardness tests.
Grain fineness number test (Sive Analysis test)
Clay content test.
Moisture content test **9 hrs**

Unit-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).
Preparation of one casting (Aluminum or cast iron-Demonstration only) 12hrs

Unit-3. Forging Operations

Preparing minimum three forged models involving upsetting, drawing and bending operations.
Out of these three models, at least one model is to be prepared by using Power Hammer. **15 hrs**

Course Articulation Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Prepare material specimen for metallographic studies and recognize the micro structural features of material.	L3	M	M			L		L		M	M	M
Determine the mechanical properties of different materials	L4	M	M			M		L		M	M	M
Determine the wear coefficient of material	L2	M	M			M				M	M	M
Determine the variation in properties before and after heat treatment of metal specimens	L2	M	M			L				L	M	M
Demonstrate fatigue test.	L1	L	L						L	L	L	L

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
Prepare material specimen for metallographic studies and recognize the micro structural features of material.	L3	2	2			1		1		2	2	2
Determine the mechanical properties of different materials	L4	2	2			2		1		2	2	2 2
Determine the wear coefficient of material	L2	2	2			2				2	2	2
Determine the variation in properties before and after heat treatment of metal specimens	L2	2	2			1				1	2	2
Demonstrate fatigue test.	L1	1	1						1	1	1	1

Text Books:

1. Hajra Choudhary S. K., Bose S. K., Hajra Choudhary A. K.Elements of Workshop Technology - 2007 Media promotors and publishers pvt. Limited

2.B S Raghuwanshi, Course in Workshop Technology, Dhanpat Rai and Company(P) Limited, 2009

Reference Books:

1. R.k Jain, Production Technology, Khanna Publ., 2012
2. W. A. J. Chapman, William Arthur James Chapman, Workshop Technology,Edward Arnold, 1975

Course Outcomes

After learning all the units of the course, the student is able to

1. Know and explain about, Preparation of sand specimens for conduction of various tests, various Testing of Moulding sand and Core sand and Use of Different foundry tools and other equipments and sketching of the same – L1,L2
2. Practice and prepare moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes) Apply the knowledge by preparing one casting (Aluminum or cast iron-Demonstration only) – L3
3. Know about Use of Different Forging tools and other equipments and explain, sketching of the same Practice and prepare minimum three forged models involving upsetting, drawing and bending operations. Apply the knowledge by preparing at least one forging model by using Power Hammer –L1,L2, L3

Topic Learning objectives

After learning all the units of Unit-1, the student is able to

1. Sketch and define about function & application of various hand tools used in Foundry and Forging applications
2. Learning about preparation of Foundry and Forging models
3. Know about Preparation of sand specimens and Interpret by conduction of the tests of Moulding sand and Core sand for applications.

After learning all the units of Unit-2, the student is able to

1. learn about Use of foundry tools and other equipments
2. Practice and learn about preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).
3. Practice and learn about Preparation of one casting (Aluminum or cast iron)

After learning all the units of Unit-3, the student is able to

1. Practice and learn about Preparing minimum three forged models involving upsetting, drawing and bending operations and use of Power Hammer.

Course Articulation Matrix (CAM)

Course Outcomes (COs)		Program Outcome (ABET/NBA-(3a-k))										
		a	b	c	d	e	f	g	h	i	j	k
Know and explain about, Preparation of sand specimens for conduction of various tests, various Testing of Moulding sand and Core sand and Use of Different foundry tools and other equipments and sketching of the same	L1, L2		M			M		M	H	M	M	M
Practice and prepare moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes) Apply the knowledge by preparing one casting (Aluminum or cast iron-Demonstration only)	L3	M	M			M		M	H	M	M	M
Know about Use of Different Forging tools and other equipments and explain, sketching of the same Practice and prepare minimum three forged models involving upsetting, drawing and bending operations. Apply the knowledge by preparing at least one forging model by using Power Hammer.	L1, L2, L3	M	M			M		M	H	M	M	M
L – Low, M – Moderate, H - High												

Review Questions

1. what is shear strength?
2. what is tensile strength of a material?
3. what is compressive strength?
4. what is the difference between strength of a material and stress in a material?
5. what is the use of conducting permeability test on a specimen?
6. How many types of sand are there which are used in the foundry and forging lab?
7. what is grain fineness number?
8. what are the types of hammers used?
9. what are blacksmith's tongs?
10. what is the composition of the moulding sand?
11. what is the use of cope and drag?
12. what are the types of cores?
13. what is theuse of a core?
14. what are the types of moulding processes? What is the definition of casting?
15. What is a metal casting?
16. What kind of metal is used in castings?
17. What are common uses for castings?
18. What do metal castings cost?
19. What is the application for the casted part?
20. What are the dimensions of the part to be cast?
21. What are the metallurgical requirements for the casted product?
22. Are their mechanical stresses or thermal factors required for the casted product?
23. How many metal castings are required?
24. What type of finishing work is required after the cast is complete?
25. How are castings made?
26. What are “green sand” castings?
27. What are the differences between wrought iron vs. cast iron?
28. What is the difference between a foundry and casting?
29. List the tools and equipment used in foundry.
30. List the Hand tools used in Foundry. Define Hand Forging.
31. Define Power Forging.
32. Small components are forged by which method?
33. Mention the tool and equipment used in hand forging.
34. What are the advantages of forging?
35. Mention the types of fire prepared in smith’s forge.
36. What do you mean by Open fire?
37. What is meant by stock fire?
38. Mention the role of Anvil during forging.
39. Body of anvil is made of which material?
40. What is the use of Horn in Anvil?
41. What are Swage Block?
42. What is the function of Swage Block?
43. Swage Block is made from which material?
44. What is the function of Hammers?
45. From which material Hammers are made?
46. List the classification of hammers.

Lesson Plan

Unit-1

1. Study of hand tools- sketching, materials used and their applications,
2. Demonstration of preparation of Moulds and casting,
3. Demonstration of preparation of smithy models
4. Preparation of sand specimens and conduction of the following tests:
   - Compression, Shear and Tensile tests on Universal Sand Testing Machine.
   - Permeability test
   - Core hardness & Mould hardness tests.
   - Grain fineness number test (Sive Analysis test)
   - Clay content test.
   - Moisture content test.

Unit-2

1. Use of foundry tools and other equipments. Preparation of moulds using two moulding boxes without patterns
2. Preparation of moulds using two moulding boxes without patterns
3. Preparation of moulds using two moulding boxes without patterns
4. Preparation of moulds using patterns (Split pattern, Match plate pattern and Core boxes).
5. Preparation of one casting (Aluminum or cast iron-Demonstration only)

Unit-3

1. Pointers :Declaration and Initialization of pointer variable, Address arithmetic
2. Pointers and arrays
3. Character Pointers and functions (strings)
4. Pointer Arrays, Command line arguments
5. Pointers to functions
6. Review

Model Paper

1. what is the composition of the moulding sand?
2. what is the use of cope and drag?
3. what are the types of cores?
4. what is the use of a core?
5. what are the types of moulding processes?
6. For the given Exercise, Using of foundry tools and other equipments, Prepare a mould using two moulding boxes using patterns or without patterns.

OR

1. For the given Exercise, Using of forging tools and other equipments, Prepare a forging model.