SYLLABUS

(With effect from 2015-2016 Academic year)

ಪಠ್ಯಕ್ರಮ

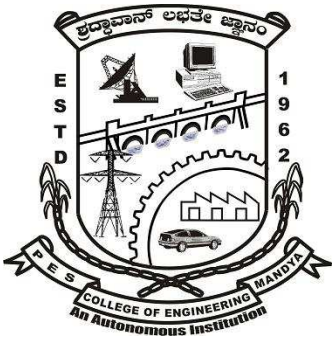
(ಶೈಕ್ಷಣಿಕವರ್ಷ 2015–16)

III & IV Semester

Bachelor Degree
in

MECHANICAL ENGINEERING

Out Come Based Education
with
Choice Based Credit System



P.E.S. College of Engineering

Mandya - 571 401, Karnataka
(An Autonomous Institution Affiliated to VTU, Belagavi)
Grant -in- Aid Institution
(Government of Karnataka)
Accredited by NBA, New Delhi
Approved by AICTE, New Delhi.

ಪಿ.ಇ.ಎಸ್. ತಾಂತ್ರಿಕ ಮಹಾವಿದ್ಯಾಲಯ
ಮಂಡ್ಯ–571 401, ಕರ್ನಾಟಕ
(ವಿ.ಟಿ.ಯು, ಬೆಳಗಾವಿ ಅಡಿಯಲ್ಲಿನ ಸ್ವಾಯತ್ತ ಸಂಸ್ಥೆ)

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Preface

PES College of Engineering, Mandya, started in the year 1962, has become autonomous in the academic year 2008-09. Since, then it has been doing the academic and examination activities successfully. The college is running Eight undergraduate and Eight Postgraduate programs. It consists of Six M.Tech programs, which are affiliated to VTU. Other postgraduate programs are MBA and MCA.

India has recently become a Permanent Member by signing the Washington Accord. The accord was signed by the National Board of Accreditation (NBA) on behalf of India on 13th June 2014. It enables not only the mobility of our degree globally but also establishes equivalence to our degrees with that of the member nations such as Taiwan, Hong Kong, Ireland, Korea, Malaysia, New Zealand, Russia, Singapore, South Africa, Turkey, Australia, Canada and Japan. Among other signatories to the international agreement are the US and the UK. Implementation of Outcome Based Education (OBE) has been the core issue for enabling the equivalence and of Indian degrees and their mobility across the countries.

Our Higher Educational Institution has adopted the CBCS based semester structure with OBE scheme and grading system.

The credit based OBE semester system provides flexibility in designing curriculum and assigning credits based on the course content and hours of teaching.

The OBE, emphasize setting clear standards for observable, measurable outcomes of programs in stages. There lies a shift in thinking, teaching and learning processes moving towards Students Centric from Teacher Centric education. OBE standards focus on mathematics, language, science, attitudes, social skills & moral values.

The key features which may be used to judge, if a system has implemented an outcome based education system is mainly Standard based assessments that determines whether students have achieved the stated standard. Assessments may take any form, so long as the process actually measure whether the student knows the required information or can perform the required task. Outcome based education is a commitment that all students of all groups will ultimately reach the same minimum standards. Outcome Based Education is a method or means which begins with the end in mind and constantly emphasizes continuous improvement.

Choice Based Credit System (CBCS) provides choice for students to select from the prescribed courses (core, Foundation, Foundation Elective, elective, open elective and minor or soft skill courses). The CBCS provides a 'cafeteria' type approach in which the students can Choose electives from a wide range of courses of their choice, learn at their own pace, undergo additional courses and acquire more than the required credits, adopt an interdisciplinary approach to learning which enables integration of concepts, theories, techniques, and, perspectives from two or more disciplines to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline. These greatly enhance the skill/employability of students.

In order to increase the Industry/Corporate readiness, many Soft Skills and Personality Development modules have been added to the existing curriculum of the academic year 2015-16. Industry Interactions have been made compulsory to enhance the field experience. In order to enhance creativity and innovation Mini Project and Industrial visit & Interaction are included in all undergraduate programs

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Deputy Dean (Academic)
Associate Professor,
Dept. of Automobile Engg

(Dr.P S Puttaswamy)
Dean (Academic)
Professor,
Dept. of Electrical & Electronics Engg.

PES College of Engineering

Vision

"An institution of high repute, imparting quality education to develop innovative and Humane engineers"

Mission

"Committed to develop students potential through high quality teaching- learning processes and state of the art infrastructure"

Department of Mechanical Engineering

ABOUT THE DEPARTMENT

The department of Mechanical Engineering was established in the year 1962 during the origination of the institute. The department was granted academic autonomy in the year 2009. The department presently offers B.E in Mechanical Engineering, M Tech in Computer Integrated Manufacturing (CIM), M Tech in Machine Design, M.Sc., (Engg.) by research and research leading to Ph.D. The present intake capacity of the department is 120 for BE, 18 for M Tech CIM and 24 for M Tech Machine Design. The department has a faculty-student ratio of 1:15 for UG courses and 1:12 for PG courses. The department has well established laboratories to meet the academic requirements of UG and PG programmes and a skilled technical faculty to train the students. The department has its own library which has a collection of about 3160 reference books.

The department regularly organizes industrial visits, technical lectures by experts from industries and institutes in contemporary areas to bridge the gap between syllabi and current developments. The students are encouraged to undergo industrial training as well as to take up industry oriented projects during their academic course. Mechanical Engineering Association, formed by the students and faculty of the department regularly organizes co-curricular and extracurricular activities for the students.

Vision

"Be a department well recognized for its ability to develop competent mechanical engineers"

Mission

"To provide quality education, essential technical skills and inculcate sense of higher education, by competent faculty, adequate infrastructure and necessary industry interaction"

Program Educational Objectives (PEOs)

The Department of Mechanical Engineering, PES College of Engineering, is dedicated to graduating mechanical engineers who:
PEO1: Use the fundamentals of basic science, mathematics and mechanical engineering, to pursue their career as engineers as well as to lead and manage teams in public and private sector organizations.
PEO2: Pursue advanced education, research and development and engage in the process of life-long learning.
PEO3: Develop their career as entrepreneurs in a responsible, professional and ethical manner to serve the society.

Programme Outcomes

	By the time of graduation, students will have:
1	Ability to apply fundamentals of science, mathematics and engineering to solve problems related to mechanical engineering.
2	Ability to identify, analyze and solve problems related to mechanical systems.
3	Ability to design mechanical components, systems and processes considering economic and safety aspects.
4	Ability to carry out experimental investigations/simulations, interpret data and arrive at meaningful conclusions.
5	Ability to use the techniques, skills, and modern engineering tools necessary for engineering practices.
6	Ability to use contextual knowledge to understand the impact of technology on public health and safety.
7	Ability to recognize the need for sustainable solutions and their influence on environment.
8	An understanding of professional and ethical responsibility.
9	Ability to work individually and in multidisciplinary teams by applying interpersonal skills.
10	Ability to communicate in oral, written, and graphical forms.
11	Ability to apply management principles and to lead multidisciplinary teams to execute projects.
12	Ability to recognize the changes and advancements in technology and engage in life-long learning by adapting to the changes.

EVALUATION SCHEME							
Scheme	**Weightage**	**Marks**	**Event Break Up**				
CIE	50%	50	**Test I**	**Test II**	**Quiz I**	**Quiz II**	**Assignment**
			35	35	5	5	10
SEE	50%	100	**Questions to Set: 10**		**Questions to Answer: 5**		
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 number of subdivisions in each main question shall be limited to three only
- Number of questions to be answered by students is 5

III Semester B.E. (ME)			**Scheme of Teaching and Examination**					
Sl. No.	**Course Code**	**Course Title**	**Teaching Dept.**	**Hrs/Week L:T:P:H**	**Total Credit**	**Examination Marks**		
						CIE	**SEE**	**Total**
1.	P15MAT31	Engineering Mathematics-III	Maths	3:2:0:5	4	50	50	100
2.	P15ME32	Material Science & Metallurgy	Mechanical	4:0:0:4	4	50	50	100
3.	P15ME33	Fluid Mechanics	Mechanical	3:2:0:5	4	50	50	100
4.	P15ME34	Manufacturing Process- I	Mechanical	4:0:0:4	4	50	50	100
5.	P15ME35	Basic Thermodynamics	Mechanical	4:0:0:4	4	50	50	100
6.	P15ME36	Computer Aided Machine Drawing	Mechanical	0:0:6:6	3	50	50	100
7.	P15MEL37	Fluids Measurement Lab	Mechanical	0:1:2:3	1.5	50	50	100
8.	P15MEL38	Foundry & Forging Lab	Mechanical	0:1:2;3	1.5	50	50	100
9	P15HUDIP39	Comprehensive Communication Development(CCD)	HS & M	2:0:0:2	[2]	[50	[50]	[100]
10	P15HU39	**Aptitude and Reasoning Development - BEGINNER (ARDB)	HS&M	2:0:0:2	0	(50)	--	--
12	P15MADIP31	*Additional Maths-I	Maths	4:0:0:4	0	--	---	---
13	P15HMDIP310	* Indian Constitution, Human Rights & Professional Ethics	Human& Science	2:0:0:2	0	--	---	---
Total					26 [28]	400 [450]	400 [450]	800 [900]

*** Additional Mathematics-I & Indian Constitution, Human Rights & Professional Ethics: <u>Lateral entry students</u> shall have to pass these mandatory learning courses before completion of VI- Semester**
**** ARDB: <u>All students</u> shall have to pass this mandatory learning courses before completion of VI- Semester**

IV Semester B.E. (ME)			**Scheme of Teaching and Examination**					
Sl. No.	**Course Code**	**Course Title**	**Teaching Dept.**	**Hrs/ Week L:T:P:H**	**Total Credit**	**Examination Marks**		
						CIE	**SEE**	**Total**
1.	P15MAAC41+	Engineering Mathematics-IV	Maths	3:2:0:5	4	50	50	100
2.	P15ME42	Applied Thermodynamics	Mechanical	4:0:0:4	4	50	50	100
3.	P15ME43	Mechanical Measurements & Metrology	Mechanical	4:0:0:4	4	50	50	100
4.	P15ME44	Mechanics of Materials	Mechanical	3:2:0:5	4	50	50	100
5.	P15ME45	Kinematics of Machinery	Mechanical	4:0:0:4	4	50	50	100
6.	P15ME46	Manufacturing Process –II	Mechanical	4:0:0:4	3	50	50	100
7.	P15MEL47	Metrology & Measurements Laboratory	Mechanical	0:1:2:3	1.5	50	50	100
8.	P15MEL48	Basic Material Testing Laboratory	Mechanical	0:1:2:3	1.5	50	50	100
9	P15HU49	Aptitude and Reasoning Development – Intermediate (ARDI)	HS&M	2:0:0:2	1	50	50	100
10	P15MADIP41	*Additional Maths-II	Maths	4:0:0:4	0	--	--	--
11	P15EVDIP410	*Environmental Studies	ENV	2:0:0:2	0	--	--	--
Total					27	450	450	900

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

Evaluation Scheme							
<u>Scheme</u>	**Weightage**	**Marks**	**Event Break Up**				
<u>CIE</u>	50%	50	**Test I**	**Test II**	**Quiz I**	**Quiz II**	**Assignment**
			35	35	5	5	10
SEE	50%	100	**Questions to Set: 10**		**Questions to Answer: 5**		

Course Title: Engineering Mathematics-III			
Course Code: P15MA31	**Semester: III**	**L – T – P – H : 3– 2 – 0 – 5**	**Credits: 04**
Contact Period - Lecture: 52Hrs.; Exam: 3Hrs.		**Weightage: CIE: 50 %;**	**SEE: 50%**

Prerequisites: The student should have acquired the knowledge of Engineering Mathematics-I & II of I and II semester B.E.

Course Learning Objectives (CLOs):
The course P15MA31 aims to:

1. Describe the concepts of elementary numerical analysis such as forward/backward finite differences, central differences, interpolation and extrapolation formulae, techniques of numerical differentiation and integration.
2. Explain the nature of periodic functions Fourier series of general as well as even /odd functions valid in full range/half-range periods along with applications through practical harmonic analysis.
3. Learn modeling in terms of partial differential equations and also, learn different exact/analytical methods of solving with special emphasis on interpretation of the solution of one-dimensional wave, heat and Laplace equations with given initial and boundary conditions in the context of various engineering and technological applications.

Relevance of the course:
Engineering Mathematics-III deals with the Numerical methods to solve interpolation and extrapolation problems in engineering field.
In Fourier series analyze engineering problems arising in control theory and fluid flow phenomena using harmonic analysis
Analyze the engineering problems arising in signals and systems, digital signal processing using Fourier transform techniques.
Z-transforms & Z-transforms of standard functions to solve the specific problems by using properties of Z-transforms.
Identify and solve difference equations arising in engineering applications using inverse Z–transforms techniques
Partial Differential Equations (PDE's), order, degree and formation of PDE's and, to solve PDE's by various methods of solution.
One – dimensional wave and heat equation and Laplace's equation and physical significance of their solutions to the problems selected from engineering field

Course Content

UNIT-I

Numerical Methods-I: Finite differences**:** Forward and Backward differences, Gregory-Newton forward and backward interpolation formulae, Newton's divided difference formula, Lagrange's interpolation formula and inverse interpolation formula .(All formulae without proof) – problems.
Central differences: Gauss Forward and Backward difference formulae, Stirling's, and Bessel's formulae (All formulae without proof) – Illustrative problems. **10 Hrs**

UNIT-II

Numerical differentiation using Newton's forward and backward interpolation formulae, Newton's divided difference formula and Stirling's formula (All formulae without proof)- problems only and Applications to Maxima and Minima of a tabulated function.

Numerical integration: Newton- Cotes quadrature formula, Trapezoidal rule, Simpson's $(\frac{1}{3})^{rd}$ rule, Simpson's $(\frac{3}{8})^{th}$ rule, Boole's rule and Weddle's rule (All rules without proof)- Illustrative problems. **10 Hrs**

UNIT-III

Fourier series: Periodic functions, Fourier series- Euler's formula, Dirichlet's conditions. Fourier series of discontinuous functions, Fourier series of even and odd functions. Change of interval- Fourier series of functions of arbitrary period. Half–range Fourier series expansions, Fourier series in complex form, Practical harmonic analysis – Illustrative examples from engineering field. **11 Hrs**

UNIT-IV

Fourier Transforms: Infinite Fourier transforms-properties. Fourier sine and Fourier cosine transforms, properties. Inverse infinite Fourier and inverse Fourier sine & cosine transforms – problems. Convolution theorem, Parseval's identities for Fourier transforms (statements only).

Difference equations and Z-transforms: Definition of Z-transforms – standard Z – transforms, linearity property, damping rule, shifting rules, initial value theorem and final value theorem (All rules and theorems without proof). Inverse Z – transforms. Difference equations- basic definitions. Application of Z-transforms to solve difference equations

10 Hrs

UNIT-V

Partial differential equations (PDE's):

Formation of PDE's. Solution of non homogeneous PDE by direct integration. Solutions of homogeneous PDE involving derivative with respect to one independent variable only (both types with given set of conditions). Method of separation of variables (first and second order equations). Solution of the Lagrange's linear PDE's of the type: $Pp + Qq = R$.

Applications of PDE's:

One – dimensional wave and heat equations (No derivation), and various possible solutions of these by the method of separation of variables. D'Alembert's solution of wave equation. Two dimensional

Laplace's equation (No derivation)–various possible solutions. Solution of all these equations with specified boundary conditions (Boundary value problems). Illustrative examples from engineering field. **11 Hrs**

Text Books:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi,42^{nd} Ed. 2012.

2 .Advanced Engineering Mathematics: - E. Kreyszig, John Wiley & Sons, 6^{th} Ed.2007.

References:

1. Advanced Modern Engineering Mathematics:- Glyn James,Pearson Education Ltd., 3rd Ed., 2007.

2. Peter V O' Neil – Advanced Engineering Mathematics, Thomson Brooks/Cole ,5th edition,2007.

Note: - Each unit contains ***two*** full questions of ***20 marks*** each. Students are required to answer ***five*** full questions choosing at least ***one*** question from each unit.

Course Outcomes

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

1. Apply forward, backward difference formulae and central differences formulae in solving interpolation- extrapolation problems in engineering field.
2. Apply Numerical differentiation and integration rules in solving engineering where the handling of numerical methods is inevitable.
3. Recognize the importance of Fourier series & Fourier transforms, difference equations and Z-transforms in the field of signals and systems, communication and network theory signal and image processing, control theory, flow & heat transfer and theory of elasticity.
4. Learn modeling in terms of partial differential equations and also, learn different exact/analytical methods of solving with special emphasis on interpretation of the solution.
5. Interpret the solution of one-dimensional wave, heat and Laplace equations with given initial and boundary conditions in the context of various engineering and technological applications.

Engineering Mathematics-III(P15MA31)

Time - 3Hrs Max. Marks- 100

Note: Answer any FIVE full questions choosing at least one full question from each unit

Model Question Paper	Marks	CO's	Levels
UNIT- I			
1. a) Find the missing values in the following data:			
x | 0 | 1 | 2 | 3 | 4 | 5 | 6 y | 5 | 11 | 22 | 4 | __ | 140 | __	6	1	L1
b) The table gives the distances in nautical miles of the visible horizon for the given heights (in feet) above the earth's surface: x = height | 100 | 150 | 200 | 250 | 300 | 350 | 400 y = distance | 10.63 | 13.03 | 15.04 | 16.81 | 18.42 | 19.9 | 21.27	7	1	L2
Find the values of y when $x = 410\ ft$.	7	1	L2
c) Given $u_{20} = 24.37, u_{22} = 49.28, u_{29} = 162.86$ and $u_{32} = 240.5,$ find u_{28} by Newton`s divided difference formula.			
2. a) Use Lagrange interpolation to fit a polynomial to the following data. x | 0 | 1 | 3 | 4 y | -12 | 0 | 6 | 12 Hence find f (1.5) and f(5).	6	1	L2
b) Using Gauss backward difference formula, find y(8) from the following table: X: 0 5 10 15 20 25 Y: 7 11 14 18 24 32	7	1	L2
c) Using sterlings formula find y_{35} given $y_{20} = 512,\ y_{30} = 439,\ y_{40} = 346,\ y_{50} = 243$	7	1	L3

UNIT- II			
3 a).Given the data x | -2 | -1 | 0 | 1 | 2 | 3 y | 0 | 0 | 6 | 24 | 60 | 120 Compute $y''(2)$ and $y''(4)$	6	2	L3
b) Find the $f''(6)$ from the following data X: 0 2 3 4 7 8 Y: 4 26 58 112 466 922 using Newton's divided difference formula	7	2	L3
c) The table below reveals the velocity v of a body during the specific time t , Find the acceleration at t=1.1 t: 1.0 1.1 1.2 1.3 1.4 v: 43.1 47.7 52.1 56.4 60.8	7	2	L3
4 a) Find the approximate value of $\int_0^{\pi/2} \sqrt{\cos\theta}\, d\theta$ by Simpson's $1/3^{rd}$ rule by dividing $[0,\ \pi/2]$ into 6 equal parts.	6	2	L2
b) Use Boole's formula to compute $\int_0^{\pi/2} e^{\sin x}\, dx$	7	2	L2
c) Evaluate $\int_0^1 \frac{x\,dx}{1+x^2}$ by Weddle's rule taking seven ordinates and hence find $\log_e 2$.	7	2	L2

UNIT- III

5. (a) If f(x)= x(2π – x) in 0≤ x ≤ 2π, obtain the Fourier series of f(x)	6	3	L2
(b) Find a Fourier series in $[-\pi,\pi]$ to represent $f(x)=x-x^2$. Hence deduce that $\frac{1}{1^2}-\frac{1}{2^2}+\frac{1}{3^2}-\frac{1}{4^2}+\cdots\cdots=\frac{\pi^2}{12}$.	7	3	L2
(c) Draw the graph of the function $f(x)=\begin{cases}\pi x, & 0\le x\le 1\\ \pi(2-x), & 1\le x\le 2\end{cases}$ and Express f(x) as a Fourier series	7	3	L3
6 (a) Obtain the complex Fourier series of $f(x)=\begin{cases}0, & 0<x<l\\ a, & l<x<2l\end{cases}$ over $[0,2l]$.	6	3	L2
(b) Find the cosine half range series for $f(x)=x(l-x);\ 0\le x\le l$	7	3	L3
(c) Express y as a Fourier series up to the third harmonic given the following data:	7	3	L3

x	0	π/3	2π/3	π	4π/3	5π/3	2π
y	1.98	1.30	1.05	1.30	-0.88	-0.25	1.98

UNIT- IV

7. (a) Find the Fourier transform of $f(x)=\begin{cases}1-x^2, & \lvert x\rvert<\alpha\\ 0, & \lvert x\rvert\ge\alpha\end{cases}$ and hence find the value of $\int_0^\infty \frac{x\cos x-\sin x}{x^3}dx$	6	4	L2
(b) Find the Fourier sine transform of f(x) = $e^{-\lvert x\rvert}$ and hence evaluate $\int_0^\infty \frac{x\sin mx}{1+x^2}dx,\ m>0$.	7	4	L2
(c) Solve the integral equation $\int_0^\infty f(x)\cos\alpha x dx=e^{-a\alpha}$.	7	4	L3
8. (a) Obtain the Z-transform of cos nθ and sin nθ.	6	4	L1
(b) Compute the inverse Z-transform of $\frac{3z^2+2z}{(5z-1)(5z+2)}$	7	4	L2
(c) Solve by using Z-transforms: $y_{n+2}+2y_{n+1}+y_n=n$ with $y_0=0=y_1$.	7	4	L3

UNIT- V

9 (a). Form the partial differential equations by elimination of arbitrary function in $f(x^2+2yz, y^2+2xz)=0$.	6	5	L1
(b). Solve by the method of separation of variables $4\frac{\partial u}{\partial x}+\frac{\partial u}{\partial y}=3u$ given that $u(0,y)=2e^{5y}$.	7	5	L3
(c). Solve: $(mz-ny)p+(nx-lz)q=(ly-mx)$.	7	4	L2
10 (a) Find the various possible solutions of the one dimensional heat equation $\frac{\partial u}{\partial t}=c^2\frac{\partial^2 u}{\partial x^2}$ by the method of separation of variables	10	5	L3
(b) Solve the wave equation $\frac{\partial^2 u}{\partial t^2}=c^2\frac{\partial^2 u}{\partial x^2}$ subject to the conditions $u(0,t)=0,\ u(l,t)=0$ for $t\ge 0$ and $u(x,0)=0,\ \frac{\partial u}{\partial t}(x,0)=x(l-x),\ 0\le x\le l$.	10	5	L3

Course Title: Material Science and Metallurgy			
Course Code: P15ME32	**Sem: 03**	**L –T-P-H: 4:0:0:4**	**Credit: 04**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Knowledge of Engineering Physics and Engineering Chemistry.

Course Objectives: This course aims to facilitate the students to acquire basic knowledge about lattice arrangement of atoms in materials, their mechanical behavior, properties, characterization, different advanced heat treatment processes and phase diagrams. Finally it helps students to expose to information on corrosion, non ferrous materials and environmental issues.

Course Content

Unit -1

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

Unit - 2

Concepts of Stress and Strain: Tensile properties, true stress and true strain, Hardness, Rockwell, Vickers and Brinell hardness testing, plastic deformation - slip and twinning.

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

10 hrs

Unit- 3

Solid Solution and Phase Diagrams: Solid solutions, Rules governing formation of solid solutions, Phase diagram- Basic terms, phase rule, cooling curves, construction of Phase diagrams, interpretation of equilibrium diagrams, Types of Phase diagrams, Lever rule.

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

10 hrs

Unit - 4

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

Unit -5

Corrosion: Galvanic cell, the electrode potentials, polarization, passivation.

General methods of corrosion prevention, cathode protection, coating corrosion prevention by alloying, stress corrosion cracking.

Engineering Alloys: Properties, composition and uses of low carbon, mild medium & high carbon steels. Steels designation & AISI –SAE designation. Cast irons, gray CI, white CI, malleable CI, SG iron. Microstructures of cast irons.

Light alloys: Al, Mg & Titanium alloys. Copper & its alloys: brasses & bronzes.

10 hrs

Text books

1. Willian D. Callister Jr., **"Materials Science and Engineering – an Introduction"**, John Wiley India Pvt.Ltd, New Delhi, 6th Edition, 2006, ISBN: 978-0471736967
2. Donald R. Askeland, Pradeep, **"Essentials of Materials For Science and Engineering"**, CL Engineering,2nd Edition, 2006, ISBN: 978-0495244462

References

1. James F. Shackel ford, **"Introduction to Material Science for Engineering",** 6th edition Pearson, Prentice Hall, New Jersy, 2006.
2. V. Raghavan, **"Physical Metallurgy, Principles & Practices",** PHI 2nd Edition, New Delhi, 2006, ISBN: 978-8120330129

Smith, **"Foundations of Materials Science and Engineering"** 3rd Edition McGraw Hill, 1997

Course Outcomes

At the end of the course the students should be able to:

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

Model question paper

Note: i) Answer any ***FIVE*** full questions, selecting at least ***ONE*** full question from each **unit**.
ii) Missing data, if any, may be suitably assumed

UNIT - I

1.	(a)	Define unit cell. List and explain different types of unit cell	10
	(b)	Define atomic packing factor and calculating APF of HCP unit cell	10
2.	(a)	Define Line Imperfection. With neat sketches explain different types of Line Imperfection	10
	(b)	Explain diffusion laws and factors affecting on atomic diffusion	10

UNIT - II

3.	(a)	Explain the properties in plastic region in conventional stress-strain diagram of mild steel	12
	(b)	Write a note on true stress and true strain	8
4.	(a)	Explain plastic deformation by slip	10
	(b)	With neat sketch explain the different stages of cup and cone fracture	10

UNIT – III

5.	(a)	Define solid solution and explain rules governing for formation of solid solution	10
	(b)	Explain different types of phase diagram	5
	(c)	Explain phase lever rule	5
6.	(a)	Explain the effect of alloying element on CCT diagram	10
	(b)	Draw a neat schematic Fe-C equilibrium diagram and explain the phases	10

UNIT - IV

7.	(a)	Explain the Aus and mar tempering with the help of neat sketches	10
	(b)	With neat sketch explain the different types of annealing	10
8.	(a)	Define Hardenability. Explain with a neat sketch the Jominy-End-Quench test	10
	(b)	With schematic representation explain the Induction Hardening	5
	(c)	With schematic representation explain the Pack Carburising	5

UNIT - V

9.	(a)	With neat schematic representation explain the galvanic cell	8
	(b)	Note down the uses of different carbon steel	8
	(c)	Classify steel according to AISI	4
10.	(a)	Explain general methods of corrosion prevention	10
	(b)	Explain polarization and passivation	10

Course Title: Fluid Mechanics			
Course Code: P15ME33	**Sem: 03**	**L –T-P-H: 3:2:0:5**	**Credit: 04**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Students should have acquired the knowledge of Engineering Mathematics – I & II (P15MA11/21) and Engineering Mechanics (P15CV13/23).

Course Objectives: The course aims to cover the basic principles and equations of fluid mechanics and their applications to the various engineering fields involving fluid flow problems so as to motivate the students to use fluid mechanics in engineering practice.

Course Content

Unit – 1

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

Unit -2

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

Unit -3

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

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

Unit -4

Flow past immersed bodies: Drag, lift, expression for lift and drag, pressure drag and friction drag, boundary layer concept. Displacement thickness, momentum thickness and energy thickness. **Flow Through Pipes:** Frictional losses in pipe flow, Darcy and Chezy equations for loss of head due to friction in pipes, hydraulic gradient & total energy line. **10 hrs**

Unit -5

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

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

Text books

1. Dr. Jagadish Lal **"Fluid Mechanics and Hydraulics"** Metropolitan Book Co. Pvt. Ltd, New Delhi, 2002, ISBN: 9788120002722
2. Dr. R.K.Bansal, "**Fluid mechanics and hydraulic machines"** Laxmi publications Ltd., New Delhi. 9th edition, 2015, ISBN: 9788131808153.

References

1. K. W. Bedford, Victor Streeter, E. Benjamin Wylie **"Fluid Mechanics"** Tata Mcgraw Hill Education Private Limited, 9th edition, 1997, ISBN: 9780070625372
2. Dr.K.L.Kumar, **"Engineering Fluid Mechanics"** S Chand Lltd., 2010, ISBN: 9788121901000
3. Dr.R.J.Garde and Dr.A.J.Mirajgaonkar **"Engineering Fluid Mechanics"** ScitechPublications (India) Chennai,2010, ISBN: 9788188429011.
4. Frank M.White **"Fluid Mechanics"** Tata Mcgraw Hill Education Private Limited, 7th edition, 2011, ISBN: 9780071333122

Course Outcomes

At the end of the course the students should be able to:

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

Model question paper

Note: i) Answer any ***FIVE*** full questions, selecting at least ***ONE*** full question from each **unit**.
ii) Missing data, if any, may be suitably assumed

UNIT - I

1 a. Explain following properties of fluids and giving their units
i) Density
ii) Specific weight
iii) Viscosity 6

b. State and Prove Pascal's law. 8

c. The dynamic viscosity of an oil, used for lubrication between a shaft and sleeve is 6 poise. The shaft is of diameter 0.4 m and rotates at 190 rpm. Calculate the power lost in the bearing for a sleeve length of 90 mm. the thickness of the oil film is 1.5 mm. 6

2 a. Explain surface tension. 4

b. What is capillarity? and Derive an expression for capillary rise. 6

c. Calculate the capillary rise in a glass tube of 2.5 mm diameter when immersed vertically in (a) water and (b) mercury. Take surface tensions σ = 0.0725N/m for water and σ = 0.52 N/m for mercury in contact with air. The specific gravity for mercury is given as 13.6 and angle of contact = 130^o 10

UNIT - II

3 a. Derive an expression for total pressure and centre of pressure in inclined plane surface submerged in liquid. 10

b. A Differential manometer is connected at the two points A and B of two pipes as shown in Fig..The pipe A contains a liquid of sp.gr.=1.5 while pipe B contains a liquid of sp.gr.=0.9. The pressure at A and B are 1 kgf/cm^2 and 1.80 kgf/cm^2 respectively. Find the difference in mercury level in the differential manometer. 10

4 a. Write a note on stability of submerged bodies. 6

b. Explain following:
(i) Buoyant force
(ii) Meta centre 4

c. A block of wood of specific gravity 0.7 floats in water. Determine the meta-centric height of the block of its size is 2m X 1m X 0.8 m. 10

UNIT - III

5 a. Differentiate between following types of fluid flow
(i) Laminar and turbulent flow
(ii)Uniform and non uniform flow 4

b. Derive an expression for continuity equation in three dimensions Cartesian co-ordinate system. 8

c. The velocity vector in a fluid flow is given by $V= 4x^3i-10x^2yj+2tk$. Find the velocity and acceleration of a fluid particle at (2, 1, 3) at time t=1. 8

6 a. Explain working principle of (i) Orifice meter and (ii) Pitot tube 4

b. State and derive Bernoulli's equation from fundamental principle. 8

c. A horizontal Venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of oil of sp.gr.0.8.The discharge of oil through venturimeter is 60 litres/s. Find the reading of the oil-mercury differential manometer. Take C_d=0.98. 8

UNIT - IV

7 a. Explain following:
(i) Boundary layer concept
(ii) Terminal velocity of a body 6

b. Derive an expression for Energy thickness. 6

c. Experiments were conducted in a wind tunnel with a wind speed of 50 km/hour on a flat plate of size 2m long 1m wide. The density of air is 1.15 kg/m^3. The coefficient of lift and drag are 0.75 and 0.15 respectively. Determine: (a) lift force (b) drag force (c) the resultant force (d) Power exerted by air on the plate. 8

8 a. Derive Darcy-Weisbach equation for loss of head due to friction in pipes. 10

b. An oil of sp.gr. 0.7 is flowing through a pipe of diameter 300 mm at the rate of 500 litres/sec. find the head lost due to friction and power required to maintain the flow for a length of 1000 m.Take v=0.29 stokes. 10

UNIT - V

9. a. Derive Hagen Poisuille's equation. 10

b. An oil of viscosity 0.1 Ns/m^2 and relative density 0.9 is flowing through a circular pipe of diameter 50 mm and of length 300 m. The rate of flow of fluid through the pipe is 3.5 litres/sec. find the pressure drop in a length of 300 m and also the shear stress at the pipe wall. 10

10 a. Explain following types of dimensionless numbers.
(i) Reynold's number
(ii) Weber's number
(iii) Mach's number
(iv) Euler's number 8

b. Using Buckingham's π- theorem, show that the discharge Q consumed by an oil ring is given by $Q = Nd^3\phi\left[\frac{\mu}{\rho Nd^2}, \frac{\sigma}{\rho N^2 d^3}, \frac{w}{\rho N^2 d}\right]$ where d is the internal diameter of the ring, N is rotational speed, ρ is density, μ is viscosity, σ is surface tension and w is the specific weight of oil. 12

Course Title: Manufacturing Processes -I			
Course Code: P15ME34	**Sem: 03**	**L –T-P-H: 4:0:0:4**	**Credit: 04**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Students should have acquired the knowledge of elementary science and Elements of Mechanical Engineering (P15ME14/24)

Course objective: This course aims to facilitate the students to acquire basic knowledge about Casting and Welding process which are most essential for the manufacturing process of engineering components.

Course Content

Unit -1

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

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

11 hrs

Unit -2

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

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

Unit -3

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

11 hrs

Unit -4

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

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

10 hrs

Unit -5

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

Text books

1. P.N.Rao, **"Manufacturing & Technology: Foundry Forming and Welding"**,Tata McGraw Hill, 2nd Edition, 2013, ISBN: 9789383286614
2. Dr.K.Radhakrishna, **"Manufacturing Process-I",** 5th Ed ,Sapna Book House, 2006, ISBN: 8128002074

References

1. Serope Kalpakjian & Steven R Schmid, **"Manufacturing Engineering and Technology",** Pearson Education Asia, 4th Edition, 2002, ISBN: 9788177581706
2. Roy A Lindberg, "**Process and Materials of Manufacturin**g",Prentice Hall, 4th Edition, 1998, ISBN: 9780205118175

Course Outcomes

At the end of the course the students should be able to:

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

Model question paper

Note: i) Answer any ***FIVE*** full questions, selecting at least ***ONE*** full question from each **unit**.
ii) Missing data, if any, may be suitably assumed

UNIT - I

1 a. Define manufacturing process? Discuss the factors to be considered in the selection of a process for production. 10
b. List out the advantages and limitations of casting process. 10
2 a. Classify various steps involved in making of casting process. 10
b. With a neat diagram explain the working principle of electric arc furnace. 10

UNIT - II

3 a. Define pattern? Explain different types of pattern allowances with necessary sketches .12
b. With a neat sketch explain blind risers. 8
4 a. How are pattern classified? Explain with neat sketch
i) Match plate pattern ii) Gated pattern 12
b. Explain the need for an additive in moulding sand. Mention the types of additive used for different requirements. 8

UNIT - III

5 a. With a neat sketch explain the different steps involved in Shell moulding process and mention it's advantages and it's limitations. 10
b. Explain Thixocasting process with a neat sketch. 10
6 a. Explain with neat sketches
i) Pressure – die casting ii) Gravity –die casting . 10
b. Explain with a neat sketch Centrifugal casting process mention it's advantages and it's limitations. 10

UNIT - IV

7 a. Explain with a neat sketch Tungsten Inert Gas [TIG] welding process. 10
b. With a neat sketch explain Resistance welding. List out its advantages and limitations. 10
8 a. With a neat sketch explain SAW process. 10
b. Explain with a neat sketch Explosive welding process. 10

UNIT - V

9 a. Write the formation of different zones during welding with a help of neat diagram. 8
b. Explain the different welding defects and also give causes and remedy. 12

10 a. What do you understand by the term HAZ? Explain the parameter affecting HAZ 12
b. Discuss factors affecting weldabillity of metals. 8

Course Title: Basic Thermodynamics			
Course Code: P15ME35	**Sem: 03**	**L –T-P-H: 4:0:0:4**	**Credit: 04**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Knowledge of elementary science of PUC (10+2) level, Engineering Physics (P15PH12/22) and Engineering Mathematics-I (P15MA11/21)

Course Objectives: The course aims at to cover the basic principles of thermodynamics, to give students a feel for how thermodynamics is applied in engineering practice and to develop an intuitive understanding of thermodynamics by emphasizing the physics and physical arguments.

Course Content

Unit -1

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 (No numerical). Thermodynamic definition of work, sign convention and examples to illustrate the definition of work. Work done at the system boundary, process equation and expressions for work done in different processes.

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

Unit -2

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

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

Unit -3

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

10 hrs

Unit -4

Second Law of Thermodynamics: Thermal reservoir. Source and sink. Heat engine, heat pump and refrigerator. Efficiency and coefficient of performance. Kelvin – Planck and Clausius statement of the Second law of thermodynamics and equivalence of the two

Statements. Definition of perpetual motion machines of II kind with example. Reversible and Irreversible processes, factors that makes a process irreversible. Reversible heat engine - Carnot Cycle and expression for efficiency of Carnot cycle. Simple numerical problems on heat engines and heat pumps. **10 hrs**

Unit -5

Entropy: Clausius Inequality: Statement, and proof. Entropy: Definition, entropy as a property of the system. Principle of increase of entropy. Entropy as a quantitative test for irreversibility. Expression for entropy using T-dS relations, Calculation of entropy changes in different thermodynamic cyclic process. Equation of state, internal energy and enthalpy. Universal and characteristic gas constants, specific heats. Simple numerical problems based on heat, work, internal energy, enthalpy and entropy change in various processes. **11 hrs**

Text books

1. P .K. Nag, **"Basic and Applied Thermodynamics"** Tata McGraw Hill, 3rd Edition, 2006, ISBN: 9780070260627
2. R K Rajput, "**Engineering Thermodynamics"** Laxmi Publications Pvt Ltd, 3rd Edition, 2011, ISBN: 9789380298405
3. Mahesh M Rathore, "**Thermal Engineering**" McGraw Hill Pvt Ltd., 1st Edition, New Delhi, 2010, ISBN: 9780070681132

References

1. Spalding and Cole, "**Engineering Thermodynamics"** ELBS Publications, 1985, ISBN: 9780713133141
2. Yunus A. Cenegal, "**Thermodynamics – An engineering approach"** Tata McGraw Hill, Featured Edition, 2001, ISBN: 9780072383324
3. Van and Wylen, "**Fundamentals of Classical Thermodynamics"** Wiley Eastern limited, 2nd Edition, 1976, ISBN: 9780471902294
4. Domkundwar, Kothandaraman "**A course in Thermal Engineering**" Dhanpat Rai & Co., New Delhi, 2004, ISBN: 9788177000214

Course Outcomes

At the end of the course the students should be able to:

1. **Understand** the basic concepts and definitions used in engineering thermodynamics.
2. **Apply** the first laws of thermodynamics and the concepts of thermodynamics to basic energy systems.
3. **Understand** the properties of pure substances.
4. **Understanding** of the second law of thermodynamics and analysis in different applications
5. **Calculate** entropy for various simple real life systems

Model Question Paper

Note: i). Answer FIVE full questions, selecting ONE from each unit
ii). Use of Thermodynamics data book is allowed
iii). missing data (if any) may be suitably assumed.

Unit I

1 a. Distinguish between the following with example
i. Open and Closed system
ii. Extensive and Intensive property
iii. Path function and Point function **06**

b. State and explain Zeroth Law of Thermodynamics **04**

c. A spherical balloon having a radius of 30cm contains air at a pressure of 1.5 bar. The radius increases to 40 cm due to heating and during the process the pressure is inversely proportional to diameter. Calculate the magnitude and direction of work. **10**

2 a. Distinguish between the following with example
i. Microscopic and Macroscopic approaches of Thermodynamics
ii. Process and Quasi static process
iii. Mechanical and Thermodynamic definition of work **06**

b. Obtain an expression for displacement work **04**

c. A fluid contained in a horizontal cylinder of diameter 60cm is fitted with a frictionless leak proof piston. The fluid is stirred for 10 min. during which piston moves slowly outwards through 80cm against the atmospheric pressure of 1 bar. The net work done by the fluid during the process is 8.5 KJ. If the speed of the motor driving the stirrer is 800 rpm. Determine shaft power and the torque. **10**

Unit II

3 a. State precisely the First law of thermodynamics for a closed system undergoing a process & hence prove that Internal energy is a property of the system **10**

b. Centrifugal Compressor delivers 960 kg of air per hour. Air enters the compressor with a velocity of 16 m/sec & specific volume of 0.5 m^3/kg & leaves with a velocity of 8 m/sec & specific volume of 0.16m^3/ kg. The suction & delivery pressure are 1 bar & 7 bar respectively. While passing through the compressor the enthalpy increases by 170 KJ/kg & heat loss to the surrounding is 750 KJ/min. The inlet & discharge are at same level. Determine a) Power required to drive the compressor. b) Ratio of inlet pipe diameter to outlet pipe diameter. **10**

4 a. Drive SFEE and state the assumption made. **6**

b. With an example State the limitations of first law of thermodynamics **4**

c. 0.2m^3 of air initially at a temperature 200^oC & 10 bar pressure is expanded according to law
$PV^n = C$ untill volume becomes 0.8m3 & temperature reduces to 20 ^oC. Calculate i) Work done ii) Heat transfer & iii) Change in enthalpy. Take R = 287.14 J/kg K **10**

Unit III

5 a. With a neat sketch explain separating and throttling calorimeter **8**

b. Define pure substance ,Triple point, critical point and saturated vapour **4**

c. 1 kg of steam at 18 bar & at 300℃ undergoes a constant pressure process until its quality becomes 50%. Find the work done, change in enthalpy, heat transfer, and change in internal energy. **8**

6 a. Sketch and explain p–v–T surface and projections for a substance
i) That contracts on freezing.
ii) That expands on freezing **10**

b. The following observations were taken with a separating and a throttling calorimeter arranged in series.
Water separated = 2Kg, steam discharged from throttling calorimeter = 20.5 kg, temperature of steam after throttling =110 ^{o}C, initial pressure =012bar abs, barometer = 760mm of Hg, final pressure = 5mm of Hg. Take C_{ps} = 2kJ/kg K. Estimate the quality of steam supplied **10**

Unit IV

7 a. State two statements of Second law of thermodynamics and Show that they are equivalent **10**

b. A heat pump is used in a house for heating in winter & cooling in summer. It is desired to maintain the house at 25 ^{o}C throughout the year. The heat losses from the roof & walls of the house is estimated to be 50 kw per degree temperature difference between inside and outside. The temperature is 5 ^{o}C in winter and 35 ^{o}C in summer. Find the power required to operate the device in summer & winter. **10**

8a. Define Reversible & irreversible process & mention the factors which render a process irreversible **8**

b. A reversible heat engine operates between two reservoirs at temperature of 600 ^{o}C and 40 ^{o}C. The engine drives a reversible refrigerator which operates between reservoirs at temperature of 40 ^{o}C and -20 ^{o}C. The heat transfer to the heat engine is 2000 kJ and the net work output of the combined engine refrigerator plant is 360kJ. Evaluate the heat transfer to the refrigerant and net heat transfer to the reservoir at 40 ^{o}C. **12**

Unit V

9 a. Using the increase in entropy principle, show that the direction of heat transfer must be from a higher temperature body to a body at a lower temperature. **10**

b. 300kJ/s of heat is supplied at a constant fixed temperature of 290 ^{o}C to a heat engine. The heat rejection takes place at 8.5 ^{o}C. the following results were obtained

i. 215kJ/s are rejected
ii. 150 kJ/s are rejected and
iii. 75 kJ/s are rejected.

Classify which of the result report a reversible cycle or irreversible cycle or impossible results **10**

10 a. Using T ds relation obtain expression for change in entropy of an ideal gas **6**

b. State and prove Clausius inequality **6**

c. An insulated cylinder of capacity 4 m3 contains 20 kg of air. Peddle work is done on the air by stirring till its pressure increases from 4 bar to 8 bar. Determine i) Change in internal energy ii) work done iii) Heat transferred iv) Change in entropy. Take C_p = 1.005 kJ / kg k, C_v =0.718 kJ / kg k. **8**

Course Title: Computer Aided Machine Drawing			
Course Code: P15ME36	**Sem: 03**	**L –T-P-H: 0:0:6:6**	**Credit: 03**
Contact Period: Lecture: 78 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Students should have acquired elementary knowledge of computer and knowledge of Computer Aided Engineering Drawing (P15MED14/24).

Course Objectives: The course aims at empowering the students with drafting skills and strengthens their ability to draw, read and interpret machine part/assembly using computer and relevant software and following standards codes and norms.

Course Content

Unit- 1

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

Unit -2

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

Unit -3

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

Unit -4

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

Unit -5

Assembly Drawings
Solids of Protrusion, Assembly drawing of following machine parts (3D parts to be created and assemble and then getting 2D drawing with required views, including part drawing).
Introduction to geometrical dimensioning and tolerance.

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

Text books

1. N.D. Bhat and V.M.Panchal, "**Machine Drawing"**, Charotar Publishing Hous, 46th Edition, 2011, ISBN: 9789380358390
2. N. Siddeshwar, P. Kannaiah and V.V.S. Sastri, "**Machine Drawing"** published by Tata Mc. GrawHill, 2010, ISBN: 9780074603376
3. Tryambaka Murthy, **"Machine Drawing",** CBS Publications, 2nd Edition, 2008, ISBN: 9788123916590

References

1. K.R. Gopala Krishna, "**Machine Drawing"**, Subhash Publication, 1st Edition, 1984.

Course Outcomes

At the end of the course the students should be able to:

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

Evaluation Scheme					
Scheme	**Weightage**	**Marks**	**Event Break Up**		
CIE	50%	50	**Test I**	**Test II**	**Assignment**
			30	30	20
SEE	50%	100 [To be reduced to 50]	**Question No.**	**Maximum Marks**	
			PART-A [unit I & II]	**20**	
			PART-B [unit III & IV]	**20**	
			PART-C [unit V]	**60**	

Scheme of SEE Question Paper (100 Marks)		
Duration: 3Hrs	**Marks: 100**	**Weightage: 50%**
• Each of the questions set shall be comprehensive as to cover the entire contents of the unit. • There will be three parts in total. • There will be direct choice between the Units 1&2 (Part-A) and Units 3&4 (Part-B). There will be internal choice in Unit 5 (Part-C).		

Model Question Paper

Note: -

a. Answer any ONE QUESTION from each part. Sketching of views is mandatory.
b. Use FIRST ANGLE PROJECTION only.
c. Missing data if any may suitably be assumed.
d. Show all calculations on the answer sheet.
e. All the drawings are in mm.
f. In PART – C, Assembled view in 3D and respective sectional views in 2D are compulsory.

PART –A

1. Draw three orthographic views of a machine component shown in Figure-1. **20**

2. Draw two views of hexagonal headed bolt with nut for a 24mm diameter bolt and thread length of 60mm. Take length of the bolt equal to 100mm. **20**

PART – B

3. Draw a KNUCKLE JOINT to connect two rods of 24 mm diameter showing sectional front view and top view. Indicate all the proportions with dimensions. **20**

4. Draw the top view and sectional front view of single riveted butt joint with single cover plate with zig- zag riveting. The thickness of the plate is 12 mm. show at least three rivets. Indicate all the dimensions. Use snap headed rivets. **20**

PART – C

5. Figure-2 Shows the details of MACHINE VICE. Assemble the parts and draw the following views: Show the dimensions.
(i) Front view showing right half in section and (ii) Top view **60**

6. Details of a PLUMMER BLOCK are shown in Figure-3. Assemble the parts and draw the following views of the assembly. Show the dimensions.
(i) Front view with top half section. (ii) Top view **60**

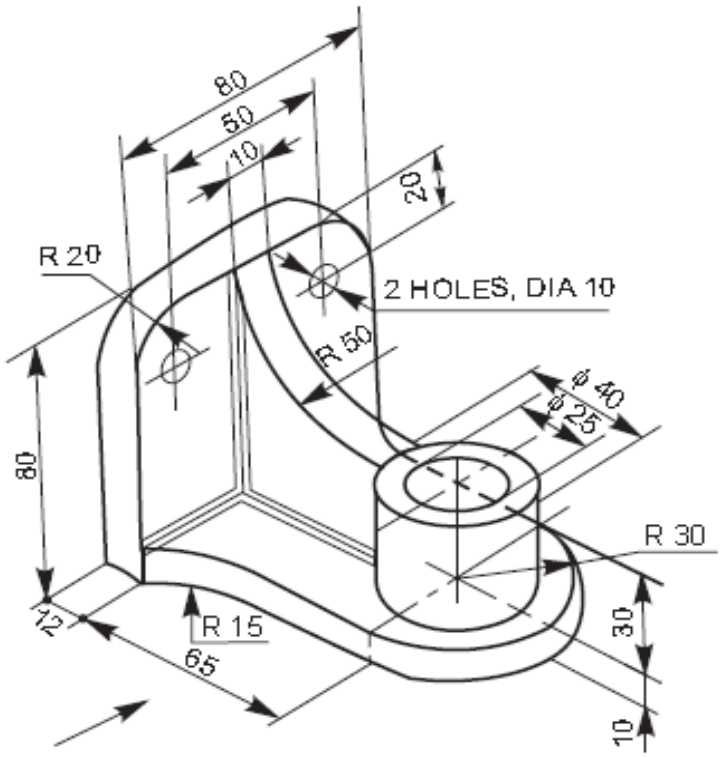

Fig-1: Machine Component

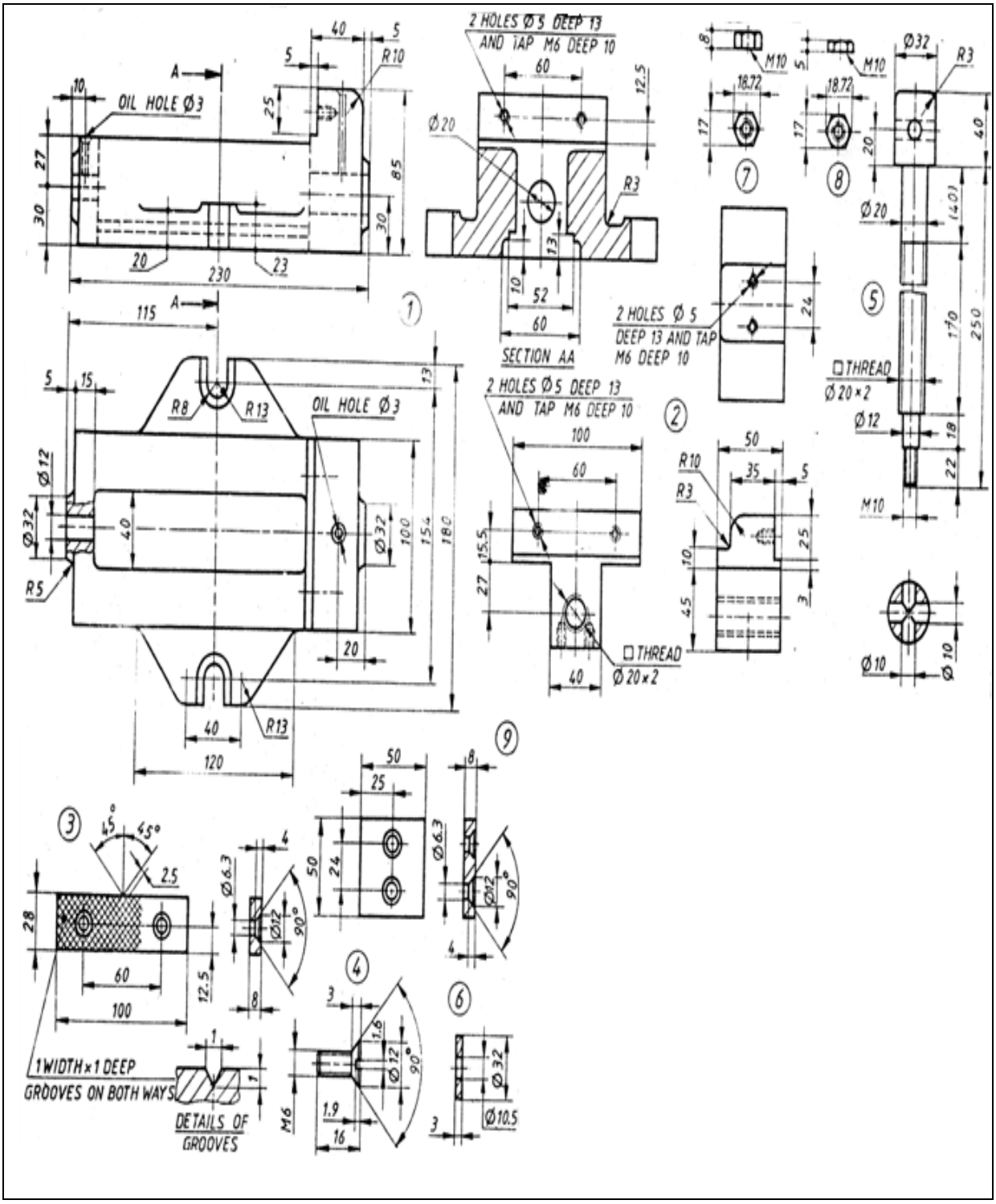

Fig-2: Machine Vice

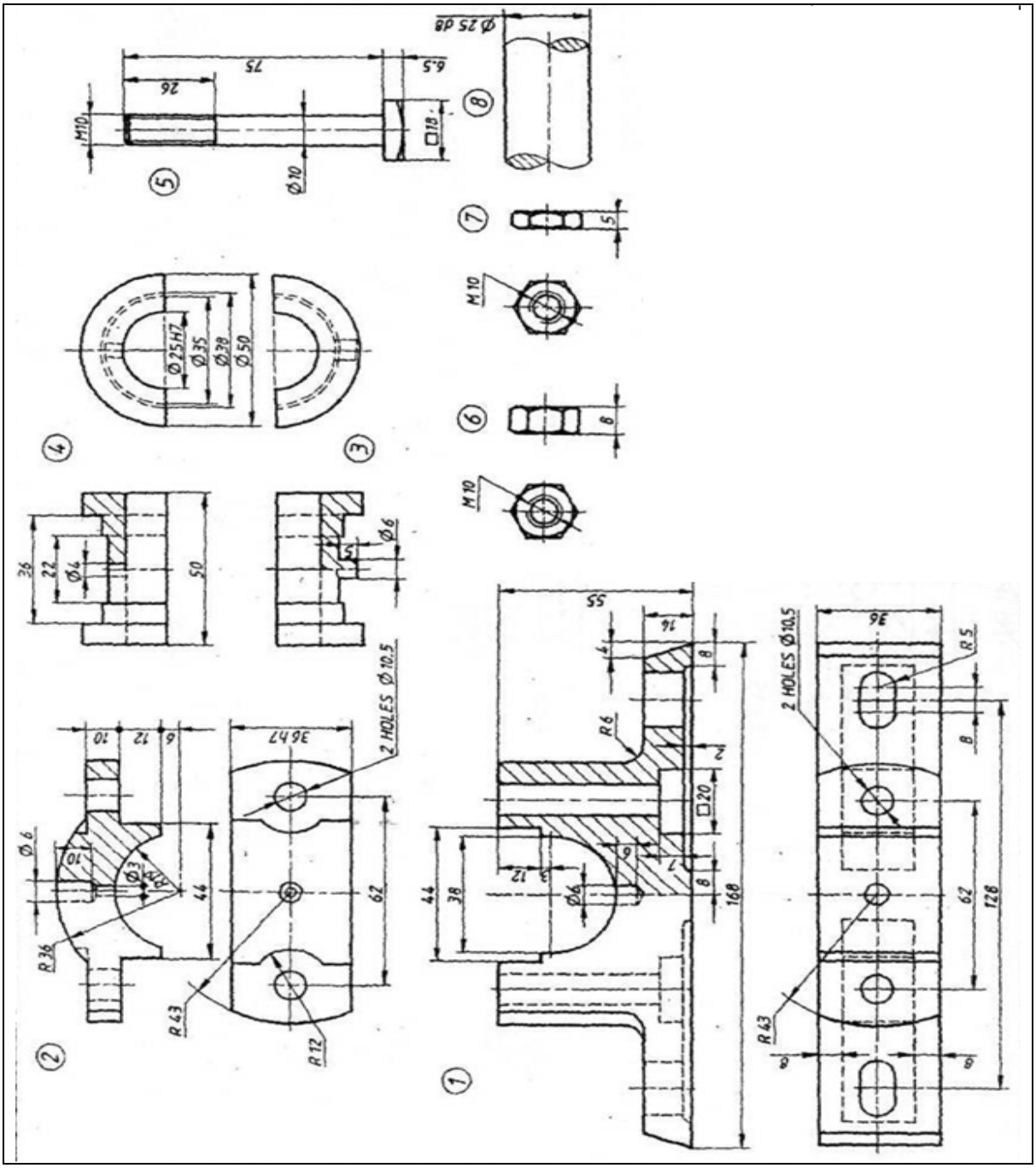

Fig-3: Plummer Block

Prerequisites & Equivalents for Courses of 2015-16						
Sl. No.	**Prerequisites Course 2015-16**		**Course of Regulations 2015-16**		**Equivalent Course for 2013-14**	
	Code	**Title**	**Code**	**Title**	**Code**	**Title**
1	P15MED14/24	Computer Aided Engineering Drawing	P15ME36	Computer Aided Machine Drawing	P13ME36	Computer Aided Machine Drawing

Course Title: Fluids Measurement Laboratory			
Course Code: P15MEL37	**Sem: 03**	**L –T-P-H: 0:0:3:3**	**Credit: 1.5**
Contact Period: Lecture: 36 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Knowledge of Fluid Mechanics (P15ME33) and Basic Thermodynamics (P15ME35).

Course objective: The course aims at enabling the students to understand the basic measurement techniques of fluid flow, fuels and lubricants properties.

Course Content

PART-A

Exp-1
Calibration of venturi meter and determination of its co-efficient of discharge **3Hrs**

Exp-2
Calibration of orifice meter and determination of its co-efficient of discharge **3Hrs**

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

Exp-4
Determination of coefficient of friction in flow through pipes. **3Hrs**

Exp-5
Determination of vane efficiency (Coefficient of impact) for different vanes. **3Hrs**

PART-B

Exp-6
Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Apparatus. **3Hrs**

Exp-7
Determination of Viscosity of lubricating oil using Redwoods, Saybolts and Torsion Viscometers. **3Hrs**

Exp-8
Determination of Calorific value of solid fuel using Lewis Thomson calorimeter. **3Hrs**

Exp-9
Determination of Calorific value of gaseous fuels using Junkers Gas calorimeter. **3Hrs**

Seminar **6Hrs**

Test **3Hrs**

References

1. Dr. Jagadish Lal **"Fluid Mechanics and Hydraulics"** Metropolitan Book Co. Pvt. Ltd, New Delhi, 2002, ISBN: 9788120002722
2. Dr. R.K.Bansal, "**Fluid mechanics and hydraulic machines"** Laxmi publications Ltd., New Delhi. 9th edition, 2015, ISBN: 9788131808153.
3. P .K. Nag, **"Basic and Applied Thermodynamics"** Tata McGraw Hill, 3rd Edition, 2006, ISBN: 9780070260627

Course Outcomes

At the end of the course the students should be able to:

1. **Calibrate** venturimeter, orificemeter and V-notch.
2. **Determine** friction coefficient for fluid flow in pipes.
3. **Determine** the efficiencies of vertical, inclined and curved vanes.
4. **Determine** Flash point, Fire point and viscosity of lubricating oil.
5. **Determine** Calorific value of solid and gaseous fuels

Evaluation Scheme					
Scheme	**Weightage**	**Marks**	**Event Break Up**		
CIE	50%	50	**Test**	**Record**	**Seminar/Mini Project**
			20	20	10
SEE	50%	50			

Scheme for Examination	
One Question from Part –A	20 Marks
One Question from Part -B	20 Marks
Viva – Voice	10 Marks
Total	**50 Marks**

Course Title: Foundry and Forging Laboratory			
Course Code: P15MEL38	**Sem: 03**	**L –T-P-H: 0:0:3:3**	**Credit: 1.5**
Contact Period: Lecture: 36 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Knowledge of Materials Science and Metallurgy (P15ME32) and Manufacturing Process-I (P15ME34).

Course objective: The course aims at enabling the students to have practical knowledge about preparation of components through sand casting and forging processes.

Course Content

PART-A

Exp-1
Use of foundry tools and equipments. **3Hrs**

Exp-2
Preparation of moulds using two boxes.
Use of patterns: split pattern, match plate pattern and cores. Mould cavity volume calculations. **6Hrs**

Exp-3
Preparation of casting: Aluminium or cast iron (demonstration only). **6Hrs**

PART-B

Exp-4
Use of forging tools and equipments. **3Hrs**

Exp-5
Preparing minimum three models involving upsetting, drawing and bending operations, along with length and volume calculations. **12Hrs**

Seminar **3Hrs**
Test **3Hrs**

References

1. Serope Kalpakjian & Steven R Schmid, **"Manufacturing Engineering and Technology",** Pearson Education Asia, 7th edition, 2013, ISBN: 978-0133128741.
2. P. N. Rao, **"Manufacturing Technology: Foundry Forming and Welding"** 2nd Ed., Tata McGraw Hill, 2003.

Course Outcomes

At the end of the course the students should be able to:

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

Evaluation Scheme					
Scheme	**Weightage**	**Marks**	**Event Break Up**		
CIE	50%	50	**Test**	**Record**	**Seminar/Mini Project**
			20	20	10
SEE	50%	50			

Scheme for Examination	
One Question from Part –A	20 Marks
One Question from Part -B	20 Marks
Viva – Voice	10 Marks
Total	**50 Marks**

Course Title: Aptitude and Reasoning Development - BEGINNER. (ARDB)			
Course Code : P15HU39	**Semester : III**	**L - T - P : 0 - 0 - 2**	**Credits: NA**
Contact Period: Lecture: 32 Hrs, Exam: 3 Hrs		**Weightage :CIE:100% - [P/NP]**	

Prerequisites: Basics of mathematics.

Course Learning Objectives (CLOs)

This course aims to

1. Solve the mathematical calculations easily and quickly using the methods of vedic mathematics.
2. Illustrate different examples to learn about percentages effectively.
3. Compare the different types of series.
4. Explain the logic behind solving problems under series such as A.P.,G.P.,H.P.
5. Explain divisibility rules, properties of different types of numbers.
6. Explain methods to find the number of factors and sum of factors.
7. Analyse the concept of power cycle, and find last digit and last two digits.
8. Solve problems involving simple equations and inequalities.
9. Explain Componendo, Dividendo, Invertendo, Alternendo and other terms related to ratio and proportion.
10. Explain the concepts behind the logical reasoning modules such as arrangement, blood relations and directions

Course Content

Unit – I

Sharpen your axe!!

Vedic mathematics:

Viniculum and de- viniculum, subtractions using viniculum .Nikhilum multiplication: For numbers close to base values, multiplication of any two digit numbers or three digits number using criss cross method. Finding the square, square root, cubes , cube root of two digit and three digit numbers quickly. Approximation in multiplication and division. Checking the answer using digital sum method

Percentage calculations and ratio comparison:

Percentage calculations : Percentage rule for calculating , percentage values through additions, percentage– fraction table, approximation in calculating percentages. Application based problems **Ratio comparison:** calculations method for ratio compressions: 1. the cross multiplication method, 2. percentage value compression method 3. numerator and denominator percentage change method. Method for calculating the value of percentage change in the ratio. Application based problems. **8 Hrs**

Unit – II

Analytical Reasoning 1: series

Number series: Standard patterns of number series, pure series: perfect square, square cube, prime, combination of this series. Difference series, ratio series, mixed series, geometric series, two-tier arithmetic series, three-tier arithmetic series, change in the order for difference series, change in the order for ratio series, sample company questions.

Letter series : Alphabet and Alphanumeric series, finding the missing term based on logic learnt in number series module, continuous pattern series, correspondence series. sample company questions.

Picture series : image analysis, addition deletion rotation or modification of lines or shapes. Understanding the symmetry of the image. Mirror image analysis. sample company questions. **6 Hrs**

Unit – III

Number system:

Introduction, **Integers:** Remainder zero concept, Odd and Even Integers, Negative and positive integers, power number a^x, properties of a perfect square number. **Prime number:** General method to identify the prime number, properties of prime numbers. Euler's number. **Factorial number:** Wilson's theorem, important results on factorial. **Divisor:** number of divisors, sum of divisors, number expressed as the product of two factors.

Divisibility rules: divisibility of a whole number by a whole number, divisibility of an expression by an expression. **Modulus concept:** divisibility rules in modulus, rules of operations in modulus. **Finding one remainder:** One divisor, remainder of $(a^n - b^n)$, remainder for more than one divisor.

Unit digit: Concept of power cycle, finding last two digits**.** Number of trailing zeroes.

6 hrs

Unit – IV

Simple equations, Ratio Proportions and Variations:

Simple equations: Linear equations-Linear equations in one variable, linear equation in two variables, Different methods of solving linear equations in two variables– Method of elimination, Method of substitution, Method of cross multiplication. Format of equations that can be converted to linear equations, Linear equations of three variables, Inequalities and its properties. Advanced problems on Simple equations. Age problems.

Ratio Proportions and Variations: Understanding the meaning and difference between ratio, proportion and variation. Properties of ratio, Comparison of more than two quantities, Proportion, Properties of proportion - Componendo, Dividendo, Invertendo, Alternendo. Continued proportion, Mean proportion. Variation - Direct variation, Indirect variation, Joint variation, Short cut methods to solve problems on variation. **6 hrs**

Unit – V

Building the fundamentals of logical reasoning:

Arrangement:

Approach to tackle questions, Different types of arrangement– Linear arrangement, Circular arrangement. Selection, Double line map. Possible ways of arrangement– Words or numbers, left side only, right side only, left right alternate, increasing or decreasing order, interchange vs push, Strategy for solutions– some tips for quick answers, general strategy.

Directions :

Basics. Pythagorean theorem, Pythagorean triplets, Solving problems for practice.

Blood relations :

Some typical relations that we come across, family tree, Structuring the given problem step by step. Suggested methods– Backtracking, drawing family tree. Problems on blood relations and professions. **6 hrs**

Reference Books:

1. The Trachtenberg speed system of basic mathematics, published by Rupa publications.
2. CAT Mathematics by AbhijithGuha. published by PHI learning private limited.
3. Quantitative aptitude by Dr. R. S Agarwal, published by S.Chand private limited.
4. Verbal reasoning by Dr. R. S Agarwal , published by S. Chand private limited.
5. Quantitative aptitude for CAT by Arun Sharma, published by McGraw Hill publication.
6. Analytical reasoning by M.K Pandey BSC PUBLISHING.CO.PVT.LTD

Course Outcomes

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

1. Solve mathematical calculations in less duration compared to the conventional method. L2
2. Give examples for AP, GP and HP and differentiate between them. L1
3. Apply divisibility rules , power cycle method and evaluate the significance of the number system module. L2
4. Point out the errors in the problems concerning inequalities and solve simple equations and problems based on ratio, proportion and variation. L5
5. Solve the problems based on blood relations, directions and arrangement. L4

Course Title : Additional Mathematics-I (A Bridge course for Diploma qualified students of III Sem. B. E.)			
Course Code : P15MADIP31	**Semester :** III	**L :T:P:H :** 2:2:0:4	**Credits:** NA
Contact Period: Lecture: 52 Hrs,		**Weightage: CIE:**100%, [P/NP]	

Course contents

UNIT -I

Complex Trigonometry: Complex Numbers: Definitions & properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof). Roots of complex number - Simple problems.

Vector Algebra: Scalar and vectors. Vectors addition and subtraction. Multiplication of vectors(Dot and Cross products). Scalar and vector triple products-simple problems.

12Hrs

UNIT -II

Differential Calculus: Review of successive differentiation. Formulae for n^{th} derivatives of standard functions- Liebnitz's theorem(without proof). Polar curves –angle between the radius vector and the tangent pedal equation- Problems. Maclaurin's series expansions-Illustrative examples. Partial Differentiation : Euler's theorem for homogeneous functions of two variables. Total derivatives-differentiation of composite and implicit function. Application to Jacobians, errors & approximations. **10 Hrs**

UNIT -III

Integral Calculus: Statement of reduction formulae for $sin^n x$, $cos^n x$, *and* $sin^m x cos^m x$ and evaluation of these with standard limits-Examples. Differentiation under integral sign(Integrals with constants limits)-Simple problems. Applications of integration to area, length of a given curve, volume and surface area of solids of revolution. **10 Hrs**

UNIT-IV

Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl and Laplacian (Definitions only). Solenoidal and irrotational vector fields-Problems.

10 Hrs

UNIT-V

Ordinary differential equations (ODE's): Introduction-solutions of first order and first degree differential equations: homogeneous**,** exact, linear differential equations of order one and equations reducible to above types. Applications of first order and first degree ODE's - Orthogonal trajectories of cartesian and polar curves. Newton's law of cooling, R-L circuits-Simple illustrative examples from engineering field. **10 Hrs**

Text Book:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi, 42^{nd} Ed. 2012.

References:

1.E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 6^{th} Ed., 2007.
2.N.P.Bali and Manish Goyal: Engineering Mathematics, Laxmi Publishers, 7^{th} Ed., 2007.

Course Title: Indian Constitution, Human Rights and Professional Ethics (A course for Diploma qualified students of III Sem. B. E.)			
Course Code: P15HMDIP310	**Semester :** III	**L-T-P-H:** 2–0-0-0-2	**Credits:** NA
Contact Period : Lecture :26 Hr		**Weightage :** CIE:100% - [P/NP]	

COURSE CONTENT

I. Indian Constitution:

1. Introductory Part - The preamble, Fundamental rights
2. Directive principles of state policy - and fundamental duties
3. The union executive, union legislature and the union judiciary
4. The state executive, state legislature and the high court in the states
5. Special provision for scheduled caste and scheduled tribes
6. Election commission - Functions - Emergency provisions and amendment of the constitution

II. Human rights:

Aims and objectives to create responsible citizenship with awareness of human rights and latest development.

1. Protection of human rights and protection of human rights act - 1993
2. Human right - with related to rights of women, children disabled, tribal's, aged and minorities

III. Professional Ethics:

1. Aims, objects - advantages with national and international, recent development.

4th SEMESTER

Course Title: Engineering Mathematics-IV (Common to AU, CV, ME and IP&E Branches)			
Course Code: P15MAAC41	**Semester: 4**	L – T – P – H : 3– 2 – 0 – 5	Credits: 4
Contact Period - Lecture: 52Hrs.; Exam: 3Hrs.		**Weightage: CIE: 50%; SEE: 50%**	

Prerequisites: The student should have acquired the knowledge of Engineering Mathematics-I, II and III of I, II and III semester B.E.

Course Learning Objectives (CLOs):

This Course aims to;

1. Understand the basics of functions of complex variables, analytic functions, conformal and bilinear transformations, complex integration, line/surface/volume integrals and residue theorems with their scientific/engineering importance
2. Solve algebraic, transcendental and ordinary differential equations arising in various engineering flow and design data problems, using numerical techniques along with physical interpretation of the solutions associated with initial/boundary conditions.
3. Apply the basic tools of statistics to understand curve fitting, moments, skewness, kurtosis, correlation and regression, for frequency distributions; explore the idea of probability, probability distributions, required in the analysis of engineering experiments
4. Apply the basic concepts of probability distributions to understand concept of joint probability and to find expectation covariance, correlation coefficient etc. and to understand probability vector, stochastic matrix etc.
   Understand iterative methods in linear algebra such as Gauss-Jacobi, Gauss -Seidel, Relaxation and Power method and their practical utility in engineering fields.
5. Explain functional and extremal of functionals Euler's equation and applications of calculus of variations to the standard variational problems and basic concepts of reliability theory including failure laws required in the analysis of engineering experiments occurring in engineering fields.
   Obtain series solution of essential ODE's such as Bessel's and Legendre's differential equations and understand their scientific/engineering utility

Relevance of the Course:

Engineering Mathematics-IV deals with Complex analysis. Here we understand the basics of complex variable, analyticity and potential fields through complex potential and conformal transformations interpret the solution in fluid flow and electromagnetic problems.

The process of complex integration and series representation of functions of complex variables in field theory and other Engineering applications.

Solving algebraic, transcendental and ordinary differential equations arising in various engineering flow and design data problems.

In Statistics interpretation and analyzing the data, fitting of curves of best fit for experimental data arising in engineering calculations and analyze the same by expressing in the form of regression lines.

Probability distributions and use them in analyzing and solving engineering problems associated with probability models

Variational problems used in structural engineering, aerospace, ground water flows and environmental fluid dynamics, etc

Understand series solution of ODE's and special functions in engineering fields.

Course Content

UNIT-I

Complex Analysis: Introduction to functions of complex variables. Definitions- limit, continuity and differentiability. Analytic functions. Cauchy–Riemann equations in cartesian and polar forms, properties of analytic functions (No proof). Construction of analytic function: Milne-Thomson

method. Conformal transformation– Definitions Discussion of transformations: $w = z^2$, $w = e^z$, w = $z + 1/z \ (z \neq 0)$ .Bilinear transformations.

Complex integration: complex line integrals. Cauchy's theorem, Cauchy's integral formula. Taylor's and Laurent's series (Statements only). Singularities, poles and residues. Cauchy's residue theorem (statement only). Simple illustrative examples. **11 Hrs**

UNIT-II

Numerical Methods-II: Solution of algebraic and transcendental equations : Bisection Method, Regula-Falsi, Newton–Raphson,Fixed point iteration method: Aitken's Δ^2 - process. - Illustrative examples only.

Numerical solution of ordinary differential equations(ODE's): Numerical solutions of ODE's of first order first degree – Introduction. Taylor's series method. Euler's and modified Euler's method. Runge - Kutta method of IV order –Milne's and Adams predictor and corrector methods (All formulae without proof). **10 Hrs**

UNIT-III

Statistics: Brief review of measures of central tendency and dispersion. Moments, skewness and kurtosis. Curve fitting – least square method

$y = a + bx; y = ax^b, y = ab^x \ and \ y = ax^2 + bx + c$.

Prof. Karl Pearson's coefficient of correlation and lines of regression

Probability Theory: Brief review of elementary probability theory. Random variables (discrete and continuous)-Introduction to probability distributions – probability mass/density functions and cumulative probability density functions – Illustrative examples. Discrete probability distributions – Binomial and Poisson's distributions. Continuous probability distributions - exponential and normal distributions (No derivation of mean and variance for all distributions) - Illustrative examples from engineering and industrial fields. **11 Hrs**

UNIT-IV

Joint probability distributions and Markov chains:

Concept of joint probability. Joint probability distributions of discrete random variables. Expectation, covariance, correlation coefficient – simple examples. Probability vectors, stochastic matrices. Fixed point and regular stochastic matrices.

Linear Algebra-II: Numerical methods for system of linear equations- Gauss-Jacobi and Gauss-Seidel iterative methods. Relaxation method**.** Determination of largest eigen value and corresponding eigen vector by power method. **10 Hrs**

UNIT-V

Calculus of Variations: Variation of a function and a functional, extremal of a functional. Variational problems – Euler's equation. Applications to standard variational problems including geodesics, minimal surface of revolution, hanging chain and brachistochrone problems.

Series solutions of ODE's and special functions: Series solution-Frobenius method. Series solution leading to $J_n(x)$ - Bessel's function of first kind. Expansions for $J_{1/2}(x) and \ J_{-1/2}(x)$. -simple related examples. Series solutions of Legendre's differential equation leading to $P_n(x)$ -Legendre's polynomials. Rodrigue's formula(No Proof)- simple illustrative examples. **10 Hrs**

Text Books:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi, 42nd Ed. 2012.
2. Advanced Engineering Mathematics: - E. Kreyszig, John Wiley & Sons, 10th Ed.,2011

References:

1. Probability – Seymour Lipschutz, Schaum's outline series, McGraw-Hill publications, **2nd Edition, 2002.**
2. **Introductory Methods of Numerical Analysis: - S.S.Sastry, PHI, 3rd Ed.2000**.
3. Advanced Modern Engineering Mathematics:- Glyn James, Pearson Education Ltd., **3rd Edition, 2011.**

Note: - Each unit contains ***two*** full questions of ***20 marks*** each. Students are required to answer ***five*** full questions choosing at least ***one*** question from each unit.

Course Outcomes

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

1. Explain the concept of analyticity and potential fields through complex functional/potential, conformal transformations and interpret the solution in fluid flow and electromagnetic problems and describe the process of complex integration and learn series representation of a function of complex variables, residues and poles.
2. Apply the familiarity of numerical methods for solving algebraic and transcendental equations and demonstrate single-step and multi-step numerical methods for solving ordinary differential equations and interpret the solution in engineering applications.
3. Apply the knowledge of statistics in interpretation the data, fitting of a linear and non-linear curves of best fit for experimental data arising in engineering calculations and analyze the same by expressing in the form of regression lines. And, Illustrate the concept of random variables (discrete/continuous) and related probability distributions and use them in analyzing and solving engineering problems associated with probability models
4. Define the concept of joint probability of two random variables and apply the knowledge of joint probability distribution in interpreting data through statistical measure. And, analyze the notion of higher transition probabilities, the Markov chain and queuing models arising in engineering problems for feasible random events.
   Understand the procedure of numerically solving large systems of linear algebraic equations and obtaining eigen value and eigen vector corresponding to a large eigen vector, with the aid of standard methods of numerical linear algebra.
5. Explain functional and extremal of functionals Euler's equation and applications of calculus of variations to the standard variational problems and basic concepts of reliability theory including failure laws required in the analysis of engineering experiments occurring in engineering fields.
   Obtain series solution of essential ODE's such as Bessel's and Legendre's differential equations and understand their scientific/engineering utility

Engineering Mathematics-IV(P15MAAC41)			
Time- 3Hrs	**Max. Marks- 100**		
Note: Answer any FIVE full questions choosing at least one full question from each unit			
Model Question Paper	Marks	CO's	Levels
UNIT- I			
1 a) If $\phi + i\psi$ represents the complex potential of an electrostatic field where $\psi = (x^2 - y^2) + \frac{x}{x^2 + y^2}$, find ϕ and also the complex potential as a function of the complex variable z.	6	1	L2
b) Discuss the transformation $w = z + 1/z$, $z \neq 0$.	7	1	L3
c) Find the bilinear transformation which maps the points $z = \infty, i, 0$ into $w = -1, -i, 1$. Also find the invariant points of the transformation.	7	1	L3
2 (a) Evaluate $\int_0^{2+i} (\bar{z})^2 dz$ along (i) the line $x = 2y$ (ii) the real axis up to 2 and then vertically to $2+i$.	6	1	L2
b) Expand $f(z) = \frac{z+1}{(z+2)(z+3)}$ as Laurent's series in the regions (*i*) $\lvert z \rvert > 3$ *and* (*ii*) $2 < \lvert z \rvert < 3$.	7	1	L3
c) Evaluate $\int_C \frac{e^{2z}}{(z+1)^2(z-2)} dz$ where C is the circle $\lvert z \rvert = 3$ by Cauchy residue theorem.	7	1	L3

UNIT- II			
3. a) Using Regula–Falsi method find the approximate root of the equation $x log_{10} x = 1.2$ (perform three iterations)	6	2	L2
b) Use Newton – Raphson method to find a real root of $x \sin x + \cos x = 0$ near $x = \pi$. Carry out the iterations upto four decimal places of accuracy.	7	2	L2
c) Find the smallest root of the equation $x^2 + 2x - 2 = 0$, using fixed point iteration method and accelerate the convergence by Aitken's $\Delta^2 -$ method.	7	2	L2
4. (a).From Taylor's series method, find $y(0.1)$ considering upto fourth degree term if $y(x)$ satisfies the equation $\frac{dy}{dx} = x - y^2, y(0) = 1$	6	2	L2
b). Using modified Euler's method find y at $x = 0.2$ given $\frac{dy}{dx} = 3x + \frac{1}{2}y$ with $y(0) = 1$ taking $h = 0.1$. Perform three iterations at each step	7	2	L3
c). Apply Milne's method to compute $y(1.4)$ correct to four decimal places given $\frac{dy}{dx} = x^2 + \frac{y}{2}$ and the data: $y(1) = 2$, $y(1.1) = 2.2156$, $y(1.2) = 2.4649$, $y(1.3) = 2.7514$	7	2	L2

UNIT- III

5. a) The first four moments about an arbitrary value 5 of a frequency distribution are -4, 22, -117 and 560. Find the skewness and kurtosis based on moments. — 6 | 3 | L1

b) Fit a best fitting parabola $y = a + bx + cx^2$, by the method of least squares for the data: — 7 | 3 | L2

x	2	4	6	8	10
y	3.07	12.85	31.47	57.38	91.29

c) The following data gives the age of husband (x) and the age of wife (y) in years. Find the correlation coefficient and hence obtain the regression lines. Also calculate the age of husband corresponding to wife of 16 years age : — 7 | 3 | L2

x	36	23	27	28	28	29	30	31	33	35
y	29	18	20	22	27	21	29	27	29	28

6. a) Find the value of k such that the following distribution represents a finite probability Distribution: — 6 | 3 | L2

x	-3	-2	-1	0	1	2	3
$p(x)$	k	$2k$	$3k$	$4k$	$3k$	$2k$	k

Also, find $P(x \le 1), P(x > 1)$ *and* $P(-1 < x \le 2)$

b) The number of telephone lines at an instant of time is a binomial variate with probability 0.1 that a line is busy. If 10 lines are chosen at random , what is the probability that (i) no line is busy (ii)all lines are busy (iii)at least one line is busy (iv)almost 2 lines are busy — 7 | 3 | L2

c) State probability density function of Gaussian (normal) distribution. An analog signal received at a detector (measured in micro-volts) may be modeled as a Gaussian random variable with mean 200 and variance 256 at a fixed point of time. What is the probability that the signal will exceed 240 micro-volts? — 7 | 3 | L3

UNIT- IV

7. a) random variable of X and Y having the following joint distribution — 6 | 4 | L2

X \ Y	-3	2	4
1	0.1	0.2	0.2
2	0.3	0.1	0.1

Find (i) Marginal distributions of X and Y (ii)Cov (X,Y)
(iii) Are the variables X, Y statically independent?

b) Define (i) stochastic matrix (ii) regular stochastic matrix. Find the unique probability vector for the regular stochastic matrix $\begin{bmatrix} 0 & 1 & 0 \\ 1/6 & 1/2 & 1/3 \\ 0 & 2/3 & 1/3 \end{bmatrix}$ — 7 | 4 | L3

c) Verify that $f(x,y) = \begin{cases} e^{-(x+y)}, & x \ge 0,\ y \ge 0 \\ 0, & otherwise \end{cases}$ is a probability density function of two - dimensional probability function.Evaluate $P(x<1), P(x \le y)$ and $P(1/2 < x < 2,\ 0 < y < 4)$ — 7 | 4 | L2

8 a) Solve the system of the equations by Gauss –Seidel method (Perform 3 iterations)
$x + y + 54z = 110, \quad 27x + 6y - z = 85, \quad 6x + 15y + 2z = 72$. — 6 | 4 | L2

b) Solve the system: $2x_1 + 8x_2 - x_3 = 24; 12x_1 + x_2 + x_3 = 31; 3x_1 + 4x_2 + 10x_3 = 58$,
by relaxation method — 7 | 4 | L2

c) Find the dominant eigen value and the corresponding eigen vector of A= $\begin{bmatrix} 6 & -2 & 2 \\ -2 & 3 & -1 \\ 2 & -1 & 3 \end{bmatrix}$ by Power method taking the initial eigen vector a $[1,1,1]^T$	7	4	L3

UNIT- V

9. a) Find the extremals of the functional. $\int_{x_1}^{x_2}(y^2+y'^2+2ye^x)dx$	6	5	L2
b) Solve the variational problem $\int_0^{\frac{\pi}{2}}(y^2-y'^2)dx=0;\ y(0)=0,\ y\left(\frac{\pi}{2}\right)=2$	7	5	L2
c) Prove that Catenary is the curve which when rotated about a line generates a surface of minimum area.	7	5	L2
10. a) Develop a series solution of the equation $(1+x^2)y''+xy'-y=0$.	6	5	L2
b) Solve the Bessel's differential equation $x^2\frac{d^2y}{dx^2}+x\frac{dy}{dx}+(x^2-n^2)y=0$.	7	5	L3
c) Express $4x^3-2x^2-3x+8$ in terms of Legendre's polynomials.	7	5	L3

Course Title: Applied Thermodynamics			
Course Code: P15ME42	**Sem: 04**	**L –T-P-H: 4:0:0:4**	**Credit: 04**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Students should have acquired the knowledge of Engineering Mathematics – I & II (P15MA11/21) and Basic Thermodynamics (P15ME35).

Course Objectives: Applied thermodynamics is a continuation course of Basic Thermodynamics with emphasis on the analysis of gas power and refrigeration cycles and the application of basic principles to engineering problems with systems involving compressors, refrigeration and air conditioning, psychrometrics and I C engines.

Course Content

Unit -1

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

Unit -2

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

Unit -3

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

Unit -4

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

Properties of atmospheric air: Dry Air, Relative Humidity, Specific humidity, degree of saturation, dry bulb and wet bulb temperature. Psychometric Chart and Psychometric Process: Sensible heating or cooling, cooling and dehumidification, heating and humidification and adiabatic mixing of two streams (No numerical problems). **11 hrs**

Unit -5

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

Text books

1. P .K. Nag **"Basic and Applied Thermodynamics"** Tata McGraw Hill, 2nd Edition 2009, ISBN: 9780070151314.
2. R K Rajput "**Engineering Thermodynamics"** Laxmi Publications, 4th Edition, ISBN: 9788131800584.
3. V Ganesan "Internal Combustion Engines" Tata McGraw Hill, 4th edition, 2012, ISBN : 9781259006197
4. Mahesh M Rathore "Thermal Engineering" Tata McGraw Hill, 1st edition**,**
5. ISBN: 9780070681132

References

1. D B Spalding and E H Cole "**Engineering Thermodynamics"** Arnold 1973, 3 edition, ISBN : 9780713132991.
2. Yunus A. Çengel, Michael A. Boles "**Thermodynamics – An engineering approach"** Tata McGraw Hill, 6th edition, 2007, ISBN : 9780073305370.
3. Gordon J. Van Wylen "**Fundamentals of Classical Thermodynamics"** John Wiley & Sons Canada, Limited, 3rd edition, 1988,ISBN : 9780471610762
4. S Domkundwar, C P Kothandaraman and V Domkundwar "**A course in Thermal Engineering**",Dhanpat Rai & Co, 2004, ISBN: 9788177000214.
5. M.L.Mathur and R.P.Sharma "**Internal Combustion Engines**", Dhanpat Rai & Co, 2010, ISBN: 9788189928469.

Course Outcomes

At the end of the course the students should be able to:

1. **Explain** the concept of air standard cycle and vapor power cycle
2. **Explain** and **calculate** the performance characteristics of reciprocating air compressor.
3. **Explain** the different types of refrigerating systems and **Apply** the knowledge of P-H chart.
4. **Calculate** the performance characteristics of I.C. Engines

Model Question Paper

Instructions:

i). Answer FIVE full questions, selecting ONE from each unit
ii). Use of Thermodynamics data book is allowed
iii). missing data (if any) may be suitably assumed.

Unit I

1. a) Develop an expression for efficiency of otto cycle. **6**

b) Compare otto and diesel cycle for constant maximum pressure and same heat input **4**

c) An engine working on otto cycle has a volume $0.5m^3$, pressure 1 bar and temperature 27^0C at the beginning of compression stroke. The pressure at the end of compression is 10 bar. The heat added during constant volume process is 200 kj. Calculate

a. the temperature and pressure at all points.
b. Efficiency of the cycle **10**

2. a) Show that for simple gas turbine cycle with regenerator efficiency is

$\eta = 1-\frac{T_1}{T_3}\ (R_P)^{\frac{\gamma-1}{\gamma}}$ **10**

b) A gas turbine power plant working on air standard brayton cycle with a pressure ratio 5:1. The starting pressure and temperature are 1 bar and 27^0c and maximum temperature in the cycle is 1027^0c. compressor efficiency is 85% and turbine efficiency is 90%. Assuming adiabatic compression and expansion. Determine Compressor work, heat supplied, turbine work, net work, heat rejected and thermal efficiency **10**

Unit II

3.a) With a neat sketch & T-S diagram explain effect of pressure & temperature on performance of Rankine cycle. **10**

b) An engine working on Rankine cycle supplied with a steam at pressure of 9 bar and the exhaust pressure being 0.7bar. Determine work done per kg of steam and cycle efficiency. When

i. Steam is dry saturated at inlet of turbine
ii. Steam is 90% dry at inlet of turbine. **10**

4. a) With a neat sketch and T-S diagram explain regenerative cycle with feed water heater. **8**

b) In a reheat steam cycle, the boiler exit conditions are 25 bar and 300 C. The exit pressure of steam at the end of first stage is 5 bar. The steam is then reheated to 300 C before expanding in the second turbine to 0.05 bar. Assuming the high and low pressure turbines to have efficiencies of 87% and85 % respectively, find (i) the thermal energy input in the reheater, (ii) the cycle efficiency, (iii) specific steam consumption and (iv) power output for a mass flow rate of 2 kg/s. **12**

Unit III

5. a) Develop an expression for volumetric efficiency of single stage single acting air compressor. **6**

b) state the advantages of multi stage over single stage **4**

c) A single stage single acting air compressor 30cm bore and 40cm stroke is running with a speed of 100 rpm. It takes in air at 1 bar and 20^{o} c and compresses it to pressure of 5 bar. Calculate the power required to drive it when compression is
1) isothermal 2) $pv^{1.2}$ and 3) adiabatic **10**

6. a) Derive an Optimum intermediate pressure for a two-stage compressor **8**
b) A two-stage air compressor is required to take in 1500 litres of free air per minute at 1 bar and 25 C. The delivery pressure is 20 bar. The heat transfer during compression, which may be assumed to be polytropic, is double that in the intercooler for the first stage, and 1/3rd of the total compression work for the second stage. Assuming the intercooler effectiveness to be 0.83 and an intermediate pressure as the geometric mean of the suction and delivery pressures of the compressor, find the power required to drive the compressor assuming a mechanical efficiency of 80 %. **12**

Unit IV

7.a) Effect of sub-cooling the refrigerant on the performance of a Vapour Compression Cycle **10**
b) A vapour compression refrigeration cycle works between the condenser pressure of 10bar and an evaporator pressure of 1 bar. The refrigerant F-12 leaves the evaporator at -12 ^{o}C and condenser at 30 ^{o}C. Determine COP of the system and power required per ton of refrigeration. Also determine the bore and stroke of the cylinder if it runs at 250 rpm Asuume volumetric efficiency of 90% and stroke equal to 1.25 time the bore **10**

8.a) Define the following
i. Relative humidity
ii. sensible heating
iii. cooling and dehumidification
iv. wet bulb temperature **8**
b) A refrigeration system of 10.5 ton capacity at an evaporator temperature of -10 ^{o}C and a condenser temperature of 30 ^{o}C is needed in a food storage locker. The refrigerant ammonia is subcooled by 6 ^{o}C before entering the expansion valve. The vapour is 0.95 dry as it leaves the evaporator. Find
i. COP
ii. Power required in kW
iii. Condition of vapour at outlet of compressor
iv. Condition of vapour at entrance of evaporator **12**

Unit V

9.a) With a neat sketch explain orifice chamber method for the measurement of air consumption **10**

b) A four stroke petrol engine 1 cm bore, 9 cm stroke is tested at full throttle at constant speed. The fuel supply fixed at 0.065 kg/min and the plugs of four cylinders are successively short circuited without change of speed. The brake torque being corresponding adjusted the power measurements are as follows

i. With all cylinder firing – 11.91 kW
ii. With cylinder one shorted -8.45kW
iii. With cylinder two shorted- 8.56 kW
iv. With cylinder three shorted -8.6 kW

With cylinder four shorted -8.495 kW calculate indicated power, , indicated thermal efficiency if calorific value of fuel is 43550 kj/kg. Compare the efficiency with air standard efficiency, the clearance volume of one cylinder being 69.5 cm^2 **10**

10.a) Explain Morse test and willians line method for measurement of frictional power **10**

b) From following data write energy balance sheet for two stroke diesel engine run for 20 min at full load, speed 350 rpm, mep 3 bar, net brake load 640N, fuel consumption 1.5kg, cooling water 160kg, water inlet temperature 35 c, water outlet temperature 60^0 c air used per kg of fuel 30kg, room temperature 20^0c , exhaust temperature 300^0 C, bore 200mm, stroke 300mm, brake diameter 1000mm, calorific value 44000kj/kg, specific heat of dry exhaust gases 1.01kJ/kg ^oC **10**

Course Title: Mechanical Measurements & Metrology			
Course Code: P15ME43	**Sem: 04**	**L –T-P-H: 4:0:0:4**	**Credit: 04**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Students should have acquired the knowledge of Engineering Physics (P15PH12/22) and Basic Electrical Engineering (P15EE15/25)

Course objective: The course aims at enabling the students to understand the basic concepts of Measurement and Metrology and strengthening their knowledge about advancements in **s**ystem of Limits, Fits, Tolerances and Gauging of mechanical elements which are commonly used in industries.

Course Content

Unit -1

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

Unit -2

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

Unit -3

Comparators: Characteristics and classification of comparators. Mechanical comparators-Johnson Mikrokator, Sigma Comparators, Optical Comparators -principles, Zeiss ultra optimeter, Electric and Electronic Comparators, LVDT, Pneumatic Comparators, Solex Comparator. Back Pressure gauges, **Angular Measurements:** Principle and use of Sine bars, Sine center, Angle gauges.
Surface roughness and Metrology of Screw Thread and Gears: Surface roughness terminology, Methods of measuring surface roughness, Taylor-Hobson talysurf, Analysis of surface traces, Measurement of basic elements of thread, worked examples. Measurement of major diameter, minor diameter, pitch, angles and effective diameter of screw threads by 2-wire and 3-wire methods, Best size wire. Toolmakers' microscope, Use of gear tooth Vernier caliper and gear tooth micrometer, Profile projector.
Interferometry: Principle of interferometry, autocollimator, optical flats. **12 hrs**

Unit -4

Transducers: Introduction, Transfer efficiency, Loading effect, Primary and Secondary transducers, classification of transducers with examples. Advantages of each type transducers.

Signal Conditioning: Mechanical systems, Electrical intermediate modifying devices, Input circuitry-simple current sensitive circuit, Electronic amplifiers, Filters, Types of filters, telemetry.
Terminiting devices: Cathode Ray Oscilloscope, Oscillographs, X-Y Plotters. **10 hrs**

Unit -5

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

Text books

1. R.K.Jain **"Engineering Metrology"** Khanna Publishers, Delhi, 20th edition, 2004, ISBN: 9788174091536.
2. R.S.Sirohi and H.C.RadhaKrishna **"Mechanical Measurements"** New Age International, Revised 3rd edition, 2013, ISBN: 9788122403831

References

1. Thomas G. Beckwith, Roy D. Marangoni & John H. Lienhard **"Mechanical Measurements"** Pearson Prentice Hall, 6th edition, 2007, ISBN : 9780201847659
2. I.C.Gupta **"Engineering Metrology"** Dhanpat Rai Publications, 7th edition, 2012, ISBN: 9788189928452.
3. Alsutko & Jerry Faulk **"Industrial Instrumentation"** Delmar cengage learning, 1996, ISBN: 9780827361256
4. Doblin **"Measurement Systems"** Tata McGraw Hill, 6th edition, 2012, ISBN: 9780070699687.

Course Outcomes

At the end of the course the students should be able to:

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

Model Question Paper

Note: i) Answer any ***FIVE*** full questions, selecting at least ***ONE*** full question from each **unit**.
ii) Missing data, if any, may be suitably assumed

UNIT - I

1 a. What is metrology? State its objectives. 06

b. Define the following:
i) Line standard ii) End standard iii) Wavelength standard 09

c. Build the following dimensions using M-112 set: 05
i) 33.4565 ii) 87.1025

2 a. Explain with sketch "Wringing Phenomenon" with respect to slip gauges. 10

b. A calibrated meter bar (end bar) has an actual length L=1000.0003mm. It is to be used in the calibration of two bars A and B, each having a basic length of 500mm. When compared with the meter bar, $L_A + L_B$ was found shorter by 0.0002mm. When A and B are compared, it was found that the bar A was 0.0004m longer than bar B. Find the actual length of bar A and bar B 10

UNIT - II

3 a. Distinguish between tolerance and allowance. 04

b. Explain the principles of interchangeability and selective assembly. 06

c. Design the general type of GO and Not Go gauges as per the present British system for a 40 mm shaft and hole pair designated as 40 H_8/d_9, given that
a) $i=0.453\sqrt[3]{D}+0.001D$
b) 40mm lies in the diameter range of 30-50mm
c) IT6=10i
d) Upper deviation of shaft=$-16D^{0.44}$
Wear allowance assumed to be 10% of gauge tolerance. 10

4 a. State and explain Taylor's principle for the design of limit gauges. 04

b. Explain the principles of interchangeability and selective assembly. 06

c. Determine the actual dimensions for a hole-shaft pair designated as $28H_7/f_8$. Dimension 28 falls in the range of 18 to 30mm. Fundamental deviation for f shaft is $-5.5D^{0.41}$, $IT_7=16i$ and $IT_8=25i$. Tolerance unit $i = 0.45(D)^{1/3}+0.001D$(microns). 10

UNIT - III

5 a. Sketch and explain the following comparators:
i) Zeiss optimeter ii) Solex comparators. 10

b. What do you understand by "best size wire". Derive an expression for the same 06

c. Build the following angles:
i) $49^0 36' 48''$ ii) $35^0 32' 36''$ 04

6 a. With a neat figure, explain the principle of sine bar. 06

b. With neat sketches, explain how you would measure the major and minor diameters of internal screw threads. 07

c. With a neat sketch explain the principle of autocollimator. 07

UNIT - IV

7 a. What is transducer? List the advantages of electrical transducers over mechanical transducers. 08

b. Explain with a neat sketch, the construction and working of a cathode ray oscilloscope 08

c. Write a note on X-Y plotters. 04

8 a. What are electronic amplifiers? List the general principles of an ideal electronic amplifier 06

b. With a block diagram, distinguish between primary and secondary transducers 06

c. What is the requirement of an intermediate modifying device? Explain the inherent problems, with a mechanical system. 08

UNIT - V

9 a. Sketch and explain the working principle of Mc-Leod gauge. 10

b. With a neat sketch, explain the working of hydraulic dynamometer. 06

c. Write a note on Bridgeman gauge. 04

10 a. What is a thermocouple? State and explain the laws of thermocouple. 08

b. Discuss the construction and working of an optical pyrometer. 08

c. Write a note on strain gauge. 04

Course Title: Mechanics of Materials			
Course Code: P15ME44	**Sem: 04**	**L –T-P-H: 3:2:0:5**	**Credit: 04**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Students should have acquired the knowledge of elementary science of PUC (10+2) level, Engineering Mathematics – I & II (P15MA11/21) and Engineering Mechanics (P15CV13/23).

Course objective: The course aims at enabling the students to understand the basic concepts of stress, strain and deformation of mechanical elements subjected to axial, bending and torsional loading.

Course Content

Unit -1

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

Unit -2

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

Unit -3

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

Unit -4

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 rectangular, circular, I and T sections. **(Moment of Inertia to be provided for numerical problems).**

Deflection of Beams: Introduction, Differential equation of deflection; Macaulay's method for simply supported beams with point load and UDL. **12 hrs**

Unit -5

Torsional stresses: Introduction to torsion, pure torsion, assumptions, derivation of torsion equation, polar modulus, torsional rigidity, and torque transmitted by solid and hallow circular shafts.

Columns: Introduction to Columns, Euler theory for axially loaded elastic long columns, Euler equation for columns with (i) both ends hinged (ii) one end fixed and other end free (iii) both ends fixed (iv) one end fixed and other end hinged, Limitations of Euler's theory, Rankine's formula. **10 hrs**

Text books

1. S. S. Bhavikatti "**Strength of Materials**" Vikas Publication House-Pvt Ltd 2nd edition, 2000, ISBN: 8125901647
2. S.S. Rattan **"Strength of Materials"** Tata McGraw-Hill, New Delhi, 2nd Edition, 2011, ISBN: 9780071072564

3. Dr. R. K. Bansal **"Strength of Materials"** Laxmi Publication, New Delhi, 5th Edition, 2007, ISBN: 9788131808146

References

1. W.A. Nash **"Strength of Materials "**Schaum's Outline Series, 4th Edition, 2007, ISBN: 9780070466173
2. Ferdinand P Beer, E Russell Johnston, JR., John T DeWolf adapted by N Shivaprasad & S Krishnamurthy **" Mechanics of Materials"** Tata McGraw-Hill
3. James M. Gere, Stephen P. Timoshenko, **"Mechanics of Materials"** CBS Publishers and Distributers Delhi.
4. Dr. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, **"Mechanics of Materials"** Laxmi Publications, New Delhi. 2002

Course Outcomes

At the end of the course the students should be able to:

1. **Classify** different types of stresses, strain and deformations induced in the mechanical components due to external loads.
2. **Estimate** thermal stresses; **calculate** principal stresses in simple 2D elements.
3. **Draw** Shear Force Diagrams and Bending Moment Diagrams for uniform beams for different types of loads and support conditions.
4. **Compute** and **analyze** bending and shear stresses and deflections induced in beams.

Estimate torsional stresses in circular shafts; **Analyze** columns under buckling load.

Model Question Paper

Note: i) Answer any ***FIVE*** full questions, selecting at least ***ONE*** full question from each **unit**.
ii) Missing data, if any, may be suitably assumed

UNIT - I

1 a. With stress-strain curve differentiate between nominal stress and true stress. 6

b. What is factor of safety? State four reasons to consider factor of safety. 6

c. A specimen of steel 25 mm dia. with a gauge length of 200 mm is tested to destruction. It has an extension of 0.16 mm under a load of 80 kN and the load at elastic limit is 160kN. The maximum load is 180kN. The total extension at fracture is 56 mm and diameter at neck is 18 mm. find;
i) Stress at elastic limit ii) Young's modulus iii) Percentage elongation iv) Percentage reduction in area. 8

2 a. Define the following: (i) Proof resilience (ii) Hooke's law (iii) Bulk modulus (iv) Thermal stresses (v) Isotropic material. 10

b. A steel rod 5 m long and 30 mm in diameter is subjected to an axial tensile load of 50 kN. Determine the change in length, diameter and volume of the rod. Take $E=2x10^5$ N/mm^2 and Poisson's ratio= 0.25. 10

UNIT - II

3 a. Three pillars two of Aluminium and one of steel support a rigid plat-form of 200kN as shown in Fig. Q 3(a) if area of each Aluminium pillar is 1000 mm^2 and that of steel pillar is 800 mm^2, find the stresses developed in each pillar;. Take $E_a= 1x10^5$ N/mm^2 and $E_s=2x10^5$ N/mm^2 what additional load P can it take if working stresses are 65 N/mm^2 in aluminium and 150 N/mm^2 in steel.
12

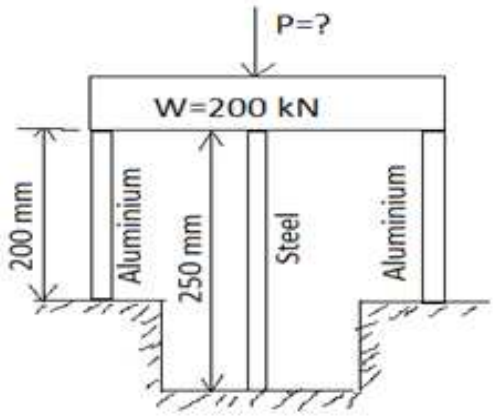

Fig. Q 3(a)

b. A steel tube of 30mm external diameter and 25 mm internal diameter encloses a gun metal rod of 20mm diameter to which it is rigidly joined at each end. The temperature of the whole assembly is raised to 140 ^oC and nuts on the rod are the screwed lightly home on the ends of the tube. Find intensity of stress in the rod when the common temperature has fallen to 30. The value of 'E, for steel and gun metal is $2.1x10^5$ N/mm^2 and $1x10^5$ N/mm^2 respectively. The linear coefficient of expansion for steel and gun metal is $12x10^{-6}/^oC$ and $20x10^{-6}/^oC$.
8

4 a.The stress on two perpendicular planes through a point in a body are 30 MPa both tensile along with shear stress of 25 MPa. Find analytically and graphically,
(i) The magnitude and direction of principal stresses (ii) The planes of maximum shear stress (iii) The normal and shear stresses on the planes of maximum shearing stress. 20

UNIT - III

5 a. What are the different types of loads acting on a beam? Explain with the sketches. 4

b. Draw the shear force and bending moment diagram for the overhanging beam shown in the Fig. Q 5(b) and locate the point of contra flexure. 16

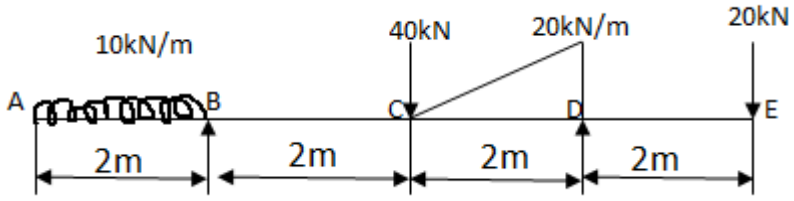

Fig. Q 5(b)

6 a. A simply supported beam AB of 6 m span is loaded as shown in Fig. Q 6(a). Draw shear force and Bending moment diagrams. 8

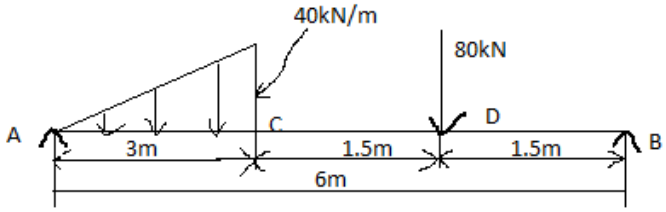

Fig. Q 6(a)

b. A cantilever of 14m span carries loads of 6kN, 4kN, 6 kN and 4 kN at 2m, 4m, 7m and 14m respectively from the fixed end. It also has a UDL of 2kN/m run for the length between 4 m and 8m from fixed end. Draw SFD and BMD. 12

UNIT - IV

7 a. Derive the relationship between moment, radius of curvature and bending stress on beam. 8

b. The unsymmetrical I-section shown in Fig. Q7(b) is subjected to a shear force of 55 kN. Draw the shear stress variation across the depth. 12

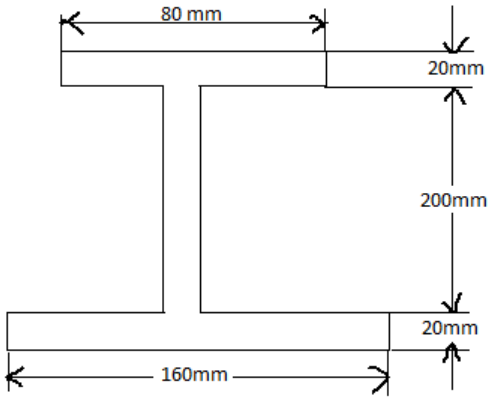

Fig. Q 7(b)

8.a. A simply supported beam of span 'L' is subjected to equal loads $\frac{1}{3}$ at each of $\frac{1}{3}$ span points. Find the expressions for deflection under the load and at midspan by using Macaulay's method. 20

UNIT - V

9. a. Determine the crippling load when the both ends of the columns are hinged. 10

b. Compare the weight of the solid with that of a hollow one having the same length to transmit a given power at a given speed, if the material used for both the shaft is same. Take the inside diameter of the hollow shaft as 0.6 times of the outer diameter. 10

10. a. Write the assumption in the theory of pure torsion. 5

b. Derive an equation for torsion of shafts. 7

c. A 2m long pin ended column of square section is to be made of wood. Assuming E= 12GPa and allowable stress being limited to 12MPa. Determine the size of the column to support 95kN of load safely. 8

Course Title: Kinematics of Machinery			
Course Code: P15ME45	**Sem: 04**	**L –T-P-H: 4:0:0:4**	**Credit: 04**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Students should have acquired the knowledge of elementary science of PUC (10+2) level, Engineering Mathematics–I (P15MA11) and Engineering Mechanics (P15CV13/23).

Course objective: The course aims at exposing students to the working principles of simple planar mechanisms and enabling them to understand the basic concepts of kinematic analysis of simple planar mechanisms.

Course Content

Unit -1

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

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

Unit -2

Velocity analysis of mechanisms: Introduction, vectors, addition and subtraction of vectors, absolute and relative motions, motion of a link, velocity analysis of a link by relative velocity method, velocity analysis of four-bar mechanism, slider-crank mechanism and crank and slotted lever mechanism by relative velocity method. Instantaneous centre, number of I-centres, Kennedy's theorem, locating I-centres, velocity analysis of four bar and slider crank mechanisms by I-centre method.

Acceleration analysis of mechanisms: Radial and tangential components of acceleration, Angular acceleration, Acceleration analysis of a link by relative acceleration method, Acceleration analysis of four bar mechanisms and slider-crank mechanisms by relative acceleration method. **12 hrs**

Unit -3

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

Unit -4

Gear trains: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Tabular method of finding velocity ratio of epicyclic gear trains. Estimation of Tooth load and torque in epicyclic gear trains.

Belt drive: Introduction, classification, **(derivation of length of belt not included)** velocity ratio, effect of slip, ratio of belt tensions, effect of centrifugal tension, power transmitted, effect of initial belt tension. V-belts – ratio of belt tensions, power transmitted. Numerical problems. **10 hrs**

Unit -5

Cams: Types of cams, types of followers, Types of follower motion - SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion. Displacement, Velocity and acceleration of follower for different types of motion; Displacement diagram for follower

motion, Construction of cam profiles - Disc cam with reciprocating follower having knife-edge, roller and flat –faced follower. **10 hrs**

Text books

1. S.S. Rattan **"Theory of Machines"** Tata McGraw-Hill, New Delhi, 4th edition, 2015, ISBN: 9789351343479.
2. Sadhu Singh "**Theory of Machines"** Person Eduction (Singapore) Pvt. Ltd Indian Branch, New Delhi, 2nd Edition, 2006, ISBN: 9788177581270

References

1. J.V. Shigley, J.J.Uickers, G R Pennock "**Theory of Machines & Mechanisms"** Oxford University Press, 4th edition 201, ISBN: 9780195371239.
2. R.S.Khurmi and J.K.Gupta "**Theory of Machines"** S.Chand and Co., 2005, ISBN: 9788121925242.
3. P.L. Ballaney "**Theory of Machines and Mechanisms"** Khanna Publishers, delhi, 24th edition, 2005, ISBN: 9788174091222.
4. R.K. Bansal "**Theory of Machines-1"** Laxmi Publications. 1st edition, 2013, ISBN:9788131809846.
5. J.B.K.Das and P I Shrinivasa Murthy "**Theory of Machines-1"** Sapna book house, ISBN: 9788128001451.

Course Outcomes

At the end of the course the students should be able to:

1. **Identify** various mechanisms, **determine** their degrees of freedom; **describe** various inversions of four bar chain, single and double slider crank chain.
2. **Analyze** velocity of four bar and slider-crank mechanisms by relative velocity method and Instantaneous centre method. **Analyze** acceleration of four bar and slider-crank mechanisms by relative acceleration method.
3. **Classify** different types of gears; **Explain** Spur Gear terminology, law of gearing, interference and Back lash. **Derive** expressions for Path of contact, arc of contact and contact ratio. **Solve** numerical problems related to gears.
4. **Describe** Simple, Compound and Epicyclic gear trains; **Determine** velocity ratio, tooth load and torque in epicyclic gear trains. **Explain** and **calculate** ratio of belt tensions; **Estimate** power transmitted by belt drive; **Analyze** effect of slip, initial and centrifugal belt tension on performance of belt drive.
5. **Explain** cam and follower types; **Explain** different follower Motions; **Construct** cam profiles for different types of follower motions.

Model question paper

Note: i) Answer any ***FIVE*** full questions, selecting at least ***ONE*** full question from each **unit**.
ii) Missing data, if any, may be suitably assumed

UNIT - I

1 a. Define the following:
i) Kinematic Chain
ii) Higher Pair
iii) Machine
iv) Degree of Freedom 4

b. Determine the mobility of the four bar and Slider Crank Mechanism 4

c. Explain with neat sketches one inversion each of single slides crank chain and double Slider crank chain. 12

2. Explain the following with help of neat sketches
i) Geneva Mechanism
ii) Toggle Mechanism
iii) Ratchet and Pawl Mechanism
iv) Pantograph. 20

UNIT - II

3 A Four bar Chain Mechanism ABCD is made up of four links, pin jointed at the ends. AD is fixed link which is 120 mm long. The links AB,BC and CD are 60 mm, 80 mm, and 80 mm long respectively. At certain instant, the link AB makes an angle of 60^0 with the link AD. If the link Ab rotates at uniform speed of 10rpm clockwise direction determine.
i) Angular velocity of the link BC and CD
ii) Angular acceleration of the link BC and CD. 20

4 a. State and prove Kennedy's theorem of instantaneous Centre. 6

b. Locate all the instantaneous centre for a Four bar Mechanism. 4

c. In a Four bar chain mechanism ABCD, the link AD is fixed, which is 120 mm long. The links AB, BC and CD are 60 mm, 80 mm and 80 mm long respectively. At certain instant the Crank AB makes an angle of 60^0 with the fixed link AD. If the crank AB rotates at uniform speed of 10 rpm clockwise. Determine the angular velocity of the links BC and CD by Instantaneous Centre Method. 10

UNIT - III

5 a. State and derive law of gearing. 8

b. Two spur gears have 24 and 30 teeth of module 10mm standard addendum 1 module, pressure angle 20^0. Find i) Length of arc of contact, length of path of contact and ii) Contact ratio. 12

6 a. Derive an expression for the path of contact. 8

b. A pair of gears having 40 and 30 teeth respectively is of 25^o involute form. The addendum length is 5mm and module pitch is 2.5mm. if the smaller wheel is driver and rotates at 1500 rpm. Find the velocity of sliding at the point of engagement and the point of disengagement. 12

UNIT - IV

7 a. Sketch and explain types of gear trains. 8

b. Fig. Q7(b) shows an epicyclic gear train in which the arm A is fixed to the shaft S. B is free to rotate on S and F is separately driven. A rotates at 200 rpm and F is driven in the same direction at 100 rpm. Determine the speed and direction of wheel B. The wheel F has 120 teeth and the wheel B has 80 teeth. 12

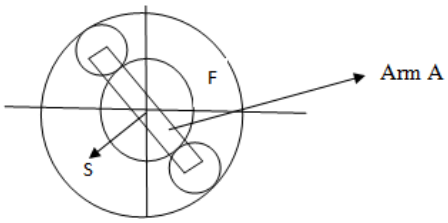

Fig. Q 7(b)

8 a. Explain the term slip and creep as applied to belt drives. 5

b. Derive an expression for ratio of tension in flat belt drives. 5

c. A leather belt is required to transmit 7.5 KW from a pulley 1.2 m in diameter, running at 250 rpm. The angle embraced is 165^0 and the coefficient of friction between the belt and the pulley is 0.3. If the safe working stress for the leather belt is 1.5 MPa, density of leather 1 Mg/m^3 and thickness of belt 10mm, determine the width of the belt taking centrifugal tension into account. 10

UNIT - V

9 a. Explain the different types of follower with sketch. 6

b. A Cam drives a flat faced reciprocating follower in the following manner, during the first 120^0 rotation of the cam, followed moves outwards through a distance of 30 mm with UARM. The follower dwells during next 30^0 of cam rotation. During next 120^0 of the cam rotation, the follower moves inwards with SHM. The follower dwells for the next 90^0 of Cam rotation. The maximum radius of the Cam is 25 mm and Cam rotates in anticlockwise direction. Draw the profile of the cam. 14

10. A disc cam to move with a roller follower with roller diameter 15mm the following motion, outward with constant period of $\pi/4$ radian of cam rotation, constant velocity period for $\pi/2$ radians, constant deceleration period for $\pi/4$ radian of cam rotation. Dwell for $\pi/4$ radians then return with SHM motion in ¾ π radian of cam rotation. Total displacement is 40 mm and minimum radius of cam is 50mm. draw the cam profile. 20

Course Title: Manufacturing Processes -II			
Course Code: P15ME46	**Sem: 04**	**L –T-P-H: 4:0:0:4**	**Credit: 03**
Contact Period: Lecture: 52 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Knowledge of Elements of Mechanical Engineering (P15ME14/24), Manufacturing Processes – I (P15ME34) and Material Science & Metallurgy (P15ME32).

Course objective: The course aims at exposing students to the working principles of machine tools and enabling them to understand the basic machining process in Lathe, Milling, Drilling, Shaper, Planer and Grinding machines.

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 **12 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

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

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

Unit -4

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

Unit -5

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

Grinding Machines: Types of abrasives, bonding process, classification, constructional features of cylindrical and surface grinding machines, Centerless grinding, tool and cutter grinder, specification of grinding wheel, selection of grinding wheel, balancing of grinding wheel. Super Finishing Operations: Lapping, honing and super finishing operations. **10hrs**

Text books

1. S.K.Hajra Choudhury, A.K.Hajra Choudhury & Nirjhar Roy "**Workshop Technology Vol-II"**, Media Promoters & Publishers Pvt. Ltd. 13th edition, 2010, ISBN: 9788185099156.
2. G. Boothroyd " **Fundamentals of Metal Machining and Machine Tools"** , CRC press, 3rd edition, 198, ISBN: 0824778529/9780824778521.
3. HMT, **"Production technology"**, Tata McGraw Hill, 1st edition 2001, ISBN: 9780070964433

References

1. Ashok Kumar Mallik & Amitabha Ghosh, "**Manufacturing Science"** East West Press, 2nd edition, 2010, ISBN: 9788176710633.
2. R.K.Jain **,"Production Technology"**, Khanna Publications, 17th edition, 2014, ISBN:8174090991/9788174090997
3. A. Bhattacharya, "**Theory of Metal Cutting & Practice",** New Central Book Agency-Kolkata, 1st edition, 2008, ISBN: 9788173812286

Course Outcomes

At the end of the course the students should be able to:

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

Model Question Paper

Note: i) Answer any FIVE full questions, selecting at least ONE full question from each unit.
ii) Missing data, if any, may be suitably assumed

UNIT – I

1. a. Sketch and explain the nomenclature of a single point cutting tool, highlighting the significance of different angles. 10
b. Derive the expression $\tan\phi = \gamma\cos\alpha/1-\gamma\sin\alpha$ with the help of a neat sketch where ø is shear plane angle 'γ' is chip thickness ratio and 'α' is back rake angle. 10

2. a. Explain the different properties required of a cutting tool material. 08
b. The following details related to an orthogonal cutting operation. Feed =1.25 mm/rev, Chip thickness 2mm, rake angle of toll 10 degree. Calculate (i) chip thikness ratio and shear angle (ii) If the shear strength is 6000kg/cm^2, width of cut 10 mm, cutting speed 30 mpm and coefficient of friction 0.9; determine the following (i) Shearing force (ii) Friction angle (iii) Cutting force (iv) Thrust force. 12

UNIT-II

3. a. Briefly explain different types of tool wears. 10
b. A lathe turning at a particular speed is cutting a mild steel workpiece with HSS toll. The speed-life relationship for the tool is given by $VT^{0.4}=400$. Determine the percentage increase in the tool life, if the cutting speed is reduced by 20%. 10
4. a. Explain briefly the factors affecting heat affecting heat generation. 10
b. What are the functions of cutting fluids? Explain the elegant properties of cutting fluids. 10

UNIT-III

5. a. With a neat sketch explain the working principle of saddle type turret lathe. 12
b. It is required to machine a surface 450x600mm on a shaping machine. Calculate the machining time for the following data; Cutting speed 7.5 mpm, return-to-cutting time ratio = 2:3, feed 2mm/double stroke, clearance at each end = 50mm. 08
6. a. Explain a tool layout for hexagonal headed bolt in a Capston and Turret lathe. 10
b. Explain with a sketch the principle of working of whit worth quick return motion mechanism in shaper. 10

UNIT-IV

7. a. Explain the different factors to be considered in the selection of a grinding wheel. 10
b. Sketch and explain the following machines indicating their field of applications:
(i) Lapping machine (ii) Honing machine. 10
8. a. With sketch explain up-milling and down- milling operations. 08
b. Indexing 69 divisions by compound indexing an index plate with the following circles of holes is available – 21, 23, 27, 29, 31, 33. 12

UNIT-V

9. a. With a neat sketch explain the constitutional features of a radial drilling machine. 10
b. Explain the following operations with a neat sketch
i) Reaming ii) Boring iii) Counter boring iv) Tapping. 10
10. a. Sketch and explain a centerless grinding wheel, highlighting its advantages and limitations. 10
b. Explain the different types of bonding materials used to make the grinding wheels. 05
c. Discuss the factors influencing the selection of grinding wheels. 05

Course Title: Metrology & Measurements laboratory			
Course Code: P15MEL47	**Sem: 04**	**L –T-P-H: 0:0:3:3**	**Credit: 1.5**
Contact Period: Lecture: 36 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Knowledge of Elements of Engineering Physics (P15PH12/22) and Basic Electrical Engineering (P15EE15/25).

Course objective: The course aims at making students familiar with different measurement equipments and use of this in industry for quality inspection and safety.

Course Content

PART-A

Exp-1 Calibration of Pressure Gauge	**1.5 Hrs**
Exp-2 Calibration of Thermocouple	**1.5 Hrs**
Exp-3 Calibration of LVDT	**3Hrs**
Exp-4 Calibration of Load Cell	**3Hrs**
Exp-5 Use of Planimeter.	**3 Hrs**
Exp-6 Measurements of alignment using Autocollimator / roller set	**3Hrs**

PART-B

Exp-7 Measurements of angle using Sine Center / Sine bar / Bevel protractor	**3Hrs**
Exp-8 Measurements of Screw thread Parameters using two wire and three-wire method.	**3Hrs**
Exp-9 Measurements using Profile Projector / Toolmaker's Microscope	**3Hrs**
Exp-10 Measurements of cutting tool forces using a) Lathe tool Dynamometer b) Drill tool Dynamometer	**3Hrs**
Exp-11 Measurements of Surface roughness using Tally surf/mechanical Comparator.	**3Hrs**
Seminar	**3Hrs**
Test	**3Hrs**

References

1. R. K. Jain, "**Engineering Metrology,"** 21st Edition, Khanna Publishers, ISBN: 978-817409153X
2. R. S. Sirohi and H. C. Radha Krishna, **"Mechanical Measurements,"** 3rd Edition, 1991, New Age International, ISBN: 978-8122403831.

Course Outcomes

At the end of the course the students should be able to:

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

Evaluation Scheme					
Scheme	**Weightage**	**Marks**	**Event Break Up**		
CIE	50%	50	**Test**	**Record**	**Seminar/Mini Project**
			20	20	10
SEE	50%	50			

Scheme for Examination	
One Question from Part –A	20 Marks
One Question from Part -B	20 Marks
Viva – Voice	10 Marks
Total	**50 Marks**

Course Title: Basic Material Testing Laboratory			
Course Code: P15MEL48	**Sem: 04**	**L –T-P-H: 0:0:3:3**	**Credit: 1.5**
Contact Period: Lecture: 36 Hrs, Exam: 3Hrs		**Weightage: CIE 50%, SEE: 50%**	

Prerequisites: Knowledge of Materials Science and Metallurgy (P15ME32) and Mechanics of Materials (P15ME44).

Course Objectives: To learn how to characterize and determine the basic mechanical properties and behaviors of engineering materials and to introduce variety of material testing equipments and techniques.

Course Content	
PART-A	
Exp-1 Tensile, Compression, Shear and Torsion tests on mild steel specimens using a Universal Testing Machine	**6Hrs**
Exp-2 Bending Test on mild steel, wooden specimens.	**3Hrs**
Exp-3 Preparation of specimen for metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, grey CI, SG iron, Brass, Bronze and composites.	**6Hrs**

PART-B

Exp-4 Impact Tests: Izod and Charpy tests on mild steel specimens.	**3Hrs**
Exp-5 Hardness tests: Brinnell, Rockwell and Vickers's Hardness tests.	**3Hrs**
Exp-6 Heat treatment: Annealing, Normalizing, Hardening and Tempering of Ferrous alloys and study their Rock well's hardness.	**6Hrs**
Exp-7 Fatigue test- 4 point bending (Demonstration only)	**3Hrs**
Seminar	**3Hrs**
Test	**3Hrs**

References

1. William D. Callister and David G. Rethwisch, "**Materials Science and Engineering"** Wiley India Pvt. Ltd, 9th edition, 2014, ISBN: 978-1118319222.
2. Sidney Avner, "I**ntroduction to Physical Metallurgy"** Tata McGraw Hill Education Private Ltd., 2nd edition, 1997, ISBN: 978-0074630068.

CLO/CO

At the end of the course the students should be able to:

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

Evaluation Scheme					
Scheme	**Weightage**	**Marks**	**Event Break Up**		
CIE	50%	50	**Test**	**Record**	**Seminar/Mini Project**
			20	20	10
SEE	50%	50			

Scheme for Examination	
One Question from Part –A	20 Marks
One Question from Part -B	20 Marks
Viva – Voice	10 Marks
Total	**50 Marks**

Course Title : Aptitude and Reasoning Development - INTERMEDIATE (ARDI)			
Course Code : P15HU49	**Semester : IV**	**L - T - P : 0 - 0 - 2**	**Credits: 01**
Contact Period: Lecture: 32 Hr, Exam: 3 Hr	**Weightage: CIE:50%;SEE:50%**		

Prerequisites :ARDB

Course Learning Objectives (CLOs)

This course aims to

1. Explain proportionality rule, average speed, relative speed and concepts in circular track.
2. Explain the application of time, speed distance in solving problems related to races, trains, boats and streams, and clocks.
3. Identify the assumptions, analyse the given argument and evaluate the inference.
4. Explain the methodology of strengthening or weakening the given statement.
5. Explain application of Venn diagrams in solving set theory problems.
6. Explains the concept of syllogism and provides the methodology to tackle the problems.
7. Describes all the important properties of triangle, polygons, circle and other geometrical figures and solve application based questions.
8. Describe the properties of cone, cylinder, sphere, cube and cuboid and solve the application based questions.
9. Differentiates between individual work and group work.
10. Integrates the concept of individual work in solving problems related to pipes and cisterns

Course Content

Unit – I

Time, Speed and Distance:
Concept of motion and mathematical representation of motion, The rule of proportionality, Conversion between kmph to m/s, Concept of average speed and its application in different scenarios, Relative speed– Importance, application and observation in day to day life, same direction and opposite direction, An application of allegation in Time speed and distance, Trains– Different scenarios. Boats and streams– resultant speed, upstream and downstream concept. Circular motion– Two or three bodies meeting at the starting point or anywhere in the track. Races– Concept of head start, solving problems under different constraints. Application of solving problems under Clocks. **6 hrs**

Unit – II

Analytical reasoning 2: The basics of logic, some informal tips, **Assumptions**– Some standard categories of assumptions, Where is the assumption invalid?, **Forcefulness of arguments**– Preliminary screening, Will the results really follow?, Is the result really desirable?, Are the argument and suggested course of action properly related?, **Evaluating Inferences**– A study of key words, How to avoid confusion?, **Evaluating given course of action**– Problem -solution relation, Fact-follow-up action relationship. **8 Hrs**

Unit – III

Set theory and Venn diagram: Set builder form, Tabular form, Venn diagram, Types of sets, Operation of sets using venn diagram, Important properties, Algebraic laws of sets, Maxima and minima in set operation, Venn diagram for four sets.
Syllogism: Meaning of syllogisms, Format of problems and standard qualifiers, Concept of distribution, Standard question pattern, Application of venn diagram to solve problems.
Logical Venn diagrams: Analysis of the given problem and solve it. **6 Hrs**

Unit – IV

Geometry and Mensuration:

Theory, straight lines, triangles– theorems, area, lines inside triangle and geometric centre, Special property of an equilateral triangle, Application of Pythagoras theorem, Congruency and similarity of triangles, Basic proportionality theorem, Polygons, Quadrilaterals, Trapezium, Parallelogram, Rectangle, Rhombus, Square, Division of polygons, Circumscribed and Inscribed polygons, Concyclic points concept, Cyclic quadrilateral, Circle– Radius, Area and perimeter, Arc, Chord, Sector, Segment, Tangent, Secant, Area of common region Solid figures– Introduction, Classification of a solid, Net of a solid, Cuboid, Cube, Right cylinder, Pyramid– right pyramid, triangular pyramid, Cone– frustum of a cone, Sphere, Combination of solid.

Co-ordinate geometry:

Cartesian coordinate geometry– rectangular coordinate axis, distance formula, Section formula, Area of a triangle, Centre of gravity or Centroid of a triangle, In-centre of a triangle, Circumcentre of a triangle, Orthocentre of a triangle, Collinearity of three points, Slope of a line, Different forms of equations of a straight line, Perpendicularity and parallelism, Length of perpendicular. **8 hrs**

Unit – V

Time and Work:

Relationship between time and work. Importance of efficiency, Conventional method of solving problems, L.C.M method, Negative work, The specific case of building a wall, Group work, Constant product rule, When work is not constant, Pipes and cistern– Similarity of logic. **4 hrs**

Reference Books:

1. The Trachtenberg speed system of basic mathematics, published by Rupa publications.
2. CAT Mathematics by AbhijithGuha. published by PHI learning private limited.
3. Quantitative aptitude by Dr. R. S Agarwal, published by S.Chand private limited.
4. Verbal reasoning by Dr. R. S Agarwal , published by S. Chand private limited.
5. Quantitative aptitude for CAT by Arun Sharma, published by McGraw Hill publication.
6. Analytical reasoning by M.K Pandey BSC PUBLISHING.CO.PVT.LTD

Course Outcomes (CO)

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

1. Solve problems of higher difficulty level with ease in the following topics– Time , speed and distance and Geometry. L5
2. Analyze the statements and identify the assumptions and infer the results based on the arguments or premises. L5
3. Apply the concept of L.C.M in the module time and work to solve the problems with comprehension. L2
4. Analyze the concepts in Co-ordinate geometry by spatial visualization. L4
5. Interpret the logic in the statements of syllogism by critical thinking and apply venn diagram for the effectives ways of deriving at the conclusion. L4
6. Determine the solutions for complicated problems of set theory using the concept of venn diagram. L4

Course Title : Additional Mathematics-II (A Bridge course for Diploma qualified students of IV Sem. B. E.)			
Course Code : P15MADIP41	**Semester : IV**	**L :T:P:H : 2:2:0:4**	**Credits: NA**
Contact Period: Lecture: 52 Hr,	**Weightage: CIE:100%, [P/NP]**		

UNIT –I

Linear Algebra: Introduction - Rank of matrix by elementary row operations - Echelon form of a matrix. Consistency of system of linear equations - Gauss elimination method. Gauss-Jordan and LU decomposition methods.Eigen values and eigen vectors of a square matrix. Application of Cayley-Hamilton theorem(without proof) to compute the inverse of a matrix-Examples. **10 Hrs**

UNIT –II

Higher order ODE's: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operators.Solutions of initial value problems. Method of undetermined coefficients and variation of parameters. Solution of Cauchy's homogeneous linear equation and Legendre's linear differential equation. **14 Hrs**

UNIT –III

Multiple Integrals: Double and triple integrals-region of integration. Evaluation of double integrals by change of order of integration.

Vector Integration : Vector Integration :Integration of vector functions. Concept of a line integrals, surface and volume integrals. Green's, Stokes's and Gauss theorems (without proof) problems. Orthogonal curvilinear coordinates. **10 Hrs**

UNIT –IV

Laplace transforms: Laplace transforms of elementary functions. Transforms of derivatives and integrals**,** transforms of periodic function and unit step function-Problems only. Inverse Laplace transforms: Definition of inverse Laplace transforms. Evaluation of Inverse transforms by standard methods. Application to solutions of Linear differential equations and simultaneous differential equations. **12 Hrs**

UNIT –V

Probability: Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability – illustrative examples. Bayes's theorem-examples. **06 Hrs**

Text Book:

1. B.S. Grewal: Higher Engineering Mathematics, Khanna Publishers, New Delhi,42nd Ed. 2012.

References:

1.E. Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons, 6th Ed., 2007

2.N.P.Bali and Manish Goyal: Engineering Mathematics, Laxmi Publishers,7th Ed., 2007.

Course Title : Environmental Studies			
Course Code: P15EVDIP410	**Semester : I/II**	**L-T-P-H: 2–0-0-2**	**Credits: NA**
Contact Period : Lecture :26 Hr		**Weightage :CIE:100% - [P/NP]**	

Prerequisites:

The student should have undergone the course on Environmental Studies (Code: P15EV19/29)

a) ***Course Learning Objectives (CLO) :***

At the end of the course the students should be able to:

1 Explain the need for Environmental Management
2 Implement standard data like water, wastewater and air pollution.
3 Demonstrate the use of standard data to compare with the field data.
4 Choose appropriate data to protect environmental.
5 Design environmental amenities based on the needs.

b) Relevance of the Course

Environmental Studies is a foundation course in BE (Environmental Engineering) program, that builds the program design and implementation competence in student through choice of appropriate areas.

The course aims at developing the understanding variations in water, wastewater and air pollution and also the ability to build new ideas.

Course Content

Unit – I

Environment – Definition, Ecosystem – Balanced Ecosystem, Human activities – Food Shelter, Economic and Social Security. Transportation activities, Environmental impact Assessment, Sustainable Development. **6 Hrs.**

Unit – II

Natural Resources – Water resources – Availability and Quality aspects, Mineral Resources, Forest Wealth, Material Cycles – (Carbon, Nitrogen and Sulphur Cycles) Water borne diseases, water induced diseases, Fluoride problem in drinking water. 5**Hrs.**

Unit – III

Energy – Different types of energy, Conventional and Non-Conventional sources – Hydro Electric, Fossil fuel based, Nuclear, Solar, geothermal, tidal, wind, Biomass and Bio-gas. Hydrogen as an alternative future source of energy. **5 Hrs.**

Unit – IV

Environmental Pollution and their effects. Water pollution, Land pollution, Noise pollution Public Health aspects. Current Environmental issues of importance: Population Growth Climate change and Global warming – Effect, Urbanizations industrialization. **5 Hrs.**

Unit –V

Acid Rain, Ozone layer depletion, Animal Husbandry. Environmental protection – Role o Government, Legal aspects, initiatives by Non-Governmental Organizations (NGO Environmental Education, Women Education. **5 Hrs.**

Text Book:

1)Environmental Studies – Benny Joseph – Tata McGraw Hill – 2005

References:

1)Principles of Environmental Science and Engineering – .VenugopalaRao P, Prentice Hall 2005
2)Elements of Environmental Science and Engineering – Meenakshi P, Prentice Hall of India, 2
3)Environmental Studies – Anil Kumar D.C, New age International Publishers, 2007