Syllabus

(With effect from 2015-2016 Academic year)

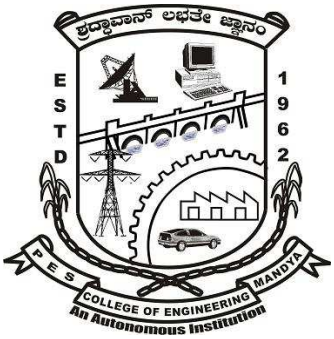
ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2015–16)

III & IV Semester

Bachelor Degree
in
INDUSTRIAL & PRODUCTION 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.

Sri.B.Dinesh Prabhu
Deputy Dean (Academic)
Associate Professor,
Dept. of Automobile Engg

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

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 INDUSTRIAL & PRODUCTION ENGINEERING

About The Department

PROFILE:

The Department of Industrial & Production Engineering was started during the year 1982 with a mission to produce the students of good management skill to cater the need of the advanced and globalized market which demand quality management people. The program offered in the department is B.E. in Industrial & Production Engineering. The department has very well experienced qualified teaching faculty among which three doctoral degree holders one is submitting his thesis and two are pursuing Post graduate courses.

The department strives hard to bring out well qualified students through all the available sources of teaching audio visual, interactive methods in teaching-learning process. The department has well-equipped laboratories, latest software facilities, to prepare the students industry ready when they become graduates.

The curriculum is designed involving industry, academia personnel to meet the demands of the current scenario and updated constantly according to industrial needs. The department regularly organizes technical talks by inviting experts from various industries and institutes, organizes industrial visits to enhance the practical knowledge of the students.

VISION

Our Vision is to produce Competent, Disciplined, Quality Engineers.

MISSION

- The mission of Industrial and Production Engineering Program is to prepare student
- For Employment
- For the pursuit of advanced degrees in Industrial, Production and Mechanical Engineering fields.
- For educating them in the fundamental concept, knowledge and skills in laboratory techniques.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1: Industrial and Production Engineering program will prepare graduates who will have the ability to apply the principles and techniques of traditional and modern quantitative and qualitative analysis and synthesis and effectively interpret, evaluate, select, and communicate the desired alternative in both manufacturing and service industries.

PEO1.1: Apply the principles and techniques of traditional and modern quantitative and qualitative analysis

PEO1.2: Effectively interpret, evaluate, select, and communicate the desired alternative in both manufacturing and service industries.

PEO2: Industrial and Production Engineering program will prepare its graduates who will possess the required engineering competence and ability to recognize the need for life-long learning to understand the impact of engineering solutions on society at all levels of an organization.

PEO2.1.analyze reallifeproblem

PEO 2.2. recognize the need for life-long learning

PEO3: Industrial and Production Engineering program will prepare graduates who will demonstrate the ability to identify, formulate, and solve engineering problems and apply continuous improvement in practice both individually and as members and/or leaders of multidisciplinary teams.

PEO3.1: ability to identify, formulate, and solve engineering problems

PEO3.2: ability to work both individually and as members and/or leaders of multidisciplinary teams

PROGRAMME OUTCOMES (POs):

PO-1 Graduates will demonstrate the ability to apply knowledge of Science and Engineering.

PO-2 Graduates will demonstrate the ability to design and conduct experiment as well as interpret data.

PO-3 Graduates will demonstrate an ability to identify, formulate and solve engineering problems.

PO-4 Graduates will demonstrate the skill to use latest CAD/CAM/CAE software and solving engineering problems.

PO-5 will demonstrate the ability to function on multidisciplinary teams

PO-6 will demonstrate the ability to identify, formulate, and solve engineering problems.

PO-7 will demonstrate the understanding of professional and ethical responsibility

PO-8 will demonstrate the ability to communicate effectively

PO-9 The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

PO-10 A recognition of the need for, and an ability to engage in life-long learning

PO-11 A knowledge of contemporary issues

PO-12 An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

PO-13 Graduation will have the alertly to recognise the importance of programme development by polis post graduate studies on complete exam that for challenging and rewinding career in Industrial 7 Production engineering

PO-14 Graduates will be able to design a system to meet desired needs within environmental, economic, political, ethical, health and safety, manufacturing and management knowledge and techniques to estimate fare, resources to complete

P.E.S.COLLEGE OF ENGINEERING, MANDYA-571401, (KARNATAKA)
(An Autonomous Institution under VTU, Belagavi)

III Semester B. E						**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**
01	P15MAT31	Engineering Mathematics - III	Maths.	3:2:0:5	4	50	50	100
02	P15IP32	Engineering Metrology.	IPE	4:0:0:4	4	50	50	100
03	P15IP33	Mechanical Measurements.	IPE	4:0:0:4	4	50	50	100
04	P15IP34	Mechanics of Materials.	IPE	4:0:0:4	4	50	50	100
05	P15IP35	Production Technology-I	IPE	4:0:0:4	3	50	50	100
06	P15IP36	Fluid Mechanics and Machinery.	IPE	4:0:0:4	4	50	50	100
07	P15IPL37	Metrology Lab.	IPE	0:1:2:3	1.5	50	50	100
08	P15IPL38	Foundry and Forging Lab.	IPE	0:1:2:3	1.5	50	50	100
09	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]	---	---
11	P15MADIP31	*Additional Maths – I	Maths	4:0:0:4	0	---	---	---
12	P15HMDIP310	*Indian Constitution. Human Rights & Professional Ethics	Human & Science	2:0:0:2	0	---	---	---
Total					26 [28]	400[450]	400[450]	800[900]

*Additional Maths – I & Constitution of India and Professional Ethics: Lateral Entry students shall have to pass these mandatory learning courses before completion of VI – Semester. **ARDB :All students shall have to pass this mandatory learning courses before completion of VI - Semester.

IV Semester B. E (I & P Engg)						**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**
01	P15MAAC4*	Engineering Mathematics - IV	Maths.	3:2:0:5	4	50	50	100
02	P15IP42	Material Science and Metallurgy	IPE	4:0:0:4	4	50	50	100
03	P15IP43	Engineering Thermodynamics	IPE	4:1:0:4	4	50	50	100
04	P15IP44	Theory of Machines	IPE	4:0:0:4	4	50	50	100
05	P15IP45	Production Technology-II	IPE	4:0:0:4	3	50	50	100
06	P15IP46	Computer Aided Machine Drawing	IPE	4:0:0:4	4	50	50	100
07	P15IPL47	Material Testing & Metallography Lab	IPE	0:1:2:3	1.5	50	50	100
08	P15IPL48	Machine Shop Practice	IPE	0:1:2:3	1.5	50	50	100
09	P15HU49	Aptitude and Reasoning Development – Intermediate (ARDI)	HS & M	2:0:0:2	1	50	50	100
10	P15MADIP41	*Additional Maths - II	Maths1	4:0:0:4	0	---	---	---
11	P15EVDIP410	*Environmental Studies	Env	2:0:0:2	0	---	---	---
Total					**27**	**450**	**450**	**900**

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

Evaluation Scheme							
Scheme	**Weightage**	**Marks**	**Event Break Up**				
CIE	50%	50	**Test I**	**Test II**	**Quiz I**	**Quiz II**	**Assignment**
			35	35	05	05	10
SEE	50%	50	**Questions to Set: 10**		**Questions to Answer: 5**		

Evaluation Scheme (Laboratory)							
Evaluation Scheme						**Scheme for Examination**	
Scheme	**Weightage**	**Marks**	**Event Break Up**			One Question from Part –A	20 Marks
CIE	50%	50	**Test**	**Record**	**Seminar**	One Question from Part -B	20 Marks
			20	20	10	Viva – Voice	10 Marks
SEE	50%	50				**Total**	**50 Marks**

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 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.	7	1	L2
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	7	2	L2

$\log_e 2$.			

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 $f(x) = \begin{cases} 1-x^2, \mid x \mid < \alpha \\ 0, \mid x \mid \geq \alpha \end{cases}$ 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) = $e^{-\mid x \mid}$ 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 $\cos n\theta$ and $\sin n\theta$.			
(b) Compute the inverse Z-transform of $\frac{3z^2+2z}{(5z-1)\ (5z+2)}$	6	4	L1
(c) Solve by using Z-transforms: $y_{n+2} + 2y_{n+1} + y_n = n$ with $y_0 = 0 = y_1$.	7	4	L2
	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 7	5 4	L3 L2
(c). Solve: $(mz-ny)p + (nx-lz)q = (ly-mx)$.	10	5	L3
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 $t \geq 0$ and $u(x,0) = 0$, $\frac{\partial u}{\partial t}(x,0) = x(l-x), 0 \leq x \leq l$.			

Course Title: Engineering Metrology			
Course Code: P15IP32	**Semester:** III	**L – T – P :** 4 - 0 - 0	**Credits:** 4
Contact Period - Lecture: 52Hrs.; Exam:3 Hrs.		**Weightage:** CIE: 50%; SEE: 50%	

Prerequisites:
Students should have the knowledge of using Scale, compass, inside and outside calipers, Spirit level, Tri square, Micrometre, Vernier Caliper, etc.

Course Learning Objectives (CLOs)
This course aims to:
1. **Understand** the students gain the knowledge in the field of Engineering Metrology.[L2]
2. **Apply** the fundamental concepts of gauging principal and to solve the gauging problems. [L3]
3. **Demonstrate** the operation principles, advantages, applications, limitations of the various comparators.[L3]
4. **Apply** the various surface measurements technique and their application. [L3]
5. **Evaluate** the various optical measuring instruments. [L5]
6. **Distinguish** between screw threads and gears terminology. [L4]
7. **Understand** the basics of NDT methods.[L2]

Relevance of the Course
Metrology is a foundation course for BE(Industrial and Production) program that aims at measurement and calibration of different gauges, implementation ideas for measurement of various Engineering application.
The course aims at developing the understanding of basic measurement in metrology. It helps in developing the student's skill in measurement techniques.

Course Content

Unit-I

General Measurement Concepts and Principles: Definition of accuracy and precision, estimating accuracy and precision, Line and End measurements, Subdivisions of Standards , Different types of length standards: Imperial standard yard, International yard, International prototype meter, Light wave (optical) length standard, Airy Points. Limits, fits and tolerance, Hole basis system and shaft basis system (problems). **12 Hours**

Unit-II

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

Measurement and Checking using Different Instruments : Straightness, Flatness, Squareness, Combination Set, Sine bars- Sine centre construction and working principle.

10 Hours

Unit-III

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

Optical Measuring Instruments : Interference of light, Arrangement for producing interference pattern, Optical flats, Laser interferometer, Construction and Principle of Tool Maker's Microscope, Optical projectors, Autocollimators. **10 Hours**

Unit-IV

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

Measurement of screw threads and gears: Terminology of screw threads, Best wire size method, two and three wires method, Bench micrometer, Measurement of Major and Minor diameter. Gear terminology, Measurement of run-out, pitch, and profile, Parkinson Gear Tester **10 Hours**

Unit-V

Machine Tool Testing: Instruments required for alignment test, Alignment tests on Lathe, drilling machine and Milling machine.

Non Destructive Testing: Comparison of Destructive and Non-destructive testing methods, Introduction to NDT Methods: Magnetic Particle Inspection, Ultrasonic Testing, Eddy Current testing, Radiography, Acoustic emission testing **10 Hours**

Text Book:

1) R.K. Jain: "Engineering Metrology"- Khanna Publishers
2) I.C. Gupta, Engineering Precision Metrology–DhanpatRai Publications

Reference Books:

1) K. J. Hume, "Engineering Metrology", Kalyani Publishers, Third Edition.
2) ASTME – Hand book of Industrial Metrology – PHI

Course Outcomes

After learning all the units of the course the students is able to

1. Learn and understand necessity of Metrology and basic of Non-destructive testing.
2. Demonstrate ability to make use of different gauges.
3. Use the different type's comparators.
4. Get exposure to different types of surface measurements methods.
5. Demonstrate the knowledge of various screw threads and gear terminology.
6. Demonstrate the need of Non-destructive testing.

No.	**Model Question Paper**	**Marks**	**CO's**	**Blooms level**
UNIT- I				
1.a	With a neat sketch explain Hole basis and Shaft basis system, and terminologies used	10	1	L4
1.b	Describe with a neat sketch the Imperial standard yard	10	1	L2
OR				
2.a	Explain with a neat sketch the accuracy and precision, illustrate with an example	10	2	L5
2.b	Describe with a neat sketch limits, fits and tolerance	10	2	L2
UNIT -II				
3.a	Construct with a neat sketch the ring gauge, snap gauge, screw pitch gauge and feeler gauge	10	2	L3
3.b	Describe the concept of designing of Go and No Go gauges according to Taylor's principle	10	2	L2
OR				
4.a	Construct the Sine centre and explain the principle of working	10	2	L3
4.b	With a neat sketch explain Sine bars.	07	2	L2
4.c	Explain straightness.	03	2	L2
UNIT- III				
5.a	Explain with a neat sketch pneumatic comparator	10	3	L5
5.b	Distinguish between Mechanical and Optical comparator	7	3	L4
5.c	Explain Optical flats	3	3	L2
OR				
6.a	Explain the arrangement of Interference of light with a neat sketch	10	4	L5
6.b	Explain the construction and Principle of Autocollimators	10	4	L5
UNIT -IV				
7.a	Describe the elements of surface finish measurement	10	4	L2
7.b	Explain Best wire size method with a neat sketch	10	5	L2
OR				
8.a	Explain with a neat sketch Tomlinson's Surface meter	12	4	L5
8.b	Describe with neat sketch Ra, Rt and Rz	8	4	L2
UNIT -V				
9.a	Distinguish between destructive and Non-destructive testing method	10	6	L4
9.b	With neat sketch, explain Ultrasonic Testing	10	6	L2
OR				
10.a	With neat sketch, explain acoustic emission Testing in Non-destructive testing method	10	6	L5
10.b	Describe with a neat sketch any two alignment test on lathe machine	10	6	L2

Course Title: Mechanical Measurements			
Course Code: P15IP33	**Semester:** III	**L – T – P** : 4 – 0 - 0	**Credits:** 4
Contact Period - Lecture: 52Hrs.; Exam:3 Hrs.		**Weightage:** CIE: 50%; SEE: 50%	

Prerequisites:
Students should have the knowledge of workshop practice, knowledge of reading various instruments is essential.

Course Learning Objectives:

1. The identify the course is to provide the students an opportunity to gain the knowledge in the field of Measurements.L1
2. Apply the fundamental concepts of instruments principal and to solve the constructional problems.L3
3. To demonstrate the operation principles, advantages, applications, limitations of the various of instruments L3
4. To understand the knowledge for various measuring instruments and pressure sensitive elements.L2
5. The students understand the knowledge of different OscillographsL2
6. The students understands the different methods of Dynamometers,L2
7. Analyse basic of Radiation Pyrometers methods.L4

Relevance of the Course

Mechanical Measurements is a foundation course in BE (Industrial and Production) program, that builds measurement and implementation ideas for measurement for various application.

The course aims at developing the understanding of advanced measurements in Mechanical Measurements. It helps the student's skill in measurement.

Course Content

Unit-I

Basic Detector Transducers: Mechanical members as primary detectors. Electric transducers - sliding contact devices. Secondary transducers - differential transformer, piezo electric effect, Ionization transducer.

Intermediate Modifying Systems Mechanical systems, kinematics linearity, Mechanical amplifications, reflected frictional amplifications, reflected inertial amplifications,- temperature problems, methods for limiting temperature errors, Telemetry. **11Hours**

Unit-II

Terminating Devices and Methods: The generalized system. vacuum tube voltmeter. Mechanical counters. CRO recording techniques, oscillographs,

Measurement of Force, Torque: Methods of force and torque measurements, elastic transducers, Hydraulic, pneumatic transmission dynamometers. **11 Hours**

Unit-III

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

Unit-IV

Vibration Measurement: vibration measurement system, concept of equation of motion, accelerometer, principle of a piezoelectric accelerometer, shakers and vibration and shoke-testing equipment.

Measurement of Pressure: Pressure measuring systems, pressure measuring transducers, elastic transducers, elastic diagrams, strain gauge pressure cell, measurement of high and low pressures. **10 Hours**

Unit-V

Temperature Measurement: Thermal expansion methods, bimetallic thermometers, liquid-in glass thermometers, pressure thermometers, thermoelectric sensors (thermocouples), and common thermocouples. Reference junction considerations, electrical resistance sensors-semiconductor sources – Radiation methods - pyrometers. **10 Hours**

Text Book

1. Mechanical Measurements - Beckwith, Buck & Maran-Goni Narosa publishing House
2. Metrology and measurement – Anand K Bewoor and Vinay A Kulkararni The McGraw-Hill Company
3. Mechanical Measurements and Control - D.S.KUMAR, Metropolitan Publishers

Course outcomes

a) Course Learning Objectives (CLO).
At the end of the Course the students should be able to:

Course Learning Outcome

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

Course Title: Mechanics of Materials			
Course Code: P15IP34	**Semester:** III	**L – T – P** : 4 – 0 - 0	**Credits:** 4
Contact Period - Lecture: Hrs.; Exam: Hrs.		**Weightage**: CIE: 50 %; SEE: 100%	

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

Course Learning Objectives (CLOs):

At the end of the Course the students should be able to,

1. Define the concept Stress, Strain, deflections, Hooke's law and Poisson's ratio [L1].
2. Derive an expression of deflections, bars with cross sections varying in steps [L1].
3. Solve the problems on principle of superposition [L3].
4. Solve the problems on composite sections, temperature stresses, etc., [L3].
5. Understand the concept of Thick and thin cylinders [L1].
6. Understand the concept of bending and shear force [L1].
7. Solve the problems on bending moment and shear force diagrams [L3].
8. Solve the problems related to the deflection of beams and torsion of circular shafts [L3].

Relevance of the Course:

Material Science and Metallurgy is a basic subject which deals with the concept of,

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

Course Content

Unit – I

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

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

Unit – II

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

Compound Stresses: Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress. **10 Hours**

Unit – III

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

Bending moment and Shear force in beams: Introduction, Types of beams, shear forces and bending moments, sign conventions, relationship between shear force and bending

moment, shear force and bending moment diagrams for Simply Supported beams subjected to concentrated loads and uniform distributed load (UDL). **11 Hours**

Unit - IV

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

Unit –V

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

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

Text books:

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

Reference books:

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

Course Outcomes

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

- Analyse determinate and indeterminate problems to determine fundamental stress states associated with kinematic modes of deformation.
- Apply Mechanics of materials equations (and formulas) to the solution of engineering and design problems.
- Recognize and extract fundamental modes in combined loading and do the appropriate stress analysis
- Extract material properties (modulus of elasticity, yield stress, Poisson's ratio) from data and apply these in the solution of problems.
- Calculate the geometric properties (moments of inertia, centroids, etc) of structural elements and apply these in the solution of problems which will enable them to solve real engineering problems.
- Identify kinematic modes of deformation (axial, bending, torsional, buckling and two dimensional) and associated stress states on infinitesimal elements and sketch stress distribution over cross sections.

Course Title: Production Technology -I			
Course Code: P15IP35	**Semester:** III	**L – T – P :** 4 – 0 - 0	**Credits:**3
Contact Period - Lecture:52 Hrs.; Exam:3 Hrs.	**Weightage:** CIE: 50 %; SEE: 50%		

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

Course Learning Objectives (CLO) :

This Course aims the students, should be able to

- Define the concept of Manufacturing processes and the classification of the process.[L1]
- Understand the functions and materials used for the preparation of Patterns.[L2]
- Define the concept and methods used in Sand moulding techniques.[L1]
- Understand the classification and constructional features of furnaces.[L2]
- Understand principle, classification and applications of welding process.[L2]
- Understand the different types of welding process.[L2]

Relevance of the Course :

Manufacturing process is a basic subject which deals with the concept of,

- Patterns : Functions, Materials used for pattern, various pattern allowances,
- Different types of Sand Moulds,
- Methods of making a Cores,
- Different types of furnaces, constructional features and working principles of Gas fired fit furnaces,
- Principles, Classification and Applications of Welding process,

Course Content

Unit – I

Casting Process:

Introduction: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Varieties of components produced by casting process. Advantages& Limitations of casting process.

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

Binder and Additives: Definition, Types, Need, Types of additives used.

Cores: Definition, Need, Types, Method of making cores.

Gating and Risering: Principle involved and types

Fettling and cleaning of castings. Basic steps involved. Casting defects causes, features and remedies. **11Hours**

Unit - II

Sand Moulding: Types of base sand, requirement of base sand. Types of sand moulds. Moulding sand mixture ingredients (base sand, binder &additives) for different sand mixtures. Method used for sand moulding.

Moulding machines: Jolt type, Squeeze type, Jolt & Squeeze type and sand slinger.

Special moulding Process: Study of important moulding processes Green sand, Core sand, Dry sand, CO2 mould, Shell mould and Investment mould. **10 Hours**

Unit - III

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

Melting Furnaces: Classification of furnaces. Constructional features & working principle of Gas fired pit furnace, Resistance furnace, Coreless Induction furnace, Electric Arc Furnace, Cupola furnace. **10 Hours**

Unit - IV

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

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

Gas Welding: Principle, Oxy–Acetylene welding, Reaction in Gas welding, Flame characteristics, Gas torch construction & working. Forward and backward welding.**11 Hrs**

Unit – V

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

Metallurgical aspects in welding: Structure of welds, Formation of different zones during welding. Heat affected zone **(HAZ),** Parameters affecting **HAZ**. Welding defects – Detection causes & remedy. **10 Hours**

Text Books:

1. P. N. Rao, "Manufacturing & Technology": Foundry Forming and Welding", Tata McGraw Hill, 2nd Ed., 2013.
2. Dr. K. Radhakrishna, "Manufacturing Process-I", Dr.K.Radhakrishna, Sapna Book House, 2nd Edition, 2007.

Reference Books:

1. SeropeKalpakjain, Steuen.R.Sechmid "Manufacturing Technology", Pearson Education Asia, 5th Ed. 2006.
2. Roy A Lindberg,"Process and Materials of Manufacturing", Pearson Edu, 4th Edition, 2006.

Course outcomes:

At the end of the Course the students, should be able to

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

No.	**Model Question Paper**	**Marks**	**CO's**	**Blooms level**
UNIT- I				
1.a	Define casting. Classifying the Manufacturing Process	10	1	L2
1.b	With neat sketch Explain in detail various patters allowance.	10	1	L2
OR				
2.a	Write notes on Casting defects.	10	1	L2
2.b	Explain the steps involved in Fettling and cleaning of castings.	10	1	L2
UNIT -II				
3.a	With a neat sketch explain Jolt type moulding machine	10	2	L2
3.b	Explain various methods used for moulding	10	2	L2
OR				
4.a	With a neat sketch explain investment moulding	10	2	L2
4.b	With a neat sketch explain CO2 moulding process.	07	2	L2
4.c	List different types of base sand.	03	2	L1
UNIT- III				
5.a	With a neat sketch explain Squeeze Casting.	10	3	L2
5.b	With neat sketch, explain working of resistance furnaces	10	3	L2
OR				
6.a	With neat sketch , Explain the working principle of cupola furnace	10	3	L2
6.b	With neat sketch, explain continuous casting	10	3	L2
UNIT -IV				
7.a	Explain the Atomic hydrogen welding process with a neat sketch.	10	4	L2
7.b	Write a notes on various flame characteristics	10	4	L2
OR				
8.a	Differentiate between forward and backward welding technique	10	5	L4
8.b	List the Application, Advantages & limitations of welding process.	10	5	L1
UNIT -V				
9.a	Differentiate between Soldering and Brazing technique.	10	6	L4
9.b	With neat sketch, explain Thermit welding.	10	6	L2
OR				
10.a	Explain the various zones present in HAZ.	10	6	L2
10.b	Write notes on welding defects	10	6	L2

Course Title: Fluid Mechanics and Hydraulic Machines			
Course Code: P15IP36	**Semester:** III	**L – T – P :** 4 – 1 - 0	**Credits:** 4
Contact Period – Lecture : 52 Hrs ; Exam : 03 Hrs		**Weightage :** CIE : 50%, SEE : 50%	

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

Course Learning Objectives (CLOs) :

On successful completion of the course, the students will be able to:

- Recall the basic principles involved in fluid behaviour and equipment's involving fluid flow, thus preparing themselves for an advanced course on hydraulic drives.[L1]
- Define the properties of fluids, fluid statics, fluid kinematics involving flow and the basic principles of dimensional analysis.[L1]
- Explain the equations of motion and demonstrate fluid flow measurement and energy losses in pipe flow.[L2]
- Explain the operation of energy producing devices like turbines through velocity triangles knowing fully the principles of impact of jets on valves. [L2]
- Define the velocity triangles for energy absorbing devices like centrifugal pumps and the working principle of reciprocating pump.[L1]

Relevance of the Course :

Fluid mechanics and Hydraulics is a basic subject which deals with the concept of,

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

Course Content

Unit – I

Properties of Fluids: Introduction, properties of fluids, density, specific weight, specific gravity, viscosity, thermodynamic properties, surface tension and Capillarity, Vapor pressure and Cavitation.

Fluid Statics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers, differential manometers **10 hrs**

Unit – II

Fluid Statics. Total pressure and center of pressure for vertical, Horizontal, inclined and curved plane surfaces submerged in liquid.

Buoyancy – center of buoyancy, Archimedes principle metacenter and metacentric height, conditions of equilibrium of floating and submerged bodies. **10hrs**

Unit – III

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

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

Fluid flow measurement: Introduction, venture-meter, orifice meter, Pitot tube. **10 hrs**

Unit – IV

Flow through pipes: Frictional loss in pipe flow, Darcy & Chezy's equation for loss of head due to friction in pipes, minor energy losses.

Impact of jets: Force exerted by the jet on a stationery vertical plate, Force exerted by the jet on a curved plate moving in the direction of the jet.

Turbines: classification of Hydraulic turbines, Impulse and reaction turbines, work done and efficiency of Pelton wheel and reaction turbine, velocity diagrams, draft tube, (Simple problems only). **10 hrs**

Unit – V

Pumps

Reciprocating pumps: Types, work done by reciprocating pump, single acting and double acting, coefficient of discharge, Percentage slip, effect of acceleration on piston, Air vessels.

Centrifugal pump: Advantages of centrifugal pump over Reciprocating pump, working of C/F pump, work done by the impeller, losses & efficiency, specific speed, multistage pump. (Simple problems only). **12hrs**

Text Books:

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

References:

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

Course Outcomes:

Upon successful completion of this course, the students will be able:

1. Explain the properties of fluid like density, specific weight, specific gravity, viscosity etc; estimate the variations of pressure in a static mass of fluid.
2. Estimate the pressure in a static mass of liquid with manometers; evaluate the total pressure and centre of pressure on different plane surfaces; explain the conditions of equilibrium of floating bodies.

3. Explain the principles of fluid kinematics involving different types of flows, velocity and acceleration, continuity equation and basic principles of dimensional analysis.
4. Derive the equations of motion and explain fluid flow measurement devices like venturimeter, orifice meter etc.; evaluate the energy losses in pipe flow.
5. Explain the operation of energy producing devices like turbines through velocity triangles knowing fully the principles of impact of jets on vanes.
6. Draw the velocity triangles to explain the working of energy absorbing device like centrifugal pump and the working principle of reciprocating pump.

Course Title: Metrology Laboratory			
Course Code: P15IPL37	**Sem:** III	**L –T-P-H:** 0:0:3:3	**Credit:** 1.5
Contact Period: Lecture: 36 Hrs, Exam: 3Hrs		**Weightage:** CIE 50%, SEE: 50%	

Prerequisite: Knowledge of Measuring instruments, P15IPL32

Course Objectives

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

Relevance of the course:

1. Metrology lab teaches the students about measurement and calibration of different measuring instruments, implementation ideas for measurement of various Engineering application.
2. It helps the students to understand the basic measurements in metrology and to enhance the student's skill in measurement techniques.

Course Content

Introduction to Metrological instruments like gauges and commonly using instruments.

1. Measurements using Micrometre, Vernier Calliper, Dial Gauges, Height gauges
2. Measurement of inside diameter using internal micrometre/ bore gauge /telescopic gauges
3. Measurements of Dovetail angle using Bevel Protractor / Roller set
4. Measurements of angle using Sine Centre / Sine bar
5. Measurements using Profile Projector
6. Measurements using Toolmaker Microscope/ Vision measuring instrument
7. Measurements of Screw Thread Parameters using thread measuring machine / micrometre.
8. Measurements on Universal length measuring machine
9. Measurements of gear tooth profile using gear tooth Vernier /gear tooth micrometre.
10. Measurements of straightness, squareness using Autocollimator
11. Measurement of roundness, eccentricity using bench centre/ roundness measuring machine
12. Measurement of flatness using Interferometer & Optical Flats
13. Use of comparators: Mechanical/ Electronics/ Pneumatic/ Dial type air gauge
14. Measurements of Surface roughness using roughness tester (demo)

Note: At least 60% of the above experiments should be conducted depending upon the availability of the instruments

Course Learning outcomes:

By learning this course the student will:

- have a good understanding of the use of measuring instruments.
- have knowledge about different measuring methods and instruments, both traditional and modern that are used in the industry.
- have the ability to apply and interpret measurement data to estimate measurement uncertainties, control of the production process,
- be able to evaluate the experiment independently on research topics in the field of measurements.

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, 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: 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
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 Δ^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: Material Science and Metallurgy			
Course Code: P15IP42	**Semester:** IV	**L – T – P** : 4 – 0 - 0	**Credits:** 4
Contact Period - Lecture: 52Hrs.; Exam: 3Hrs.	**Weightage:** CIE: 50 %; SEE: 50%		

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

Course Learning Objectives (CLOs):

The Course aim the students should be able to,

1. Define the concept of Unit cell, Space Lattice, Atomic Packing Factor, Coordination Number and different types of Crystal Imperfections, the concept of Mechanical Properties of the materials.[L1]
2. Explain the concept and mechanism of Fracture, Fatigue and Creep.[L2]
3. Construct and analyse the different types of Solid Solutions and Iron Carbon Equilibrium diagram.[L3]
4. Classify and explain the different heat treatment techniques to improve the specific properties of the engineering materials.[L4]
5. Identify the composition, properties and application of ferrous and non-ferrous materials.[L3]
6. Explain the different kinds of Reinforcement and Matrix in composites.[L2]

Relevance of the Course:

Material Science and Metallurgy is a basic subject which deals with the concept of,

- Internal Structure of the materials and their properties,
- Investigates the relationship between the Internal Structure and its properties,
- Different methods used for Testing the properties of materials,
- Different methods of failures of materials (Fracture, Fatigue and Creep),
- Preparation of Alloys and study of their compositions,
- Different Engineering materials,
- Synthesis of composites and application of composites.

Course Content

UNIT – I

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

CONCEPTS OF STRESS & STRAIN: Tensile properties, True Stress & Strain, Hardness, Rockwell, Vickers & Brinell Hardness Testing. Plastic deformation - Slip & Twinning.

11Hours

UNIT – II

FRACTURE, FATIGUE &CREEP: FRACTURE: Types, Stages in Cup & Cone fracture. FATIGUE: Fatigue tests, S-N curves, Factors affecting fatigue life and protection methods. CREEP: The Creep curves, Mechanisms of Creep, Creep - resistant materials.

SOLID SOLUTIONS AND PHASE DIAGRAM: Solid solutions - Types, Rules governing the formation of solids solutions. Phase diagrams - Basic terms, phase rule, cooling curves, construction of phase diagrams, interpretation of equilibriums diagrams, Types of phase diagrams, Lever rule. **11 Hours**

UNIT – III

IRON CARBON EQUILIBRIUM DIAGRAM: Phases in the Fe–C system, Invariant reactions, critical temperatures, Microstructure of slowly cooled steels, effect of alloying elements on the Fe-C diagram, ferrite & Austenite stabilizers. The TTT diagram, drawing of

TTT diagram, TTT diagram for hypo & hypereutectoid steels, effect of alloying elements on TTT diagram. **9 Hours**

UNIT – IV

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

FERROUS MATERIALS: Properties, Composition and uses of Grey cast iron, malleable iron, SG iron and steel. **11 Hours**

UNIT – V

NON-FERROUS MATERIALS: Properties, Composition and uses of Copper alloys-brasses and bronzes. Al, Mg & Titanium alloys.

INTRODUCTION TO COMPOSITES: Definition, classifications, types of matrix materials and reinforcements, fundamentals of production of FRP's and MMC's, advantages and applications of composites. **10 Hours**

Text Books:

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

Reference Books:

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

Course Outcomes:

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

1. Know the Fundamental concepts of Materials, and different Structures of Materials and common types of defects in the materials.
2. Explain the tensile properties of Materials.
3. Analyse the concept and mechanism of Fracture, Fatigue and Creep.
4. Construct and analyse the different types of Solid Solutions and Iron Carbon Equilibrium diagram.
5. Analyse the different heat treatment techniques to improve the specific properties of the engineering materials.
6. Identify the composition, properties and application of ferrous and non-ferrous materials.
7. Understand the different kinds of Reinforcement and Matrix in composites and their applications.

	Model Question Paper	Marks	CO's	Levels
	Unit- I			
1.a	Define atomic packing factor? Prove that the APF for FCC is higher than BCC.	9	1	L5
b	Differentiate between edge and screw dislocation.	5	1	L4
c	Aluminum has atomic radius of 0.143 nm. Assuming the atoms of aluminum to be in spherical shape which touch each other along the face diagonal of the unit cell, Determine the density of aluminum. The atomic mass of aluminum is 26.98g/mol.	6	1	L5
2.a	With a stress strain diagram Explain the tensile properties for ductile materials.	8	2	L2
b	List and Explain the different types of Surface defects in Materials.	12	1	L2
	Unit- II			
3.a	What is S-N diagram? Explain its importance with the example of mild steel and aluminum	8	3	L2
b	What is meant by creep? With the help of creep curve, Explain different stages of creep.	9	3	L1
c	List the factors affecting fatigue life of a material.	3	3	
4.a	Explain Hume Rothery rules for formation of substitutional solid solution.	10	3	L2
b	With a neat sketch Explain the construction of Phase Diagram.	10	3	L2
	Unit- III			
5.a	Draw a neat Label sketch of Fe-C phase diagram and mention all the phases present at different temperatures.	12	4	L1
b	List and Explain the different regions in the Fe-C diagram.	8	4	L2
6.a	With the help of a neat sketch Explain the construction of TTT diagram.	10	4	L2
b	Explain with a neat sketch Hypo and Hyper Eutectoid Steel.	10	4	L2
	Unit -IV			
7.a	With a neat sketch Explain Annealing process.	7	5	L2
b	Differentiate between Normalising and Annealing process.	5	5	L4
c	With a neat sketch Explain Jominy End Quench test.	8	5	L2
8.a	With the help of a neat sketch Explain induction hardening and flame hardening process.	10	5	L2
b	State the properties and uses of grey cast iron, malleable cast iron, spheroidal cast iron and white cast iron.	10	6	L1
	Unit -V			
9.a	Write a note on Titanium alloys and Copper and its alloys.	10	6	L6
b	Explain the role of Reinforcement and Matrix materials in composites.	10	7	L2
10.a	List the advantages of Composites.	4	7	L1
b	Distinguish between α and (α+β) brasses with respect to composition, properties and applications.	10	6	L4
c	Define composites? Explain how composites are classified.	6	7	L2

Course Title: Engineering Thermodynamics			
Course Code: P15IP43	**Semester:** IV	**L – T – P** : 4 – 1 - 0	**Credits:** 4
Contact Period - Lecture: 52Hrs.; Exam: 3Hrs.		**Weightage:** CIE: 50 %;	SEE: 50%

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

Course Learning Objectives (CLO):

The course aim, the students will be able to:

- Apply the basic principles of thermodynamics in solving engineering problems knowing the real world engineering examples.[L3]
- Define thermodynamic system, process, cycle, equilibrium, properties, work and heat transfer in thermodynamic context, laws of thermodynamics and properties of pure substances and perfect gases.[L1]
- Explain basic constructional features of energy producing cycles like Rankine cycle, Air standard cycle and gas turbine cycles.[L2]
- Explain the basic principles of energy absorbing device like Air compressor.[L2]

Relevance of the Course:

Engineering Thermodynamics is a basic subject which deals with the concept of,

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

Course Content

Unit – I

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

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

Unit – II

Laws of thermodynamics: First law for closed system undergoing a cycle, First law for a closed system undergoing a change of state, Energy – a property of the system, different form of energies, specific heat at constant volume, Enthalpy , Specific heat at constant pressure, PMMI, First law applied to a flow process.

Second law of Thermodynamics, Heat engine and efficiency, Heat pump and COP, Energy reservoirs, Kelvin Planck and Clausius Statements of Second law of thermodynamics, PMM II, Reversible and Irreversible processes, Carnot cycle, Carnot Theorem,

Entropy – Clausius inequality, showing cyclic integral of $\delta Q/T$ is independent of path. (No problems on entropy) **10 hrs**

Unit – III

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

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

Unit – IV

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

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

Unit – V

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

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

10 hrs

Text Books:

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

Reference Books:

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

Course Outcomes:

After learn the course, the students will be able to:

1. Explain Working of IC Engines, Refrigerator and Air Conditioner.
2. Explain Thermodynamic system and Properties like equilibrium, Quasistatic process, Zeroth law of thermodynamics etc.
3. Apply first and second laws of Thermodynamics to the real world engineering devices knowing fully the limitations of energy conversion.

4. Identify and explain the properties of Pure Substance and Perfect Gas.
5. Explain different Power cycles like Carnot cycle, Rankine cycle, Efficiency, Effect of pressure and temperature on Rankine cycle, Reheat and Regenerative cycles, Air standard cycles – Otto, Diesel, Dual cycles, P-v and T-s diagrams,
6. Know the working of gas turbines and air compressor.

	Model Question Paper	Marks	CO's	Levels
	Unit I			
1.a	What is a system? Briefly Explain the three types of systems.	10	2	L2
b	Explain what you understand by Thermodynamic equilibrium.	5	1	L2
c	Distinguish between Macroscopic and Microscopic points of view.	5	1	L4
2.a	State and Explain Zeroth law of Thermodynamics.	8	2	L2
b	The temperature t on a certain Celsius thermodynamic scale is given by means of property through a relation t = a In p + b where a and b are constants and P is the property of the fluid. If the ice point and steam point have values of P are found to be 4 and 20 respectively. What will be temperature reading corresponding to a reading of P = 16?	8	2	L1
c	With the help of a PV diagram Show that work is a path function.	7	2	L1
	Unit II			
3.a	State the first law of Thermodynamics for a closed system –undergoing i) Cycle and ii) Process Hence Prove that internal energy is a property of the system for a process.	8	3	L5
b	A gas at 65 KPa, 200°C is heated in a closed rigid vessel till it reaches a temperature of 400°C. Determine the amount of heat required for 0.5kg of this gas if the internal energy at 200°C and 400°C is 26.6 kJ/kg and 37.8 kJ/kg respectively.	6	3	L5
c	Briefly Explain Kelvin-Planck and Clausius statements.	6	3	L2
4.a	Show that violation of Clausius statement of 2^{nd} law of thermodynamics, violated the Kelvin-Planck statement of 2^{nd} law of thermodynamics.	7	3	L1
b	Briefly Explain the four important factors that render processes irreversible.	6	3	L2
c	A reversible engine is supplied with heat from a constant temperature course at 900^oK and rejects heat to constant temperature at 300^oK. What is the least amount of heat rejected by the Engine, when developing 100 kN	7	3	L1
	Unit III			
5.a	Draw enthalpy and entropy diagram for water and indicate the following on the same (i) Triple point (ii) Fusion curve (iii) Critical point (iv) Sublimation curve (v) Vaporization curve	5	4	L1
b	What is dryness fraction? Briefly Explain the principle of determination of dryness fraction using throttling calorimeter.	8	4	L2
c	A rigid vessel of volume 0.86 m^3 contains 1 kg of steam at a pressure of 2 bar. Evaluate the specific volume, temperature, dryness fraction, internal energy, enthalpy and entropy of steam.	7	4	L5
6.a	Prove that characteristic gas equation is given by PV = mRT and explain why gases have two specific heats.	8	4	L5
b	What is a Pure substance? Give an example.	5	4	L1
c	Define "Quality of Steam". Explain any one method for determining the quality of steam with a sketch.	7	4	L2
	Unit IV			
7.a	Derive an expression for the air Standard efficiency of a Diesel Cycle.	10	5	L6
b	An engine with a bore of 20cms and a stroke of 30cms works on Otto cycle. The clearance volume is 1600 cm^3. The initial pressure and temperature are 1 Bar and 60˚C. If the maximum pressure is limited to 24 Bar, Find the air standard efficiency of the cycle.	10	5	L1
8.a	With the help of PV and T.S. diagram Derive an expression for the efficiency of a Rankine cycle.	10	5	L6
b	Briefly Explain: (i) Reheat cycle (ii) Regenerative cycle	10	5	L2
	Unit V			
9.a	Briefly Explain Brayton cycle.	4	5	L2
b	Derive an expression for the work done w.r.t. single stage single acting	10	6	L6

	reciprocating air compressor with clearance with the help of indicator diagram.			
c	Air is compressed in a single stage reciprocating compressor from 1.013 bar and 15°C to 7 bar. Calculate the indicated power required for a free air delivery of $0.3m^3$/min, when the compression process is as follows: (i) Isentropic (ii) Reversible Isothermal (iii) Polytropic with n = 1.25 What will be the delivery temperature in each case?	6	6	L1
10.a	What are the advantages of multistage air compression over single stage air compressor? List at least five advantages with the help of PV- diagram.	10	6	L1
b	Determine the size of the cylinder of a double acting air-compressor of 32 kW IP in which air is drawn in at 1 bar and compressed to 16 bar according to the law $PV^{1.25}$ = Constant RPM = 300, Piston speed = 180 m/min, volumetric efficiency = 0.8.	10	6	L5

Course Title: Theory of Machines			
Course Code: P15IP44	**Semester**: IV	**L – T – P :** 4 – 0 - 0	**Credits:**4
Contact Period - Lecture: 52Hrs.; Exam: 3Hrs.		**Weightage:** CIE: 50 %; SEE: 50%	

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

Course Learning Objectives (CLO) :

At the end of the Course the students should be able to,

1. Define link, kinematic pairs, degrees of freedom, kinematic chains and mechanisms [L1].
2. Understand the kinematic chains and Inversions – Four bar chain and single slider crank chain and double slider crank chain [L1].
3. Understand the quick return motion mechanisms and Whitworth mechanisms [L1].
4. Define the gear terminology – Spur gears [L1].
5. Understand the concept of Simple and compound gear trains [L1].
6. Understand the concept Friction [L1].
7. Solve the problems on Balancing [L1].

Relevance of the Course:

Theory of Machines is a basic subject, which deals with the concept of:

- Link or element, Kinematic pairs, degrees of freedom, kinematic chain and mechanisms,
- Mechanisms – quick return motion, whitworth and crank and slotted lever mechanism,
- Spur gears – terminology and law of gearing,
- Gear Trains – Simple and Compound gear trains,
- Belt drives – ratio of belt tensions, centrifugal tension, power transmitted and v-belt.
- Gyroscope and Gyroscopic effects.
- Balancing and Governors.

Course Content

UNIT– I

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

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

UNIT – II

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

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

10 Hours

UNIT – III

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

Unit - IV

Balancing of Machinery: Static and dynamic balancing, Balancing of single rotating mass in same plane and in different planes. Balancing of several masses rotating in same plane and in different planes. (No graphical method)

Governors: Types of governors; force analysis of porter Governor, Hartnell Governor, controlling force, stability and sensitiveness. **11 Hours**

Unit - V

Gyroscopic Effects and Gyroscope: Introduction, Spinning and Precision, Gyroscopic Couple, Effect of Gyroscopic couple on the stability of Automobile Vehicles (Four Wheelers and Two Wheelers), Stability of Two wheelers, Gyroscopic Effects on Ships and Aeroplanes, Gyroscope and Problems on Gyroscopic Couple. **10 Hours**

Text Books:

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

Reference books:

1. Shigley. J. V. and Uickers, J.J., "Theory of Machines & Mechanisms" , OXFORD University press - 2004
2. R.K Bansal, "Theory of Machines", S. Chand; 14th Revised edition, st 2005)
3. R.S.Khurmi, "Theory of Machines",

Course Outcomes

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

1. Familiarity with common mechanisms used in machines and everyday life.
2. Calculate mobility (number of degrees-of-freedom) and enumerate rigid links and types of joints within mechanisms.
3. Conduct a complete (translational and rotational) velocity, acceleration analysis of the mechanism and to understand steering mechanism and the importance of universal (Hooke's) joint
4. Understand gear mechanism classification and to become familiar with gear standardization and specification in design.
5. Importance gear trains and their practical applications.
6. Understand uses and advantages of belt drives Types and their nomenclature, Relationship between belt tensions commonly used design parameters.
7. Draw inversions and determine velocity and acceleration of different mechanisms.
8. Calculate loss of power due to friction in various machine elements.
9. Solve problems on power transmission.
10. Calculate balancing mass and its position.

Course Title: Production Technology - II			
Course Code: P15IP45	**Sem:** IV	**L-T-H:** 4-0-0	**Credits:** 3
Contact Period: Lecture:52 Hr Exam: 3Hr		**Weightage:**CIE:50%; SEE:50%	

Prerequisites:
Students should have the knowledge of elements of Mechanical engineering. Knowledge of reading different types machines.

Course Learning Objectives:
At the end of the Course the students should be able to:

1. The understand the course is to provide the students an opportunity to gain the knowledge in the field of manufacturing process.[L2]
2. Apply the fundamental concepts, constructions and principal of machine and parts.[L3]
3. To demonstrate the operation principles, advantages, applications, limitations of the various machines.[L3]
4. Impart knowledge to students about the different type's attachments, and Work holding devices their application.[L4]

Relevance of the Course
Manufacturing process is a foundation course in BE (Industrial and Production) program, that, machining ideas for various types' applications, attachments, and Work holding devices their application of attachments, and Work holding devices.
The course aims at developing the understanding of machining ideas for various types applications

Course Content

Unit-I

The Lathe: Introduction, Functions of lathe types of lathes, parts of lathes, specification of lathe, operation of lathe, lathe accessories and attachments. Difference between capstan and turret lathe, principal parts of capstan and turret lathe, Capstan and turret lathe mechanisms, work holding devices, tool holding devices, capstan and turret lathe operation, turret tooling layout(Production of an hexagonal bolt) cutting speed , feed and depth of cut. **11Hours**

Unit-II

Drilling machines: Classification, constructional features, drilling Machine & drilling operations, work holding devices, tool holding devices types of drill & drill bit nomenclature, drill materials. Cutting speed, feed and depth of cut. Machining time in drilling.
Shaping and Planning machines: Introduction, types of shaper and planer Constructional features of shaper and planer. **10Hours**

Unit-III

Milling machines: Classification, constructional features, milling cutters nomenclature, milling operations, up milling and down milling concepts.
Indexing: Simple, compound, differential and angular indexing calculations. **10 Hours**

Unit-IV

Grinding machines: Types of abrasives, bonding process, classification, constructional features (surface grinding), and types of surface grinding, selection of grinding wheel.
Laping, Honing and Super Finishing machines: Principles of operation, construction, applications. **10 Hours**

Unit-V

Non-traditional machining: Introduction, classifications, Principles of operations, advantages, limitations and applications of Abrasive jet machining, Ultrasonic machining, Chemical

machining, Electro- Chemical machining, Electric discharge machining, Electron-Beam machining, Laser Beam machining and Plasma Arc machining. **11 Hours**

Text Books:

1. Hazara Choudhry, " Workshop Technology", Vol-II, Media Promoters & Publishers Pvt. Ltd. 2004
2. R.K.Jain, , "Production Technology", Khanna Publications, 2003.
3. HMT "Production technology" Tata MacGraw Hill, 2001.

Reference Books:

1. Amitabha Ghosh and Mallik "Manufacturing Science", East West Press, 2003.
2. G.Boothroyd, "Fundamentals of Metal Machining and Machine Tools", McGraw Hill, 2000.

Course Learning Outcome

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

Course Title: Computer Aided Machine Drawing			
Course Code: P15IP46	**Semester: IV**	**L – T – P : 4 – 0 - 0**	**Credits: 4**
Contact Period - Lecture: 52Hrs.; Exam: 3Hrs.		**Weightage:** CIE: 50 %; SEE: 50%	

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

Course Learning Objectives (CLO):

The Course aim the students should be able to,

1. Develop computer-aided mechanical drawings of components and assemblies of machine parts and other mechanical equipments.[L3]
2. Visualizing and applying basic drafting fundamentals.[L3]
3. Preparing and editing engineering drawings,[L2]
4. Interpreting and applying drafting standards,[L3]
5. Using software for CAD such as SOLIDWORKS / CATIA ,[L6]
6. Drawing sectional views and Assembly drawings.[L3]

Relevance of the Course:

Computer aided machine drawing is a basic subject which deals with the concept of,

- Visualizing the 2D and 3D drawings,
- Creating CAD drawings,
- Interpreting and applying the drawing standards such as dimensioning, scaling, etc.,
- Use of design software such as SOLIDWORKS / CATIA environment,
- Drawing Sectional views,
- Drawing Assembly drawings.

Course Content

Introduction: Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing. Drawing units, grid and snap. **02 Hours**

PART A

UNIT I

Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids). True shape of sections.

Orthographic views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines. **08 Hours**

UNIT II

Thread forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

08 Hours

PART B

UNIT III

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

UNIT IV

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

PART C

UNIT V

Assembly Drawings (Part drawings should be given) 18 Hours

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

Text books:

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

Reference Books :

1. S. Trymbaka Murthy, **'A Text Book of Computer Aided Machine Drawing'**, CBS Publishers, New Delhi, 2007
2. K.R. Gopala Krishna, **'Machine Drawing'**, Subhash Publications, 2006
3. GoutamPohit & GouthamGhosh**, 'Machine Drawing with Auto CAD'**, Pearson Education, 1st Indian Print, 2005.

Course outcomes:

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

1. Analyze different views of solids of projections and orthographic views.
2. Identify and draw the views of Threads and fasteners.
3. Draw the different types of keys, couplings and joints.
4. Design and assemble different machine parts and other mechanical equipment's.

Note :

Internal assessment: 50 Marks

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

Evaluation Scheme

CIE Scheme

Assessment	Weightage in Marks
Test	15
Submission	35
Total Marks	**50**

SEE Scheme

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

Scheme of Examination

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

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

Q. No.	Question	Marks	CO's	Blooms level
	PART A			
1.	A hexagonal pyramid side of base 30mm and altitude 70mm is rests with its base on the HP and with a side of base parallel to the VP. It is cut by a cutting plane inclined at 35^0 to the HP and perpendicular to the VP and is bisecting the axis. Draw the front view, the sectional view looking from the top and true shape of section.	20	1	L2
	OR			
2.a	Draw the dimensional sketch of Sellers Thread of pitch 40mm.	06	2	L2
2.b	Draw two views of a Square headed Bolt with a Hexagonal Nut. Show the bolt head and the nut across corners in the Front View. The nut is screwed on the bolt. The bolt is 20 mm diameter, 120 mm long with a thread length of 50 mm. The end of the bolt is chamfered to 45^0.	14	2	L2
	PART B			
3.a	Draw the two View of Taper sunk Key to connect a shaft of 20 mm diameter. The noncircular views of the assembly should be shown in half section. Indicate the actual dimensions and empirical proportions of the key.	10	3	L3
3.b	Draw the Sectional Front and Top View of a double Riveted Butt Joint with Single Cover Straps for 10 mm thick plates. Use snap Head rivets and indicate all the dimensions.	10	3	L3
	OR			
4.a	Draw half Sectional Front View and Side View of Pin type Flexible Coupling to connect two shafts of 20 mm diameter.	10	3	L3
4.b	Draw half Sectional Front View and Side View of Oldham's coupling to connect two shafts of 20 mm diameter.	10	3	L3
	PART C			
5.a	The part drawings of a SCREW JACK are given in the following figure. Assemble the parts and draw the following views of the SCREW JACK. a. Sectional Front View, b. Top View.	60	4	L6
	OR			
6.a	The part drawings of a MACHINE VICE are given in the following figure. Assemble the parts and draw the following views of the MACHINE VICE. a. Sectional Front View, b. Top View.	60	4	L6

Course Title: Material Testing and Metallography Lab			
Course Code: P15IPL47	**Semester:** IV	**L – T – P :** 0 – 0 – 3	**Credits:** 1.5
Contact Period - Practical: 36Hrs. Exam: 3Hrs.		**Weightage:** CIE: 50 %; SEE: 50%	

Prerequisites:

Students should have studied Elements of Mechanical Engineering, Materials Science and Metallurgy and Mechanics of Materials.

Course Learning Objectives (CLO).

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

1. Learn the preparation of the specimen of different engineering materials for indentifying the microstructures.
2. Learn hardness of the with and without heat treated materials.
3. Learn few non-destructive test experiments for detection of Ultrasonic flaw, magnetic crack, dry penetration and also know the defects of casted and welded materials.
4. Learn different material testing machines which are used for testing.

Relevance of the Course:

Material Science and Metallurgy is a basic subject which deals with the concept of,

- Internal Structure of the materials and their properties,
- Different methods used for Testing the mechanical properties of materials,
- Different methods of failures of materials (Fracture, Fatigue and Creep),
- Preparation of specimen for metallographic examination of different engineering materials and to identify the microstructures.

Course Content

PART –A

1. Tensile test of metallic specimen using Universal Testing Machine.
2. Single shear and double shear using Universal Testing Machine.
3. Compression test on metallic specimen using a Universal Testing Machine.
4. Bending Test on wood using a Universal Testing Machine.
5. Izod and Charpy tests on M.S. Specimen.
6. Brinell, Rockwell and Vickers's Hardness test.
7. Jominy Hardenability Test
8. Hardness studies of heat treated samples

PART – B

9. Non-destructive test experiments
   (a). Ultrasonic flaw detection
   (b). Magnetic crack detection
10. Demonstrations of the following;
    (a) Preparation of specimen for metallographic examination of different engineering materials and to identify the microstructures.

Course Outcome:

At the end of the session students should be able to

1. Prepare the specimen for metallographic examination.
2. Do the non –destructive test experiments.
3. Do the Tensile, Shear, and Bending, Fatigue, and compression tests on metallic and non – metallic materials.
4. do the different hardness test and impacts on different materials

Course Title: Machine Shop Practice			
Course Code: P15IPL48	Semester: IV	**L – T – P :** 0 – 0 – 3	**Credits:** 1.5
Contact Period - Practical: 36Hrs. Exam: 3Hrs.		**Weightage:** CIE: 50 %; SEE: 50%	

Prerequisites:

The student should have studied Elements of Mechanical Engineering and Production Technology-II.

Relevance of the Course:

This course helps the students to understand the different operations and mechanism of different machines like lathe, shaper, drilling and milling machines. This course also helps the students in handling different machines in manufacturing industries.

Course learning objectives:

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

Relevance of the Course:

Machine shop practice is a basic lab in BE (Industrial and Production) program,

- Machining ideas for various types and Work holding devices their applications.
- Understanding of machining ideas for various types industrial applications.

B. Course Content

Part – A

1. Introduction to cutting tools, Machine tools and preparing the layout of machine shop.
2. Preparation of models on lathe involving Facing, Plain turning, Taper turning, Step turning.
3. Thread cutting, Knurling.
4. Boring and Reaming operations.
5. Drilling operations.
6. Eccentric turning. **21 hrs**

Part – B

1. Machining V Groove Rectangular groove using Shaping machine
2. Gear Teeth Cutting using Milling Machine **15 hrs**

Course Learning Outcome

1. Student will do machining operations like facing, plain turning, step turning, taper turning thread cutting and knurling on lathe.
2. Student will do calculations for taper turning, thread cutting.
3. Student will get good knowledge and understanding the operations on Drilling machine.
4. Student will perform operations on shaping machine for different models.
5. Student will do different operation on milling machine gear cutting.

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 Hrs.		**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 Hrs	**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