# SYLLABUS

(With effect from 2018-19)

# ಪಠ್ಯಕ್ರಮ

(ಶೈಕ್ಷಣಿಕವರ್ಷ 2018–19)

## III & IV Semester

**Bachelor Degree**
**in**

# Industrial Production and 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.

| | |
|---|---|
| Dr. Umesh D R | Dr. Nagarathna |
| Deputy Dean (Academic) | Dean (Academic) |
| Associate Professor | Professor |
| Dept. of CS &Engg. | Dept. of CS &Engg |

## PES College of Engineering
### VISION

"PESCE shall be a leading institution imparting quality engineering and management education, developing creative and socially responsible professionals"

### MISSION

- Provide state of the art infrastructure, motivate the faculty to be proficient in their field of specialization and adopt best teaching -learning practices
- Impart engineering and managerial skills through competent and committed faculty using Outcome Based Educational curriculum
- Inculcate professional ethics, leadership qualities and entrepreneurial skills to meet the societal needs
- Promote research, product development and industry-institution interaction.

## DEPARTMENT OF INDUSTRIAL PRODUCTION AND ENGINEERING

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 globalised market which demand quality management people.
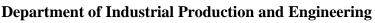
### Vision

Contribute to achieve or pursue academic excellence for imparting quality education in I & P Engineering and to carry out the researchactivity on continuous basis to develop competent and social responsible engineers and managers.

### Mission

- To educate them in the fundamental concept, knowledge, skills in theory and practices.

- To prepare them through skilled programmes for better Employment as engineers and managers or pursuit of advanced degrees in Industrial, Production and Mechanical Engineering fields.

- To inculcate qualities of communication skills, professional personality and ethical values to make them the responsible and competent professionals.

### 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, qualitative analysis, synthesis and 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 in industrial engineering, production engineering and managerial skills.

- **PEO3:** Industrial and Production Engineering program will prepare graduates, who possess communication skills, professional personality and ethical values as responsible and competent entrepreneur and professionals**.**

## PROGRAMME OUTCOMES (PO's):

The department adopted the POs specified by the NBA in the Annexure-1 of the format provided in the SAR application. The graduates of the program will be able to exhibit their skills and knowledge as per the POs.

- **PO-1** Engineering knowledge: Graduates will have the ability to apply knowledge of Science, Engineering concepts and Management principles to solve the problems.
- **PO-2** Problem analysis: will have the ability to identify, formulate and solve complexengineering problems using principles of mathematics, natural sciences, and engineering sciences in various design, manufacturing process and industrial management.
- **PO-3** Design/development of solutions: 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.
- **PO-4** Conduct investigations of complex problems: will be able to demonstrate the knowledge of design and conduct experiment as well as interpret data to find the solutions for industrial problems.
- **PO-5** Modern tool usage: Will have the ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- **PO-6**The engineer and society: Will have the knowledge of recent and advanced techniques related to social, health, and safety, legal and cultural issues in production filed.
- **PO-7** Environment and sustainability: Will have the ability to understand and analyze the impact of engineering applications in the global and societal context and need for sustainable development.
- **PO-8** Ethics: Will be able to understand the professional and ethical responsibility in decision making in various engineering fields.
- **PO-9** Individual and team work: Graduates will be able to exhibit the skills of functioning individually as well as in the multidisciplinary teams.
- **PO-10** Communication: Will be able to communicate effectively in the manufacturing field and at the societal level and make effective presentations with clear decisions to demonstrate the leadership quality.
- **PO-11** Project management and finance: Graduates will have the ability to recognize the importance of engineering and management principles and apply them in their own work, as a member and as a leader in the team and to manage the projects even multidisciplinary environments.
- **PO-12** Life-long learning: Will have the ability to recognize the necessity and importance of knowledge and engage in life-long learning process to update with current scenario.

## Program Specific Outcomes (PSOs):

- PSO1: Industrial & Production engineering graduates will be able to apply the knowledge acquired in the program about materials and finishing process.
- PSO2 : Industrial & Production engineering graduates will be able design product based on Ergonomic

## SCHEME OF TEACHING AND EXAMINATION 2018-19

### III – Semester

| Sl. No. | Course Code | Course Title | Teaching Department | Hrs / Week | | | Credits | Examination Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | CIE | SEE | Total |
| 1 | P18MA31 | Transform calculus, fouries and numerical techniques | MA | 4 | - | - | 4 | 50 | 50 | 100 |
| 2 | P18IP32 | Core Course – I- Engineering Metrology | IP | 3 | - | - | 3 | 50 | 50 | 100 |
| 3 | P18IP33 | Core Course – II- Mechanical Measurements | IP | 3 | - | - | 3 | 50 | 50 | 100 |
| 4 | P18IP34 | Core Course – III- Mechanics of Materials | IP | 3 | - | - | 3 | 50 | 50 | 100 |
| 5 | P18IP35 | Core Course – IV- Fluid Mechanics and Machinery | IP | 3 | - | - | 3 | 50 | 50 | 100 |
| 6 | P18IP36 | Foundation Course – I- Manufacturing Technology – 1 | IP | 2 | 2 | - | 3 | 50 | 50 | 100 |
| 7 | P18IPL37 | Metrology  Lab | IP | - | - | 3 | 1.5 | 50 | 50 | 100 |
| 8 | P18IPL38 | Foundry and Forging Lab | IP | - | - | 3 | 1.5 | 50 | 50 | 100 |
| 9 | P18HU39 | #Aptitude and Reasoning Development - Basics (ARDB) | HM | 2 | - | - | - | 50 | - | - |
| 10 | P18HUDIP310 | *Comprehensive Communication Development (CCD) | HM | 2 | - | - | [2] | [50] | [50] | [100] |
| 11 | P18HUDIP311 | *Indian Constitution, Human Rights & Professional Ethics (ICHRPF) | HM | 2 | - | - | - | (50) | - | - |
| 12 | P18MADIP31 | *Additional Mathematics - I | MA | 4 | - | - | | (50) | - | - |
| | | **Total** | | | | | 22 [24] | 400 [450] | 400 [450] | 800 [900] |

* CCD / ICHRPF / Additional Mathematics-I: Lateral entry (i.e. Diploma) students shall have to pass these mandatory learning courses before completion of VI- Semester. CIE only for 50 marks.

#ARDB: All students shall have to pass this mandatory learning courses before completion of VI- Semester

+ Common to BE (AU, CV, ME and I&PE)

++ Common to BE (CS, EC, E&E and IS&E)

### IV – Semester        SCHEME OF TEACHING AND EXAMINATION 2018-19

| Sl. No. | Course Code | Course Title | Teaching Department | Hrs / Week | | | Credits | Examination Marks | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | CIE | SEE | Total |
| 1 | P18MA41 | Complex analysis, statistics, probability and numerical techniques | MA | 4 | - | - | 4 | 50 | 50 | 100 |
| 2 | P18IP42 | Core Course – I- Material Science and Metallurgy | IP | 3 | - | - | 3 | 50 | 50 | 100 |
| 3 | P18IP43 | Core Course – II- Engineering Thermodynamics | IP | 3 | - | - | 3 | 50 | 50 | 100 |
| 4 | P18IP44 | Core Course – III- Manufacturing Technology – II | IP | 3 | - | - | 3 | 50 | 50 | 100 |
| 5 | P18IP45 | Core Course – IV - Computer Aided Machine Drawing | IP | - | 3 | 3 | 3 | 50 | 50 | 100 |
| 6 | P18IP46 | Foundation Course – II- Theory of Machines | IP | 2 | 2 | - | 3 | 50 | 50 | 100 |
| 7 | P18IPL47 | Material Testing & Metallography Lab | IP | - | - | 3 | 1.5 | 50 | 50 | 100 |
| 8 | P18IPL48 | Machine Shop Practice | IP | - | - | 3 | 1.5 | 50 | 50 | 100 |
| 9 | P18HU49 | Aptitude and Reasoning Development - Intermediate (ARDI) | HM | 2 | - | - | 1 | 50 | 50 | 100 |
| 10 | P18EVDIP50 | *Environmental Studies | HM | 2 | - | - | - | (50) | - | - |
| 11 | P18MADIP41 | *Additional Mathematics - II | MA | 4 | - | - | | (50) | | |
| | | **Total** | | | | | 23 | 450 | 450 | 900 |

* Additional Mathematics-II & Environmental Studies: Lateral entry (i.e. Diploma) students shall have to pass these mandatory learning courses before completion of VI- Semester. CIE only for 50 marks.

+ Common to BE (AU, CV, ME and I&PE)

++ Common to BE (CS, EC, E&E and IS&E)

| Course Title: TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES | | | |
|---|---|---|---|
| Course Code: P18MA31 | Semester: III | L:T:P:H: 4:0:0:4 | Credits: 4-0-0 |
| Contact Period-Lecturer: 52Hrs.  Exam: 3Hrs | | Weightage:CIE:50%; SEE:50% | |

**(Common to All Branches)**

## 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 only

Central differences: Gauss Forward and Backward difference formulae, Sterling's, and Bessel's formulae (All formulae without proof) – problems.

**Self-Study Component: Problems using Everett's formula in Central differences**

**10Hrs.**

## UNIT-II

**Numerical differentiation** using Newton's forward and backward interpolation formulae, Newton's divided difference formula and Sterling'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.

**Self-Study Component:** Derive Newton- Cote's quadrature formula                    **10Hrs.**

## UNIT-III

**Fourier series:** Periodic functions, Euler's formula, Dirichlet's conditions. Discontinuous functions, even and odd functions, functions of arbitrary intervals. Half–range Fourier series expansions, complex form of Fourier series, Practical harmonic analysis- Illustrative examples from engineering field.

**Self-Study Component:** Derivations of Euler's formulae

**11Hrs.**

## UNIT-IV

**Fourier Transforms:** Infinite Fourier transforms-properties. Fourier sine and cosine transforms properties. Inverse infinite Fourier and inverse Fourier sine & cosine transform –Illustrative examples.

**Difference equations and Z-transforms:** Definition, Z-transform of standard functions, linearity  property, damping rule, shifting rules, initial value theorem and final value theorem (All rules and t

heorems without proof). Inverse Z – transforms. Difference equations- basic definitions. Application of Z-transforms to solve difference equations.

**Self-Study Component:** Convolution theorem, Parseval's identities. Related problems.

**10Hrs.**

# UNIT-V

### Partial differential equations (PDE's):

Formation of PDE by eliminating arbitrary constants and functions. Solution of non-homogeneous PDE by the method of 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.

**Self-Study Component: Finding the solution of non-linear equations of first order: Char pit's Method -simple problem**

.                                                                                                   **11Hrs.**

### Text Books:

1. Higher Engineering Mathematics: B.S. Grewal, Khanna Publishers, New Delhi, 42nd 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., 3$^{rd}$ Ed., 2007.
**2.**Advanced Engineering Mathematics: Peter V O' Neil Thomson, Brooks/Cole, 5th edition, 2007.
3. Higher Engineering Mathematics: - B.V. RAMANA, McGraw Hill Education, 2007

## Course Articulation Matrix
## Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

| Sem: 3 | Course code : P18MAT31 | | | | | | | Title : Engineering Mathematics –III | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO's | Statement | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO-1 | Apply forward, backward difference formulae and central differences formulae in solving interpolation- extrapolation problems in engineering field. | 1 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO-2 | Numerical differentiation and integration rules in solving engineering where the handling of numerical methods are inevitable | 2 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO-3 | Apply the knowledge of periodic function, Fourier series, complex Fourier series, Fourier sine/cosine series of a function valid in different periods. Analyze engineering problems arising in control theory/fluid flow phenomena using harmonic analysis. | 3 | 3 | - | - | - | - | - | - | - | - | - | - |
| CO-4 | Understand complex/infinite Fourier transforms, Fourier sine and Fourier cosine transforms with related properties Analyze the engineering problems arising in signals and systems, digital signal processing using Fourier transform techniques. Define Z-transforms& find 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. | 2 | 3 | - | - | - | - | - | - | - | - | - | - |
| CO-5 | Define Partial Differential Equations (PDE's),order, degree and formation of PDE's and, to solve PDE's by various methods of solution Explain one - dimensional wave and heat equation and Laplace's equation and physical significance of their solutions to the problems selected from engineering field. | 2 | 3 | - | - | - | - | - | - | - | - | - | - |

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

| Course Title: Engineering Metrology | | | |
|---|---|---|---|
| Course Code: P18IP32 | Semester: III | L-T-P-H: 4-0-0-4 | Credits: 3 |
| Contact Period - Lecture: 52 Hrs. Exam: 3Hrs. | | Weightage: CIE: 50 %;SEE: 50% | |

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

**Course Learning Objectives:**

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

## 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**

**SSC:** Define GD&T. write characteristics and symbols of GD&T**.**

## 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 :** **S**traightness, Flatness, Squareness, Combination Set, Sine bars- Sine center construction and working principle.

**10 Hours**

*SSC: List the Industrial applications of Slip gauges.*

## 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**

*SSC:* Use of Comparators in Industries.

## 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 Tracer type Profilgram, Light cross-section method, Tomlinson's Surface meter an 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**

*SSC:* write the benefits of measuring surface finish with respect to quality and cost- control

## 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 Nondestructive testing methods, Introduction to NDT Methods: Magnetic Particle Inspection, Ultrasonic Testing, Eddy Current testing, Radiography, Acoustic emission Testing.

**10 Hours**

*SSC:* Use of NDT in Industries*.*

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

**Reference Books:**
1. K. J. Hume, Engineering Metrology, Kalyani Publishers, Third Edition.
2. Shobont and Bolt, Engineering Metrology. ASTME – Hand book of Industrial Metrology - PHI

 **Course Outcomes**

1. The students should able to learn and understand necessity of Metrology

2. Students should be able to make use of different gauges.
3. Students will be able to use different type's comparators.
4. The students get exposure to different types of surface measurements methods and able tounderstand the gear & screw threads terminology.
5. Students will be able to understand the need of Nondestructive testing.

## Course Assessment Matrix (CAM)

| Sl. No | Course Outcome – CO | Program outcome | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| 01 | The students should able to learn and understand necessity of Metrology | 1 | 2 | 1 | | | | | | | | | | | |
| 02 | Students should be able to make use of different gauges. | 1 | 2 | 3 | 1 | 1 | | | | | | | | | |
| 03 | Students will be able to use different type's comparators. | 1 | 2 | 1 | | 1 | | | | | | | | | |
| 04 | The students get exposure to different types of surface measurements methods and able to understand the gear & screw | 1 | 2 | 1 | | 1 | | | | | | | | 1 | |
| 05 | Students will be able to understand the need of Nondestructive testing. | 2 | 1 | 1 | | 1 | | | | | | | | | |

| Course Title: Mechanical Measurements | | | |
|---|---|---|---|
| **Course Code: P18IP33** | **Semester: III** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period - Lecture: 52 Hrs. Exam: 3Hrs.** | | **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 understand the knowledge for various measuring instruments and pressure sensitive elements.L2
4. The students understands the different methods of Dynamometers,L2
5. Analyses basic of Radiation Pyrometers methods.L2

**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. Electrictransducers - sliding contact devices. Secondary transducers - differential transformer, piezo electric effect, Ionization transducer.
**Intermediate Modifying Systems** Mechanical systems, kinematics linearity, Mechanicalamplifications, reflected frictional amplifications, reflected inertial amplifications,- Temperature problems, methods for limiting temperature errors, Telemetry.

**11Hours**

**SSC:** Difference between Passive and Active Transducers

### 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**

**SSC:** Use of Dynamometer in Industries.

## 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**

**SSC:** Compare Mechanical and Optical strain gauges

## 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**

**SSC:** Write the importance of Vibration Measurement.

## 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**
**SSC:** Write the Laws of thermocouples

**Text Book**
1. Mechanical Measurements - Beckwith, Buck &Maran-GoniNarosa publishing House
2. Metrology and measurement – Anand K Bewoor and V inay A Kulkararni The McGraw-Hill Company
3. Mechanical Measurements and Control - D.S.Kumar, Metropolitan Publishers

## Course outcomes

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 will be able to demonstrate the need of Radiation Pyrometers methods.

## Course Assessment Matrix (CAM)

| Sl. No | Course Outcome – CO | Program outcome | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| 01 | The students should learn and understand necessity of Mechanical Measurements. | 1 | 2 | 1 | | | | | | | | | | | |
| 02 | Demonstrate ability to make use of various measuring instruments. | 1 | 2 | 3 | 1 | 1 | | | | | | | | | |
| 03 | Students will be able to use different types of Dynamometers | 1 | 2 | 1 | | 1 | | | | | | | | | |
| 04 | The students get exposure to different types of measurements methods. | 1 | 2 | 1 | | 1 | | | | | | | | | |
| 05 | Students will be able to demonstrate the need of Radiation Pyrometers methods. | 2 | 1 | 1 | | 1 | | | | | | | | | |

| Course Title: Mechanics of Materials | | | |
|---|---|---|---|
| **Course Code: P18IP34** | **Semester: III** | **L-T-P-H: 4-0-0-4** | **Credits: 3** |
| **Contact Period - Lecture: 52 Hrs; Exam: 3Hrs.** | | **Weightage: CIE: 50 %;    SEE: 50%** | |

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

**Course Learning Objectives (CLOs):**

The Course aims to:

1. Define the concept Stress, Strain, deflections, Hooke's law and Poisson's ratio [L1].
2. Solve the problems on composite sections, temperature stresses, etc., [L3].
3. Understand the concept of Thick and thin cylinders [L1].
4. Understand the concept of bending and shear force [L1].
5. Solve the problems related to the deflection of beams and torsion of circular shafts [L3].

**Relevance of the Course:**

- Mechanics of Materials is a basic subject which deals with the concept of Engineering Stress, Strain, Hooke's law and Poisson's ratio,
- Composite section – Volumetric strain, expression for volumetric strain, elastic constants.
- Temperature stresses and compound stresses.
- Thick and Thin cylinders – Problems.
- Bending moment and shear force diagrams.
- Deflection of beams – differential equation for deflection.
- 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**

**SSC:** Problems on Principle of Superposition.

### 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.

**10Hours**

**SSC:** Principle of Complimentary Shear Stresse

## UNIT – III

**Thick and Thin Cylinders:** Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume), and 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 load intensity, shear force and bending moment, shear force and bending moment diagrams for Cantilever, Simply Supported and overhanging beams subjected to concentrated loads and uniformly distributed load (UDL).

**11Hours**

**SSC:** Shear Force and Bending Moment diagrams for Beams subjected to Couples.

## 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, 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).

**10Hours**

**SSC:** Moment carrying capacity of different sections.

## 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, power transmitted by hollow and solid shafts. Introduction to columns, Euler's theory for axially loaded elastic long columns, derivation of Euler's load for various end conditions, Rankine's formula.

**10Hours**

**SSC:** Problems on Rankin's formula.

**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,
1. **Analyze** determinate and indeterminate problems to determine fundamental stress states associated with kinematic modes of deformation.
2. Apply Mechanics of materials equations (and formulas) to the solution of engineering and design problems, and Recognize and extract fundamental modes in combined loading and do the appropriate stress analysis

3. Extract material properties (modulus of elasticity, yield stress, Poisson's ratio) from data and apply these in the solution of problems.
4. 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.
5. 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 Articulation Matrix | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes** | | **Program Outcomes** | | | | | | | | | | | | **PSO** | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 |
| **CO1** | Analyze determinate and indeterminate problems to determine fundamental stress states associated with kinematic modes of deformation. | 2 | 1 | | | | | | | | | | | 1 | |
| **CO2** | Apply Mechanics of materials equations (and formulas) to the solution of engineering and design problems, and Recognize and extract fundamental modes in combined loading and do the appropriate stress analysis. | 1 | 2 | | | | | | | | | | | | |
| **CO3** | Extract material properties (modulus of elasticity, yield stress, Poisson's ratio) from data and apply these in the solution of problems. | 3 | 2 | 3 | | 3 | | | | | | | | | |
| **CO4** | 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. | 3 | 2 | 2 | | 2 | | | | | | | | | 2 |
| **CO5** | 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. | 3 | 3 | 2 | | 3 | | | | | | | | | 2 |

| Course Title: Fluid Mechanics and Hydraulic Machines | | | |
|---|---|---|---|
| Course Code: P18IP35 | Semester: III | L-T-P-H: 4-0-0-4 | Credits: 3 |
| Contact Period - Lecture: 52 Hrs.; Exam: 3Hrs. | | Weightage: CIE: 50 %; SEE: 50% | |

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

**Course Learning Objectives (CLOs):**
This course aims to:
1. Recall the basic principles involved in fluid behavior and equipment's involving fluid flow, thus preparing themselves for an advanced course on hydraulic drives.[L1]
2. Define the properties of fluids, fluid statics and fluid kinematics involving flow.[L1]
3. Explain the equations of motion and demonstrate fluid flow measurement and energy losses in pipe flow.[L2]
4. Explain the operation of energy producing devices like turbines through velocity triangles knowing fully the principles of impact of jets on valves. [L2]
5. 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.
- 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, density, specific weight, specific gravity, viscosity, thermodynamic properties, surface tension and Capillarity.
**Fluid Statics:** Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, atmospheric,Gauge Pressure and vacuum pressures, simple manometers, differential manometers.

**10 Hours**

**SSC:** Vapor pressure and Cavitation.
**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 met center and met centric height, conditions of equilibrium of floating and submerged bodies.

**10 Hours**

**SSC:** Experimental method for determining Meta centric height.

## UNIT – III

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

**10Hours**

**SSC:velocity potential function and stream function**.

## 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.
**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).

**10Hours**

**SSC:** Force exerted by the jet on a stationery vertical plate, Force exerted by the jeton a curved plate moving in the direction of the jet.

## 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:** Working of C/F pump, work done by the impeller, losses & efficiency, specific speed, multistage pump.(Simple problems only).

**12Hours**

**SSC:** Advantages of centrifugal pump over Reciprocating pump, Types of reciprocating pump.

**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:**

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

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

| Course Articulation Matrix | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes** | | **Program Outcomes** | | | | | | | | | | | | **PSO** | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 |
| **CO1** | Explain the properties of fluid like density, specific weight, specific gravity, viscosity etc; estimate the variations of pressure in a static mass of fluid, and Applying Pascal's Law. | 1 | | 2 | | 2 | | | | | | | | 1 | |
| **CO2** | Explain the principles of fluid kinematics involving different types of flows, velocity and acceleration, continuity equation. | 1 | 1 | | | 2 | | | | | | | | | |
| **CO3** | Derive the equations of motion and explain fluid flow measurement devices like Venturimeter, orifice meter etc.; evaluate the energy losses in pipe flow. | 1 | 1 | | | 3 | | | | | | | 2 | | |
| **CO4** | Explain the operation of energy producing devices like turbines through velocity triangles knowing fully the principles of impact of jets on vanes. | 1 | 1 | 2 | | 2 | | | | | | | 1 | 1 | |
| **CO5** | Draw the velocity triangles to explain the working of energy absorbing device like centrifugal pump and the working principle of reciprocating pump. | 1 | 1 | | | 2 | | | | | | | 1 | 1 | |

| Course Title: MANUFACTURING TECHNOLOGY - I | | | |
|---|---|---|---|
| Course Code:P18IP36 | Sem: III | L-T-P-H: 2-2-0-4 | Credits: 3 |
| Contact Period: Lecture:52Hr    Exam: 3Hr | | Weightage: CIE:50;  SEE:50 | |

**Prerequisites:** Students should have the knowledge of 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.
- Define the concept and methods used in casting & Sand moulding techniques.
- Understand the classification and constructional features of furnaces.
- Understand principle, classification and applications of welding process.

## UNIT – I

**Casting Process:**
**Introduction:** Concept of manufacturing process. Classification of Manufacturing processes. Casting process & steps involved. Application, 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.
**Gating and Rise ring**: Principle involved and types
**Fettling and cleaning of castings**. Basic steps involved. Casting defects causes, features and remedies.

**11Hours**

**SSC:** Steps involved in Casting Design Consideration*.*

## UNIT - II

**Sand Moulding:** Types of base sand, properties, requirement of base sand.
**Moulding machines**: Jolt type, Squeeze type, Jolt & Squeeze type and sand slinger.
**Special moulding Process:**Green sand, Core sand, $CO_2$mould, Shell mould and Investment mould.
**Metal moulds**: Gravity die-casting, Pressure die casting, centrifugal casting, Squeeze Casting, Slush casting, continuous casting and stir casting processes.

**10Hours**

**SSC: Concept of Moulding Sand Test.**

## UNIT - III

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

**11Hours**

**SSC:** Casting of Aluminum Material and its Application.

## UNIT - IV

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

**Advance welding processes:** Resistance welding - principles, Seam welding, Butt welding, Spot welding, projection welding, Friction welding, Explosive welding, Thermit welding, Laser welding and Electron beam welding

**10Hours**

**SSC***:* Concept of Welding Symbols.

## UNIT – V

**Friction stirs welding:** Principle, working, Application, Advantages & Limitations.

**Metallurgical aspects in welding:** Structure of welds, Formation of different zones during welding, Parameters affectingHAZ, Shrinkage & Residual stresses, concept of Electrode, Filler rod & Flux, welding defects – Detection causes & remedy.

**10Hours**

**SSC:Importance of Microstructure in welding.**

**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"**, Sapna Book House, 2nd Edition, 2016.

**Reference Books:**
1. SeropeKalpakjian and Steuen.R.Schniid - **Manufacturing Technology**, Pearson Education Asia, 5th Edition. 2013.
2. Roy A Lindberg,**"Process and Materials of Manufacturing",** Pearson Edu, 4th Edition, 2010.

**Course outcomes:**

At the end of the Course the students, should be able to
1. **Explain** the requirements of patterns, Binder, Additives and core.
2. **Identify** and **explain** different types of Sand Moulds, Moulding Machines & Metal Moulds.
3. **Describe** different Welding processes and melting furnace with its applications.
4. **Identify** different advance welding processes with its Industrial applications.
5. **Explain** concept of friction stir welding and Microstructure concept to meet Industrial requirements.

## Course Assessment Matrix (CAM)

| Sl. No | Course Outcome – CO | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | Program outcome | | |
| 01 | **Explain** the requirements of patterns, Binder, Additives and core. | L2 | 2 | 2 | 2 | | 1 | | | | | | | 2 | | |
| 02 | **Identify** and **explain** different types of Sand Moulds, Moulding Machines & Metal | L2 | 2 | 2 | 2 | | 1 | | | | | | | 2 | | |
| 03 | **Describe** different Welding processes and melting furnace with its applications. | L2 | 2 | 2 | 1 | | 1 | | | | | | | 2 | 2 | |
| 04 | **Identify** different advance welding processes with its Industrial applications. | L2 | 3 | 3 | 1 | | 1 | | | | | | | 2 | 2 | |
| 05 | **Explain** concept of friction stir welding and Microstructure concept to meet Industrial requirements. | L2 | 2 | 2 | 1 | | 2 | | | | | | | 2 | 2 | |

| Course Title: Metrology Laboratory | | | | |
|---|---|---|---|---|
| **Course Code: P18IPL37** | **Semester: III** | **L-T-P-H: 0-0-3-3** | | **Credits: 1.5** |
| **Contact Period - Practical: 36Hrs. Exam: 3Hrs.** | | **Weightage: CIE: 50 %; SEE: 50%** | | |

**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 applications.
2. It helps the students to understand the basic measurements in metrology and to enhance the student's skill in measurement techniques.

**Course Content**

1. Introduction to Metrological instruments like gauges and commonly using instruments.
2. Measurements using Micrometer, Vernier Caliper, Dial Gauges, Height gauges
3. Measurement of inside diameter using internal micrometer/ bore gauge /telescopic gauges
4. Measurements of Dovetail angle using Bevel Protractor / Roller set
5. Measurements of angle using Sine Centre / Sine bar
6. Measurements using Profile Projector
7. Measurements using Toolmaker Microscope
8. Measurements of Screw Thread Parameters using thread measuring machine / micrometer.
9. Use of comparators: Mechanical/ Electrical/ Dial type air gauge
10. Measurements of gear tooth profile using gear tooth Vernier /gear tooth micrometer.
11. Measurements of straightness, squareness using Autocollimator
12. Measurement of roundness, eccentricity using bench centre/ roundness measuring machine
13. Measurement of flatness using Interferometer & Optical Flats

DEMO Experiments:

Measurements of Surface roughness using roughness tester andVideo measuring instrument

**Note:** At least 70% of the above experiments should be conducted depending upon the availability of the instruments.

**Course outcomes:**

At the end of the session students should be able to

1. Conduct and interpret measurement data to estimate measurement uncertainties, control of the production process.
2. Demonstrate the importance of calibration in the field of Metrology and Measurement

| Course Articulation Matrix | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes** | | **Program Outcomes** | | | | | | | | | | | | **PSO** | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 |
| **CO1** | Conduct and interpret measurement data to estimate measurement uncertainties, control of the production process. | 2 | 2 | 2 | | 2 | | | | | | | 2 | 2 | |
| **CO2** | Demonstrate the importance of calibration in the field of Metrology and Measurement | 2 | 2 | 2 | | 2 | | | | | | | 2 | 3 | |

| Course Title: Foundry and Forging Lab. | | | | |
|---|---|---|---|---|
| **Course Code: P18IPL38** | **Semester: III** | **L – T – P– H :0 – 0 – 3–3** | | **Credits: 1.5** |
| **Contact Period - Practical: 36Hrs. Exam: 3Hrs.** | | **Weightage: CIE: 50 %; SEE: 50%** | | |

**Prerequisites:** The student should have studied Production Engineering – I.

**Course Learning Objectives:**

This course aims to:

- Able to understand different types of sand molds.
- Able to learn operations of smith and forging.
- Able to do calculations for the preparation of given models both in molding and forging.

## Course Content

### 1. Testing of Moulding sand and Core sand

Preparation of sand specimens and conduction of the following tests:

1. Compression, Shear and Tensile tests on Universal Sand Testing Machine. Permeability test
2. Core hardness &Mould hardness tests.
3. Grain fineness number test (Sieve Analysis test)
4. Clay content test.
5. Moisture content test.

**09Hours**

### 2. Foundry Practice

1. Use of foundry tools and other equipment's.
2. Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).

**12Hours**

### 3. Forging Operations

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

**15 Hours**

## Course Outcome

At the end of the session students should be able to

1. Demonstrate the knowledge and necessary skills to perform sand testing and preparation of moulds.
2. Demonstrate the steps involved and necessary skills to perform metal forging operation.

| | **Course Outcomes** | **Program Outcomes** | | | | | | | | | | | | **PSO** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 |
| **CO1** | Demonstrate the knowledge and necessary skills to perform sand testing and preparation of moulds. | 2 | 2 | 2 | | 2 | | | | | | | 2 | | |
| **CO2** | Demonstrate the steps involved and necessary skills to perform metal forging operation | 2 | 2 | 2 | | 2 | | | | | | | 2 | 1 | |

| Course Title: Aptitude and Reasoning Development - BEGINNER. (ARDB) | | | |
|---|---|---|---|
| Course Code : P18HU39 | Semester : III | L-T-P-H : 2-0-0-2 | Credits: NA |
| Contact Period: Lecture: 32 Hr. Exam: 3 Hr | | 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. Analyze 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

**Relevance of the course:**

3$^{rd}$ Semester is considered as the right time to build a base to a student's analytical and logical ability. This course connects the basics of maths learnt in school into the present problem solving techniques. It creates an awareness towards the importance and significance of an individual's logical abilities.

### 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

**SSC-** Get hands on multiplication tables, increasing the speed in basic arithmetic operations. Classification of numbers.

**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.

**SSC-** Thorough with fractions and decimal values. Applications of tabulated fractions. Product of means and extremes. **8 Hours**

### 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.

**SSC-** Basic knowledge of letter positions, Different number series for example – even, odd, prime, composite etc

**6 Hours**

## 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.

**SSC-**Basic arithmetic operations, knowledge about quotient and remainders, multiples and factors.

**6 Hours**

## 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.

**SSC-**Knowledge about factors, types of factors. Splitting the middle term rule, formula rule.

**6 Hours**

## 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.

**SSC-**Basic knowledge of directions, Pythagoras theorem. Logical reasoning skills, Relations, Family tree.

**6 Hours**

**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** | | | |
|---|---|---|---|
| Course Code : **P18MADIP31** | Semester : III | L:T:P:H : 4:0:0:4 | Credits: 0 |
| Contact Period: Lecture: 52 Hr. | | Weightage: CIE (max:50) | |

**((Mandatory Learning Course: Common to All Branches)**
(A Bridge course for Diploma qualified students of III Sem. B. E.)

### UNIT -I

**Complex Trigonometry**: Complex Numbers: Definitions & properties. Modulus and amplitude of a complex number, Argand's diagram,

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

**Self-study components:** De-Moivre's theorem (without proof). Roots of complex number – Simple problems. **12 Hours**

### UNIT -II

**Differential Calculus**: 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.

**Self-study components:** Review of successive differentiation. Formulae for $n^{th}$ derivatives of standard functions- Liebnitz's theorem (without proof). Application to Jacobians, errors & approximations. **10 Hours**

### 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. Applications of integration to area, length of a given curve, volume and surface area of solids of revolution.

**Self-study components:** Differentiation under integral sign (Integrals with constants limits)-Simple problems. **10 Hours**

### 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).

**Self-study components:** Solenoidal and irrotational vector fields-Problems. **10 Hours**

### 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.

**Self-study components:** 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 Hours**

### 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:  COMPLEX ANALYSIS, STATISTICS, PROBABILITY AND NUMERICAL TECHNIQUES | | | |
|---|---|---|---|
| Course Code: P18MA41 | Semester: IV | L:T:P:H: 4:0:0:4 | Credits: 4-0-0 |
| Contact Period-Lecturer: 52Hrs.  Exam: 3Hrs | | Weightage:CIE:50%; SEE:50% | |

**(Common to all Branches)**

## UNIT-I

Numerical Methods-II: Solution of algebraic and transcendental equations: Bisection method, Regula-Falsi& Newton-Raphson method. Fixed point iteration method: Aitken's $\Delta^2$- process - Illustrative examples only. Numerical solution of ordinary differential equations (ODE's): Numerical solutions of ODE's of first order and first degree – Introduction. Taylor's series method. Modified Euler's method, Runge - Kutta method of fourth order, Milne's and Adams-Bashforth predictor & corrector methods (All formulae without proof). Illustrative examples only

**Self-Study Component:** Solution of second order ordinary differential equations using Runge-Kutta methods. Solution of first order simultaneous differential equations.

**10Hours.**

## UNIT-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.Series solutions of ODE's and special functions:Power series solution of a second order ODE, Series solution-Frobenius method. Series solution of Bessel's differential equation leading to $J_n(x)$. Expansions for $J_{1/2}(x) and J_{-1/2}(x)$.. Series solutions of Legendre's differential equation leading to $P_n(x)$-Legendre's polynomials. Rodrigue's formula (No Proof) - simple illustrative examples

.**Self-Study Component: Basics of Series solutions of ODE's; analytic, singular point and basic recurrencrelations.**

**10Hours.**

## UNIT-III

**Complex Analysis:** Introduction to functions of complex variables. Definitions- limit, continuity and differentiability. Analytic functions. Cauchy - Riemann equations in Cartesian and polar forms (no proof). Construction of analytic function using Milne-Thomson method. Harmonic functions –Problems. Applications of analytic function to flow problems. Conformal transformation – Definitions and Discussion of Transformations: w=z$^2$, w =e$^z$ and w= $z + 1/z (z \neq 0)$ and related problems. Bilinear transformation.

**Self-Study Component:** Derivation of Cauchy- Riemann equation in Cartesian and polar form.

**11Hours.**

## UNIT-IV

**Complex integration:** complex line integrals. Cauchy theorem, Cauchy integral formula. Taylor's and Laurent's series (Statements only) and illustrative examples. Singularities, poles and residues. Cauchy residue theorem (statement only). Illustrative examples. 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 $y = ax^2 + bx + c$. Correlation and **regression**.

**Self-Study Component:** Derivation of Cauchy theorem, Cauchy integral formula and Cauchy's residue theorem. Fit an equation of the curves of the type : $y = ae^{bx}$,

**11 Hours.**

## UNIT – V

**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). Illustrative examples from engineering and industrial fields.

Joint probability distributions and Markov chains: Concept of joint probability. Joint probability Distributions of discrete random variables. Expectation, Covariance, correlation coefficient – illustrative Examples. Continuous joint probability distributions. Probability vectors, stochastic matrices. Fixed point and regular stochastic matrices.

**Self-Study Component:** Basic definitions of probability and problems up to Bayes' theorem.

Derivation of Mean and SD of Binomial &Poisson distribution.

**10 Hours.**

**Text Books:**
**1. Higher Engineering Mathematics:** B.S. Grewal, Khanna Publishers, New Delhi, 42nd Ed. 2012.
**2. Advanced Engineering Mathematics: -** E. Kreyszig, John Wiley & Sons, 10th Ed., 2011
**References:**
**3. Linear Algebra and its applications: -** David C.Lay, Pearson Education Ltd., 3rd Edition, 2003.
**4. Seymour Lipschutz: Probability:-,**Schaum's outline series, McGraw-Hill Pub., 2nd Ed, 2002.
**5. Higher Engineering Mathematics: -** B.V. RAMANA, McGraw Hill Education, 2007

**Course Articulation Matrix**
## Mapping of Course Outcomes (CO) with Program Outcomes (POs) and Program Specific Outcomes (PSOs)

| Sem: 4 | | Course code : P18MAES41 | | | Title : Engineering Mathematics –IV | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO's | | Statement | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO-1 | | 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 (UNIT-I) | 2 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO-2 | | Learn logical thinking and analytical /geometrical skills in linear algebra through vector spaces, basis, dimension and linear transformations along with construction a matrix of linear transformations with respect change of Bases of same or different dimensions. Understand iterative methods in linear algebra such as Gauss-Jacobi, Gauss -Seidel, Relaxation and Power method and their practical utility in engineering fields(UNIT-II) | 3 | 3 | - | - | - | - | - | - | - | - | - | - |
| CO-3 | | 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 (UNIT-III) | 3 | 3 | - | - | - | - | - | - | - | - | - | - |
| CO-4 | | 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 (UNIT-IV) | 2 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO-5 | | 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. Obtain series solution of essential ODE's such as Bessel's and Legendre's differential equations and understand their scientific/engineering utility (UNIT-V) | 3 | 3 | - | - | - | - | - | - | - | - | - | - |

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

| Course Title: Material Science and Metallurgy | | | |
|---|---|---|---|
| Course Code: P18IP42 | Semester: IV | L-T-P-H: 4-0-0-4 | Credits: 3 |
| Contact Period - Lecture: 52 Hrs. 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 aims to:
1. Understand 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.[L2]
2. Apply the concept and mechanism of Fracture, Fatigue and Creep.[L2]
3. Construct and analyze the different types of Solid Solutions and Iron Carbon Equilibrium diagram.[L3]
4. Analyze 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]

**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 and Plastic deformation - Slip & Twinning.

**11Hours**

**SSC:** Hardness, Rockwell, Vickers &Brinell Hardness Testing.

### 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**

**SSC:** Study of Peritectic and Monotectic System.

## 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 and Austenite stabilizers. The TTT diagram, drawing of TTT diagram, TTT diagram for hypo & hypereutectoid steels.          **09Hours**

**SSC:** Effect of alloying elements on TTT diagram.

## UNIT – IV

**Heat Treatment:** Annealing and its types, Normalizing, Hardening, Tempering, Martempering, Austempering, Surface hardening like Case hardening, Carburizing, Cyaniding, Nitriding, Induction hardening. Hardenability. Age hardening of Al & Cu alloys.

**Ferrous Materials:** Properties, Composition and uses of Grey cast iron, malleable iron, SG iron and steel.

**11 Hours**

**SSC:** Study of Jominy – End Quench Test.

## 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 material sand reinforcements, fundamentals of production of FRP's and MMC's, advantages and applications of composites.

**10Hours**

**SSC:** Study of Copper – Zinc Partial Phase diagram.

**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. Analyze the concept and mechanism of Fracture, Fatigue and Creep.
3. Construct and analyze the different types of Solid Solutions and Iron Carbon Equilibrium diagram.
4. Analyze the different heat treatment techniques to improve the specific properties of the engineering materials.
5. Identify the composition, properties and application of ferrous, non-ferrous materials and composite materials.

**Course Assessment Matrix (CAM)**

| Sl. No | Course Outcome – CO | | Program outcome | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| 01 | Know the Fundamental concepts of Materials, and different Structures of Materials and common types of defects in the materials. | L2 | 2 | 2 | 2 | | 1 | | | | | | | | | |
| 02 | Analyze the concept and mechanism of Fracture, Fatigue and Creep. | L2 | 2 | 2 | 2 | | 1 | | | | | | | | 2 | |
| 03 | Construct and analyze the different types of Solid Solutions and Iron Carbon Equilibrium diagram. | L2 | 2 | 2 | 1 | | 1 | | | | | | | | | |
| 04 | Analyze the different heat treatment techniques to improve the specific properties of the engineering materials. | L2 | 3 | 3 | 1 | | 1 | | | | | | | | 1 | |
| 05 | Identify the composition, properties and application of ferrous, non-ferrous materials and composite materials. | L2 | 2 | 2 | 1 | | 2 | | | | | | | | 1 | |

| Course Title: Engineering Thermodynamics | | | |
|---|---|---|---|
| Course Code: P18IP43 | Semester: IV | L-T-P-H: 4-0-0-4 | Credits: 3 |
| Contact Period - Lecture: 52 Hrs. 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 aims to:

1. Apply the basic principles of thermodynamics in solving engineering problems knowing the real world engineering examples.[L3]
2. Define thermodynamic system, process, cycle, equilibrium, properties, work and heat transfer in thermodynamic context, laws of thermodynamics and properties of pure substances and perfect gases.[L1]
3. Explain basic constructional features of energy producing cycles like Rankine cycle, Air standard cycle and gas turbine cycles.[L2]
4. 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 viewpoints, 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, Simple steam power plants, IC engines, Domestic Refrigerator, Room Air conditioner, Macroscopic and Microscopic viewpoints, 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.

**12 Hours**

**SSC:** Practical Examples of Engineering Thermodynamics, Points to Remember about work and heat transfer.

## 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. **10 Hours**

**SSC:** Entropy – Clausius inequality, showing cyclic integral of δQ/T is independent of path.

## UNIT – III

**Pure Substance and Perfect Gas:** P-T and P-v diagrams, Triple point and critical points, sub-cooled liquid, saturated liquid, 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), 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 Isothermal Process, Polytropic process. **10 Hours**

**SSC:** Mixture of saturated liquid.

## 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, (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),(no derivation for MEP).

**10 Hours**

**SSC:** Comparison of Otto, Diesel and Dual cycles, Reheat and Regenerative cycles.

## UNIT – V

**Gas Turbine Cycle:** Brayton cycle, efficiency, methods to improve the efficiency of Brayton cycle using regeneration and intercooling (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 Hours**

**SSC:** Brayton cycle using reheating.

**Text Books:**
1.  P.K.Nag, "Basic and Applied Thermodynamics", Tata M cGraw Hill, 3$^{rd}$ Edi. 2005
2.  Yunus A. Cenegal and Michael A.Boles, "Thermodynamicsan engineering approach", Tata McGraw hill pub. 2008.

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

**Course Outcomes:**

After learning all the units of the course, the student is able to,
1. Explain Working of IC Engines, Refrigerator and Air Conditioner, and to Explain Thermodynamic system and Properties like equilibrium, Quasistatic process, Zeroth law of thermodynamics etc.
2. Apply first and second laws of Thermodynamics to the real world engineering devices knowing fully the limitations of energy conversion.
3. Identify and explain the properties of Pure Substance and Perfect Gas.
4. 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 dia grams,
5. Recognize the working of gas turbines and air compressor.

| Course Articulation Matrix | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes** | | **Program Outcomes** | | | | | | | | | | | | **PSO** | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 |
| **CO1** | Explain Working of IC Engines, Refrigerator and Air Conditioner, and to Explain Thermodynamic system and Properties like equilibrium, Quasistatic process, Zeroth law of thermodynamics etc. | 1 | | 2 | | 2 | | | | | | | | 1 | |
| **CO2** | Apply first and second laws of Thermodynamics to the real world engineering devices knowing fully the limitations of energy conversion. | 1 | 1 | | | 2 | | | | | | | | | |
| **CO3** | Identify and explain the properties of Pure Substance and Perfect Gas. | 1 | 1 | | | 3 | | | | | | | 2 | | |
| **CO4** | 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 dia grams, | 1 | 1 | 2 | | 2 | | | | | | | 1 | 1 | |
| **CO5** | Recognize the working of gas turbines and air compressor. | 1 | 1 | | | 2 | | | | | | | 1 | 1 | |

| Course Title: MANUFACTURING TECHNOLOGY - II | | | |
|---|---|---|---|
| Course Code:P18IP44 | Sem: IV | L-T-P-H: 4-0-0-4 | Credits: 3 |
| Contact Period: Lecture:52Hr   Exam: 3Hr | | Weightage: CIE:50;  SEE:50 | |

**Prerequisites:** Students should have the knowledge of elements of Mechanical engineering.

**Course Learning Objectives:**

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

1.  Apply the fundamental concepts, constructions and principal of machine and parts.
2.  Demonstrate the operation principles, advantages, applications, limitations of the various machines.
3.  Impart knowledge to students about the different type's attachments, and Work holding devices their application.

## UNIT-I

**The Lathe:** Introduction, Functions of lathe, types of lathes, parts of lathes, feed mechanism, Lathe accessories- three jaw and four jaw chucks, collets chuck, steady and follower rests, mandrels, operations of lathe, nomenclature of a single point turning tool, cutting speed, feed and depth of cut, machining time, problems.

**Capstan and Turret lathe:** principal parts, turret indexing mechanism, Production of a hexagonal bolt, Differences between Capstan, turret and engine lathe.          **11Hours**

**SSC:** Different types of Cutting Tools and its Application.

## UNIT-II

**Drilling Machine:** Introduction, types of drilling machines, important parts of upright and radial drilling machines, work and tool holding devices, drilling machine operations, twist drill nomenclature, cutting speed, feed, depth of cut, machining time in drilling, problems.

**Shaper:** Introduction, types, principal parts of a shaper, work holding devices, shaper operations.

**Planer:** types, comparison between shaper and planer.          **11Hours**

**SSC:** Use of drilling, shaping and planning machine in industry

## UNIT-III

**Milling machines**: Introduction, classification: - column and knee, plain, universal, vertical milling machine, principal parts of column and knee type, work holding devices, plain milling cutter nomenclature, milling operations, up milling and down milling concepts.

**Indexing**: Simple, compound, differential and angular indexing calculations.      **10Hours**

**SSC:** Use of milling machine in Industry.

## UNIT-IV

**Grinding Machines:** kinds of grinding, Types of grinding machines, Construction and principal parts of plain centre–type grinders, universal grinding machine, centre less grinders, surface grinders, wet and dry grinding, abrasives, types, bond and Bonding processes, Selection of grinding wheels, mounting the grinding wheels, dressing and truing of grinding wheels, balancing of grinding wheels, Diamond wheels.

**10Hours**

**SSC:** Application of different materials for surface finishing and machining processes.

## UNIT-V

**Surface finishing processes:** Lapping, Honing, super finishing operations, polishing, buffing, metal spraying.

**Broaching:** Introduction, broaching methods, broaching machines, operations, advantages & Limitations.

**Gear cutting:** Rack cutter generating process, pinion cutter generating process, gear hobbing.

**10 Hours**

**SSC:** Application of surface finishing, broaching and gear cutting in Industry.

**Text Books**:
1. Hazara Choudhry, **" Workshop Technology",** Vol-II, Media Promoters & Publishers Pvt. Ltd. 2015

**Reference Books**:
1. Roy A. Lindberg "Manufacturing Process and Materials of Manufacture", Prentice Hall of India, 2008.
2. R.K.Jain, "Production Technology", Khanna Publications, 2010.
3. HMT "Production technology" Tata MacGraw Hill, 2016.

**Course Outcome:**
1. **Identify** lathe parts and **explain** its operations.
2. **Explain** the drilling machine, its operations and **distinguish** shaper and planer.
3. **Describe** the importance of milling machine and **solve** different types of indexing calculations.
4. **Describe** the types of grinding machines and abrasive particles with its applications.
5. **Summarize** surface finishing processes and **explain** importance of broaching and gear cutting.

## Course Assessment Matrix (CAM)

| Sl. No | Course Outcome – CO | | Program outcome | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| 01 | **Identify** lathe parts and **explain** its operations. | L2 | 2 | 2 | 1 | | 2 | | | | | | | 2 | 2 | |
| 02 | **Explain** the drilling machine, its operations and **distinguish** shaper and planer. | L2 | 2 | 2 | 1 | | 2 | | | | | | | 2 | 2 | |
| 03 | **Describe** the importance of milling machine and **solve** different types of indexing calculations. | L2 | 2 | 2 | 1 | | 2 | | | | | | | 2 | 2 | |
| 04 | **Describe** the types of grinding machines and abrasive particles with its applications. | L2 | 2 | 2 | 1 | | 2 | | | | | | | 2 | 2 | |
| 05 | **Summarize** surface finishing processes and **explain** importance of broaching and gear cutting. | L2 | 1 | 1 | 1 | | 2 | | | | | | | 2 | 2 | |

| Course Title: Computer Aided Machine Drawing | | | |
|---|---|---|---|
| Course Code:P18IP45 | Semester: IV | L-T-P-H: 0-2-4-6 | Credits: 3 |
| Contact Period: Lecture:52Hr    Exam: 3Hr | | Weightage: CIE:50;  SEE:50 | |

**Prerequisites:** Students should have the knowledge of Computer aided machine engineering

**Course Learning Objectives:** To learn and draw the various views, to locate the section line at appropriate location and to assemble the drawings of machine components.

## Course Content
## PART A

### UNIT- I
**Sections of Solids:** True shape Sections of pyramids, prisms, tetrahedron, cones and cylinders resting only on their bases and section plane inclined to horizontal plane only.

**06 Hours**

**Orthographic Views:** Conversion of pictorial views into orthographic projections of simple machine parts with or without section, hidden line conventions, precedence of lines.

**08 Hours**

### UNIT –II
**Thread Forms:** Thread terminology, sectional view of threads. ISO Metric -Internal and External, BSW, square, acme and sellers thread.

**Fasteners:** Hexagonal headed bolt and nut with washer, square headed bolt and nut with washer.

**06 Hours**

## PART B
### UNIT- III
**Keys and Joints:** Keys: Sunk Taper key, Feather key, Woodruff key and Gib - head key. **Joints:** Single and double riveted lap joints, butt joints with single/double cover straps -chain and zigzag, using snap head rivets.

**06 Hours**

### UNIT IV
**Cotter joint -** socket and spigot, knuckle joint (pin joint).

**Couplings:** Solid muff coupling, protected type flanged coupling and pin (bush) type flexible coupling& Oldham's coupling.

**08 Hours**

## PART C
### UNIT V
**Assembly Drawings-** (Part drawings should be given)
1. Plummer Block (Pedestal Bearing)
2. Tailstock of a Lathe
3. Machine Vice
4. Tool head of a shaper
5. Screw jack (bottle type)

**18 Hours**

*Software: Solid works 2015.*

**Text Books:**
1. **"Machine Drawing"**, K.R. Gopala Krishna, Subhash Publication.2007
2. **"Machine Drawing"**, P.S.Gill, S.K.Kataria and Sons, Seventeenth Revised Edition, 2008.

**Reference Books:**
1. **"Machine Drawing"**, N.D. Bhat and V.M.Panchal, 2007.
**2. A Primer on Computer Aided Machine Drawing**-2007, Published by VTU, Belgaum.

**Course outcomes:**
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 and joints.
4. Draw different types of coupling required to couple two shafts for power transmission
5. Design and assemble different machine parts and other mechanical equipment's.

**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 |

| **Course Articulation Matrix** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes** | | **Program Outcomes** | | | | | | | | | | | | **PSO** | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 |
| CO1 | Analyze different views of solids of projections and orthographic views | 2 | 1 | 2 | | 2 | | | | | | | 2 | | |
| CO2 | Identify and draw the views of Threads and fasteners. | 2 | 1 | 2 | | 2 | | | | | | | 2 | | |
| CO3 | Draw the different types of keys and joints. | 2 | 2 | 2 | | 2 | | | | | | | 2 | | |
| CO4 | Draw different types of coupling required to couple two shafts for power transmission | 2 | 2 | 2 | | 2 | | | | | | | 2 | | |
| CO5 | Design and assemble different machine parts and other mechanical equipment's. | 3 | 1 | 3 | | 2 | | | | | | | 3 | | |

| Course Title: Theory of Machines | | | |
|---|---|---|---|
| **Course Code: P18IP46** | **Semester: IV** | **L-T-P-H: 2-2-0-4** | **Credits: 3** |
| **Contact Period - Lecture: 52 Hrs. 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):**

This course aims 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, whit worth 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.

**11Hours**

**SSC:** Use of different inversions of mechanisms and its applications

**UNIT – II**

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

**Gear Trains:** Simple gear trains, Compound gear trains for large speed reduction, Epicyclicgear trains, Algebraic and tabular methods of finding velocity ratio of epicyclical gear trains, Torque calculations in Epicyclic gear train.

**10 Hours**

**SSC:** Uses of different gears and gear trains

## UNIT – III

**Friction:** Definition, Types of friction, Laws of Static and Dynamic Co-efficient of Friction, Friction between sliding pair, friction between turning pairs, friction in collar and pivot (Thrust bearing).

**Belt drives:** velocity ratio of belt drive, slip in belts, creep in belts, length of open and cross belt drive, ratio of belt tensions, centrifugal tension, power transmitted by belt drive, Maximum power condition. Effect of centrifugal tension on power transmitted, V-Belt Drives, Rope drives, ratio of belt tensions for V-belt or rope drive, problems.

**10Hours**

**SSC:** Applications of belt drives

## 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. **11Hours**

**SSC**: Concept of static and dynamic loads

## 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**

**SSC:** Applications and uses of gyroscopic couple in industry

**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, 1st 2005)
3. R.S.Khurmi, "Theory of Machines"

**Course Outcomes**
After learning all the units of the course, the student is able to,
1. Calculate mobility (number of degrees-of-freedom) and enumerate rigid links and types of joints within mechanisms, and to Understand gear mechanism classification and to become familiar with gear standardization and specification in design.
2. Explain Terminology of gears and Importance of gear trains and their practical applications.
3. Know uses and advantages of belt drives Types and their nomenclature, Relationship between belt tensions commonly used design parameters.
4. Draw inversions dend determine velocity and acceleration of different mechanisms, and to Calculate loss of power due to friction in various machine elements and Importance of Governors.
5. Explain Gyroscopic Effects and Gyroscope in automobile sector.

| Course Articulation Matrix | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes** | | **Program Outcomes** | | | | | | | | | | | | **PSO** | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 |
| **CO1** | Calculate mobility (number of degrees-of-freedom) and enumerate rigid links and types of joints within mechanisms, and to Understand gear mechanism classification and to become familiar with gear standardization and specification in design. | 2 | 1 | | | | | | | | | | | 1 | |
| **CO2** | Explain Terminology of gears and Importance of gear trains and their practical applications. | 1 | 2 | | | | | | | | | | | 2 | |
| **CO3** | Know uses and advantages of belt drives Types and their nomenclature, Relationship between belt tensions commonly used design parameters. | 2 | 2 | 3 | | 3 | | | | | | | | | |
| **CO4** | Draw inversions and determine velocity and acceleration of different mechanisms, and to Calculate loss of power due to friction in various machine elements and Importance of Governors. | 3 | 2 | 2 | | 2 | | | | | | | | 2 | |
| **CO5** | Explain Gyroscopic Effects and Gyroscope in automobile sector. | 3 | 2 | 2 | | 3 | | | | | | | | 2 | |

| Course Title: Material Testing and Metallography Lab | | | |
|---|---|---|---|
| **Course Code:P18IPL47** | **Semester: IV** | **L-T-P-H: 0-0-3-3** | **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 identifying the microstructures.
2. Learn hardness 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.

**Course Content**

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. JominyHarden ability Test
8. Hardness studies of heat treated samples
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 of nonferrous material and conduct the non-destructive testing.
2. **Conduct** and **evaluate** mechanical properties of the ferrous and nonferrous material.

| Course Articulation Matrix | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes** | | **Program Outcomes** | | | | | | | | | | | | **PSO** | |
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 |
| **CO1** | Prepare the specimen for metallographic examination of nonferrous material and conduct the non-destructive testing. | 2 | 2 | 2 | | 3 | | | | | | | 2 | 2 | |
| **CO2** | Conduct and evaluate mechanical properties of the ferrous and nonferrous material. | 2 | 2 | 2 | | 3 | | | | | | | 2 | 2 | |

| Course Title: Machine Shop Practice | | | |
|---|---|---|---|
| Course Code:P18IPL48 | Semester: IV | L-T-P-H: 0-0-3-3 | 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.

**Course learning objectives:**

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

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. Shaping machine and milling machine

## Course Content

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.
7. Machining V Groove Rectangular groove using Shaping machine
8. Gear Teeth Cutting using Milling Machine **36 Hours**

## Course Outcome

At the end of the session students should be able to

1. Operate Lathe, Drilling, Milling and shaping machine to perform operations like facing, plain turning, step turning, taper turning thread cutting and knurling on lathe, gear cutting on milling machine, drilling and reaming operation on pillar drilling machine, grooves on shaping machine.
2. Do Calculations for taper turning, thread cutting and for Indexing mechanism.

| Course Articulation Matrix | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Course Outcomes** | **Program Outcomes** | | | | | | | | | | | | | **PSO** | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 01 | 02 | |
| **CO1** Operate Lathe, Drilling, Milling and shaping machine to perform operations like facing, plain turning, step turning, taper turning thread cutting and knurling on lathe, gear cutting on milling machine, drilling and reaming operation on pillar drilling machine, grooves on shaping machine. | 2 | 2 | 3 | | 3 | | | | | | | 2 | 1 | | |
| **CO2** Do Calculations for taper turning, thread cutting and for Indexing mechanism. | 2 | 2 | 2 | | 3 | | | | | | | 2 | 1 | | |

| Course Title : Aptitude and Reasoning Development - Intermediate (ARDI) | | | |
|---|---|---|---|
| Course Code : P18HU49 | Semester : IV | L - T - P : 2-0 - 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. Explain different methods to calculate number of smaller cubes, the date and the day of any year and the concepts of clocks.
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

**Relevance of the course:**

4$^{th}$ semester deals with more of quantitative aptitude. It is the intermediate level of aptitude which involves modules like Time speed distance. Time and work, set theory. This course also touches upon logical abilities through modules like cubes and Calendars.

## 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.

**SSC:** Basic relation between the 3 different quantities. Conversions between different UNITs of measurement. Speed and velocity.                                                              **6 Hours**

## UNIT – II

**Cubes, Clocks & Calendars:**
**Cubes:** Number of faces, vertices and edges. Colored cubes. Number of colored faces and the formulae to find-out the same. Problems on cubes.
**Clocks & Calendars:** Minute spaces. Hour hand and minute hand. Angle between the hands. Relative speed. Faulty clocks. Time gained or lost by the clock. Odd days. Leap year. Ordinary year. Counting of odd days. Problems on clocks and calendars.
**Self-study Component-** Knowledge about shapes and dimensions, Area and volume. Leap year, number of days. Important dates.                                        **8 Hours**

## 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.
**Self-study Component-** Basics about sets, operations using venn diagram. Basic applications.

                                                                 **6 Hours**
## 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.
**Self-study Component-**Basics of geometry, formula, dimensions, shapes. Different types of lines. Example – parallel, intersecting etc…                                   **8 Hours**
## 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.
**SSC:** LCM methods, basic arithmetic. Fractions and efficiency.                   **4 Hours**
**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 number of colored faces in a cube when it is cut into different number of pieces and solve the problems under clocks and calendars. 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 | | | |
|---|---|---|---|
| Course Code : P18MADIP41 | Semester : 4 | L :T:P:H : 4:0:0:4 | Credits: 0 |
| Contact Period: Lecture: 52 Hr. | | Weightage: CIE:(Max 50 marks) | |

((Mandatory Learning Course: **Common to All Branches**)

(A Bridge course for Diploma qualified students of IV Sem. B. E.)

## 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..

**Self-study Components:** Application of Cayley-Hamilton theorem (without proof) to compute the inverse of a matrix-Examples

**10 Hours**

## 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. and variation of parameters. Solution of Cauchy's homogeneous linear equation and Legendre's linear differential equation.

**Self-study Components:** Method of undetermined coefficients                **14 Hours**

## 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.

**Self-study Components:** Orthogonal curvilinear coordinates.                **10 Hours**

## 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.

**Self-study Components:** Application to solutions of linear differential equations and simultaneous differential equations.                **12 Hours**

## UNIT –V

**Probability:** Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability – illustrative examples.

**Self-study Components:** State and prove Bayes'stheorem.                **06 Hours**

**Text Book:**

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

**References:**

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

2. N.P.Bali and Manish Goyal: Engineeri