| | | | |
|---|---|---|---|
| Course Title | **TRANSFORMS AND STATISTICAL METHODS** | Semester | III |
| Course Code | **MVJ19MAE31 /MAS31/MME31** | **CIE** | 50 |
| Total No. of Contact Hours | 60 L : T : P :: 40 : 0 : 20 | **SEE** | 50 |
| No. of Contact Hours/week | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3Hrs |

**Course objective is to:** This course will enable students to

- Comprehend and use of analytical and numerical methods in different engineering fields.
- Apprehend and apply Fourier Series.
- Realize and use of Fourier transforms and Z-Transforms.
- Use of statistical methods in curve fitting applications.
- Use of numerical methods to solve algebraic and transcendental equations, vector integration and calculus of variation.

| **Module-1** | **RBT Level** | Hrs. |
|---|---|---|
| **Laplace Transform:**<br>Definition and Laplace transforms of elementary functions. Laplace transforms of Periodic functions and unit-step function and problems.<br>**Inverse Laplace Transform:**<br>Definition and problems, Convolution theorem to find the inverse Laplace transforms and problems.<br>**Applications**: Solution of linear differential equations using Laplace transforms.<br>**Web Link and Video Lectures:**<br>1. https://www.khanacademy.org/<br>2. http://www.nptelvideos.in/<br>3. https://www.classcentral.com/ | L1,L2 & L3 | 10 |
| **Module-2** | **RBT Level** | Hrs. |
| **Fourier series:**<br>Recapitulation of Series, Continuous and Discontinuous functions, Periodic | L1,L2 & L3 | 10 |

| | | |
|---|---|---|
| functions, Dirichlet's conditions, Fourier series of periodic functions of period $2l$ and with arbitrary period$2\square$, Half-range Fourier sine and cosine series, Practical Harmonic Analysis and Problems.<br>**Web Link and Video Lectures:**<br>1. https://www.khanacademy.org/<br>2. http://www.nptelvideos.in/<br>3. https://www.classcentral.com/ | | |
| **Module-3** | **RBT Level** | Hrs. |
| **Fourier transforms:**<br>Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse Fourier sine and cosine transforms, Convolution theorem and problems.<br>**Applications**: Applications of Fourier Transforms.<br>**Web Link and Video Lectures:**<br>1. https://www.khanacademy.org/<br>2. http://www.nptelvideos.in/<br>3. https://www.classcentral.com/ | L1,L2 & L3 | 10 |
| **Module-4** | **RBT Level** | Hrs. |
| **Z-Transforms:**<br>Difference Equations, Z-Transforms, Standard Z-transforms, Initial-value and Final-value theorems. Inverse Z-transforms.<br>**Applications**: Application of Z- transforms to solve difference equations.<br>**Web Link and Video Lectures:**<br>1. https://www.khanacademy.org/<br>2. http://www.nptelvideos.in/<br>3. https://www.classcentral.com/ | L1,L2 & L3 | 10 |
| **Module-5** | **RBT Level** | Hrs. |
| **Curve Fitting:**<br>Curve fitting by the method of least squares. Fitting of the curves of the form $y=ax+b$, $y=ax^2+bx+c$, $y=ae^{bx}$.Linear Programming problem – Formulation and solution by Simplex method.<br>**Statistical Methods:**<br>Introduction, Correlation and coefficient of co relation, Regression, line of | L1,L2& L3 | 10 |

| | | |
|---|---|---|
| regression problems.<br><br>**Web Link and Video Lectures:**<br><br>1. https://www.khanacademy.org/<br>2. http://www.nptelvideos.in/<br>3. https://www.classcentral.com/ | | |

| **Course outcomes:** | |
|---|---|
| CO1 | Use Laplace transform and inverse transforms techniques in solving differential equations. |
| CO2 | Demonstrate Fourier Transform as a tool for solving Integral equations. |
| CO3 | Demonstrate Fourier Transform as a tool for solving Integral equations. |
| CO4 | Apply Z Transform to solve Difference Equation.Use Method of Least Square for appropriate Curves. |
| CO5 | Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data. |

| **Reference Books:** | |
|---|---|
| 1. | B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013. |
| 2. | Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition,2014. |
| 3 | Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006. |
| 4 | Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition. |
| 5 | Jain R. K. & Iyengar S.R.K., Advanced Engineering Mathematics, Narosa Publishing House, 2002. |

| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CO2 | 3 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| CO3 | 2 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CO4 | 3 | 3 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO5 | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| Course Title | **AEROTHERMODYNAMICS** | Semester | III |
| Course Code | **MVJ19AE32/AS32** | **CIE** | 50 |
| Total No. of Contact Hours | 60 L : T : P :: 40 : 0 : 20 | **SEE** | 50 |
| No. of Contact Hours/week | 4 | **Total** | 100 |
| **Credits** | 4 | **Exam. Duration** | 3 Hrs |

**Course objective is to:** This course will enable students to

1. Understand various concepts and definitions of thermodynamics.
2. Comprehend the I-law of thermodynamics.
3. Comprehend the II-law of thermodynamics
4. Acquire the knowledge of Pure Substances & Ideal Gases
5. Acquire the knowledge of various types of gas cycles.

| **Module-1** | **L1, L2, L3** | 10Hrs. |
|---|---|---|

**Fundamental Concepts & Definitions:**
Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and Modules, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic ;processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements.

**Work and Heat:**
Mechanics-definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work

Laboratory Sessions / Experimental learning:
To determine the unknown area of a given drawing using planimeter

Applications:
1.For temperature measurements
2.To obtain displacement work
Video link / Additional online information (related to module if any):
https://nptel.ac.in/courses/101/104/101104067/

| **Module-2** | **L1, L2, L3** | 10Hrs. |
|---|---|---|

**First Law of Thermodynamics:**

Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, analysis of unsteady processes such as film and evacuation

of vessels with and without heat transfer

Laboratory Sessions/ Experimental learning:
https://www.youtube.com/watch?v=suuTC9uGLrI
https://www.youtube.com/watch?v=7bJywbP7ZIU

Applications:

1. Conservation of energy principle to Heat and Thermodynamic processes
2. Compressors, Blowers, Steam or Gas Turbines, IC engines Video link /

Additional online information (related to module if any):

https://nptel.ac.in/courses/101/104/101104067/

| **Module-3** | **L1, L2, L3** | 10Hrs. |
|---|---|---|

**Second Law of Thermodynamics:**
Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Reversible and Irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles.

**Entropy:**

Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy.

Laboratory Sessions/ Experimental learning:
https://www.youtube.com/watch?v=7OJG-ZHrbD8
https://www.youtube.com/watch?v=7bJywbP7ZIU
https://www.youtube.com/watch?v=2vHLJjlinjw

Applications:

1. All types of heat engine cycles including Otto, Diesel, etc
2. Refrigerators and heat pumps based on the Reversed Carnot Cycle
3. Mixing of two fluids, heat transfer through a finite temperature difference Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/104/101104067/

| **Module-4** | **L1, L2, L3** | 10Hrs. |
|---|---|---|

**Pure Substances & Ideal Gases:**
Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and HS diagrams, representation of various processes on these diagrams.

**Thermodynamic relations:**
Maxwell`s equations, Tds relations, ratio of heat capacities, evaluation of thermodynamic properties from an equation of state

Laboratory Sessions/ Experimental learning:
https://www.youtube.com/watch?v=Juz9pVVsmQQ
https://www.youtube.com/watch?v=L1AHGHRvv9s

Applications: Working fluids and its properties, in power plants for power generations.
Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/104/101104067/

| **Module-5** | **L1, L2, L3** | 10Hrs. |
|---|---|---|

**Gas Cycles:**

Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency, Numerical

**vapour power cycle:**

Carnot vapour power cycle, simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle.

Laboratory Sessions/ Experimental learning:
To determine the unknown area of a given drawing using planimeter To calculate the thermal efficiency of Petrol cycle. To calculate the thermal efficiency of Diesel cycle.

Applications:
IC engines, Gas turbine engines etc..
Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/104/101104067/

**Course outcomes:**

| | |
|---|---|
| CO202.1 | Apply the concepts of thermodynamics in various engineering problems. |
| CO202.2 | Differentiate thermodynamic work and heat and apply I law of thermodynamics to different process |
| CO202.3 | Differentiate thermodynamic work and heat and apply II law of thermodynamics to different process |
| CO202.4 | Apply the concepts of Pure Substances & Ideal Gases |
| CO202.5 | Apply the principles of various gas cycles |

| Reference Books: | |
|---|---|
| 1. | A Venkatesh, Basic Engineering Thermodynamics, Universities Press, India, 2007, ISBN 13: 9788173715877 |
| 2. | P K Nag, Basic and Applied Thermodynamics, 2nd Ed., Tata McGraw Hill Pub. 2002, ISBN 13: 9780070151314 |
| 3. | YunusA.Cenegal and Michael A.Boles, Thermodynamics: An Engineering Approach, TataMcGraw Hill publications, 2002, ISBN 13: 9780071072540 |
| 4. | J.B.Jones and G.A.Hawkins, Engineering Thermodynamics, Wiley 1986, ISBN 13: 9780471812029 |

| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |

High-3, Medium-2, Low-1

| Course Title | **ELEMENTS OF AERONAUTICS** | Semester | III |
|---|---|---|---|
| Course Code | **MVJ19AE33** | **CIE** | 50 |
| Total No. of Contact Hours | 60 L : T : P :: 40 : 0 : 20 | **SEE** | 50 |
| No. of Contact Hours/week | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs |

**Course objective is to: : This course will enable students to**

1. To know the history and basic principle of aviation
2. To understand the foundation of flight, aircraft structures, material aircraft propulsion
3. To develop an understanding stability of an aircraft along with its different systems

| **Module-1** | **RBT Level** | Hrs. |
|---|---|---|
| **Introduction to Aircrafts**<br>History of aviation; Atmosphere and its properties; Classification of aircrafts; Basic components of an aircraft; structural members; aircraft axis system; aircraft motions; control surfaces and high lift devices; classification of aircraft; conventional design configurations; principle of operation of each major part; Helicopters, their parts and functions.<br>**Aircraft Structures and Materials:**<br>Introduction; general types of construction; monocoque, semi-monocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application.<br>Laboratory Sessions/ Experimental learning: Visualization of structural members of a wing in Structural Lab<br>Applications: Identify and describe various components of an aircraft.<br>Video link<br>1. https://nptel.ac.in/courses/101/101/101101079/ | L1, L2 | 10 Hrs |
| **Module-2** | **RBT Level** | Hrs. |
| **Basic principles of flight** – significance of speed of sound; airspeed and groundspeed; standard atmosphere; Bernoulli's theorem and its application for generation of lift and measurement of airspeed; forces over wing section, aerofoil nomenclature, pressure distribution over a wing section. Lift and drag components – generation of lift and drag; lift curve, drag curve, types of drag, | L1, L2 | 10 Hrs |

| | | |
|---|---|---|
| factors affecting lift and drag; centre of pressure and its significance; aerodynamic centre, aspect ratio, Mach number and supersonic flight effects; simple problems on lift and drag.<br><br>Laboratory Sessions/ Experimental learning: Visualization of airfoil cross-section in Aerodynamics Lab<br><br>Applications: Understand and explain lift production theories for 2-D and their extension to 3-D Video link: https://nptel.ac.in/courses/101/101/101101079/<br><br>https://nptel.ac.in/courses/101/101/101101079/ | | |
| **Module-3** | **RBT Level** | Hrs. |
| **Aircraft Propulsion:**<br><br>Aircraft power plants, classification based on power plant and location and principle of operation. Turboprop, turbojet and turbofan engines; ramjets and scramjets; performance characteristics. Aircraft power plants – basic principles of piston, turboprop and jet engines; Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation.<br><br>Laboratory Sessions/ Experimental learning: Visualization of engines in Propulsion Lab<br><br>Applications: Understand various configurations layouts, power-plant options available.<br><br>Video link:<br><br>https://nptel.ac.in/courses/101/101/101101079/<br>https://nptel.ac.in/courses/101/101/101101079/ | L1, L2, L3 | 10 Hrs |
| **Module-4** | **RBT Level** | Hrs. |

| | | |
|---|---|---|
| **Aircraft Stability :**<br><br>Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Effect of flaps and stats on lift, control tabs, | L1, L2 | 10 Hrs |

| | | |
|---|---|---|
| stalling, gliding, landing, turning, aircraft maneuvers; stalling, gliding, turning. Simple problems on these. Performance of aircraft – power curves, maximum and minimum speeds for horizontal flight at a given altitude; effect of changes in engine power and altitude on performance; correct and incorrect angles of bank; aerobatics, inverted maneuver, maneuverability. Simple problems.<br><br>Laboratory Sessions/ Experimental learning: Creating paper planes to have hands on experience of understanding the concepts<br><br>Applications: Identify the required performance characteristics of different class of aircraft Video link: https://nptel.ac.in/courses/101/101/101101079/ https://nptel.ac.in/courses/101/101/101101079/ | | |
| **Module-5** | **RBT Level** | Hrs. |

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|---|---|---|
| **Aircraft Systems:**<br>Mechanical systems and their components; hydraulic and pneumatic systems; oxygen System; environmental Control System; fuel system. Electrical systems, flight deck and cockpit systems; navigation system, communication system.<br>**Aircraft systems (Mechanical)** – hydraulic and pneumatic systems and their applications; environment control system; fuel system, oxygen system.<br>**Aircraft systems (Electrical)** – flight control system, cockpit instrumentation and displays; communication systems; navigation systems; power generation systems – engine driven alternators, auxiliary power Module, ram air turbine; power conversion, distribution and management.<br>Applications: Identify the main components, subsystems of aircraft and their functionality and various flight control systems , fuel and hydraulic control systems<br>Video link:<br>https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraftsystems-engineering-fall-2005/video-lectures/lecture-7/ | L1, L2 | 10 Hrs |

| **Course outcomes:** | |
|---|---|
| CO1 | Appreciate and apply the basic principle of aviation. |
| CO2 | Apply the concepts of fundamentals of flight, basics of aircraft structures. |
| CO3 | Aircraft propulsion and aircraft materials during the development of an aircraft. |
| CO4 | Understand the basic concepts of aircraft stability and control |
| CO5 | Understand and Comprehend the complexities involved during development of flight vehicles |

| Reference Books: | |
|---|---|
| 1. | John D. Anderson, Introduction to Flight, McGraw-Hill Education, 2011. ISBN 9780071086059. |
| 2. | Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books, 2006, ISBN: 706. |
| 3. | A.C. Kermode, Flight without formulae, Pearson Education India, 1989. ISBN: 9788131713891. |
| 4. | Nelson R.C., Flight stability and automatic control, McGraw-Hill International Editions, 1998. ISBN 9780071158381 |
| 5. | Ian Moir, Allan Seabridge, Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration, John Wiley & Sons, 2011. ISBN 978111965006. |

| | |
|---|---|
| 6. | Sutton G.P., Rocket Propulsion Elements, John Wiley, New York, 8th Ed., 2011; ISBH: 1118174208, 9781118174203. |

| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO4 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO5 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| Course Title | **MECHANICS OF MATERIALS** | Semester | **III** |
| Course Code | **MVJ19AE34/AS34** | **CIE** | 50 |
| Total No. of Contact Hours | 60 L : T : P :: 40 :0 : 20 | **SEE** | 50 |
| No. of Contact Hours/week | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs |

**Course objective is to:**

1. Comprehend the basic concepts of strength of materials.
2. Acquire the knowledge of stresses due to bending
3. Understand the different failure in materials

| **Module-1** | **RBT Level** | Hrs. |
|---|---|---|

| | | |
|---|---|---|
| **Basics of linear elasticity:** The concept of stress& strain, state of stress & Strain at a point, Equilibrium equations, The state of plane stress and plane strain. Compatibility equations, Constitutive Laws (Hooke's Law), Stress strain curves for brittle and ductile materials, Allowable stress, Material selection for structural performance.<br><br>**Simple & Compound Stresses:** Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections. Elongation due to self-weight. Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses, Introduction to Plane stress, stresses on inclined sections, principal stresses & strains, Analytical & graphical method (Mohr's Circle) to find principal stresses & strains.<br>Laboratory Sessions/ Experimental learning: UTM in Material Testing Lab<br>Applications: Testing of Mild steel components, Bricks<br>Video link / Additional online information (related to module if any):<br>Prof. Dr. Suraj Prakash Harsha,Indian Institute of Technology, Roorkee.<br>Lecture – 12 for Ductile and Brittle Materials | L1, L2,L3 | 10 Hrs |
| | | |
| **Module-2** | **RBT Level** | Hrs. |
| **Bending Moment and Shear Force in Beams:** Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams.<br><br>**Euler-Bernoulli beam theory:** The Euler-Bernoulli assumptions, | L1, L2. L3 | 10 Hrs |
| Implications of the Euler-Bernoulli assumptions, the Euler-Bernoulli Beam theory derivation, Bending stress equation, Moment carrying capacity of a section. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections (Only Numerical).<br>Laboratory Sessions/ Experimental learning: Different load conditions can be practiced in Structures Lab<br>Applications: Civil Construction with Symmetrical I & T sections Video link / Additional online information (related to module if any): Prof: S .K.Bhattacharya, IIT, Kharagpur, Lecture no 24. Bending of Beams-III | | |
| | | |
| **Module-3** | **RBT Level** | Hrs. |

| | | |
|---|---|---|
| **Deflection of Beams:** Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method.<br><br>**Torsion of Circular Shafts and Elastic Stability of Columns:** Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts.<br>Laboratory Sessions/ Experimental learning: Beam Expt in Structures lab and Torsion Test apparatus available in MT Lab.<br>Applications: Civil Construction and Automobile Transmission.<br>Video link / Additional online information (related to module if any):<br>Prof. S. K. Bhattacharyya Indian Institute of Technology, Kharagpur Lecture - 33 Deflection of Beams – IV<br><br>Prof. S. K. Bhattacharya Dept. of Civil Engineering I.I.T Kharagpur Lecturer#20 Torsion-III | L1, L2, L3 | 10 Hrs |
| | | |
| **Module-4** | **RBT Level** | Hrs. |
| **Virtual work principles:** Introduction, Equilibrium and work fundamentals, Principle of virtual work, Principle of virtual work applied to mechanical systems, Principle of virtual work applied to truss structures, Principle of virtual work applied to beams. Principle of complementary virtual work, internal virtual work in beams and solids.<br><br>**Energy methods:** Conservative forces, Principle of minimum total potential energy, Strain energy in springs, Strain energy in beams, Strain energy in solids, Applications to trusses, Development of a finite element formulation for trusses, Principle of minimum complementary, Energy theorems, | L1, L2, L3, L4 | 10 Hrs |
| Reciprocity theorems, Saint-Venant's principle.<br><br>Laboratory Sessions/ Experimental learning: Few of the Energy Method Theorems can be explained from Structures Lab.<br>Applications: **Virtual work** arises in the **application** of the **principle** of least action to the study of forces and movement of a mechanical system.<br><br>Video link / Additional online information (related to module if any): Energy Methods in Structural Analysis Version 2 CE IIT, Kharagpur | | |
| | | |
| **Module-5** | **RBT Level** | Hrs. |

| | | |
|---|---|---|
| **Mechanical Properties of materials**:<br><br>**Fracture**: Type I, Type II and Type III.<br>**Creep**: Description of the phenomenon with examples. Three stages of creep, creep properties, stress relaxation.<br>**Fatigue**: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram.<br><br>Laboratory Sessions/ Experimental learning: Impact Tests in MT lab for Fracture.<br>Applications: Boilers, Rotating Machine Elements<br>Video link / Additional online information (related to module if any):<br>Creep Deformation of Materials Dr. Srikant Gollapudi Indian Institute of Technology, Bhubaneswar<br><br>Prof. K.Gopinath & Prof. M.M.Mayuram, Machine Design II, Indian Institute of Technology Madras | L1, L2, L3 | 10 Hrs |

| **Course outcomes:** | |
|---|---|
| CO1 | Apply the basic concepts of strength of materials. |
| CO2 | Compute stress, strain under different loadings. |
| CO3 | Acquire the knowledge of deflection of beams |
| CO4 | Acquire the knowledge of virtual work principle and energy methods |
| CO5 | Identify different failures |


| Reference Books: | |
|---|---|
| 1. | T.H.G Megson "Introduction to Aircraft Structural Analysis", Butterworth-Heinemann Publications, 2007, ISBN 13: 9781856179324 |
| 2. | Beer F.P. and Johnston.R, Mechanics of Materials, McGraw Hill Publishers, 2006, ISBN13:978-0073380285. |
| 3. | Timoshenko and Young, Elements of Strength of Materials, East-West Press, 1976, ISBN 10: 8176710199 |


| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| Course Title | **MECHANICS OF FLUIDS** | Semester | III |
| Course Code | **MVJ19AE35/AS35** | **CIE** | 50 |
| Total No. of Contact Hours | 60 L : T : P :: 40 : 0 : 20 | **SEE** | 50 |
| No. of Contact Hours/week | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs |

**Course objective is to:**

1. Understand the basic fluid properties.
2. To estimate velocity, acceleration and stream function for an incompressible and inviscid flow along with governing equations of fluid flow.
3. Understand the dimensional analysis and apply Bernoulli's and Euler's equation for flow measuring devices
4. To calculate boundary layer thickness and drag co-efficient for laminar and turbulent flows
5. Acquire the knowledge of compressible flows and boundary Layers

| **Module-1** | **L1, L2, L3** | 10Hrs |
|---|---|---|

**Basic Considerations:**

Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids.

**Fluid Statics:**

Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples.

Laboratory Sessions/ Experimental learning: Use of piezometer and manometers Applications: For pressure measurements by using different types of manometers.

Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/103/101103004/

| **Module-2** | **L1, L2, L3** | 10Hrs |
|---|---|---|

**Fluids in motion:**

Methods of describing fluid motion, types of fluid flow, continuity equation in 3 dimensions, velocity potential function and stream function. Types of motion, Source sink, doublet, plotting of stream lines and potential lines Numerical problems.

**Fluid Kinematics:**

Kinematics of fluid motion and the constitutive equations, Integral (global) form of conservation equations (mass, momentum, energy) and applications, Differential form of conservation equations (continuity, Navier-Stokes equations, energy equation).

Laboratory Sessions/ Experimental learning: An experimental study of the continuity equation and Bernoulli's equation by using Venturimeter, Orificemeter and pitot tube.
Applications: For rotational and irrotational fluid flows, laminar and turbulent fluid flows. Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/103/101103004/

| **Module-3** | **L1, L2, L3** | 10Hrs |
|---|---|---|

**Fluid Dynamics:**

Equations of motion: Euler's and Bernoulli's equation of motion for ideal and real fluids. Momentum equation, Fluid flow measurements. Numerical problems.

**Dimensional analysis and similarity:**

Dimensional homogeneity, methods of dimensional analysis, model analysis, types of similarity and similitude. Dimensionless numbers. Model laws. Numerical problems

Laboratory Sessions/ Experimental learning: An experimental study of the continuity equation and Bernoulli's equation by using Venturimeter, Orificemeter and pitot tube.

Applications: flow measuring devices and model studies.

Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/103/101103004/

| **Module-4** | **L1, L2, L3** | 10Hrs |
|---|---|---|

**Flow past Immersed bodies:**

Introduction to boundary layer, boundary layer thickness, karman's integral momentum theory, drag on a flat plate for laminar and turbulent flow, Drag on immersed bodies. Expression for drag and lift. Kutta –joukowsky theorem; Fundamentals of airfoil theory Numerical problems.

Laboratory Sessions/ Experimental learning: Determination of boundary layer thickness. Applications: Flow over a sloid body, separation point and Understanding of lift and drag. Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/103/101103004/

| **Module-5** | **L1, L2, L3** | 10Hrs |
|---|---|---|

**Compressible flow and Boundary Layers theory:**

Steady, one-dimensional gas dynamics, Propagation of pressure waves in a compressible medium, velocity of sound , Mach number, Mach cone, Stagnation properties , Bernoulli's eqn for isentropic flow, normal shock waves . Numerical Problem; Laminar and turbulent boundary layers.

Laboratory Sessions/ Experimental learning: Propagation of disturbance for different Mach number Applications: Compressible flows through nozzles, diffusers, turbines etc… Video link / Additional online information (related to module if any):

https://nptel.ac.in/courses/101/103/101103004/

| **Course outcomes:** | |
|---|---|
| CO205.1 | Evaluate the effects of fluid properties |
| CO205.2 | Estimate velocity, acceleration and stream function for an incompressible and invisid flow along with governing equations of fluid flow. |
| CO205.3 | Perform dimensional analysis and apply Bernoulli's and Eulers equation for various flow situations involving venturimeter, orificemeter and pitot-tube |
| CO205.4 | Calculate boundary layer thickness and drag co-efficient for laminar and turbulent flows. |
| CO205.5 | Illustrate the basic concepts of compressible flows. |

| Reference Books: | |
|---|---|
| 1. | Bansal, R.K, Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi 2015,ISBN-13: 978-8131808153 |
| 2. | Yunus A. Cengel & John M Cimbala, Fluid Mechanics and Applications, McGraw Hill Education; 3rd edition, 2013, ISBN-13: 978-0073380322. |
| 3. | Rathakrishnan. E, Fluid Mechanics, Prentice-Hall of India Pvt.Ltd, 2010, ISBN 13: 9788120331839. |

| | |
|---|---|
| 4. | Ramamritham. S, Hydraulic Fluid Mechanics and Fluid Machines, Dhanpat Rai& Sons, Delhi, 1988, ISBN 13: 9788187433804. |

| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |
| CO5 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | | 1 |

High-3, Medium-2, Low-1

| Course Title | **AEROSPCE MATERIALS** | Semester | III |
|---|---|---|---|
| Course Code | **MVJ19AE36/AS 36** | **CIE** | 50 |
| Total No. of Contact Hours | 60 L : T : P :: 40 : 0 : 20 | **SEE** | 50 |
| No. of Contact Hours/week | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs |

**Course objective is to:**

1. To impart knowledge on the basics of phase diagrams and their applications.
2. To make the students to understand the use of non-ferrous materials in aircraft construction:
3. To introduce various ferrous materials for aircraft construction
4. To learn about the various applications of Composite materials in an aircraft
5. To impart knowledge about Wood, fabric and other non- metals in Aircraft construction.

| **Module-1** | **L1, L2** | 10Hrs. |
|---|---|---|

**Phase diagrams and Microstructures:**

Basic concepts - Gibbs phase rule – Unary phase diagram (iron) - Binary phase diagrams: isomorphous systems (Cu-Ni).

The Fe-Fe3C phase diagram: phases, invariant reactions, development of microstructure in eutectoid, hypoeutectoid and hypereutectoid alloys – influence of other alloying elements in the Fe-C system. Microstructures: pearlite, bainite, spheroidite and martensite.

https://www.youtube.com/watch?v=woNUlqu8ReE

https://www.youtube.com/watch?v=S7GH0FH0wtI

| **Module-2** | **L1, L2** | 10Hrs. |
|---|---|---|

**Non-ferrous materials in aircraft construction:**

Aluminium and its alloys: Types and identification. Properties - Castings - Heat treatment processes - Surface treatments.

Magnesium and its alloys: Cast and Wrought alloys - Aircraft application, features specification, fabrication problems, Special treatments.

Titanium and its alloys: Applications, machining, forming, welding and heat treatment.

https://nptel.ac.in/courses/113/105/113105021/

https://www.intechopen.com/books/aluminium-alloys-recent-trends-in-processing-characterization-mechanical-behavior-and-applications

https://www.intechopen.com/books/titanium-alloys-novel-aspects-of-their-manufacturing-and-processing

| **Module-3** | **L1,L2** | 10Hrs. |
|---|---|---|

**Ferrous materials in aircraft construction**:

Steels : low, medium and high carbon steels , alloy steels, corrosion resistant steels, structural applications.

Maraging Steels: Properties and Applications.

Super Alloys: Use - Nickel base - Cobalt base - Iron base - Forging and Casting of Super alloys - Welding, Heat treatment.

https://nptel.ac.in/courses/113/105/113105057/

https://nptel.ac.in/courses/113/104/113104059/

https://www.coursera.org/lecture/ferrous-technology-2/introduction-and-classification-mknez

| **Module-4** | **L1, L2** | 10Hrs. |
|---|---|---|

**Composites:**

Definition and comparison of composites with conventional monolithic materials, classification, role of matrix and reinforcement -Reinforcing fibers and Matrix materials. Fabrication processes involved in polymer composites, metal matrix composites, applications in aerospace.

Introduction to modern ceramic materials, cermets, glass ceramics, Carbon/Carbon composites – properties and applications. Introduction to nano composites.

https://nptel.ac.in/courses/101/104/101104010/

https://nptel.ac.in/courses/113/107/113107078/

https://nptel.ac.in/courses/113/107/113107078/

| **Module-5** | **L1, L2** | 10 Hrs. |
|---|---|---|

**Non Metals in Aircraft construction:**

Wood: Types, properties, and applications. Fabric in aircraft construction and specifications. Glues. Glass: Types, properties, and applications.

Plastics &rubber in aircraft: Types, characteristics, and applications.

https://www.youtube.com/watch?v=074RceRJphs

| **Course outcomes:** | |
|---|---|
| CO1 | Apply the knowledge about the phase diagrams and microstructure of alloys. |
| CO2 | Explain the applications of Non-ferrous alloys in Aircraft and Aerospace industry. |

| | |
|---|---|
| CO3 | Gain knowledge about the application of Ferrous alloys in Aircraft construction |
| CO4 | Explain the applications of Polymer, Metal matrix composites. |
| CO5 | Get adequate understanding about the application of Non-metals in Aircraft construction |

| Reference Books: | |
|---|---|
| 1. | Titterton G F, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition, 1998, ISBN-13: 978-8175980136 |
| 2. | Introduction to Physical Metallurgy by Sydney Avner, Tata McGraw-Hill Edition 1997. |
| 3. | Hill E T, The Materials of Aircraft Construction, Pitman London. |
| 4. | C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore, 1993 |

| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 2 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 |
| CO2 | 3 | 1 | 1 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 |
| CO3 | 3 | 2 | 1 | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 1 |
| CO4 | 3 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| CO5 | 3 | 1 | 1 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 |

High-3, Medium-2, Low-1

| Course Title | **MEASUREMENT AND METROLOGY LAB** | Semester | III |
|---|---|---|---|
| Course Code | **MVJ19AEL37A** | **CIE** | 50 |
| Total No. of Contact Hours | 42 L : T : P :: 0 : 0 : 42 | **SEE** | 50 |
| No. of Contact Hours/week | 3 | **Total** | 100 |
| **Credits** | 2 | **Exam. Duration** | 3 Hrs |

Course objectives: This course will enable students to

1. Learn the concepts of mechanical measurements and metrology
2. Use the concept of accuracy, error and calibration
3. Acquire the knowledge of basic metrological instruments

| |
|---|
| 1. Calibration of Pressure Gauge |
| 2. Calibration of Thermocouple |

| |
|---|
| 3. Calibration of LVDT |
| 4. Calibration of Load cell |
| 5. Determination of modulus of elasticity of a mild steel specimen using strain gauges. |
| 6. Comparison and measurements using vernier caliper and micrometer |
| 7. Measurement of vibration parameters using vibration setup. |
| 8. Measurements using Optical Projector / Toolmaker Microscope. |
| 9. Measurement of angle using Sine Center / Sine bar / bevel protractor |
| 10. Measurement of alignment using Autocollimator / Roller set |
| 11. Measurement of Screw threads Parameters using Two-wire or Three-wire method. |
| 12. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator |
| 13. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer |
| 14. Calibration of Micrometer using slip gauges |

Course outcomes:

After studying this course, students will be able to:

1. Use different measuring tools related to experiments.
2. Identify, define, and explain accuracy, precision, and some additional terminology.
3. Conduct, Analyze, interpret, and present measurement data from measurements experiments.

| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CO2 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CO3 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| Course Title | **MATERIAL TESTING LAB** | Semester | III |
| Course Code | **MVJ19AEL37B** | **CIE** | 50 |
| Total No. of Contact Hours | 42 L : T : P :: 0 : 0 : 42 | **SEE** | 50 |
| No. of Contact Hours/week | 3 | **Total** | 100 |
| **Credits** | 2 | **Exam. Duration** | 3 Hrs |

**Course objective is to:**

1. Understand the relations among materials and their properties.
2. Comprehend the formation, properties and significance of the alloys through different experiments.
3. Acquire the practical knowledge of metallographic testing of engineering materials.
4. Understand the various heat treatment process of metals.
5. Know the types, advantages and applications of various NDT methods.

| **Module-1** | **RBT Level** | Hrs. |
|---|---|---|
| 1. Hardness Testing – Vicker's, Brinell, Rockwel | L1, L2, L3 | 3 |
| **2.** Tensile Test | L1, L2, L3 | 3 |
| 3. Flexural Test | L1, L2, L3 | 3 |
| **4.** Torsional Test | L1, L2, L3 | 3 |
| 5. Impact Test | L1, L2, L3 | 3 |
| **6.** Shear Test | L1, L2, L3 | 3 |
| 7. Fatigue Test | L1, L2, L3 | 3 |
| 8. Preparation of specimen for metallograpic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & metal matrix composites | L1, L2, L3 | 3 |
| 9. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples. | L1, L2, L3 | 3 |
| 10. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters. | L1, L2, L3 | 3 |
| 11. Visual Testing Technique, Dye penetration testing. To study the defects of Cast and Welded specimens. | L1, L2, L3 | 3 |

| | | |
|---|---|---|
| 12. Magnetic Particle Inspection. | L1, L2, L3 | 3 |
| 13. Ultrasonic Inspection. | L1, L2, L3 | 3 |

**Course outcomes:**

| | |
|---|---|
| CO1 | Examine the relations among materials properties. |
| CO2 | Differentiate the formation, properties and significance of the alloys through different experiments. |
| CO3 | Apply the knowledge of metallographic testing in aircraft materials. |
| CO4 | Examine the heat treatment process to improve the properties of aircraft materials. |
| CO5 | Analyze the types, advantages and applications of various NDT methods. |

Reference Books:


| | |
|---|---|
| 1 | Jindal U. C., Strength of Materials, 2012. |
| 2 | Mikell. P. Groover, Fundamentals of modern manufacturing materials, processes and systems, Second Edition, 2015. |
| 3 | Beer and Johnston E.R., Mechanics of Material, 3rd Edition, Tata McGraw Hill,NewDelhi,2007. |
| 4 | Joseph R. Davis, Tensile Testing, 2nd Edition, 2004. |
| 5 | Titterton G F, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition, 1998. |
| 6 | Hearn E,J., Mechanics of Material, Pergaman Press, England,1972. |
| 7 | G.E. Dieter, Mechanical Metallurgy, SI Metric Edition, McGraw – Hill. |


CO-PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CO2 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| CO3 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| CO4 | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| CO5 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| Course Title | **MACHINE SHOP** | Semester | III |
| Course Code | **MVJ19AEL38/ASL38** | **CIE** | 50 |
| Total No. of Contact Hours | 50 L : T : P :: 0 : 0 : 50 | **SEE** | 50 |
| No. of Contact Hours/week | 3 | **Total** | 100 |
| **Credits** | 2 | **Exam. Duration** | 3 Hrs |

**Course objectives:** This course will enable students to

1. Practice general-purpose machine tools and manufacturing process.
2. Operate the special purpose machine tools
3. Prepare physical models using different manufacturing processes.

| **PART A** | **RBT Level** | Hrs. |
|---|---|---|
| **1.** Introduction to Machining operations & tools (i.e. Lath machine & shaper machine etc.)<br>**2.** Machining and machining time estimation for plain turning, taper turning & step turning<br>**3.** Machining and machining time estimation for thread cutting<br>**4.** Machining and machining time estimation for knurling<br>**5.** Machining and machining time estimation for knurling operation<br>**6.** Machining and machining time estimation for drilling operation<br>**7.** Machining and machining time estimation for boring operation | **L1 L2 L3** | 25 |
| **PART B** | **RBT Level** | Hrs. |
| **1.** Machining and machining time estimation for internal thread cutting<br>**2.** Machining and machining time estimation for external thread cutting<br>**3.** Machining and machining time estimation for eccentric turning<br>**4.** Machining of hexagon in shaping machine<br>**5.** Machining of square in shaping machine<br>**6.** Cutting of gear teeth using milling machine **7.** Grinding operations using grinding machine. | **L1 L2 L3** | 25 |
| | | |
| **Laboratory Sessions** | | |

| Machine work Shop | |
|---|---|
| **Course outcomes:** | |
| 1 | Demonstrate the operation of general purpose machine tools and manufacturing process. |
| 2 | Identify the special purpose machine tools for specific requirements |
| 3 | Develop physical models using different mechanical processes. |

| Reference Books: | |
|---|---|
| 1. | Workshop Technology by Hazara Choudry |

| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO2 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CO3 | 3 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

High-3, Medium-2, Low-1