| | | | |
|---|---|---|---|
| **Course Title** | **TRASNFORMS & STATISTICAL METHODS** | **Semester** | III |
| **Course Code** | **MVJ20MAE31 /MAS31/MME31** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L: T : P :: 3: 1 : 0 | **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.
- Realize and use of Z-Transforms.
- Use of statistical methods in curve fitting applications.

| **Module-1** | L1,L2 & L3 | **8 Hours** |
|---|---|---|

**Laplace Transform:**
Definition and Laplace transforms of elementary functions. Laplace transforms of Periodic functions and unit-step function and problems.
**Inverse Laplace Transform:**
Definition and problems, Convolution theorem to find the inverse Laplace transforms and problems.
**Applications**: Solution of linear differential equations using Laplace transforms.
**Web Link and Video Lectures:**
https://www.youtube.com/watch?v=8oE1shAX96U
https://www.intmath.com/laplace-transformation/7-inverse-laplace-transform.php

| **Module-2** | L1,L2 & L3 | **8 Hours** |
|---|---|---|

**Fourier series:**
Recapitulation of Series, Continuous and Discontinuous functions, Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period $2\pi$ and arbitrary period $2l$, Half-range Fourier sine and cosine series, Practical Harmonic Analysis and Problems.
**Web Link and Video Lectures:**
https://www.youtube.com/watch?v=Sq2FhCxcyI8
https://www.youtube.com/watch?v=4N-IwHUCFa0

| **Module-3** | L1,L2 & L3 | **8 Hours** |
|---|---|---|

**Fourier transforms:**
Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse Fourier sine and cosine transforms, Convolution theorem.
**Web Link and Video Lectures:**
https://www.youtube.com/watch?v=spUNpyF58BY
https://www.youtube.com/watch?v=6spPyJH6dkQ

| **Module-4** | L1,L2 & L3 | **8 Hours** |
|---|---|---|

**Z-Transforms:**
Z-transform: Difference equations, basic definition, z-transform -definition, Standard z-transforms, Damping rule, Shifting rule, Initial value and final value theorems (without proof) and problems, Inverse Z-transform.

**Applications**: Application of Z- transforms to solve difference equations.
**Web Link and Video Lectures:**
http://www.eas.uccs.edu/~mwickert/ece2610/lecture_notes/ece2610_chap7.pdf
https://electricalbaba.com/final-value-theorem-and-its-application/

| **Module-5** | L1,L2& L3 | **8 Hours** |
|---|---|---|

**Curve Fitting:**

Curve fitting by the method of least squares. Fitting of the curves of the form $y = ax + b$, $y = ax^2 + bx + c$, $y = ae^{bx}$.

**Statistical Methods:**
Introduction, Correlation and coefficient of correlation, Regression, lines of regression and problems.
**Web Link and Video Lectures:**
https://mathbits.com/MathBits/TISection/Statistics2/correlation.htm
https://www.youtube.com/watch?v=xTpHD5WLuoA

**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. |

**Text Books:**

| | |
|---|---|
| 1 | Prof G.B.Gururajachar "Engineering Mathematics-III , Academic Excellent series Publications, 2016-17 |
| 2 | B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013 |

**Reference Books:**

| | |
|---|---|
| 1 | Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition,2014. |
| 2 | Ramana B. V., "Higher Engineering Mathematics", Tata McGraw-Hill, 2006. |
| 3 | Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition. |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (10 marks)
- Assignment (10 marks)

**SEE Assessment:**

i. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

ii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

iii. One question must be set from each unit. The duration of examination is 3 hours.

| **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** | **MVJ20AE32/AS32** | **CIE** | 50 |

| | | | |
|---|---|---|---|
| **Total No. of Contact Hours** | 50 L : T : P :: 3 : 2 : 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 5 | **Total** | 100 |
| **Credits** | 4 | **Exam. Duration** | 3 Hours |

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

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

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

**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** | **10Hours** |
|---|---|---|

**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=suuTC9uGLrIhttps://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** | **10Hours** |
|---|---|---|

**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-ZHrbD8https://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** | **10Hours** |
|---|---|---|

**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** | **10Hours** |
|---|---|---|

**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 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

iv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

v. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

vi. One question must be set from each unit. The duration of examination is 3 hours.

**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** | **MVJ20AE33** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 3 : 1 : 0 | **SEE** | 50 |

| | | | |
|---|---|---|---|
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | 03 | **Exam. Duration** | 3 Hours |

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

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

| **Module-1** | **L1, L2** | **8Hours** |
|---|---|---|

**Introduction to Aircrafts**

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.

**Aircraft Structures and Materials:**

Introduction; general types of construction; monocoque, semi-monocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application.

Laboratory Sessions/ Experimental learning: Visualization of structural members of a wing in Structural Lab

Applications: Identify and describe various components of an aircraft.

Video link

1. https://nptel.ac.in/courses/101/101/101101079/

| **Module-2** | **L1, L2** | **8Hours** |
|---|---|---|

**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, 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.

Laboratory Sessions/ Experimental learning: Visualization of airfoil cross-section in Aerodynamics Lab

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/ https://nptel.ac.in/courses/101/101/101101079/

| **Module-3** | **L1, L2** | **8Hours** |
|---|---|---|

**Aircraft Propulsion:**

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.

Laboratory Sessions/ Experimental learning: Visualization of engines in Propulsion Lab

Applications: Understand various configurations layouts, power-plant options available.

Video link:

https://nptel.ac.in/courses/101/101/101101079/ https://nptel.ac.in/courses/101/101/101101079/

| **Module-4** | **L1, L2** | **8Hours** |
|---|---|---|

**Aircraft Stability :**

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,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 manoeuvre, manoeuvrability. Simple problems.

Laboratory Sessions/ Experimental learning: Creating paper planes to have hands on experience of understanding the concepts

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** | **L1, L2** | **8Hours** |
|---|---|---|

**Aircraft Systems:**

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.

**Aircraft systems (Mechanical)** – hydraulic and pneumatic systems and their applications; environment control system; fuel system, oxygen system.

**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.

Applications:Identify the main components, subsystems of aircraft and their functionality and various flight control systems, fuel and hydraulic control systems

Video link:

| |
|---|
| https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraftsystems-engineering-fall-2005/video-lectures/lecture-7/ |

| **Course outcomes:** | |
|---|---|
| CO303.1 | Appreciate and apply the basic principle of aviation. |
| CO303.2 | Apply the concepts of fundamentals of flight, basics of aircraft structures. |
| CO303.3 | Aircraft propulsion and aircraft materials during the development of an aircraft. |
| CO303.4 | Understand the basic concepts of aircraft stability and control |
| CO303.5 | 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 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

vii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

viii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

ix. One question must be set from each unit. The duration of examination is 3 hours.

| 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** | **MVJ20AS34/AE34** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 3 : 1 : 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

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

| Module-1 | L1, L2, L3 | 8Hours |
|---|---|---|
| **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), Stressstrain curves for brittle and ductile materials, Allowable stress, Material selection for structural performance.<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. Lecture – 12 for Ductile and Brittle Materials | | |
| **Module-2** | **L1, L2, L3** | **8Hours** |
| **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>**Euler-Bernoulli beam theory:** The Euler-Bernoulli assumptions, 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<br>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** | **L1, L2, L3** | **8Hours** |
| **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. | | |

**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.

Laboratory Sessions/ Experimental learning: Beam Expt in Structures lab and Torsion Test apparatus available in MT Lab.

Applications: Civil Construction and Automobile Transmission.

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

Prof. S. K. Bhattacharyya Indian Institute of Technology, Kharagpur Lecture - 33 Deflection of Beams – IV

Prof. S. K. Bhattacharya Dept. of Civil Engineering I.I.T Kharagpur Lecturer#20 Torsion-III

| **Module-4** | **L1, L2, L3** | **8Hours** |
|---|---|---|

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.

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, Reciprocity theorems, Saint-Venant's principle

Laboratory Sessions/ Experimental learning: Few of the Energy Method Theorems can be explained from Structures Lab.

Applications: Virtual work arises in the application of the principle of least action to the study of forces and movement of a mechanical system.

Video link / Additional online information (related to module if any): Energy Methods in Structural Analysis Version 2 CE IIT, Kharagpur

| **Module-5** | **L1, L2, L3** | **8Hours** |
|---|---|---|

**Mechanical Properties of materials**:

**Fracture**: Type I, Type II and Type III.

**Creep**: Description of the phenomenon with examples. Three stages of creep, creep properties, stress relaxation.

**Fatigue**: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram.

Laboratory Sessions/ Experimental learning: Impact Tests in MT lab for Fracture.

Applications: Boilers, Rotating Machine Elements

| Video link / Additional online information (related to module if any):<br>Creep Deformation of Materials Dr.SrikantGollapudi Indian Institute of Technology, Bhubaneswar<br>Prof.K.Gopinath&Prof.M.M.Mayuram, Machine Design II, Indian Institute of Technology Madras | |
|---|---|
| **Course outcomes:** | |
| CO304.1 | Apply the basic concepts of strength of materials. |
| CO304.2 | Compute stress, strain under different loadings. |
| CO304.3 | Acquire the knowledge of deflection of beams |
| CO304.4 | Acquire the knowledge of virtual work principle and energy methods |
| CO304.5 | 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 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

x. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xi. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xii. One question must be set from each unit. The duration of examination is 3 hours.

| **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** | **MVJ20AE35/AS35** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 3 : 1 : 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Understand the basic fluid properties.
- To estimate velocity, acceleration and stream function for an incompressible and inviscid flow along with governing equations of fluid flow.
- Understand the dimensional analysis and apply Bernoulli's and Euler's equation for flow measuring

devices

- To calculate boundary layer thickness and drag co-efficient for laminar and turbulent flows
- Acquire the knowledge of compressible flows and boundary Layers

| **Module-1** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**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** | **8Hours** |
|---|---|---|

**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** | **8Hours** |
|---|---|---|

**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** | **8Hours** |
|---|---|---|

**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** | **8Hours** |
|---|---|---|

**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 isentropicflow, 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 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

xiii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xiv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xv. One question must be set from each unit. The duration of examination is 3 hours.

**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** | **MVJ20AE36/AS36** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hours** |

**Course objective is to:**

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

| Module-1 | L1,L2 | 8Hours |
|---|---|---|
| **Phase diagrams and Microstructures:**<br>Basic concepts - Gibbs phase rule – Unary phase diagram (iron) - Binary phase diagrams: isomorphous systems (Cu-Ni).<br>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.<br>Microstructures: pearlite, bainite, spheroidite and martensite.<br>Video link / Additional online information (related to module if any):<br>https://nptel.ac.in/courses/101/103/101103004/<br>https://www.youtube.com/watch?v=woNUlqu8ReE | | |
| **Module-2** | **L1,L2** | **8Hours** |
| **Non-ferrous materials in aircraft construction:**<br>Aluminium and its alloys: Types and identification. Properties - Castings - Heat treatment processes - Surface treatments.<br>Magnesium and its alloys: Cast and Wrought alloys - Aircraft application, features specification, fabrication problems, Special treatments.<br>Titanium and its alloys: Applications, machining, forming, welding and heat treatment.<br>Video link / Additional online information (related to module if any):<br>https://nptel.ac.in/courses/113/105/113105021/<br>https://www.intechopen.com/books/aluminium-alloys-recent-trends-in-processing-characterization-mechanical-behavior-and-applications | | |
| **Module-3** | **L1,L2** | **8Hours** |
| **Ferrous materials in aircraft construction**:<br>Steels : low, medium and high carbon steels , alloy steels, corrosion resistant steels, structural applications.<br>Maraging Steels: Properties and Applications.<br>Super Alloys: Use - Nickel base - Cobalt base - Iron base - Forging and Casting of Super alloys - Welding, Heat treatment.<br>Video link / Additional online information (related to module if any):<br>https://nptel.ac.in/courses/113/105/113105057/<br>https://nptel.ac.in/courses/113/104/113104059/ | | |
| **Module-4** | **L1,L2** | **8Hours** |
| **Composites:**<br>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.

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

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

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

| **Module-5** | **L1,L2** | **8Hours** |
|---|---|---|

**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.

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

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

**Course outcomes:**

| | |
|---|---|
| CO306.1 | Apply the knowledge about the phase diagrams and microstructure of alloys. |
| CO306.2 | Explain the applications of Non-ferrous alloys in Aircraft and Aerospace industry. |
| CO306.3 | Gain knowledge about the application of Ferrous alloys in Aircraft construction |
| CO306.4 | Explain the applications of Polymer, Metal matrix composites. |
| CO306.5 | 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. |
| | C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore, 1993 |


**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

| **SEE Assessment:** |
|---|
| xvi. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. |
| xvii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. |
| xviii. One question must be set from each unit. The duration of examination is 3 hours. |

| **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** | **MVJ20AEL37A** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Learn the concepts of mechanical measurements and metrology
- Use the concept of accuracy, error and calibration
- Acquire the knowledge of basic metrological instruments

| **Sl No** | **Experiment Name** | **RBT Level** | **Hours** |
|---|---|---|---|
| **1** | Calibration of Pressure Gauge | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **2** | Calibration of Thermocouple | L1,L2,L3 | 03 |
| **3** | Calibration of LVDT | L1,L2,L3 | 03 |
| **4** | Calibration of Load cell | L1,L2,L3 | 03 |
| **5** | Determination of modulus of elasticity of a mild steel specimen using strain gauges. | L1,L2,L3 | 03 |
| **6** | Comparison and measurements using verniercaliper and micrometer | L1,L2,L3 | 03 |
| **7** | Measurement of vibration parameters using vibration setup. | L1,L2,L3 | 03 |
| **8** | Measurements using Optical Projector / Toolmaker Microscope. | L1,L2,L3 | 03 |
| **9** | Measurement of angle using Sine Center / Sine bar / bevel protractor | L1,L2,L3 | 03 |
| **10** | Measurement of alignment using Autocollimator / Roller set | L1,L2,L3 | 03 |
| **11** | Measurement of Screw threads Parameters using Two-wire or Three-wire method. | L1,L2,L3 | 03 |
| **12** | Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator | L1,L2,L3 | 03 |
| **13** | Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer | L1,L2,L3 | 03 |
| **14** | Calibration of Micrometer using slip gauges | L1,L2,L3 | 03 |

| **Course outcomes:** | |
|---|---|
| CO1 | Use different measuring tools related to experiments |
| CO2 | Identify, define, and explain accuracy, precision, and some additional terminology. |
| CO3 | Conduct, Analyse, interpret, and present measurement data from measurements Identify, define, and explain accuracy, precision, and some additional terminology |

| **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** | **MVJ20AEL37B** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

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

| **Sl No** | **Experiment Name** | **RBT Level** | **Hours** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **1** | Hardness Testing – Vicker's, Brinell, Rockwel | L1,L2,L3 | 03 |
| **2** | Tensile Test | L1,L2,L3 | 03 |
| **3** | Flexural Test | L1,L2,L3 | 03 |
| **4** | Torsional Test | L1,L2,L3 | 03 |
| **5** | Impact Test | L1,L2,L3 | 03 |
| **6** | Shear Test | L1,L2,L3 | 03 |
| **7** | Fatigue Test | L1,L2,L3 | 03 |
| **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 | 03 |
| **9** | Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples. | L1,L2,L3 | 03 |
| **10** | To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters. | L1,L2,L3 | 03 |
| **11** | Visual Testing Technique, Dye penetration testing. To study the defects of Cast and Welded specimens. | L1,L2,L3 | 03 |
| **12** | Magnetic Particle Inspection. | L1,L2,L3 | 03 |
| **13** | Ultrasonic Inspection. | L1,L2,L3 | 03 |

| **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. |

| 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** | **MVJ20AEL38/ASL38** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

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

| **Sl No** | **Experiment Name** | **RBT Level** | **Hours** |
|---|---|---|---|
| | PART A | | |
| **1** | Introduction to Machining operations & tools (i.e. Lath machine & shaper machine etc.) | L1,L2,L3 | 03 |
| **2** | Machining and machining time estimation for plain turning, taper turning & step turning | L1,L2,L3 | 03 |
| **3** | Machining and machining time estimation for thread cutting | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **4** | Machining and machining time estimation for knurling | L1,L2,L3 | 03 |
| **5** | Machining and machining time estimation for knurling operation | L1,L2,L3 | 03 |
| **6** | Machining and machining time estimation for drilling operation | L1,L2,L3 | 03 |
| **7** | Machining and machining time estimation for boring operation | L1,L2,L3 | 03 |
| | **PART B** | | |
| **8** | Machining and machining time estimation for internal thread cutting | L1,L2,L3 | 03 |
| **9** | Machining and machining time estimation for external thread cutting | L1,L2,L3 | 03 |
| **10** | Machining and machining time estimation for eccentric turning | L1,L2,L3 | 03 |
| **11** | Machining of hexagon in shaping machine | L1,L2,L3 | 03 |
| **112** | Machining of square in shaping machine | L1,L2,L3 | 03 |
| **13** | Cutting of gear teeth using milling machine | L1,L2,L3 | 03 |
| **14** | Grinding operations using grinding machine | L1,L2,L3 | 03 |

| **Course outcomes:** | |
|---|---|
| CO1 | Demonstrate the operation of general purpose machine tools and manufacturing process. |
| CO2 | Identify the special purpose machine tools for specific requirements |
| CO3 | Develop physical models using different mechanical processes. |

| **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

| Course Title | Balike Kannada | Semester | III |
|---|---|---|---|
| **Course Code** | **MVJ20BK39** | **CIE** | 50 |
| **Total No. of Contact Hours** | 20 L: T: P 1:0:0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 1 | **Total** | 100 |
| **Credits** | 1 | **Exam. Duration** | 3Hrs |

**Course objective :**This course will enable students to understand Kannada and communicate in Kannada language

- Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada )
- Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation.
- Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).
- Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)
- Activities in Kannada

| |
|---|
| **CHAPTER-1** |
| Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada ) |
| **CHAPTER-2** |
| Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation |
| **CHAPTER-3** |
| Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication) |
| **CHAPTER-4** |
| Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana) |
| **CHAPTER-5** |
| Activities in Kannada |

**Scheme of Evaluation:**

| **Details** | | **Marks** |
|---|---|---|
| Average of three Internal Assessment (IA) Tests of 30 Marks each i.e.<br><br>$\Sigma$ (Marks Obtained in each test) / 3 | **CIE(50)** | **30** |
| ASSIGNMENT | | **20** |
| Semester End Examination | **SEE (50)** | **50** |
| | **Total** | **100** |

| Course Title | **SAMSKRUTHIKA KANNADA** | Semester | III |
|---|---|---|---|
| Course Code | **MVJ20SK39** | **CIE** | 50 |
| Total No. of Contact Hours | 20 L: T: P 1:0:0 | **SEE** | 50 |
| No. of Contact Hours/week | 1 | **Total** | 100 |
| **Credits** | 1 | **Exam. Duration** | 3Hrs |

**Course objective :**This course will enable students to understand Kannada and communicate in Kannada language

- Samskruthika Kannada –Parichaya (Introduction to Adalitha kannada )
- Kannada Kavyagala parichaya (Kannada D Ra Bendre, Siddalingaiha)
- Adalithdalli Kannada Padagalu (Kannada Kagunitha Balake, Patra Lekhana, Prabhandha)
- Kannada Computer Gnyana (Kannada Shabdha Sangraha, Computer Paribashika padagalu)
- Activities in Kannada.

| CzsÁåAiÀÄ -1 |
|---|
| PÀ£ÀßqÀ ¨sÁµÉ-¸ÀAQë¥ÀÛ «ªÀgÀuÉ. |
| CzsÁåAiÀÄ -2 |
| ¨sÁµÁ ¥ÀæAiÉÆÃUÀ¯ÁèUÀÄªÀ ¯ÉÆÃ¥ÀzÉÆÃµÀUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À ¤ªÁgÀuÉ. |
| CzsÁåAiÀÄ -3 |
| ¯ÉÃR£À aºÉßUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À G¥ÀAiÉÆÃU.À |
| CzsÁåAiÀÄ -4 |
| ¥ÀvÀæ ªÀåªÀºÁgÀ. |
| CzsÁåAiÀÄ -5 |
| DqÀ½vÀ ¥ÀvÀæUÀ¼ÀÄ. |

| |
|---|
| CzsÁåAiÀÄ -6 |
| ¸ÀPÁðgÀzÀ DzÉÃ±À ¥ÀvÀæUÀ¼ÀÄ |
| CzsÁåAiÀÄ -7 |
| ¸ÀAQÃ¥ÀÛ ¥Àæ§AzsÀ gÀZÀ£É, ¥Àæ§AzsÀ ªÀÄvÀÄÛ ¨sÁµÁAvÀgÀ |
| CzsÁåAiÀÄ -8 |
| PÀ£ÀßqÀ ±À§Ý¸ÀAUÀæºÀ |
| CzsÁåAiÀÄ -9 |
| PÀA¥ÀÆålgï ºÁUÀÆ ªÀiÁ»w vÀAvÀæeÁÕ£À |
| CzsÁåAiÀÄ -10 |
| ¥Áj¨sÁ¶PÀ DqÀ½vÀ PÀ£ÀßqÀ ¥ÀzÀUÀ¼ÀÄ ªÀÄvÀÄÛ vÁAwæPÀ/PÀA¥ÀÆålgï ¥Áj¨sÁ¶PÀ ¥ÀzÀUÀ¼ÀÄ. |

| **Scheme of Evaluation:** | | |
|---|---|---|
| **Details** | | **Marks** |
| Average of three Internal Assessment (IA) Tests of 30 Marks each i.e.<br><br>Σ (Marks Obtained in each test) / 3 | **CIE(50)** | **30** |
| ASSIGNMENT | | **20** |
| Semester End Examination | **SEE (50)** | **50** |
| | **Total** | **100** |
| | | |

| | | | |
|---|---|---|---|
| Course Title | **CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW** | Semester | **III/IV** |
| Course Code | **MVJ20CPH39/49** | CIE | **50** |
| Total No. of Contact Hours | **20 L : T : P :: 1 :0 : 0** | SEE | **50** |
| No. of Contact Hours/Week | **01** | Total | **100** |
| Credits | **01** | Exam. Duration | **2 hrs** |

**Course objective is to:**

- To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.
- To provide overall legal literacy to the young technograts to manage complex societal issues in the present scenario.
- To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.

| **Module-1** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Introduction to Indian Constitution**

The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.

| **Module – II** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Union Executive and State Executive**

Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.

| **Module – III** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Elections, Amendments and Emergency Provisions**

Elections, Electoral Process, and Election Commission of India, Election Laws.

Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements).

Emergency Provisions, types of Emergencies and it's consequences.

**Constitutional Special Provisions:**

Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.

| **Module – IV** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Professional / Engineering Ethics**

Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India) : Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. **Responsibilities in Engineering** - Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility.Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.

| **Module – V** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Internet Laws, Cyber Crimes and Cyber Laws:**

Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.

| **Course Outcomes:** On completion of this course, students will be able to | |
|---|---|
| CO1 | Have constitutional knowledge and legal literacy |
| CO2 | Understand Engineering and Professional ethics and responsibilities of Engineers. |
| CO3 | Understand the cyber crimes and cyber laws for cyber safety measure. |

| Text Books: | |
|---|---|
| 1. | Constitution of India and Professional Ethics, T.S. Anupama, Sunstar Publisher |
| | |
| **Reference Books:** | |
| 1. | Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th/20th Edn., (Latest Edition) or 2008. |
| 2. | Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018. |
| 3 | M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice –Hall of India Pvt. Ltd. New Delhi, 2004. |
| 4. | M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002. |
| 5. | Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi. |

| **CIE Assessment:** |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (40 marks each), the final IA marks to be awarded will be the average of three tests<br>- Assignment (10 marks) |
| **SEE Assessment:** |
| xix. Question paper for the SEE consists one part. It is compulsory and consists of objective type 1 mark each for total of 50 marks covering the whole syllabus.<br>xx. Ten questions must be set from each unit. The duration of examination is 3 hours. |

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

| **Course Title** | **Additional Mathematics-I** | **Semester** | III |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Course Code** | **MVJ20MATDIP31** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | - | **Exam. Duration** | 3hrs |

**Course objective is to:** This course viz., aims to prepare the students:

To familiarize the important and basic concepts of Differential calculus and Differential Equation, ordinary/partial differential equations and Vector calculus and analyse the engineering problems.

| **Module-1** | **L1,L2** | 8Hrs. |
|---|---|---|

**Differential calculus:** Recapitulations of successive differentiations -$n^{th}$ derivative -Leibnitz theorem and Problems, Mean value theorem -Rolle's theorem, Lagrange's Mean value theorem , Cauchy's theorem and Taylor's theorem for function of one variables.

Video Link:

https://users.math.msu.edu/users/gnagy/teaching/ode.pdf

| **Module-2** | **L1,L2** | 8 Hrs. |
|---|---|---|

**Integral Calculus:**

Review of elementary Integral calculus, Reduction formula

$\int_0^{\frac{\pi}{2}} sin^m x\, dx$ , $\int_0^{\frac{\pi}{2}} cos^m x\, dx$ , $\int_0^{\frac{\pi}{2}} sin^m cos^n x\, dx$ and problems.

Evaluation of double and triple integrals and Simples Problems.

Video Link:

https://www.youtube.com/watch?v=rCWOdfQ3cwQ

https://nptel.ac.in/courses/111/105/111105122/

| **Module-3** | **L1,L2** | 8Hrs. |
|---|---|---|

**Vector Calculus:** Derivative of vector valued functions, Velocity, Acceleration and related problems, Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields. Vector identities - div ( φA), curl (φA), curl (grad φ), div (curl A).

Video Link:

| | | |
|---|---|---|
| https://www.whitman.edu/mathematics/calculus_online/chapter16.html<br><br>https://www.math.ust.hk/~machas/vector-calculus-for-engineers.pdf | | |
| **Module-4** | **L1,L2,L3** | 8 Hrs. |
| **Probability:**<br>Introduction-Conditional Probability, Multiplication theorem ,Independent events ,Baye's theorem and Problems.<br>Video Link:<br>https://www.khanacademy.org/math/statistics-probability/probability-library<br>https://nptel.ac.in/courses/111/105/111105041/ | | |
| **Module-5** | **L1,L2,L3** | 8 Hrs. |
| **Differential equation:** Homogenous differential equation, Linear differential equation, Bernoulli's differential equation and Exact differential equation.<br>Video Link:<br>https://www.mathsisfun.com/calculus/differential-equations.html | | |

| **Course outcomes:** | |
|---|---|
| CO1 | Apply the knowledge of Differential calculus in the modeling of various physical and engineering phenomena |
| CO2 | Apply the concept of change of order of integration and variables to evaluate multiple integrals and their usage in computing the area and volumes. |
| CO3 | Study on Vector calculus to understand the various solution to Application to Engineering problems. |
| CO4 | Understand the basic Concepts of Probability |
| CO5 | Solve first order linear differential equation analytically using standard methods. |

| Text Books: | |
|---|---|
| 1. | B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013. |

| | |
|---|---|
| 2. | Ramana B. V., “Higher Engineering Mathematics”, Tata Mc Graw-Hill, 2006. |

| Reference Books: | |
|---|---|
| 1. | Erwin Kreyszig, “Advanced Engineering Mathematics”, Wiley-India publishers, 10th edition,2014. |
| 2. | G. B. Gururajachar: Calculus and Linear Algebra, Academic Excellent Series Publication, 2018-19 |

| | | | |
|---|---|---|---|
| **Course Title** | **UNIVERSAL HUMAN VALUES** | **Semester** | III |
| **Course Code** | **MVJ20UHV310** | **CIE** | 50 |
| **Total No. of Contact Hours** | 20 L : T : P :: 1 : 0 :0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 1 | **Total** | 100 |
| **Credits** | 1 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Perceive the need for developing a holistic perspective of life
- Sensitise the scope of life – individual, family (inter-personal relationship), society and nature/existence, Strengthening self-reflection
- Develop more confidence and commitment to understand, learn and act accordingly

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

**Welcome and Introductions:** Getting to know each other (Self-exploration)

**Aspirations and Concerns:** Individual academic, career, Expectations of family, peers, society, nation, Fixing one's goals (Basic human aspirations Need for a holistic perspective Role of UHV)

**Self-Management:**Self-confidence, peer pressure, time management, anger, stress, Personality development, self-improvement (Harmony in the human Being)

**Health:** Health issues, healthy diet, healthy lifestyle, Hostel life (Harmony of the Self and Body Mental and physical health)

**Relationships:** Home sickness, gratitude, towards parents, teachers and, others Ragging and interaction, Competition and cooperation, Peer pressure (Harmony in relationship Feelings of trust, respect, gratitude, glory, love)

**Society:** Participation in society (Harmony in the society)

**Natural Environment:** Participation in nature (Harmony in nature/existence)

**Video link:**

1. https://youtube.com/playlist?list=PLYwzG2fd7hzc4HerTNkc3pS_IvcCfKznV
2. https://youtube.com/playlist?list=PLYwzG2fd7hzcZz1DkrAegkKF4TseekPFv

**Presentation:** https://fdp-si.aicte-india.org/AicteSipUHV_download.php

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

**Introduction to Value Education:** Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Self-exploration as the Process for Value Education, Happiness and Prosperity – Current Scenario.

**Video link:**

1. https://www.youtube.com/watch?v=85XCw8SU084
2. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3p Z3yA7g_OAQz

https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

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

**Introduction to Harmony in the Human Being:** Understanding Human being as the Co-existence of the Self and the Body, The Body as an Instrument of the Self, Harmony of the Self with the Body.

| | | |
|---|---|---|
| **Video link:**<br>1. https://www.youtube.com/watch?v=GpuZo495F24<br>https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw | | |
| **Module-4** | **L1, L2, L3** | **10Hours** |
| **Introduction to Harmony in the Family and Society:** Harmony in the Family – the Basic Unit of Human Interaction, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society.<br>**Video link:**<br>1. https://www.youtube.com/watch?v=F2KVW4WNnS8<br>https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw | | |
| **Module-5** | **L1, L2, L3** | **10Hours** |
| **Introduction to Implications of the Holistic Understanding:** Natural Acceptance of Human Values, Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Holistic Technologies, Production Systems and Management Models-Typical Case Studies.<br>**Video link:**<br>1. https://www.youtube.com/watch?v=BikdYub6RY0<br>https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw | | |

| **Course outcomes:** | |
|---|---|
| CO2 | Develop a holistic perspective about life |
| CO3 | Explore his/her role (value) in all aspects of living – as an individual, as a member of a family, as a part of the society as an unit in nature |
| CO4 | Become more responsible in life, and in handling problems with sustainable solutions |
| CO5 | Have better critical ability |
| | Become sensitive to their commitment |

| **Reference Books:** | |
|---|---|
| 1 | Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010 |
| 2 | Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999. |
| 3 | Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004. |

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | **COMPLEX VARIABLES & NUMERICAL METHODS** | **Semester** | IV |
| **Course Code** | **MVJ20MAE41 /MAS41/MME41** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1 : 0** | **SEE** | 50 |
| **No. of Contact Hours/week** | **4** | **Total** | 100 |
| **Credits** | **3** | **Exam. Duration** | 3 Hours |

**Course objective is to:** This course enables students to:

- . Understand the concepts of Complex variables and transformation for solving Engineering Problems.
- Understand the concepts of complex integration, Poles and Residuals in the stability analysis of engineering problems.
- Apply the concept to find external of functional.
- Solve initial value problems using appropriate numerical methods.
- Students learn to obtain solution s of ordinary and partial differential equations numerically.

| **Module-1** | **L2,L3,L4** | **8 Hours** |
|---|---|---|

**Complex variables - 1:**

Functions of complex variables, Analytic function, Cauchy-Riemann Equations in Cartesian and polar coordinates, Consequences of Cauchy-Riemann Equations, Construction of analytic functions (Using Milne-Thomson method).

**Transformations:**

Bilinear Transformation, Conformal transformation, Discussion of the transformations $w = z^2$, $w = e^z$ and $w = z + \frac{a}{z}, (z \neq 0)$.

**Video Link:**

https://www.youtube.com/watch?v=oiK4gTgncww

https://www.youtube.com/watch?v=WJOf4PfoHow

| **Module-2** | **L2,L3,L4** | **8 Hours** |
|---|---|---|

**Complex variables-2:**

Complex integration - Cauchy theorem, Cauchy's Integral Theorem-Problems, Taylor & Laurent series-Problems, Singularities, Types of Singularities, Poles, Residues-definitions, Cauchy residue theorem - Problems.

**Video Link:**

https://math.mit.edu/~jorloff/18.04/notes/topic4.pdf

https://math.mit.edu/~jorloff/18.04/notes/topic10.pdf

| **Module-3** | **L2,L3** | **8 Hours** |
|---|---|---|

**Numerical methods-1**:

Numerical solution of Ordinary Differential Equations of first order and first degree, Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order, Milne's and Adam-Bashforth Predictor and Corrector method.

**Video Link:**

https://youtu.be/b5VUnapu-qs

http://www.nptelvideos.in/

| **Module-4** | **L2,L3** | **8 Hours** |
|---|---|---|

**Numerical methods-2**:

Numerical solution of Ordinary Differential Equations of second order: Runge-Kutta method of fourth order, Milne's Predictor and Corrector method.

**Calculus of variations:**

Variation of function and Functional, variational problems, Euler's equation, Geodesics.

**Applications** : Hanging Chain problem.

**Video Link:**

https://www.khanacademy.org/
http://www.nptelvideos.in/

| **Module-5** | **RBT Level** | **8 Hours** |
|---|---|---|

**Numerical methods-3**:

Numerical solution of Partial Differential Equations: Introduction, Finite difference approximations to derivatives, Numerical Solution of Laplace Equation, Numerical solution of one-dimensional heat equation by Bender - Schmidt's method and by Crank-Nicholson Method, Numerical solution of one-dimensional wave equation.

Video Links: https://youtu.be/nNnnBMF03lI

**Course outcomes:**

| | |
|---|---|
| CO1 | State and prove Cauchy - Riemann equation with its consequences and demonstrate Con-formal Transformation. |
| CO2 | Illustrate Complex Integration using Cauchy's Integral theorem, Cauchy's Integral formula and Cauchy's Residue theorem. |
| CO3 | Identify appropriate numerical methods to solve ODE. |
| CO4 | Determine the extremals of functionals and solve the simple problems of the calculus of variations. |
| CO5 | Choose appropriate numerical methods to solve Partial Differential Equations. |

**Text Books:**

| | |
|---|---|
| 1 | Prof G.B.Gururajachar "Engineering Mathematics-III , Academic Excellent series Publications, 2016-17 |
| 2 | B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013. |

**Reference Books:**

| | |
|---|---|
| 1 | B.V.Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill, 2006 |
| 2 | N.P. Bali & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition. |
| 3 | H K Dass: **"Advanced Engineering Mathematics"**- S Chand & Company Ltd.12th edition. |

| **CIE Assessment:** |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (10 marks)<br>- Assignment (10 marks) |
| **SEE Assessment:** |
| xxi. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.<br>xxii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.<br>xxiii. One question must be set from each unit. The duration of examination is 3 hours. |

| **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** | **INCOMPRESSIBLE AERODYNAMICS** | **Semester** | IV |
|---|---|---|---|
| **Course Code** | **MVJ20AE42/AS42** | **CIE** | 50 |
| **Total No. of Contact Hours** | **50 L : T : P :: 3 : 2 : 0** | **SEE** | 50 |
| **No. of Contact Hours/week** | 5 | **Total** | 100 |
| **Credits** | 4 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Understand the basics of fluid mechanics as a prerequisite to Aerodynamics

- Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil
- Acquire knowledge of incompressible flows over airfoil
- Understand the fundamentals of incompressible flow over finite wings
- Assimilate the understanding of application of finite wing theory and high lift systems

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

Review of Basic Fluid Mechanics

Continuity, momentum and energy equation, Control volume approach to Continuity, momentum and energy equation, Types of flow, pathlines, streamlines, and streaklines, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes. Vorticity, Angular velocity, Stream function, velocity potential function, Circulation, Numericals, Mach cone and Mach angle, Speed of sound.

Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds

Applications: provides a proper understanding of the flow properties and their characteristics features which helps in the study of flow over airfoils

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

https://nptel.ac.in/courses/101105059/

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

**Airfoil Characteristics**

Fundamental aerodynamic variables, Airfoil nomenclature, airfoil characteristics. wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, aerodynamic center, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. Types of drag-Definitions.

Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds

Applications: understand the characteristics and the distribution of pressure over the airfoil Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101105059/

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

**Two Dimensional Flows & Incompressible Flow Over Airfoil**

Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D'Alembert's paradox, Numericals,Incompressible flow over airfoils: Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. KuttaJoukowski theorem. and generation of Lift, Numerical.

Laboratory Sessions/ Experimental learning: Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey.

Applications: study the lifting and non lifting flows over cylinders and arbitrary bodies and understanding the theory behind lift generation

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

https://nptel.ac.in/courses/101105059/

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

**IncompressibleFlowOverFiniteWings**

Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory:Downwash and induced drag. Elliptical and modified elliptical lift distribution.Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory-lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane

Laboratory Sessions/ Experimental learning: Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.

Applications: understanding the theory of lift generation over finite wings and their flow patterns Video link / Additional online information (related to module if any):

http://web.iaa.ncku.edu.tw/~aeromems/Aerodynamics/Ch5.pdf

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

**Applications of Finite Wing Theory & High Lift Systems**

Simplified horse-shoe vortex model, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, and typical aerodynamic characteristics. Introduction to high-lift systems, flaps, leading-edge slats and typical high – lift characteristics. Effects of thickness, camber and aspect ratio of wings, tip effects. Introduction to

Source panel & vortex lattice method

Laboratory Sessions/ Experimental learning: Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various angles of incidence, speed.

Applications: study the typical aerodynamics characteristics of swept wings and different types of high lift devices

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

https://nptel.ac.in/courses/101/106/101106035/

**Course outcomes:**

| | |
|---|---|
| CO211.1 | Describe the fundamental equations of continuity, momentum & energy of fluid flow. |
| CO211.2 | Evaluate typical airfoil characteristics and two-dimensional flows over airfoil |

| | |
|---|---|
| CO211.3 | Analyze the incompressible flow over airfoil |
| CO211.4 | Compute and analyze the incompressible flow over finite wings |
| CO211.5 | Apply finite wing theory and analyze high lift systems |

| **Reference Books:** | |
|---|---|
| 1 | Anderson J.D, Fundamental of Aerodynamics, 5th edition, McGraw-Hill International Edition, New York **(**2011), ISBN-13: 978-0073398105. |
| 2 | E. L. Houghton, P.W. Carpenter, Aerodynamics for Engineering Students, 5th edition, Elsevier, New York. (2010), ISBN-13: 978-0080966328 |
| 3 | Clancy L. J., Aerodynamics, Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804 |
| 4 | Louis M. Milne-Thomson, Theoretical Aerodynamics, Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804. |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

xxiv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xxv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxvi. One question must be set from each unit. The duration of examination is 3 hours.

**CO-PO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 2 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 11 |
| CO2 | 3 | 3 | 2 | 3 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 3 | 3 | 3 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| CO5 | 3 | 3 | 3 | 2 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |

High-3, Medium-2, Low-1

| **Course Title** | **FUNDAMENTALS OF AIRCRAFT STRUCTURES** | **Semester** | IV |
|---|---|---|---|
| **Course Code** | **MVJ20AE43** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1 : 0** | **SEE** | 50 |
| **No. of Contact Hours/week** | **4** | **Total** | 100 |
| **Credits** | **3** | **Exam. Duration** | 3 Hours |

**Course objective is to:**

1. Comprehend the basic concepts of stress strain and understand the different failure theories and to learn the concept of static strength
2. Illustrate the methods to design a structure against impact and fatigue loads.
3. Acquire the knowledge of types of loads on aerospace vehicles.

4. Understand the theory of elasticity.

5. Apply different Energy methods in calculations related to structural components and to understand the different methods to analyse columns

| **Module-1** | **L1,L2,L3** | **8Hours** |
|---|---|---|

Design for Static Strength: Introduction: Normal, shear, biaxial and tri-axial stresses, Stress tensor, Principal Stresses, Stress Analysis, Design considerations, Codes and Standards. Static Strength: Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, and Distortion energy theory, failure of brittle and ductile materials, Stress concentration, and Determination of Stress concentration factor.

Laboratory Sessions/ Experimental learning:

1. Determination of Stress concentration factor for static load.
2. Determine the strain in x-y-z directions using strain gauge for a given beam

Applications: Stress Analysis, Theory of failures

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

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

| **Module-2** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**Design for Impact and Fatigue Strength:** Impact Strength: Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Fatigue Strength: Introduction, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

Laboratory Sessions/ Experimental learning:

1. Determine the notch sensitivity and impact toughness of engineering materials**.**
2. Demonstrate how fatigue tests are conducted and how to interpret results

Applications: Fatigue Testing, Combined Loading

Video link / Additional online information (related to module if any):
https://www.youtube.com/watch?v=ZsIwEp574ho

https://www.youtube.com/watch?v=X-_qUQ3xaTA

| **Module-3** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**Loads on Aircraft and Spacecrafts**: Structural nomenclature, Types of loads, load factor, Aerodynamic loads, Symmetric manoeuvre loads, Velocity diagram, Function of structural components.

**Spacecraft Structures:** StaticallyDeterminate and Indeterminate structures, Analysis of plane truss, Method of joints, 3D Truss, Plane frames, Composite beam, Clapeyron's Three Moment Equation.

Laboratory Sessions/ Experimental learning:

1. Determination of Deflection in a beam by applying point load and combined loading.

2. Determine the deflection of composite beam

Applications: Analysis of Loads, Determinate and Indeterminate structures.

Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/105105166/https://www.youtube.com/watch?v=q0_piF4-eNc

| **Module-4** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**Theory of Elasticity:** Theory of Elasticity: Concept of stress and strain, derivation of Equilibrium equations, strain displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity. Principle Stresses and Orientation of Principle Directions. **Columns**: Columns with various end conditions, Euler's Column curve, Rankine's formula, Column with initial curvature, Eccentric loading, southwell plot, Beam-column.

Laboratory Sessions/ Experimental learning:

1. Determine the Spring Stiffness for the given spring.
2. Buckling load of slender Eccentric Columns and Construction of Southwell Plot

Applications: Stress and Strain displacement, Columns

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

http://www.digimat.in/nptel/courses/video/112101095/L02.htmlhttps://www.digimat.in/nptel/courses/video/105105177/L01.html

| **Module-5** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**Energy Methods:** Strain Energy due to axial, bending and Torsional loads. Castigliano's theorem, Maxwell's Reciprocal theorem.

**Introduction to Shear Flow:** Symmetrical and Unsymmetrical bendingConcept of shear flow – The shear centre and its determination – Shear flow distribution in symmetrical and unsymmetrical thin-walled sections.

Laboratory Sessions/ Experimental learning:

1. Verify Maxwell's Reciprocal theorem
2. Determining of Shear centre location for open sections-unsymmetrical bending

Applications: Maxwell's Theorem, Shear Flow and Shear Center

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

https://www.youtube.com/watch?v=149j7Ys0F58http://www.nptelvideos.com/video.php?id=1637

**Course outcomes:**

| | |
|---|---|
| CO212.1 | Apply the different failure theories to understand the concept of static strength. |
| CO212.2 | Design a structure against fatigue loads and to design a material for impact load. |
| CO212.3 | Analyze various loads experienced by an aircraft in flight and to understand the usage of different materials. |

| | |
|---|---|
| CO212.4 | Assess compatibility conditions and boundary conditions to find the stress and strain of an elastic material. |
| CO212.5 | Formulate different Energy methods in calculations related to structural components and to understand the different methods to analyse columns. |

| **Reference Books:** | |
|---|---|
| 1 | Megson, T.H.G., "Aircraft Structures for Engineering Students", Edward Arnold, 6th Edition 2017, Elsevier Aerospace Engineering series, ISBN-13: 978-0081009147, ISBN10: 9780081009147. |
| 2 | Bruhn E.F., "Analysis and Design of Flight Vehicles Structures", Tri-State offset Co.USA,1985 |
| 3 | Bruce K Donaldson, "Analysis of Aircraft structures", Cambridge Aerospace Series, reprint 2012, ISBN-9780511801631 |
| 4 | Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw, Hill, N.Y, 2nd edition, 1993 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

xxvii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xxviii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxix. One question must be set from each unit. The duration of examination is 3 hours.

**CO-PO Mapping**

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| CO4 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 |

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | **AIRCRAFT PROPULSION** | **Semester** | IV |
| **Course Code** | **MVJ20AE44** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1 : 0** | **SEE** | 50 |
| **No. of Contact Hours/week** | **4** | **Total** | 100 |
| **Credits** | **3** | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Understand and apply the basic thermodynamic principles in aircraft propulsion.
- Understand and solve the problems on turboprop, turbojet and turbofan engines.
- Acquire knowledge on subsonic and supersonic inlets.
- Describe the working of combustion chambers and nozzles.
- Understand the fundamentals of rocket propulsion.

| **Module-1** | **L1,L2** | **8Hours** |
|---|---|---|
| Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two stroke and four stroke piston engines, Gas, turbine | | |

engines, Cycle analysis of reciprocating engines and jet engines , advantages and disadvantages, numerical problems

Laboratory Sessions/ Experimental learning:

1. Identify and demonstrate the various components of Guiberson T-1020 (9 cylinder radial engine) andTumansky R-25-300 R-26(Jet engine)

Applications: Automobile industries , Gas turbine industries and Power plants

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

1. https://youtu.be/XKcRf2R5h4o
2. https://youtu.be/fTAUq6G9apg
3. https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-enginesspring-2017/lecture-notes/MIT2_61S17_lec1.pdf
4. https://nptel.ac.in/courses/101106033/

| **Module-2** | **L1,L2** | **8Hours** |
|---|---|---|

**Propeller Theories & Jet propulsion**

**Propeller Theories & Jet propulsion**: Types of propeller, Propeller thrust: momentum theory, Blade element theories, propeller blade design, and propeller selection.

**Jet Propulsion:** Illustration of working of gas turbine engine, the thrust equation, Factors affectingthrust, Effect of pressure, velocity and temperature changes of air entering compressor Methods of thrust augmentation, Characteristics of turboprop, turbofan and turbojet, Performance characteristics. Ramjet and Scramjet Engines.

**Laboratory Sessions/ Experimental learning:**

1. Analyze the performance of a 2 blade fixed pick propeller and plot the performance

**Applications:** Gas turbine and aircraft engine design industries

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

1. https://youtu.be/0bP2MH3LqvI
2. https://youtu.be/KjiUUJdPGX0
3. https://youtu.be/vq54Tn9djsY

| **Module-3** | **L1,L2** | **8Hours** |
|---|---|---|

**Inlets**

**Subsonic Inlets**

Internal flow and Stall in Subsonic inlets, Boundary layer separation. Major features of external flow near a subsonic inlet. Relation between minimum area ratio and external deceleration ratio.

**Diffuser performance.**

Supersonic inlets: Supersonic inlets, starting problem in supersonic inlets, Shock swallowing by area

variation, External deceleration. Modes of inlet operation.

**Laboratory Sessions/ Experimental learning:**

Visualize the external and internal deceleration (pre compression and diffusion) over inlet using wind tunnel

Learn NASA's EngineSim Applet Version 1.8a (latest edition) by using Beginner's Guide to Propulsionhttps://www.grc.nasa.gov/WWW/K-12/airplane/ngnsim.html

Calculate and draw the performance curves using EngineSim Applet Version 1.8a

**Applications:** gas turbine engine design industries

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

https://youtu.be/ZoObIZfLa94

https://youtu.be/hFO_n44Uv_Y

| **Module-4** | **L1,L2** | **8Hours** |
|---|---|---|

**Combustion chambers & Nozzles**

**Combustion chambers**

Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance , Flame tube cooling , Flame stabilization , Use of flame holders

**Nozzles:** Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions. Nozzle efficiency, Losses in nozzles. Over,expanded and under,expandednozzles, Ejector and variable area nozzles, Thrust reversal.

**Laboratory Sessions/ Experimental learning:**

Make a model and explain thrust reversal technique

Learn NASA's Range Games Version 1.3 (latest edition) by using Beginner's Guide to Propulsionhttps://www.grc.nasa.gov/WWW/K-12/airplane/ngnsimr.html

Calculate and understand the aircraft motion and performance using Range Games Version

**Applications:** Gas turbine industries

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

https://youtu.be/3u7d-IlvRqs

https://youtu.be/LPXLFY-WR-4

https://youtu.be/E4wFJCHEwW4

| **Module-5** | **L1,L2** | **8Hours** |
|---|---|---|

**Rocket Propulsion**

Classification of rockets, Principle of rocket propulsion, Analysis of ideal chemical rocket, The chemical rocket, Solid propellant rockets, Liquid propellant rockets, Hybrid rockets, Cryogenic rockets nuclear propulsion, Electrodynamic propulsion, Photon propulsion, Propulsive efficiency.

| |
|---|
| **Laboratory Sessions/ Experimental learning:**<br>Make Sugar rocket by using potassium nitrate (small size)<br>Find the specific impulse of the sugar rocket<br>**Applications:** Rockets and missile manufacturing industries<br>**Video link / Additional online information (related to module if any):**<br>https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsionsystems-spring-2012/lecture-notes/MIT16_50S12_lec9.pdf<br>https://nptel.ac.in/courses/101106033/ |

| **Course outcomes:** | |
|---|---|
| CO213.1 | Apply the basic thermodynamic principles and theories in aircraft propulsion. |
| CO213.2 | Understand the thrust generation and performance of turbojets, turbofans and turboprops. |
| CO213.3 | Analyze the performance of inlet for subsonic and supersonic applications |
| CO213.4 | Demonstrate the principle of combustion and distinguish between different types of combustion chambers |
| CO213.5 | Explain the basic principles of rocket propulsion. |

| **Reference Books:** | |
|---|---|
| 1 | Bhaskar Roy, Aircraft propulsion, Elsevier (2011), ISBN,13: 9788131214213 |
| 2 | V. Ganesan, Gas Turbines, Tata McGraw,Hill, 2010, New Delhi, India, ISBN: 0070681929. |
| 3 | Hill, Philip G., and Carl R. Peterson. "Mechanics and Thermodynamics of Propulsion, 0201146592." (2010). |
| 4 | Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman, 1989, ISBN 13: 9780582236325. |

| **CIE Assessment:** |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| **SEE Assessment:** |

xxx. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xxxi. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxxii. One question must be set from each unit. The duration of examination is 3 hours.

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

| | | | |
|---|---|---|---|
| **Course Title** | **TURBOMCHINES** | **Semester** | IV |
| **Course Code** | **MVJ20AE45/AS45** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1 : 0** | **SEE** | 50 |
| **No. of Contact Hours/week** | **4** | **Total** | 100 |
| **Credits** | **3** | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Understand the basics of turbomachines
- Understanding the concept of energy transfer taking place in turbomachines
- Acquire the knowledge on design of centrifugal and axial compressors
- Acquire the knowledge on design of centrifugal and axial turbines
- Assimilate the understanding of hydraulic pumps and turbines

| | | |
|---|---|---|
| **Module-1** | **L1,L2** | **8Hours** |

**I**ntroduction to turbomachines:

Classification and parts of a turbo machines; comparison with positive displacement machines; dimensionless parameters and their physical significance; specific speed; illustrative examples on dimensional analysis and model studies.

Energy transfer in turbomachines:

Basic Euler turbine equation and its alternate form; components of energy transfer; general expression for degree of reaction; construction of velocity triangles for different values of degree of reaction.

Laboratory Sessions/ Experimental learning: Aircraft propulsion lab for acquiring knowledge of Gas turbine engine.

Applications: Study of Turbomachines, components of gas turbine engines.

Video link / Additional online information:

https://nptel.ac.in/courses/112/106/112106200/

| **Module-2** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**General analysis of Turbomachines**

**Axial flow machines**-general analysis, degree of reaction, velocity triangles, diagram efficiency, maximum utilization factor for different R values, Numerical Problems

**Radial flow machines** –general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance.

**Laboratory Sessions/ Experimental learning**: Aircraft Propulsion lab and Fluid Mechanics lab for compressor and turbines.

**Applications**: Compressors and Turbines in Aircraft engines.

**Video link / Additional online information**: https://nptel.ac.in/courses/101/101/101101058/

https://www.youtube.com/watch?v=oitC03G-QYE

| **Module-3** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**Compression process:**

Overall isentropic efficiency of compression; stage efficiency; comparison and relation between overall efficiency and stage efficiency; polytropic efficiency; preheat factor.

**Expansion process:**

Over all isentropic efficiency for a turbine; stage efficiency for a turbine; comparison and relation between stage efficiency and overall efficiency, polytropic efficiency; reheat factor for expansion process.

**Laboratory Sessions/ Experimental learning**: Fluid Mechanics lab for compressor and turbines and Aircraft propulsion lab: Study of gas turbine turbojet engine

**Applications:** Turbojet, turbofan, turbo shaft engines.

**Video link / Additional online information**:

https://youtu.be/8y5KX4kzt0A

| **Module-4** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**DesignandperformanceanalysisofCentrifugal compressors:** Types, design parameters, flow analysis in impeller blades, volutes and diffusers, losses, slip factor, characteristic curves, surging, choking. Construction details.

**Designandperformanceanalysisofaxial fans and compressors:** Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, simple stage design problems, performance characteristics, instability in axial compressors. Construction details.

**Laboratory Sessions/ Experimental learning**: Aircraft propulsion lab: Study of gas turbine turbojet engine

**Applications:** Turbojet, turbofan, turbo shaft engines.

**Video link / Additional online information**:

http://www.infocobuild.com/education/audio-video-courses/aeronautics-and-astronautics/TurbomachineryAerodynamics-IIT-Bombay/lecture-31.html

https://www.youtube.com/watch?v=3bhoVSI6VoI

https://www.youtube.com/watch?v=b1dyUVA19kQ

| **Module-5** | **L1,L2** | **8Hours** |
|---|---|---|

**Design and performance analysis of axial flow turbines:**

Turbine stage, work done, degree of reaction, losses and efficiency, flow passage; subsonic, transonic and supersonic turbines, multi-staging of turbine; exit flow conditions; turbine cooling

**Designandperformanceanalysisofradialturbines:**

Thermodynamics andaerodynamicsofradialturbines; radial turbine characteristics; losses and efficiency; design ofradial turbine.

**Laboratory Sessions/ Experimental learning**: Aircraft propulsion lab and Fluid mechanics lab.

**Applications:** Turbojet, turbofan, turbo shaft engines.

**Video link / Additional online information**:

http://www.infocobuild.com/education/audio-video-courses/aeronautics-and-astronautics/TurbomachineryAerodynamics-IIT-Bombay/lecture-22.html

**https://www.youtube.com/watch?v=h4LYyUOtQow**

**Course outcomes:**

| | |
|---|---|
| CO214.1 | Compute the energy transfer and energy transformation in turbomachines. |
| CO214.2 | Analyse the design of turbomachine blades. |
| CO214.3 | Apply hydraulic pumps and turbines for specific requirements |
| CO214.4 | Apply dimensionless parameters for turbomachines |

| | |
|---|---|
| CO214.5 | Analyse Compression and Expansion process |

| **Reference Books:** | |
|---|---|
| 1 | S.M.Yahya,Turbines,Compressors&Fans,Tata-McGrawHillCo.,2nd Edition(2002),ISBN 13: 9780070707023. |
| 2 | D.G.Shephered,PrinciplesofTurboMachinery,TheMacmillanCompany(1964),ISBN-13: 978-0024096609. |
| 3 | V. Kadambi and Manohar Prasad, An introductionto Energyconversion, VolumeIII, Turbo machinery,WileyEastern Ltd, 1977, ISBN: 9780852264539 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

xxxiii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xxxiv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxxv. One question must be set from each unit. The duration of examination is 3 hours.

**CO-PO Mapping**

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | **MECHANICS OF MACHINE THEORY** | **Semester** | IV |
| **Course Code** | **MVJ20AE46/AS46** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1 : 0** | **SEE** | 50 |
| **No. of Contact Hours/week** | **4** | **Total** | 100 |
| **Credits** | **3** | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Understand the theory of mechanisms including velocity, acceleration and static force analysis.
- Acquire knowledge of spur gears, gear train, balancing of rotating and reciprocating masses.
- Understand the concept of governors and gyroscope.

| **Module-1** | **L1,L2,L3** | **8Hours** |
|---|---|---|

Introduction to Mechanisms:

Types of constrained motion, Link and its types, joints and its types, kinematic pair and its types, degrees of freedom, Grubler's criterion, Types of kinematic chains and inversions: Inversions of Four bar chain: Beam engine, coupling rod of a locomotive, Watt's indicator mechanism. Inversions of Single Slider Crank Chain: Pendulum pump or Bull engine, Oscillating cylinder engine, Rotary internal combustion engine, Crank and

slotted lever quick return motion mechanism, Whitworth quick return motion mechanism. Inversions of Double Slider Crank Chain: Elliptical trammels, Scotch yoke mechanism, Oldham's coupling. Straight line motion mechanisms: Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism and Ratchet and Pawl mechanism, Ackerman steering gear mechanism.

Laboratory Sessions/ Experimental learning: Whitworth quick return motion mechanism. (Machine Shop)

Applications: Ackerman steering gear mechanism.

Video link / Additional online information:

https://www.youtube.com/watch?v=g8uqeru2LQw

| **Module-2** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**Velocity, Acceleration and static force analysis of Mechanisms (Graphical Methods**):

Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons. Static force analysis: Introduction: Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction

Video link / Additional online information:

https://www.youtube.com/watch?v=CTcdQzH5e04

| **Module-3** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**Spur Gears and Gear Trains**

Spur Gears: Gear terminology, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear, Interference in involute gears, Methods of avoiding interference.

Gear Trains: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains.

Applications: Design Of spur Gear

Video link / Additional online information:

https://www.youtube.com/watch?v=N0hTFnvIE7A

| **Module-4** | **L1,L2,L3** | **8Hours** |
|---|---|---|

**Balancing of Rotating and Reciprocating Masses Balancing of Rotating Masses:** Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes (only Graphical Methods). Balancing of Reciprocating Masses: Primary and Secondary Unbalanced Forces of Reciprocating Masses, Partial Balancing of Unbalanced Primary Force in a Reciprocating Engine, Balancing of Primary and secondary Forces of Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods)

Video link / Additional online information:

https://www.youtube.com/watch?v=N0hTFnvIE7A

| **Module-5** | **L1,L2,L3** | **8Hours** |
|---|---|---|

| |
|---|
| Types of governors; force analysis of Porter and Hartnell governors, Controlling force, stability, sensitiveness, isochronism, effort and power of Porter and Hartnell governors. Gyroscopes: Vectorial representation of angular motion, gyroscopic couple, effect of gyroscopic couple on plane disc and aeroplane<br>Laboratory Sessions/ Experimental learning: Porter and Hartnell governors (Design lab)<br>Applications:: Working Of Governors<br>Links https://www.youtube.com/watch?v=FydJu1A1oeM |

| **Course outcomes:** | |
|---|---|
| CO215.1 | Apply the theory of velocity, acceleration and static force analysis to design of mechanisms. |
| CO215.2 | Analyze static and dynamic force analysis of mechanisms. |
| CO215.3 | Design of spur gears & Gear train. |
| CO215.4 | Evaluate spur gears, gear train, balancing of rotating and reciprocating masses. |
| CO215.5 | Analyse governors and gyroscope |

| **Reference Books:** | |
|---|---|
| 1 | Rattan S.S, "Theory of Machines", Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009, ISBN: 007014477X, 9780070144774. |
| 2 | J.J. Uicker, G.R. Pennock, J.E. Shigley. "Theory of Machines & Mechanisms", OXFORD 3rd Ed. 2009, ISBN-13: 978-0195371239 |
| 3 | R. S. Khurmi, J.K. Gupta, "Theory of Machines", Eurasia Publishing House, 2008, ISBN 13: 9788121925242. |

| **CIE Assessment:** |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| **SEE Assessment:** |
| xxxvi. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. |

xxxvii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xxxviii. One question must be set from each unit. The duration of examination is 3 hours.

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | **MATERIAL TESTING LAB** | **Semester** | IV |
| **Course Code** | **MVJ20AEL47A** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

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

| **Sl No** | **Experiment Name** | **RBT Level** | **Hours** |
|---|---|---|---|
| **1** | Hardness Testing – Vicker's, Brinell, Rockwel | L1,L2,L3 | 03 |
| **2** | Tensile Test | L1,L2,L3 | 03 |
| **3** | Flexural Test | L1,L2,L3 | 03 |
| **4** | Torsional Test | L1,L2,L3 | 03 |
| **5** | Impact Test | L1,L2,L3 | 03 |
| **6** | Shear Test | L1,L2,L3 | 03 |
| **7** | Fatigue Test | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **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 | 03 |
| **9** | Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples. | L1,L2,L3 | 03 |
| **10** | To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters. | L1,L2,L3 | 03 |
| **11** | Visual Testing Technique, Dye penetration testing. To study the defects of Cast and Welded specimens. | L1,L2,L3 | 03 |
| **12** | Magnetic Particle Inspection. | L1,L2,L3 | 03 |
| **13** | Ultrasonic Inspection. | L1,L2,L3 | 03 |

| **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. |

| **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** | **MEASUREMENT AND METROLOGY LAB** | **Semester** | IV |
| **Course Code** | **MVJ20AEL47B** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Learn the concepts of mechanical measurements and metrology
- Use the concept of accuracy, error and calibration
- Acquire the knowledge of basic metrological instruments

| Sl No | Experiment Name | RBT Level | Hours |
|---|---|---|---|
| **1** | Calibration of Pressure Gauge | L1,L2,L3 | 03 |
| **2** | Calibration of Thermocouple | L1,L2,L3 | 03 |
| **3** | Calibration of LVDT | L1,L2,L3 | 03 |
| **4** | Calibration of Load cell | L1,L2,L3 | 03 |
| **5** | Determination of modulus of elasticity of a mild steel specimen using strain gauges. | L1,L2,L3 | 03 |
| **6** | Comparison and measurements using vernier caliper and micrometer | L1,L2,L3 | 03 |
| **7** | Measurement of vibration parameters using vibration setup. | L1,L2,L3 | 03 |
| **8** | Measurements using Optical Projector / Toolmaker Microscope. | L1,L2,L3 | 03 |
| **9** | Measurement of angle using Sine Center / Sine bar / bevel protractor | L1,L2,L3 | 03 |
| **10** | Measurement of alignment using Autocollimator / Roller set | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **11** | Measurement of Screw threads Parameters using Two-wire or Three-wire method. | L1,L2,L3 | 03 |
| **12** | Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator | L1,L2,L3 | 03 |
| **13** | Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer | L1,L2,L3 | 03 |
| **14** | Calibration of Micrometer using slip gauges | L1,L2,L3 | 03 |
| | | | |

| **Course outcomes:** | |
|---|---|
| CO1 | Use different measuring tools related to experiments |
| CO2 | Identify, define, and explain accuracy, precision, and some additional terminology. |
| CO3 | Conduct, Analyse, interpret, and present measurement data from measurements Identify, define, and explain accuracy, precision, and some additional terminology |

| **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** | **COMPUTER AIDED AIRCRAFT DRAWING** | **Semester** | IV |
| **Course Code** | MVJ20AEL48/ASL48 | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Understand and interpret drawings of machine and aircraft components
- Prepare assembly drawings either manually or by using standard CAD packages.
- Familiarize with standard components and their assembly of an aircraft

| **Sl No** | **Experiment Name** | L1,L2,L3,L4 | 20Hours |
|---|---|---|---|
| | PART A | | |
| | Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.<br>Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.<br>Laboratory Sessions/ Experimental learning: CAAD Lab<br>Applications: Helps to understand Engineering Drawing.<br>Video link / Additional online information (related to module if any): https://www.youtube.com/watch?v=f1Hdtf_iAWk | | |
| | PART B | L1,L2,L3,L4 | 10Hours |
| | **Thread Forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.<br>**Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.<br>**Keys & Joints:** Parallel key, Taper key, Feather key, Gibhead key and Woodruff key.<br>**Riveted Joints:** Single and double riveted lap joints, butt joints with single/double cover strap. | | |

| | | | |
|---|---|---|---|
| | **Couplings:** Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)<br>Laboratory Sessions/ Experimental learning: CAAD Lab<br>Applications: For Manufacturing Aerospace Components.<br>Video link / Additional online information (related to module if any):<br>https://www.youtube.com/watch?v=70hESLwUhME<br>https://www.youtube.com/watch?v=Gdvtw0pTAOs | | |
| | PART C | L1,L2,L3,L4 | 20Hours |
| **1** | Modeling of propeller and hub assembly | | |
| **2** | Modeling of wing assembly | | |
| **3** | Modeling of fuselage assembly | | |
| **4** | Modeling of Engine Mounts | | |
| **5** | Modeling of main rotor blade assembly of helicopter | | |
| **6** | Modeling of UAV assembly | | |
| **7** | Modeling of Landing Gear Assembly | | |
| | Laboratory Sessions/ Experimental learning: CAAD Lab Applications: To Design an Aircraft Model.<br>Video link / Additional online information (related to module if any):<br>https://www.youtube.com/watch?v=rmlUXhvJHt0 | | |

| **Course outcomes:** | |
|---|---|
| CO1 | Distinguish drawings of machine and aircraft components |
| CO2 | Identify assembly drawings either manually or by using standard CAD packages. |
| CO3 | Practice with standard components and their assembly of an aircraft. |

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

| | | | |
|---|---|---|---|
| Course Title | **CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW** | Semester | **IV** |
| Course Code | **MVJ20CPH39/49** | CIE | **50** |
| Total No. of Contact Hours | **20 L : T : P :: 1 :0 : 0** | SEE | **50** |
| No. of Contact Hours/Week | **01** | Total | **100** |
| Credits | **01** | Exam. Duration | **2 hrs** |

**Course objective is to:**

- To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.
- To provide overall legal literacy to the young technograts to manage complex societal issues in the present scenario.
- To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.

| **Module-1** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Introduction to Indian Constitution**

The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.

| **Module – II** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Union Executive and State Executive**

Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.

| **Module – III** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Elections, Amendments and Emergency Provisions**

Elections, Electoral Process, and Election Commission of India, Election Laws.

Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements).

Emergency Provisions, types of Emergencies and it's consequences.

**Constitutional Special Provisions:**

Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.

| **Module – IV** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Professional / Engineering Ethics**

Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India) : Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. **Responsibilities in Engineering** - Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility.Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.

| **Module – V** | **RBT Level** L1,L2,L3 | 03 Hours |
|---|---|---|

**Internet Laws, Cyber Crimes and Cyber Laws:**

Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.

| **Course Outcomes:** On completion of this course, students will be able to | |
|---|---|
| CO1 | Have constitutional knowledge and legal literacy |
| CO2 | Understand Engineering and Professional ethics and responsibilities of Engineers. |
| CO3 | Understand the cyber crimes and cyber laws for cyber safety measure. |

| **Text Books:** | |
|---|---|
| 1. | Constitution of India and Professional Ethics, T.S. Anupama, Sunstar Publisher |

| | |
|---|---|
| | |
| **Reference Books:** | |
| 1. | Durga Das Basu (DD Basu): "Introduction to the Constitution on India", (Students Edition.) Prentice –Hall EEE, 19th/20th Edn., (Latest Edition) or 2008. |
| 2. | Shubham Singles, Charles E. Haries, and Et al : "Constitution of India and Professional Ethics" by Cengage Learning India Private Limited, Latest Edition – 2018. |
| 3 | M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice –Hall of India Pvt. Ltd. New Delhi, 2004. |
| 4. | M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002. |
| 5. | Latest Publications of NHRC - Indian Institute of Human Rights, New Delhi. |

| **CIE Assessment:** |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (40 marks each), the final IA marks to be awarded will be the average of three tests<br>- Assignment (10 marks) |
| **SEE Assessment:** |
| xxxix. Question paper for the SEE consists one part. It is compulsory and consists of objective type 1 mark each for total of 50 marks covering the whole syllabus.<br>xl. Ten questions must be set from each unit. The duration of examination is 3 hours. |

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

| | | | |
|---|---|---|---|
| Course Title | Balike Kannada | Semester | IV |
| Course Code | MVJ20BK39 | **CIE** | 50 |
| Total No. of Contact Hours | 20 L: T: P 1:0:0 | **SEE** | 50 |

| | | | |
|---|---|---|---|
| No. of Contact Hours/week | 1 | **Total** | 100 |
| **Credits** | 1 | **Exam. Duration** | 3Hrs |

**Course objective :**This course will enable students to understand Kannada and communicate in Kannada language

- Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada )
- Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation.
- Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).
- Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)
- Activities in Kannada

**CHAPTER-1**

Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada )

**CHAPTER-2**

Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation

**CHAPTER-3**

Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication)

**CHAPTER-4**

Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)

**CHAPTER-5**

Activities in Kannada

**Scheme of Evaluation:**

| Details | | Marks |
|---|---|---|
| Average of three Internal Assessment (IA) Tests of 30 Marks each i.e.<br><br>Σ (Marks Obtained in each test) / 3 | **CIE(50)** | **30** |
| ASSIGNMENT | | **20** |
| Semester End Examination | **SEE (50)** | **50** |
| | **Total** | **100** |

| Course Title | **SAMSKRUTHIKA KANNADA** | Semester | IV |
|---|---|---|---|
| Course Code | **MVJ20SK39** | **CIE** | 50 |
| Total No. of Contact Hours | 20 L: T: P 1:0:0 | **SEE** | 50 |
| No. of Contact Hours/week | 1 | **Total** | 100 |
| **Credits** | 1 | **Exam. Duration** | 3Hrs |

**Course objective :**This course will enable students to understand Kannada and communicate in Kannada language

- Samskruthika Kannada –Parichaya (Introduction to Adalitha kannada )
- Kannada Kavyagala parichaya (Kannada D Ra Bendre, Siddalingaiha)
- Adalithdalli Kannada Padagalu (Kannada Kagunitha Balake, Patra Lekhana, Prabhandha)
- Kannada Computer Gnyana (Kannada Shabdha Sangraha, Computer Paribashika padagalu)
- Activities in Kannada.

| |
|---|
| CzsÁåAiÀÄ -1 |
| PÀ£ÀßqÀ ¨sÁµÉ-¸ÀAQë¥ÀÛ «ªÀgÀuÉ. |
| CzsÁåAiÀÄ -2 |
| ¨sÁµÁ ¥ÀæAiÉÆÃUÀ¯ÁèUÀÄªÀ ¯ÉÆÃ¥ÀzÉÆÃµÀUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À ¤ªÁgÀuÉ. |
| CzsÁåAiÀÄ -3 |
| ¯ÉÃR£À aºÉßUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À G¥ÀAiÉÆÃU.À |
| CzsÁåAiÀÄ -4 |
| ¥ÀvÀæ ªÀåªÀºÁgÀ. |
| CzsÁåAiÀÄ -5 |
| DqÀ½vÀ ¥ÀvÀæUÀ¼ÀÄ. |
| CzsÁåAiÀÄ -6 |
| ¸ÀPÁðgÀzÀ DzÉÃ±À ¥ÀvÀæUÀ¼ÀÄ |
| CzsÁåAiÀÄ -7 |
| ¸ÀAQÃ¥ÀÛ ¥Àæ§AzsÀ gÀZÀ£É, ¥Àæ§AzsÀ ªÀÄvÀÄÛ ¨sÁµÁAvÀgÀ |
| CzsÁåAiÀÄ -8 |
| PÀ£ÀßqÀ ±À§Ý¸ÀAUÀæºÀ |
| CzsÁåAiÀÄ -9 |
| PÀA¥ÀÆålgï ºÁUÀÆ ªÀiÁ»w vÀAvÀæeÁÕ£À |
| CzsÁåAiÀÄ -10 |
| ¥Áj¨sÁ¶PÀ DqÀ½vÀ PÀ£ÀßqÀ ¥ÀzÀUÀ¼ÀÄ ªÀÄvÀÄÛ vÁAwæPÀ/PÀA¥ÀÆålgï ¥Áj¨sÁ¶PÀ ¥ÀzÀUÀ¼ÀÄ. |

**Scheme of Evaluation:**

| Details | | Marks |
|---|---|---|
| Average of three Internal Assessment (IA) Tests of 30 Marks each i.e.<br><br>Σ (Marks Obtained in each test) / 3 | **CIE(50)** | **30** |
| ASSIGNMENT | | **20** |
| Semester End Examination | **SEE (50)** | **50** |
| | **Total** | **100** |

| | | | |
|---|---|---|---|
| **Course Title** | **Additional Mathematics-II** | **Semester** | II |
| **Course Code** | MVJ20MATDIP41 | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | - | **Exam. Duration** | 3 Hours |

**Course objective is to:** This course viz., aims to prepare the students:

- To familiarize the important and basic concepts of Differential calculus and Differential Equation, ordinary/partial differential equations and Vector calculus and analysethe engineeringproblems.

| **Module-1** | **L1,L2** | 8Hrs. |
|---|---|---|

**Linear Algebra:**

Introduction,Rank of a matrix-echelon form. Solution of system of linear equations – consistency. Gauss-elimination method and problems. Eigen values and Eigen vectors of square matrix and Problems.

Video Link:

**https://www.math.ust.hk/~machas/matrix-algebra-for-engineers.pdf**

**https://nptel.ac.in/content/storage2/courses/122104018/node18.html**

| **Module-2** | **L1,L2** | 8 Hrs. |
|---|---|---|

**Differential calculus:**

Tangent and normal, sub tangent and subnormal both Cartesian and polar forms. Increasing and decreasing functions, Maxima and Minima for a function of one variable. Point of inflections and Problems

**Beta and Gamma functions:**

Beta functions, Properties of Beta function and Gamma function ,Relation Between beta and Gamma function-simple problems.

Video Link:

https://www.youtube.com/watch?v=6RwOoPN2zqE

https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWlUqBoTCQDtYlloI-o-9hxp11

http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx

| **Module-3** | **L1,L2** | 8Hrs. |
|---|---|---|

**Analytical solid geometry :**

Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems.

Video Link:

https://www.toppr.com/guides/maths/three-dimensional-geometry/

https://www.toppr.com/guides/maths/three-dimensional-geometry/distance-between-skew-lines/

| **Module-4** | **L1,L2,L3** | 8 Hrs. |
|---|---|---|

**Probability:**

Random variable, Discrete probability distribution, Mean and variance of Random Variable, Theoretical distribution-Binomial distribution, Mean and variance Binomial distribution -Problems. Poisson distribution as a limiting case of Binomial distribution, Mean and variance of Poisson distribution. Normal Distribution-Basic properties of Normal distribution –standard form of normal distribution and Problems.

Video Link:

https://nptel.ac.in/courses/111/105/111105041/

https://www.mathsisfun.com/data/probability.html

| **Module-5** | **L1,L2,L3** | 8 Hrs. |
|---|---|---|

**Partial differential equation:** Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only.

Video Link:

http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx

https://www.studyyaar.com/index.php/module-video/watch/233-cauchys-legendres-de-a-method-of- variation-of-parameters

**Course outcomes:**

| | |
|---|---|
| CO1 | Apply the knowledge of Matrices to solve the system of linear equations and to understand the concepts of Eigen value and Eigen vectors for engineering problems. |
| CO2 | Demonstrate various physical models ,find Maxima and Minima for a function of one variable., Point of inflections and Problems .Understand Beta and Gamma function |
| CO3 | Understand the 3-Dimentional geometry basic, Equation of line in space- different forms, Angle between two line and studying the shortest distance . |

| | |
|---|---|
| CO4 | Concepts OF Probability related to engineering applications. |
| CO5 | Construct a variety of partial differential equations and solution by exact methods. |

| **Text Books:** | |
|---|---|
| 1 | B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013. |
| 2 | Ramana B. V., "Higher Engineering Mathematics", Tata Mc Graw-Hill, 2006. |
| **Reference Books:** | |
| 1 | Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition,2014. |
| 2 | G. B. Gururajachar: Calculus and Linear Algebra, Academic Excellent Series Publication, 2018-19 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (8 marks)

**SEE Assessment:**

xli. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xlii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xliii. One question must be set from each unit. The duration of examination is 3 hours.

| **Course Title** | **TECHNICALMANAGEMENT &ENTREPRENEURSHIP** | **Semester** | V |
|---|---|---|---|
| **Course Code** | MVJ20TEM51 | **CIE** | 50 |
| **Total No. of Contact Hours** | 40L: T: P::3: 1 :0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |

| Credits | 3 | Exam. Duration | 3 Hours |
|---|---|---|---|

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

- Introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
- Explain need of coordination between the manager and staff, the social responsibility of business and leadership.
- Explain the role and importance of the entrepreneur in economic development and the concepts of entrepreneurship.
- Discuss the importance of Small Scale Industries and the related terms and problems involved.
- Explain project feasibility study and project appraisal and discuss project financing.

| **Module-1** | **L1., L2** | **8Hours** |
|---|---|---|

**Management:** Definition, Importance – Nature and Characteristics of Management, Management Functions, Roles of Manager, Levels of Management, Managerial Skills, Management & Administration, Management as a Science, Art &Profession.

**Planning:** Nature, Importance and Purpose Of Planning, Types of Plans, Steps in Planning, Limitations of Planning, Decision Making – Meaning, Types of Decisions- Steps in Decision Making.

Laboratory Sessions/ Experimental learning: Case study on decision making process in a corporate.

Applications: Planning in engineering field.

Web Link and Video Lectures

https://nptel.ac.in/courses/110/105/110105146/

https://nptel.ac.in/courses/122/108/122108038/

| **Module-2** | **L1., L2** | **8Hours** |
|---|---|---|

**Organizing and Staffing:** Meaning, Nature and Characteristics of Organization – Process of Organization, Principles of Organization, Departmentalization, Committees – meaning, Types of Committees, Centralization Vs Decentralization of Authority and Responsibility, Span of Control,

Nature and Importance of Staffing, Process of Selection and Recruitment.

**Directing and Controlling:** Meaning and Nature of Directing-Leadership Styles, Motivation Theories, Communication – Meaning and Importance, Coordination- Meaning and Importance, Techniques of Coordination. Controlling – Meaning, Steps in Controlling.

Laboratory Sessions/ Experimental learning

Case study of steel plant departmentalization.

Applications: Effective communication in a corporate.

| | | |
|---|---|---|
| Web Link and Video Lectures<br>https://nptel.ac.in/content/storage2/courses/122106031/slides/3_2s.pdf<br>https://www.slideshare.net/100005130728571/27-nature-of-directing | | |
| **Module-3** | **L1., L2** | **8Hours** |
| **Social Responsibilities of Business:** Meaning of Social Responsibility, Social Responsibilities of Business towards Different Groups, Social Audit, Business Ethics and Corporate Governance.<br>**Entrepreneurship**: Definition of Entrepreneur, Importance of Entrepreneurship, concepts of Entrepreneurship, Characteristics of successful Entrepreneur, Classification of Entrepreneurs, Intrapreneur – An Emerging Class, Comparison between Entrepreneur and Intrapreneur, Myths of Entrepreneurship, Entrepreneurial Development models, Entrepreneurial development cycle, Problems faced by Entrepreneurs and capacity building for Entrepreneurship.<br><br>Laboratory Sessions/ Experimental learning<br>Case study of a startup.<br>Application: Social auditing in a software company Web Link and Video Lectures<br>https://nptel.ac.in/courses/110/106/110106141/<br>https://nptel.ac.in/courses/127/105/127105007/ | | |
| **Module-4** | **L1., L2** | **8Hours** |
| **Modern Small Business Enterprises:** Role of Small Scale Industries, Concepts and definitions of SSIEnterprises, Government policy and development of the Small Scale sector in India, Growth and Performance of Small Scale Industries in India, Sickness in SSI sector, Problems for Small Scale Industries, Impact of Globalization on SSI, Impact of WTO/GATT on SSIs, Ancillary Industry and Tiny Industry (Definition only).<br>**Institutional Support for Business Enterprises:** Introduction, Policies & Schemes of Central– Level Institutions, State-Level Institutions.<br>Laboratory Sessions/ Experimental learning<br>Case study on the growth of small scale industries.<br>Application: Small Scale Industries Web Link and Video Lectures<br>https://www.slideshare.net/syedmubarak15/institutional-support-for-business-enterprises | | |
| **Module-5** | **L1., L2** | **8Hours** |
| **Project Management:** Meaning of Project, Project Objectives & Characteristics, Project Identification-Meaning & Importance; Project Life Cycle, Project Scheduling, Capital Budgeting, Generating an Investment Project Proposal, Project Report-Need and Significance of Report, Contents, Formulation, Project Analysis-Market, Technical, Financial, Economic, Ecological, Project Evaluation and Selection, Project Financing, | | |

| |
|---|
| Project Implementation Phase, Human & Administrative aspects of Project Management, Prerequisites for Successful Project Implementation. New Control Techniques- PERT and CPM, Steps involved in developing the network, Uses and Limitations of PERT and CPM.<br>Laboratory Sessions/ Experimental learning<br>Investigation on the market in correspondence to project. Application<br>Preparations of project report. Web Link and Video Lectures<br>ttps://www.projectmanager.com/project-scheduling<br>https://kissflow.com/project/basics-of-project-scheduling/ |

| **Course outcomes:** | |
|---|---|
| CO1 | UnderstandtheconceptofManagement |
| CO2 | Understandthestaffingprocess |
| CO3 | ExplainthesocialresponsibilitiesofbusinesstowardsDifferentGroups |
| CO4 | ExplaintheRoleofSmallScale Industries |
| CO5 | InterprettheProjectObjectives |

| **Reference Books:** | |
|---|---|
| 1 | StephenP.Robbins&MaryCoulter,Management‖,PrenticeHall(India)Pvt.Ltd.,10th Edition, 2009 |
| 2 | JAFStoner,FreemanR.EandDanielRGilbert,Management‖,PearsonEducation, Edition, 2004. |
| 3 | StephenA. Robbins&DavidA. Decenzo& Mary Coulter, Fundamentals ofManagement, PearsonEducation,7thEdition,2011. |
| 4 | RobertKreitner&MamataMohapatra,Management‖,Biztantra,2008. |

| **CIE Assessment:** |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| **SEE Assessment:** |

xliv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xlv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xlvi. One question must be set from each unit. The duration of examination is 3 hours.

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | **AIRCRAFT SYSTEMS & INSTRUMENTATION** | **Semester** | V |
| **Course Code** | **MVJ20AE52** | **CIE** | 50 |
| **Total No. of Contact Hours** | 50 L : T : P :: 3 : 2: 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 5 | **Total** | 100 |
| **Credits** | 4 | **Exam. Duration** | 3 Hrs. |

**Course objective is to:**

1. Gain knowledge of the aircraft control systems.
2. Understand the applications of hydraulics and pneumatics in aircraft systems.
3. Acquire knowledge regarding aircraft engine systems.
4. Comprehend the aircraft auxiliary systems

5. Acquire the knowledge of aircraft instruments.

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

**Airplane Control Systems:** Conventional Systems, fully powered flight controls, Power actuated systems, Modern control systems, Digital fly by wire systems, Auto pilot system active control Technology.

**LaboratorySessions/ Experimental learning:**

How it works, flight controls PID controls.

**Applications:**

Pilot training, UAV design and piloting, RC aircraft design and piloting.

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

1. https://nptel.ac.in/courses/101/104/101104066
2. https://onlinecourses.nptel.ac.in/noc21_ae05/preview
3. https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1067&context=aerosp

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

**Aircraft Systems:** Hydraulic systems, Study of typical workable system, components, Pneumatic systems, Advantages, Working principles, Typical Air pressure system, Brake system, Typical Pneumatic power system, Components, Landing Gear systems, Classification.

**Laboratory Sessions/ Experimental learning:**

Calculation on force required for hydraulic system and pneumatic system in aircraft applications.

**Applications:**

Hydraulic lifts, pneumatic door openings and closing, landing gears, breaks.

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

1. https://nptel.ac.in/courses/112/105/112105047/
2. https://nptel.ac.in/courses/112/103/112103249/
3. https://sciencing.com/make-simple-hydraulic-system-7380816.html

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

**Engine Systems:** Fuel systems for Piston and jet engines, Components of multi engines. lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.

**Laboratory Sessions/ Experimental learning:**

Engine Fuel and Fuel Metering Systems (Lab session IIT Kanpur, Virtual lab)

https://www.youtube.com/watch?v=xEssM_sYtd8

**Applications:**

Range and Endurance calculation, actions to take in case of engine failures.

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

1. https://nptel.ac.in/courses/101/101/101101002/

2. https://spocathon.page/video/lecture-06-lubrication-system

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

**Auxiliary System:** Basic Air cycle systems, Vapour Cycle systems, Evaporative vapour cycle systems, Evaporative air cycle systems, Fire protection systems, Deicing and anti-icing systems.

**Laboratory Sessions/ Experimental learning:**

Response time and operations of firefighting systems in case of engine failure.

**Applications:**

Firefighting, precautions, how to fight different classes of fire.

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

1. https://nptel.ac.in/content/storage2/courses/101106035/001_Chapter%201_L1_(01-10-2013)
2. https://nptel.ac.in/courses/103/107/103107156/
3. https://www.draeger.com/en_seeur/ Products/Aircraft-fire-training-systems.

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

**Aircraft Instruments:** Flight Instruments and Navigation Instruments, Gyroscope, Accelerometers, Air speed Indicators, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles.

**Laboratory Sessions/ Experimental learning:**

Gyroscope working and applications, Avionics lab instruments working.

**Applications:**

Understanding readings of the flight instruments, prediction of failure or trouble before actual encounter and taking necessary precautions.

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

1. https://nptel.ac.in/courses/101/108/101108056/
2. https://onlinecourses.nptel.ac.in/noc20_ae01/preview
3. https://www.wingbug.com/wingbug-for-experimental-aircraft/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO302.1 | Distinguish the conventional and modern control systems. |
| CO302.2 | Analyse the aircraft systems. |
| CO302.3 | Analyse the working of Aircraft engine systems. |
| CO303.4 | Describe aircraft Auxiliary systems |
| CO303.5 | Applydifferent aircraft instruments. |

| **Reference Books**: | |
|---|---|
| 1. | Ian MoirandAllanSeabridge,Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration, Wiley India Pvt Ltd, 3rd edition, 2012. |
| 2. | Lalit Gupta and OP. Sharma,Aircraft Systems (Fundamentals of Flight Vol. IV), Himalayan Books, 2006. |
| 3. | William A Neese,Aircraft Hydraulic Systems, Himalayan Books, 2007 |
| 4. | SR. Majumdar,Pneumatic Systems, Tata McGraw Hill Publishing Co, 1st Edition, 2001 |

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO, PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CO2 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CO3 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CO4 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CO5 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

| | | | |
|---|---|---|---|
| **Course Title** | **FINITE ELEMENT METHODS** | **Semester** | V |
| **Course Code** | **MVJ20AE53** | **CIE** | 50 |
| **Total No. of Contact Hours** | 50 L : T : P :: 3 : 2: 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 5 | **Total** | 100 |
| **Credits** | 4 | **Exam. Duration** | 3 Hrs. |

**The course objective is to:**

1. Understand the importance of discretization of domain using different finite elements.
2. Acquire the knowledge of different loading and boundary conditions.
3. Understand the governing methods of finite element analysis.
4. Comprehend the higher order discretization.
5. Gain the knowledge offield problems.

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

**Introduction: Basic Concepts, Background Review:** Introduction,Stresses and Equilibrium, Plane stress, Plane strain, Boundary Conditions, Strain-Displacement Relations, simple elements for the FEM, Potential Energy and Equilibrium, The Rayleigh-Ritz Method, Galerkin's Method, Saint Venant's Principle, Von Mises Stress, Finite Element Modeling, node, element, Coordinates and Shape Functions, Element Stiffness Matrix and assembly, Properties of K, Use of local and natural coordinates, compatibility, and convergence requirements of shape functions.

**Laboratory Sessions/ Experimental learning:**2D plane stress analysis using ANSYS

**Applications:**

1. Solving practical technical problems using scientific and mathematical tools,
2. Calculating the global stiffness matrix in the finite element method

**Video link / Additional online information**

4. https://nptel.ac.in/courses/112/104/112104193/
5. https://nptel.ac.in/courses/112/104/112104116/
6. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

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

**Analysis of bars, truss, frames, and beams:**

Construction of shape functions for bar element and beam element, Plane trusses, Three-Dimensional trusses, Three-dimensional Frames

Construction of shape functions for bar element and beam element, Bar elements, uniform bar elements, uniform section, mechanical and thermal loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary

**Laboratory Sessions/ Experimental learning:**To determine maximum deflection and bending stress for given cantilever beam using ANSYS

**Applications:**

1. 2D and 3 D elements to apply boundary conditions,
2. The direct stiffness method to compute degrees of freedom at the element nodes.
3. To determine the value of state variable at any point of element based on values of state variable.

**Video link / Additional online information**

1. https://nptel.ac.in/courses/112/104/112104193/
2. https://nptel.ac.in/courses/112/104/112104116/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

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

**Analysis of Two- and Three-dimensional Elements:** Shape functions of Triangular, Rectangular and Quadrilateral elements, different types of higher order elements, constant and linear strain triangular elements, stiffness matrix Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Numerical

**Laboratory Sessions/ Experimental learning:**Analysis of CST Element by using ANSYS

**Applications:**

To approximate the *shape* of the object and to compute the displacement of points inside the boundary of the object

**Video link / Additional online information:**

3. https://nptel.ac.in/courses/112/104/112104193/
4. https://nptel.ac.in/courses/112/104/112104116/
5. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

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

**Theory of Isoparametric Elements and Axisymmetric:** Isoparametric, sub parametric and super-parametric elements, characteristics of Isoparametric quadrilateral elements, structure of computer program for FEM analysis, description of different modules, pre and post processing, Axisymmetric formulation finite element modeling of triangular and quadrilateral element. Numerical

**Laboratory Sessions/ Experimental learning:**Analysis of Long Cylinder (Axiymmetric Problem) using Quadrilateral Elements in ANSYS

**Applications:**

1. To create shape functions that would ensure the compatibility of the displacement between neighbouringelements while maintaining the requirements for shape functions
2. Higher-order approximation of the unknown function over a bounding surface described by non-planar elements.

**Video link / Additional online information:**

4. https://nptel.ac.in/courses/112/104/112104193/
5. https://nptel.ac.in/courses/112/104/112104116/
6. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

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

**Field Problems:** Heat transfer problems, Steady state fin problems, 1D heat conduction governing equation, Derivation of element matrices for two dimensional problems, Dynamic consideration- Formulation- Hamilton's principle, Element mass matrices. Numerical

**Laboratory Sessions/ Experimental learning:** Performing Heat Transfer Analysis Using ANSYS

**Applications:**

1. Problem involving heat flow
2. Structural dynamics

**Video link / Additional online information:**

4. https://nptel.ac.in/courses/112/104/112104193/
5. https://nptel.ac.in/courses/112/104/112104116/
6. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO303.1 | Apply discretization technique for domain using different finite elements |
| CO303.2 | Evaluate the effects of different loading and boundary conditions |
| CO303.3 | Analyse the governing equations of finite element analysis |
| CO303.4 | Formulating mathematical model using higher order element type |
| CO303.5 | Analyseheat flow problem by considering dynamic consideration |

Reference Books:


| | |
|---|---|
| 1. | ChandruPatla T. R, PHI Finite Elements in engineering, 3rd edition, 2002 |
| 2. | BhaviKatti, Finite element Analysis, New Age International, 3rd edition,2015 |
| 3. | Zienkiewicz. O.C, The Finite Element Method, Elsevier, 7th edition,2013 |
| 4. | C.S. Krishnamurthy, Finite Element analysis - Theory and Programming, Tata McGraw Hill Co. Ltd, New Delhi, 2nd edition,2011 |
| 5. | Rao S. S, Elsevier, Finite Elements Method in Engineering, 5th edition, 2008 |


CIE Assessment:

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- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

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- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO, PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 2 |

| **Course Title** | **THOERY OF VIBRATIONS** | Semester | V |
|---|---|---|---|
| **Course Code** | **MVJ20AE54/AS54** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 3:1: 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs. |

**Course objective is to:**

1.Understand the basic concepts of vibrations

2.Gain the knowledge of the undamped free vibration and damped free vibrations

3. Learn the vibration measuring instrumentation

4. Acquire knowledge of two degrees of freedom systems

| | | |
|---|---|---|
| 5. Understand numerical methods for Multi-Degree Freedom Systems | | |
| **Module 1** | **L1,L2,L3** | 10 Hrs. |
| Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions.Beats, Fourier theorem and simple problems.<br>**Laboratory Sessions/ Experimental learning:**<br>Simple pendulum experiment to understand concept of wave motion<br>**Applications:** Various types of vibrations and its real time applications<br>Concept of wave and its characteristics.<br>**Video link / Additional online information (related to module if any): (NPTEL,IIT ROORKEE)**<br>https://www.youtube.com/watch?v=9r630K5HmJc&list=PLSGws_74K01_pG3R7rgtDtrDZBjcTgPdR | | |
| **Module 2** | **L1,L2,L3** | 10 Hrs. |
| **Undamped Free Vibrations:** Single degree of freedom systems. Undamped free vibration, natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.<br>**Damped Free Vibrations:** Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, criticaland over damping, Logarithmic decrement<br>**Laboratory Sessions/ Experimental learning:**<br>Identifying Damping ration experiment allows students to understand behavior of vicious damper. [Design lab]<br>**Applications:** Various types of dampers and its real time applications**.**<br>**Video link / Additional online information (related to module if any) (NPTEL,IIT MADRAS)**<br>https://www.youtube.com/watch?v=tJNaPt5aPmg | | |
| **Module 3** | **L1,L2.L3** | 10 Hrs. |
| **Forced Vibration:** Single degree of freedom systems, steady state solution with viscous damping due toharmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation,transmissibility ratio due to harmonic excitation and support motion.<br>**Vibration Measuring Instruments & Whirling of Shafts:** Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral and torsional Vibrations.<br>**Laboratory Sessions/ Experimental learning:**<br>Whirling of shaft experiment [Design Lab]<br>**Applications:**<br>Isolators and its Application.<br>**Video link / Additional online information (related to module if any): (NPTEL,IIT KANPUR)**<br>https://www.youtube.com/watch?v=XGQr1uEX-Dc | | |
| **Module 4** | **L1,L2,L3** | 10 Hrs. |

**Systems with Two Degrees of Freedom:** Introduction, principle modes and Normal modes of vibration, coordinatecoupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Gearedsystems. Forced Oscillations-Harmonic excitation. Applications: Vehicle suspension, Dynamic vibrationabsorber and Dynamics of reciprocating Engines.

**Continuous Systems:** Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration ofrods, Euler's equation for beams.

**Laboratory Sessions/ Experimental learning:**Determination of two natural frequencies, or modes, for the system

**Applications: Dynamic vibration absorber and its application in reciprocating engine.**

**Video link / Additional online information (related to module if any): (NPTEL,IIT MADRAS)**

https://www.youtube.com/watch?v=V_Lj4Pun_WM

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

**Numerical Methods for Multi-Degree Freedom Systems:**

Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonalityofprincipal modes, Method of matrix iteration-Method of determination of all the natural frequencies usingsweeping matrix and Orthogonality principle. Holzer's method, Stodola method.

**Non-Linear Vibration** : (Advance theory of vibration by ssrao)

**Laboratory Sessions/ Experimental learning:**

Plotting displacement curve using Analytical Approach**.**

**Applications:**

Understanding non linear behavior of waves or vibration.

**Video link / Additional online information (related to module if any): (NPTEL,IIT MADRAS)**

https://www.youtube.com/watch?v=V_Lj4Pun_WM

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO304.1 | Apply the principle of super position to Simple Harmonic Motions. |
| CO304.2 | Analyse undamped free and damped free vibration |
| CO304.3 | Perform measurements of vibrations |
| CO304.4 | Evaluate the equations of twodegrees of freedom systems. |
| CO304.5 | Evaluate themulti degree of freedom system. |

| Reference Books: | |
|---|---|
| 1. | W.T. Thomson and MarieDillonDahleh, Theory of Vibration with Applications, Pearson Education, 2008 |
| 2. | V.P. Singh, Mechanical Vibrations, DhanpatRai& Company Pvt. Ltd, 2016 |
| 3. | S.S. Rao, Mechanical Vibrations, Pearson Education Inc, 2003 |
| 4. | S. Graham Kelly, Mechanical Vibrations, Tata McGraw Hill, 2007 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 3 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 1 | 3 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 3 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 1 | 0 | 0 | 1 | 0 | 1 | 3 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 2 | 0 | 0 | 1 | 0 | 01 | 3 | 1 | 1 |
| CO5 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 3 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **EXPERIMENTAL AERODYNAMICS** | Semester | V |
| **Course Code** | MVJ20AE551 | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 3:1: 0 | **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 Aerodynamic Measurements
2. Acquire the knowledge of various subsonic and transonic wind tunnels
3. Acquire the knowledge of supersonic and hypersonic wind tunnels
4. Understand the basics of various measurement techniques
5. Acquire the knowledge of role of wind tunnel in Aerodynamic Design

| **Module 1** | **L1,L2,L3** | 10 Hrs. |
|---|---|---|
| **Introduction Aerodynamics, Review of Wind Tunnels:**Background, Principle, Open and Close Circuit Wind Reynolds Number Effect and Laminar to Turbulent Transition, Dynamics Similarity and Dimensionless | | |

Parameters, Constraints of Testing: Blockage and correction, Model Installation and Different Kinds of Support, Free stream Vortical and Acoustic Perturbations, Design and Fabrication of Wind Tunnel Models. Deformation of Models, Deformation of Models, Limitations and Constraints of Numerical Methods and Wind Tunnel Test

**Industrial Aerodynamics Testing**: Combining Tests and Numerical Simulation. Flight Test Beds, Catapulted Flight Test, Aeroballistics Flight Test, Simulated Altitude Test Cells, Impact of Altitude, an Altitude Test Cell Work, Benefits of Simulated Altitude Tests in Addition to Ground

**Laboratory Sessions/ Experimental learning:** Estimation of forces on various models

**Applications:**Applicable in standard Airplane Design

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

https://nptel.ac.in/courses/101/106/101106040/

https://nptel.ac.in/courses/101/104/101104066/

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

**Subsonic Wind Tunnels:** Various Cross Sections, Low Reynolds Number, Multiple Test Section, Low Turbulence Research, Pressurized, Large Research Wind Tunnels. Special Purpose Wind Tunnels: Vertical, Climatic, Icing, Anechoic Chambers and Aero acoustic Wind Tunnel, Dual Purpose Aerodynamic and Acoustic Wind Tunnel, Wind Tunnels for Ground Vehicles, Water Tunnels.

**Transonic Wind Tunnels** : Definition of the Transonic Regime, Blockage Reduction and Flow Un-Chocking : Perforated or Slotted Walls , Adaptive Walls , Reflection of Disturbances, Double Throat Diffuser, Typical Transonic Wind Tunnels

**Laboratory Sessions**/ Experimental learning: Estimation **of blockage and corrections on various models**

**Applications:**Applicable in standard Airplane Design to validate the CFD results

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

https://nptel.ac.in/courses/101/106/101106040/

https://nptel.ac.in/courses/101/104/101104066/

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

**High speed wind tunnels:** Types of high speed tunnels Supersonic wind tunnels: Test section flow parameters, Components of supersonic wind tunnels, Power required for the operation of supersonic wind tunnels. Closed circuit supersonic wind tunnel. Actual flow in the supersonic wind tunnel Starting, Model Sizing and operational problems of the supersonic the wind tunnel.

**The shock tube**: Shock tube equations, Reflected shocks, Viscous effects and the shock tube boundary layer, Observation time in shock tube, Measurement of shock speed , Hypersonic facilities: Hypersonic wind tunnels, Plasma arc tunnels, Ballistic ranges, Low density wind tunnels

**Laboratory Sessions/ Experimental learning:** Estimation of power required for various wind tunnels

**Applications:** Applicable in standard High speed Airplane Design

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

https://nptel.ac.in/courses/101/106/101106040/

https://nptel.ac.in/courses/101/105/101105024/

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

Flow Visualization Techniques, Intrusive and Non-intrusive: Mechanical, Electrical and Electronic measuring Devices and their error estimates: Pressure, Temperature, Velocity, Density, Forces and Moment, Flow properties on a surface. Special Devices: Laser Spectroscopy and Electron Beam Excitation

**Laboratory Sessions/ Experimental learning:** Estimation of errors for various measurement techniques

**Applications:**Applicable in standard High speed Airplane Design

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

https://nptel.ac.in/courses/101/106/101106040/

https://nptel.ac.in/courses/112/103/112103290/

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

Computer-Aided Wind Tunnel Test and Analysis: Experimental Versus Numerical Analysis, CFD for the Preparation of Wind Tunnel Tests, Correction and Monitoring of Wind Tunnel Results by CFD, Towards the Hybrid Wind Tunnel , Reconstruction of Data. Prospects and Challenges for Aerodynamics: Role of the Wind Tunnel in Design and Optimisation, Flow Control, Developments in Aeroacoustic Measurements, Search for Novel Aircraft Architectures, Supersonic and Hypersonic Flights, Prospects for the Aerodynamic Design.

**Laboratory Sessions/ Experimental learning:** Estimation of errors in Experiments Vs CFD

**Applications:**Applicable in standard Airplane Design

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

https://nptel.ac.in/courses/101/106/101106040/

https://nptel.ac.in/courses/101/104/101104066/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO305.1.1 | Analyze various Aerodynamic Measurements |
| CO30.5.1.2 | Develop design experiments on subsonic and transonic wind tunnels |
| CO305.1.3 | Design experiments on supersonic and hypersonic wind tunnels. |
| CO305.1.4 | Illustrate the limitations of various measurement techniques |
| CO305.1.5 | Apply the knowledge of wind tunnel in Aerodynamic Design |

| Reference Books: | |
|---|---|
| 1. | Low Speed wind Tunnel Testing - Rae, W.H. and Pope,Alan |
| 2. | Wind Tunnel Techniques - Pankrust, R.C and Holder, D.W. |
| 3. | High Speed Wind Tunnel Testing - Pope,Alan&Goin |
| 4. | Shock Tubes in high temperature chemical physics - Gaydon,A.G. and Hurle, J.R |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO – PO MAPPING

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 |
| CO3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 3 | 3 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **COMPOSITE STRUCTURES** | Semester | V |
| **Course Code** | **MVJ20AS552/AE552** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 3:1: 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs. |

**The course objective is to:**

1.Understand theproperties and advantages of composite materials compared to conventional materials.

2.Comprehend the properties of polymer matrix composites with fibre reinforcements and to learn the fabrication methods used in composites

3. Gain knowledge about the Micro and macro mechanical properties of composite lamina and laminates

4.Understand the failure theories for predicting the failure of a composite lamina

5. Learn the NDT and DT methods of Composites with Composite applications

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

**Introduction to Composite Materials**

Definition, classification of composite materials, classification of reinforcement - particulate, short fibers, whiskers, long fibers composites. matrix materials – metals, ceramics, polymers (including thermoplastics and thermosets), Carbon-Carbon Composites

**Metal Matrix Composites:**

MMC with particulate and short fiber reinforcement, liquid and solid state processing of MMC – stir casting, squeeze casting. Properties of MMCs, Applications of Al, Mg, Ti based MMC

**Laboratory Sessions/ Experimental learning:**

**Determination of various composite materials by different types of fibers with application**

**Applications:** Aircraft structural Parts, Automobile Sector and Many Engineering fields

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

7. https://youtu.be/0kB0G6WKhKE?list=PLSGws_74K01-bdEEUElQ9-obrujIKGEhg – IIT Kanpur

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

**Processing of Polymer Matrix Composites:** Thermoset Polymers, Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding,**Resin Transfer Moulding**, Pultrusion, Pulforming, Autoclave Process

**Processing of Polymer Matrix Composites:** Thermoplastic Polymers, Extrusion process, Injection Moulding Process, Thermo-forming process.

**Post Processing of Composites –** Adhesive bonding, drilling, cutting processes.

**Laboratory Sessions/ Experimental learning:**

Preparation of Composite laminates by Hand layup method

**Applications:** Thermosets and Thermoplastics are used in Aircraft Construction, corrosive environment, Common applications include fans, grating, tanks, ducts, hoods, pumps and cabinets.

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

https://youtu.be/tP8JCX87DzI - IIT Roorkee

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

**Micro-Mechanical Behavior of a Lamina**

Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants. **Ultimate Strengths of a Unidirectional Lamina**

**Macro-Mechanical Behavior of a Lamina:**

Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Global and local axis for angle lamina, Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

**Laboratory Sessions/ Experimental learning:**

Determination of Young's Modulus of a Composite beam

**Applications:**Basics of macro level elastic properties, Scales of analysis of composites. Unidirectional and Woven fibers

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

https://youtu.be/loyeZN5UQT8 - IIT Madras

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

**Failure Theory**

**Different Strengths of Composite Lamina,Failure of Composite,** Tsai-Hill, Tsai-Wu, Max Stress and Max Strain theories

Classical plate theory- Stress and strain variation in a laminate- Resultant forces and moments- A B & D matrices- Strength analysis of a laminate.

**Laboratory Sessions/ Experimental learning:**

**Evaluate the mechanical properties of a lamina and a laminate**

**Applications:** Prediction of failure of composite, load analysis methodology.

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

https://youtu.be/6CLEWA2WNqM - IIT Madras

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

**Inspection & Quality Control**: Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan

**Applications of Composites Materials**

Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites.

**Laboratory Sessions/ Experimental learning:**

Determination of Defects in a composite by NDT Methods

**Applications: NDT- DT Methods, Composites in Aerospace sector**

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

https://youtu.be/ZMJ7O4vs-Q8 - IIT Kanpur

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO305.2.1 | Compare the properties and select material for the given application. |
| CO305.2.2 | Analyse the properties of polymer matrix composites and Fabrication of Composite materials |
| CO305.2.3 | Apply constitutive equations of *composite* materials and understand mechanical behaviour at *micro and macro* levels. |
| CO305.2.4 | Design and failure *analysis* for manufacturing *composite* materials and Determine stresses and strains relation in composites materials. |
| CO305.2.5 | Carry out various inspectionsin accordance with the established procedures and differentiate various defect types and select the appropriate **NDT** methods for better evaluation |

Reference Books:

| | |
|---|---|
| 1. | K.K Chawla, Composite Materials- Science and Engineering, IV edition, Springer International Publishing, 2019: ISBN: 978-3-030-28983-6 |
| 2. | Autar Kaw, Mechanics of Composites, II edition, Taylor & Francis Group CRC Press. 2006, ISBN:978-0-8493-1343-1 |
| 3. | R M Jones,Mechanics of Composite Materials, 2nd Edition, Taylor & Francis, 2015; ISBN:978-1560327127 |
| 4. | Ajay Kapadia**,** Non-Destructive Testing of Composite Materials, National Composites Network, Best Practices Guide, TWI Publications, 2006. |


**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| CO2 | 3 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| CO5 | 3 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **HEAT & MASS TRANSFER IN AERONAUTICAL APPLICATIONS** | **Semester** | **V** |
| **Course Code** | **MVJ20AE553** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 3:1: 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs. |

**The courseobjective is to:**

1. Understand the different modes of heat transfer.
2. Understand the conduction mode of heat transfer
3. Understand the free convection and forced convection.
4. Acquire knowledge on the working of heat exchangers used in aero industry.
5. Acquire the knowledge of heat transfer problems in aircraft technology.

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

**Fundamentals:**

- Different modes of heat transfer and mass and momentum transfer, elements of mass diffusion and boundary layer theory.
- Mass transfer definition and terms used in mass transfer analysis, Fick's First law of diffusion.Numerical problems

**Laboratory Sessions/ Experimental learning:**Heat and mass transfer lab

**Applications:** Gas turbine engines, Heat exchangers in Aero applications.

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

8. https://nptel.ac.in/courses/112/101/112101097/

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

**Conduction:** Derivation of general three-dimensional conduction equation in Cartesian coordinate, special cases, discussion on 3-D conduction in cylindrical and spherical coordinate systems.

Effect of variation of thermal conductivity on heat transfer in solids - Heat transfer problems in infinite and semi-infinite solids - Extended surfaces.

One dimensional transient heat conduction: Systems with negligible internal resistance, Significance of Biot and Fourier Numbers, Chart solutions of transient conduction systems.

**Laboratory Sessions/ Experimental learning:**Heat conduction experiment in HMT lab

**Applications:** Gas turbine combustion chamber, turbine and afterburners etc

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

4. https://nptel.ac.in/courses/112/105/112105271/

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

**Convection:**Concepts of Continuity, Momentum and Energy Equations. Dimensional analysis-Buckingham's Pi Theorem - Application for developing non-dimensional correlation for convective heat transfer

- **Free Convection:**Development of Hydrodynamic and thermal boundary layer along a vertical plate, Use of empirical relations for Vertical plates and pipes.
- **Forced Convection:**External Flows, Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders. Internal Flows, Concepts about Hydrodynamic and Thermal Entry Lengths, use of empirical correlations for Horizontal Pipe Flow and annulus flow.

**Laboratory Sessions/ Experimental learning:**Free and Forced convection experiments in HMT lab

**Applications:**Heat exchangers in Aero applications,Gas turbine combustion chamber, turbine and afterburners etc

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

1. https://nptel.ac.in/courses/112/106/112106170/

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

**Radiation:**

- Introduction to physical mechanism - Radiation properties - Radiation shape factors Heat exchange between non-black bodies – Radiation shields

**Heat Exchangers:**

- Heat Exchangers used in Aeronautical Industry: Classification of heat exchangers; overall heat transfer coefficient, Heat exchanger components, Numerical problems.

**Laboratory Sessions/ Experimental learning:**Radiation experiment in HMT lab

**Applications:** Combustion chambers in Rockets and varies gas turbine engines.

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

7. https://nptel.ac.in/courses/112/106/112106170/

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

**Heat and Mass Transfer Problems in Aeronautical Engineering:**

Heat transfer problems in gas turbine combustion chambers - Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer. Heat transfer problems in turbine and nozzle blades. Cooling of Turbines. Environmental control systems of aircraft.

**Laboratory Sessions/ Experimental learning: Basics in Aircraft propulsion lab**

**Applications:** Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer turbine and nozzle blades.

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

7. https://nptel.ac.in/courses/112/101/112101097/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO305.3.1 | Analyse the fundamentals of heat and mass transfer |
| CO305.3.2 | Explain the concept of one dimensional steady and transient heat conduction through various systems |
| CO305.3.3 | Evaluate the heat transfer by convection with the flow of fluids |
| CO305.3.4 | Analyzing heat transfer in heat exchangers |
| CO305.3.5 | Analysing heat transfer problems occurring in aircraft systems. |

**Reference Books:**


| | |
|---|---|
| 1. | Ozisik, Heat transfer-A basic approach, Tata McGraw Hill 2002 |
| 2. | Holman Heat Transfer, J.P McGraw Hill Book Co., Inc., New York 8th edition,1996 |
| 3. | Sachdeva.Fundamentals of Engineering Heat and Mass Transfer, S.C Wiley Eastern Ltd., New Delhi 1981 |
| 4. | SuttonRocket Propulsion Elements, G.P John Wiley and Sons 5th Edn.1986 |


**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

| **CO,PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| CO5 | 3 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **AERODYNAMICS LAB** | **Semester** | V |
| **Course Code** | **MVJ20AEL56** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Be acquainted with basic principles of aerodynamics using wind tunnel.
- Acquire the knowledge on flow visualization techniques.
- Understand the procedures used for calculating the lift and drag.

| **Sl No** | **Experiment Name** | **RBT Level** | **Hours** |
|---|---|---|---|
| **1** | Calibration of a subsonic wind tunnel: test section static pressure and total head distributions. | L1,L2,L3 | 03 |
| **2** | Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds. | L1,L2,L3 | 03 |
| **3** | Smokeflowvisualizationstudiesonatwodimensionalairfoilatdifferentanglesofincidenceatlowspeeds | L1,L2,L3 | 03 |
| **4** | Smoke flow visualization studies on a two dimensional wing with flaps and slats at different angles of incidence at low speeds | L1,L2,L3 | 03 |
| **5** | Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows. | L1,L2,L3 | 03 |
| **6** | Surface pressure distributions on a two dimensional smooth circular cylinder at low speeds and calculation of pressure drag. | L1,L2,L3 | 03 |
| **7** | Surface pressure distributions on a two-dimensional wing of symmetric airfoil and estimation of Center of pressure and Aerodynamic center | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **8** | Surface pressure distributions on a two-dimensional wing of cambered airfoil at different angles of incidence, and estimation of Center of pressure and Aerodynamic center. | L1,L2,L3 | 03 |
| **9** | Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey. | L1,L2,L3 | 03 |
| **10** | Calculation of total drag of a two-dimensional wing of cambered airfoil at low speeds at incidence using pitot-static probe wake survey. | L1,L2,L3 | 03 |
| **11** | Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness. | L1,L2,L3 | 03 |
| **12** | Calculation of aerodynamic forces and moments acting on a model aircraft at various Angle of Attack and speeds using wind tunnel balance With Yaw. | L1,L2,L3 | 03 |
| **13** | Calculation of aerodynamic coefficients and forces acting on a model aircraft at various Angle of Attack and speeds using wind tunnel balance Without Yaw. | L1,L2,L3 | 03 |
| **14** | Pressure measurements on aerofoil for a case of reverse flow. | L1,L2,L3 | 03 |

**Course outcomes:**

| | |
|---|---|
| CO1 | Apply the flow visualization techniques |
| CO2 | Estimate the pressure distribution over the bodies |
| CO3 | Calculate the forces and moments on models. |

**CO-PO Mapping**

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

High-3, Medium-2, Low-1

| Course Title | ENERGY CONVERSION LAB | Semester | V |
|---|---|---|---|
| Course Code | MVJ20AEL57 | CIE | 50 |
| Total No. of Contact Hours | 40 | SEE | 50 |
| No. of Contact Hours/week | 03 | Total | 100 |
| Credits | 02 | Exam. Duration | 3 Hours |

**Course objective is to:**

- Familiarizewiththeflashpoint,firepointandviscosityoflubricatingoils.
- StudyICengineparts,openingandclosingofvalvestodrawthevalve-timingdiagram.
- Gain knowledge of performance of IC engines.

| Sl No | Experiment Name | RBT Level | Hours |
|---|---|---|---|
| 1 | DeterminationofFlashpointandFirepointoflubricatingoilusingAbelPenskyApparatus | L1,L2,L3 | 03 |
| 2 | Determination of Flash point and Fire point of lubricating oil using Pensky Martins Apparatus. | L1,L2,L3 | 03 |
| 3 | Determination of Flash point and Fire point of lubricating oil using Cleave land Apparatus. | L1,L2,L3 | 03 |
| 4 | DeterminationofCalorificvalueoffuels using bomb calorimeter | L1,L2,L3 | 03 |
| 5 | DeterminationofCalorificvalueoffuels using Junker gas calorimeter | L1,L2,L3 | 03 |
| 6 | DeterminationofViscosityoflubricatingoilusingRed wood viscometer | L1,L2,L3 | 03 |
| 7 | DeterminationofViscosityoflubricatingoilusingSaybolt Viscometers. | L1,L2,L3 | 03 |
| 8 | DeterminationofViscosityoflubricatingoilusingTorsionviscometers | L1,L2,L3 | 03 |
| 9 | ValveTimingdiagramof4-strokeICEngine. | L1,L2,L3 | 03 |
| 10 | Estimation of viscosity of fluid by using Planimeter. | L1,L2,L3 | 03 |
| 11 | PerformanceTestonFourStrokePetrolEngineandcalculationsofIP,BP,Thermalefficiencies,SFC,FPandtodrawheatbalancesheet. | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **12** | PerformanceTestonFourstrokeMulti-cylinder Engine andcalculationsofIP,BP,Thermalefficiencies,SFC,FPandtodrawheatbalancesheet. | L1,L2,L3 | 03 |
| **13** | Performance testing and Morse test on four stroke cylinder petrol engine with hydraulic dynamometer | L1,L2,L3 | 03 |
| **14** | Performance testing on four stroke single cylinder VCR engine with resistance loading | L1,L2,L3 | 03 |

**Course outcomes:**

| | |
|---|---|
| CO1 | Determine theflashpoint,firepointandviscosityoflubricatingoils. |
| CO2 | Analyzeclosingofvalvestodrawthevalve-timingdiagram |
| CO3 | Performance estimation of IC engines. |

**CO-PO Mapping**

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

High-3, Medium-2, Low-1

| Course Title | FLUID MECHANICS LAB | Semester | V |
|---|---|---|---|
| Course Code | MVJ20AEL58 | CIE | 50 |
| Total No. of Contact Hours | 40 | SEE | 50 |
| No. of Contact Hours/week | 03 | Total | 100 |
| Credits | 02 | Exam. Duration | 3 Hours |

**Course objective is to:**

- Gaintheknowledgeofvariousflowmetersandtheconceptoffluidmechanics.
- Understand functioning of hydraulic pumps
- Gaintheknowledgeof Compressors

| Sl No | Experiment Name | RBT Level | Hours |
|---|---|---|---|
| 1 | Calibration of Venturimeter. | L1,L2,L3 | 03 |
| 2 | DeterminationofCoefficientofdischargeforasmallorificebyaconstantheadmethod. | L1,L2,L3 | 03 |
| 3 | Determination of coefficient of friction of flow in a pipe | L1,L2,L3 | 03 |
| 4 | CalibrationofcontractedRectangularNotch. | L1,L2,L3 | 03 |
| 5 | CalibrationofcontractedV-Notch. | L1,L2,L3 | 03 |
| 6 | VerificationofBernoulli'sequation. | L1,L2,L3 | 03 |
| 7 | Pipefrictionapparatuswithlossofheadonpipefittings. | L1,L2,L3 | 03 |
| 8 | DeterminationofCoefficientoflossofheadinasuddencontractionandfrictionfactor. | L1,L2,L3 | 03 |
| 9 | Estimate performanceof hydraulic Pumps -Single stage centrifugal pumps | L1,L2,L3 | 03 |
| 10 | Estimate performance of hydraulic Pumps –Multi- stage centrifugal pumps | L1,L2,L3 | 03 |
| 11 | Performance hydraulic Pumps- Reciprocating pump | L1,L2,L3 | 03 |
| 12 | Performance test on a two stage Reciprocating Air Compressor | L1,L2,L3 | 03 |
| 13 | Determination of force developed by impact of Jets on Vannes. | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **14** | Estimate the performance of Air Blower | L1,L2,L3 | 03 |
| | | | |
| **Course outcomes:** | | | |
| CO1 | Verify the Bernoulli's equation. | | |
| CO2 | Analyze performance of hydraulic pumps | | |
| CO3 | Analyze performance of Compressors | | |

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

High-3, Medium-2, Low-1

| Course Title | **ENVIRONMENTAL STUDIES** | Semester | V |
|---|---|---|---|
| Course Code | MVJ20ENV59 | **CIE** | 50 |
| Total No. of Contact Hours | 20 L: T: P 1 : 0 :0 | **SEE** | 50 |
| No. of Contact Hours/week | 1 | **Total** | 100 |
| **Credits** | 1 | **Exam. Duration** | 3 Hrs. |

**Course objective is to:**

- Relatetointerdisciplinaryapproachtocomplexenvironmentalproblemsusingbasictoolsofthenatural and social sciences including geo-systems, biology, chemistry, economics, political science and international processes; Study drinking water quality standards and to illustrate qualitative analysis of water.
- Critically evaluate the science and policy ramifications of diverse energy portfolios on air and water quality, climate, weapons proliferation and societal stability..

| **Module 1** | **L1,L2,** | 04 Hrs. |
|---|---|---|

**Introduction** to environmental studies, Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.

**Ecosystems (Structure and Function):** Forest, Desert, Rivers, Ocean

**Biodiversity:** Types, Hot spots; Threats and Conservation of biodiversity, Deforestation**.**

**Video link:**

https://nptel.ac.in/courses/127/106/127106004/

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

**AdvancesinEnergySystems(Merits,Demerits,GlobalStatusandApplications):** Hydrogen,Solar,OTEC, Tidal andWind.

**Natural Resource Management (Concept and case-study):** Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

**Video link:**

| | | |
|---|---|---|
| https://nptel.ac.in/courses/121/106/121106014/ | | |
| **Module 3** | **L1,L2,L3** | 10 Hrs. |
| **Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant EnvironmentalActs, Case-studies):**SurfaceandGroundWaterPollution;Noisepollution;SoilPollutionand Air Pollution.<br>**Waste Management & Public Health Aspects:** Bio-medical Waste; Solid waste; Hazardous waste; E-waste.<br>**Video link**:<br>• https://nptel.ac.in/courses/122/106/122106030/<br>• https://nptel.ac.in/courses/105/103/105103205/ | | |
| **Module 4** | **L1,L2,L3** | 10 Hrs. |
| . **Global Environmental Concerns (Concept, policies, and case-studies**): Global Warming ClimateChange;AcidRain;OzoneDepletion;Fluorideproblem Indrinkingwater.<br>**Video link:**<br>• https://nptel.ac.in/courses/122/106/122106030/<br>• https://nptel.ac.in/courses/120108004/ | | |
| **Module 5** | **L1,L2** | 10 Hrs. |
| **Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications):** G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO 14001.<br>**Video link:**<br>• https://nptel.ac.in/courses/105/102/105102015/<br>https://nptel.ac.in/courses/120/108/120108004/ | | |

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO1 | Describe the principles of ecology and environmental issues that apply to air, land, and water issueson a global scale. |
| CO2 | Develop critical thinking and/or observation skills, and apply them to the analysis of a problem orquestion related to the environment. |
| CO3 | Demonstrate ecology knowledge of a complex relationship between biotic and Abioticcomponents. |
| CO4 | Apply their ecological knowledge to illustrate and graph a problem and describe the realities thatmanagers face when dealing with complex issues. |

**Reference Books**:

| | |
|---|---|
| 1. | Principals of Environmental Science and Engineering, Raman Siva kumar,Cengage learning, Singapur, 2nd Edition, 2005 |
| 2. | Environmental Science – working with the Earth G.Tyler Miller Jr. Thomson Brooks /Cole,11th Edition, 2006 |
| 3. | Textbook of Environmental and Ecology, Pratiba Singh, Anoop Singh&PiyushMalaviya ,ACME Learning Pvt. Ltd. New Delhi, 1st Edition. |

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

High,3, Medium,2, Low,1

| Course Title | UNIVERSAL HUMAN VALUES-II | Semester | III |
|---|---|---|---|
| Course Code | MVJ20UHV510 | CIE | 50 |
| Total No. of Contact Hours | 20 L : T : P :: 1 : 0 :0 | SEE | 50 |
| No. of Contact Hours/week | 1 | Total | 100 |
| Credits | 1 | Exam. Duration | 3 Hours |

**Course objective is to:**

- Appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
- Facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
- Highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

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

Review on Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Self-exploration as the Process for Value Education, Happiness and Prosperity – Current Scenario,

**Value Education:** Understanding Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, , Method to Fulfill the Basic Human Aspirations,

**Practical Sessions:** Sharing about Oneself (Tutorial 1), Exploring Human Consciousness (Tutorial 2), Exploring Natural Acceptance (Tutorial 3)

**Video link:**

1. https://www.youtube.com/watch?v=85XCw8SU084
2. https://www.youtube.com/watch?v=E1STJoXCXUU&list=PLWDeKF97v9SP_Kt6jqzA3p Z3yA7g_OAQz

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

Review on Understanding Human being as the Co-existence of the Self and the Body, The Body as an Instrument of the Self, Harmony of the Self with the Body.

Harmony in the Human Being: Distinguishing between the Needs of the Self and the Body, Understanding Harmony in the Self, Programme to ensure self-regulation and Health.

**Practical Sessions:** Exploring the difference of Needs of Self and Body (Tutorial 4), Exploring Sources of Imagination in the Self (Tutorial 5), Exploring Harmony of Self with the Body (Tutorial 6).

**Video link:**

1. https://www.youtube.com/watch?v=GpuZo495F24

https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

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

Review on Harmony in the Family – the Basic Unit of Human Interaction, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society.

**Harmony in the Family and Society:** Trust' – the Foundational Value in Relationship, 'Respect' – as the Right Evaluation, Vision for the Universal Human Order,

**Practical Sessions:** Exploring the Feeling of Trust (Tutorial 7), Exploring the Feeling of Respect (Tutorial 8), Exploring Systems to fulfill Human Goal (Tutorial 9).

**Video link:**

1. https://www.youtube.com/watch?v=F2KVW4WNnS8

https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

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

**Harmony in the Nature/Existence:** Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfillment among the Four Orders of Nature, Realizing Existence as Co-existence at All Levels, The Holistic Perception of Harmony in Existence.

**Practical Sessions:** Exploring the Four Orders of Nature (Tutorial 10), Exploring Co-existence in Existence (Tutorial 11).

**Video link:**

1. https://www.youtube.com/watch?v=1HR-QB2mCF0
2. https://www.youtube.com/watch?v=lfN8q0xUSpw

https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw

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

Review on Natural Acceptance of Human Values,Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Holistic Technologies, Production Systems and Management Models-Typical Case Studies.

**Implications of the Holistic Understanding – a Look at Professional Ethics:** Definitiveness of (Ethical) Human

| |
|---|
| Conduct, Competence in Professional Ethics, Strategies for Transition towards Value-based Life and Profession<br>**Practical Sessions:** Exploring Ethical Human Conduct (Tutorial 12), Exploring Humanistic Models in Education (Tutorial 13), Exploring Steps of Transition towards Universal Human Order (Tutorial 14).<br>**Video link:**<br>1. https://www.youtube.com/watch?v=BikdYub6RY0<br><br>https://www.youtube.com/channel/UCQxWr5QB_eZUnwxSwxXEkQw |

| **Course outcomes:** | |
|---|---|
| CO1 | Explore themselves, get comfortable with each other and with the teacher |
| CO2 | Enlist their desires and the desires are not vague. |
| CO3 | Restate that the natural acceptance (intention) is always for living in harmony, only competence is lacking |
| CO4 | Differentiate between the characteristics and activities of different orders and study the mutual fulfillment among them |
| CO5 | Present sustainable solutions to the problems in society and nature |

| **Reference Books:** | |
|---|---|
| 1 | Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010 |
| 2 | Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999. |
| 3 | Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004. |
| 4 | The Story of Stuff (Book). |

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| Course Title | COMPRESSIBLE AERODYNAMICS | Semester | VI |

| | | | |
|---|---|---|---|
| Course Code | MVJ20AE61 | **CIE** | 50 |
| Total No. of Contact Hours | 50 L : T : P :: 3:2: 0 | **SEE** | 50 |
| No. of Contact Hours/week | 5 | **Total** | 100 |
| **Credits** | 4 | **Exam. Duration** | 3 Hrs. |

**The course objective is to:**

**1.** Understand the concepts of compressible flow.

2. Acquire knowledge of normal shock waves

3. Comprehend the phenomenon of oblique shocks and expansion waves

**4.** Understand the concepts of Differential Equations of Motion for Steady Compressible Flows

**5.** Gain knowledge of flow measurement techniques

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

**One Dimensional Compressible Flow:** Energy, Momentum, continuity and state equations, velocity of sound, Adiabatic steady state flow equations, Flow through converging, diverging passages, Performance under various back pressures. Numerical

**Laboratory Sessions/ Experimental learning:**Visualization of Flow analysis in Ansys Lab

**Applications:** Understanding the close coupling of thermodynamics and fluid dynamics and analyse typical aircraft systems like nozzles, diffusers, intakes

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

9. https://www.youtube.com/watch?v=mS3ZVuOn_lU&list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0&index=2
10. https://youtu.be/mS3ZVuOn_lU?list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0
11. https://youtu.be/HfZ5gfybJK4?list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0

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

**Normal Shock:** Prandtl Meyer equation and Rankine – Hugonoit relation, Normal shock equations: Property ratios in terms of upstream Mach number, Numericals, Moving Normal Shock wave. Shock tube.

**Laboratory Sessions/ Experimental learning:**Visualization of airfoil cross-section in Aerodynamics Lab

**Applications:** Analyzing the supersonic flow problems involving normal shock waves to design and analyze aircraft systems like nozzles, diffusers, intakes, shock tubes, wind tunnels, pipe flows.

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

1. https://nptel.ac.in/courses/112/106/112106166/
2. https://nptel.ac.in/courses/101/108/101108086/#

| Module 3 | L1,L2,L3 | 10 Hrs. |
|---|---|---|
| **Oblique shocks and Expansion waves**: Prandtl equation and Rankine – Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, flow past wedges and concave corners, strong, weak and detached shocks, Flow past convex corners, Prandtl –Meyer expansion function, Reflection and interaction of shocks and expansion waves.<br>**Laboratory Sessions/ Experimental learning:** Visualization of airfoil cross-section in Aerodynamics Lab<br>**Applications:** Analyzing the supersonic flow problems involving oblique shock waves to design and analyze aircraft systems like nozzles, diffusers, intakes, shock tubes, wind tunnels, pipe flows<br>**Video link / Additional online information (related to module if any):**<br>6. https://nptel.ac.in/courses/112/106/112106056/<br>7. https://nptel.ac.in/courses/112/106/112106056/<br>8. **https://nptel.ac.in/courses/112/106/112106056/** | | |
| **Module 4** | **L1,L2,L3** | 10 Hrs. |
| **Differential Equations of Motion for Steady Compressible Flows:** Basic potential equations for compressible flow. Linearisation of potential equation-small perturbation theory. Methods for solution of nonlinear potential equation –Introduction, Method of characteristics, Boundary conditions, Pressure coefficient expression, small perturbation equation for compressible flow - Prandtl, Glauret and Geothert's rules - Ackert's supersonic airfoil theory, Von-Karman rule for transonic flow, Lift, drag pitching moment and center of pressure of supersonic profiles<br>**Laboratory Sessions/ Experimental learning:**Flow Problems using Ansys Lab<br>**Applications:** Analyze and interpret the flow behavior<br>**Video link / Additional online information (related to module if any):**<br>1. https://nptel.ac.in/courses/101/106/101106044/<br>2. https://nptel.ac.in/courses/112/106/112106056/ | | |
| **Module 5** | **L1,L2** | 10Hrs. |
| **Measurements in High-speed Flow:** Types of subsonic wind tunnels Balances and measurements - Interference effects transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance – Shock tubes and shock tunnels - Free flight testing - Measurements of pressure, velocity and Mach number -Flow visualization methods of subsonic and supersonic flows.<br>**Laboratory Sessions/ Experimental learning:**Wind Tunnel model force measurements<br>**Applications:** Understand the significance of wind tunnels in Aeronautics/Aerospace and perform experiments on appropriate model's wind tunnel<br>**Video link / Additional online information (related to module if any):** | | |

| |
|---|
| 1. https://nptel.ac.in/courses/101/106/101106040/<br>2. https://nptel.ac.in/courses/101/106/101106044/ |
| **Course outcomes:**<br>Upon completion of the course, students will be able to: |

| | |
|---|---|
| CO310.1 | Apply the basic concepts of compressible flow |
| CO310.2 | Evaluate the concepts of normal shock phenomenon |
| CO310.3 | Apply the concepts of oblique shock and expansion wave formation. |
| CO310.4 | Utilize the concepts of Differential Equations of Motion for Steady Compressible Flows |
| CO310.5 | Investigate the parameters of high-speed flow. |

| **Reference Books:** | |
|---|---|
| 1. | John D Anderson, Modern Compressible Flow, McGraw Hill,3rd edition,2012,ISBN-13: 978-1259027420. |
| 2. | Radhakrishnan, E., Gas Dynamics, Prentice Hall of India,5th edition,2014,ISBN-13: 978-8120348394 |
| 3. | Ascher.H. Saphiro, Dynamics and Thermodynamics of Compressible fluid flow, John Wiley& Sons,1st edition,1977, ISBN-13: 978-0471066910. |
| 4. | Yahya, S.M., Fundamentals of Compressible flow, NEW AGE, 2009, ISBN-13: 978-8122426687. |
| 5. | H.W. Liepmann and A. Roshko, Elements of Gas Dynamics, Dover Publications Inc,2003,ISBN-13: 978-0486419633. |

| CIE Assessment: |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be:<br>Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| SEE Assessment: |

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO,PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| CO3 | 3 | 3 | 0 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **AIRCRAFT STRUCTURAL ANALYSIS** | **Semester** | **VI** |
| **Course Code** | **MVJ20AE62** | **CIE** | **50** |
| **Total No. of Contact Hours** | **50 L : T : P :: 3:2: 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **5** | **Total** | **100** |
| **Credits** | **4** | **Exam. Duration** | **3 Hrs.** |

**The courseobjective is to:**

1. Understand symmetrical and unsymmetrical sections.
2. Acquire the knowledge of Structural Idealization on open section tubes.
3. Acquire the knowledge of Structural Idealization on closed section tubes.
4. Gain knowledge of the failure modes in structures
5. Comprehend the stress analysis on Spar box beams and fuselage frames.

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

**Introduction:** Elementary theory of bending – Introduction to semi-Monocoque structures - Stresses in beams of symmetrical and unsymmetrical sections -Box beams – General formula for bending stresses- principal axes method – Neutral axis method.

**Laboratory Sessions/ Experimental learning**: Stress analysis on a flat plate using Ansys.

**Applications**: To differentiate and analyze the components of aircraft components.

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

12. https://swayam.gov.in/nd1_noc19_ae05/previewhttps://youtu.be/bQQMIy7Dlt0
13. https://nptel.ac.in/courses/101/101/101101079/
14. https:52/2013/AAE%20352%20Course%20Text%20Weisshaar%202011.pdf

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

**Shear Flow**: Shear stresses in beams – Shear flow in stiffened panels - Shear flow in thin-walled open tubes –Shear center – Shear flow in open sections with stiffeners.

**Laboratory Sessions/ Experimental learning**: Shear center and angle of twist in Aircraft Structures laboratory

**Applications:**To analyze shear flow in aircraft/spacecraft skin panels.

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

9. https://cosmolearning.org/courses/introduction-aerospace-structures/video-lectures/
10. https://ocw.tudelft.nl/course-lectures/shear-flow-thin-walled-section-2/
11. https://www.ae.msstate.edu/tupas/SA2/chA14.7_text.html

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

**Shear Flow Analyses:** Shear flow in closed sections with stiffeners– Angle of twist - Shear flow in two flange and three flange box beams – Shear center - Shear flow in thin-walled closed tubes - Bredt-Batho theory - Torsional shear flow in multi cell tubes - Flexural shear flow in multi cell stiffened structures.

**Laboratory Sessions/ Experimental learning**: Shear flow analyses for closed section in Ansys workbench.

**Applications**: To analyze the shear flow in closed thin-walled section of the aircraft.

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

1. https://swayam.gov.in/nd1_noc19_ae05/previewhttps://youtu.be/bQQMIy7Dlt0

2. https://www.popsci.com/story/technology/best-aerospace-innovations-2019/

3. https://nptel.ac.in/courses/101/101/101101079/

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

**Failure concepts**: Stability problems of thin-walled structures– Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham's and Gerard's methods–Sheet stiffener panels-Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams (Wagner's).

**Laboratory Sessions/ Experimental learning**: Fatigue analysis can be analyzed using Ansys workbench.

**Applications**: Used to predict the product life cycle management of aircraft components.

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

8. https://www.youtube.com/watch?v=3HE3A_vUZnw
9. https://www.youtube.com/watch?v=aivDhiLwu8E
10. https://www.youtube.com/results?search_query=unsw+aerospace+structures

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

**Stress Analysis in Wing Spars and Box beams:**

Tapered wing spar, open and closed section beams, beams having variable stringer areas, three- boom shell, torsion and shear, tapered wings, cut-outs in wings.

Stress Analysis in Fuselage Frames:

Bending, shear, torsion, cut-outs in fuselages, principles of stiffeners construction, fuselage frames, shear flowdistribution.

**Laboratory Sessions/ Experimental learning**: Fuselage Pressure Vessel experiment can be conducted using Ansys Workbench.

**Applications:**Helps to analyze the stress in Aircraft components.

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

8. https://youtu.be/bQQMIy7Dlt0
9. https://nptel.ac.in/courses/101/101/101101079/

Course outcomes:

| | |
|---|---|
| CO311.1 | Analyse symmetrical and unsymmetrical sections |
| CO311.2 | Perform structural idealization and analysis on open section tubes. |
| CO311.3 | Perform structural idealization and analysis on closed section tubes. |
| CO311.4 | Analyse failure of structures |

| | |
|---|---|
| CO311.5 | Estimatethe stress analysis in wing spar and box beams. |

| Reference Books: | |
|---|---|
| 1. | Megson, T.H.G., Aircraft Structures for Engineering Students, Edward Arnold,1995 |
| 2. | Perry D J & Azar J J , Aircraft Structures, 2nd edition, McGraw Hill N.Y.,1993 |
| 3. | BruhnE.F., Analysis and Design of Flight Vehicles Structures, Tri-Stateoffset Co.USA,1985 |
| 4. | T.H.G Megson, Introduction to Aircraft Structural Analysis, Elsevier,2nd Edition,2014 |

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

| CO, PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2.6 | 2.2 | 1.6 | 2.4 | 1 | 0 | 0 | 0.6 | 1.4 | 0.2 | 3 | 1 | 1 |
| CO2 | 3 | 2.6 | 2.2 | 1.6 | 2.4 | 1 | 0 | 0 | 0.6 | 1.4 | 0.2 | 3 | 1 | 1 |
| CO3 | 3 | 2.6 | 2.2 | 1.6 | 2.4 | 1 | 0 | 0 | 0.6 | 1.4 | 0.2 | 3 | 1 | 1 |
| CO4 | 3 | 2.6 | 2.2 | 1.6 | 2.4 | 1 | 0 | 0 | 0.6 | 1.4 | 0.2 | 3 | 1 | 1 |
| CO5 | 3 | 2.6 | 2.2 | 1.6 | 2.4 | 1 | 0 | 0 | 0.6 | 1.4 | 0.2 | 3 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **`Course Title** | **HELICOPTER DYNAMICS** | **Semester** | **VI** |
| **Course Code** | **MVJ20AE631** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 :1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1. Comprehend the basic concepts of helicopter dynamics.
2. Acquire knowledge of helicopter performance and rotor bearing system.

3. Understand the Aerodynamics of Rotor Airfoil and rotor wake phenomenon
4. Gain knowledge on the stability and control of Helicopter and its flight test requirements
5. Comprehend the design of Helicopter and its standards and specifications

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

**Introduction:** History of helicopter flight. Fundamentals of Rotor Aerodynamics; Momentum theory analysis in hovering flight. Disk loading, power loading, thrust and power coefficients. Figure of merit, rotor solidity and blade loading coefficient. Power required in flight. Axial climb, descent, and autorotation.

**Blade Element Analysis:** Blade element analysis in hovering and forward flight. Rotating blade motion. Types of rotors. Concept of blade flapping, lagging and coning angle. Equilibrium about the flapping hinge, lead/lag hinge, and drag hinge.

**Laboratory Sessions/ Experimental learning:**

Study of Performance of Propeller

**Applications:**

Understand the fundamentals of Helicopters dynamics

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

15. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

https://nptel.ac.in/courses/101/104/101104017/

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

**Basic Helicopter Performance**: Forces acting on helicopters in forward flight. Methods of achieving translatoryflight. Controlling cyclic pitch: Swash-plate system. Lateral tilt with and without conning. Lateral and longitudinal asymmetry of lift in forward flight. Forward flight performance- total power required effects of gross weight, effect of density altitude. Speed for minimum power, and speed for maximum range. Factors affecting forward speed, and ground effects.

**Laboratory Sessions/ Experimental learning:**

Study of the Surface pressure distribution on a 2-D cambered airfoil

**Applications:**

Study the performance of helicopter and the mechanism of swash plate assembly

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

https://nptel.ac.in/courses/101/104/101104017/

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

**Rotor Airfoil Aerodynamics:** Rotor airfoil requirements, effects of Reynolds number and Mach number. Airfoil shape definition, Airfoil pressure distribution. Pitching moment. Maximum lift and stall characteristics, high angle of attack range.

**Rotor Wakes and Blade Tip Vortices:** Flow visualization techniques, Characteristics of rotor wake in hover, and forward flight. Other characteristics of rotor wake.

**Laboratory Sessions/ Experimental learning:**

Smoke Flow visualization studies on 2-D airfoil and Circular cylinder

Tuft Flow visualization studies on 2-D airfoil

**Applications:**

Learn the aerodynamics of helicopter rotor

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics
   https://nptel.ac.in/courses/101/104/101104017/

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

**Helicopter Stability and Control.** Introductory concepts of stability.Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. Static stability of helicopters: longitudinal, lateral-directional and directional. Dynamic stability aspects. Main rotor and tail rotor control. Flight and Ground Handling Qualities-General requirements and definitions. Control characteristics, Levels of handling qualities.

**Flight Testing**- General handing flight test requirements and, basis of limitations.

**Laboratory Sessions/ Experimental learning:**

Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various angles of incidence

**Applications:**

Understand the stability & control aspects of helicopter and flight test requirements

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

https://nptel.ac.in/courses/101/104/101104017/

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

**Standards and Specifications:** Scope of requirements. General and operational requirements. Military derivatives of civil rotorcraft. Structural strength and design for operation on specified surfaces. Rotorcraft vibration classification.

**Conceptual Design of Helicopters:** Overall design requirements. Design of main rotors-rotor diameter, tip speed, rotor solidity, blade twist and aerofoil selection, Fuselage design, Empennage design, Design of tail rotors, High speed rotorcraft.

**Laboratory Sessions/ Experimental learning:**

Measurement of typical boundary layer velocity profile on the airfoil from leading edge to trailing edge

**Applications:**

Learn the design requirements of helicopter and its standards & specifications

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

https://nptel.ac.in/courses/101/104/101104017/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO312.1.1 | Apply the basic concepts of helicopter dynamics. |
| CO312.1.2 | Evaluate the helicopter performance. |
| CO312.1.3 | Outline the Aerodynamics of rotor Airfoil and rotor wake |
| CO312.1.4 | Generalize the helicopter stability and control and its test requirements |
| CO312.1.5 | Illustrate the design of a helicopter and its standards and specifications |

Reference Books:


| | |
|---|---|
| 1. | J. Gordon Leishman, Principles of Helicopter Aerodynamics, Cambridge University Press, 2002. |
| 2. | George H. Saunders, Dynamics of Helicopter Flight, John Wiley & Sons, Inc, NY,1975. |
| 3. | W Z Stepniewski and C N Keys, Rotary Wing Aerodynamics, Dover Publications, Inc, New York, 1984. |
| 4. | ARS Bramwell, George Done, and David Balmford, Helicopter Dynamics, 2nd Edition, Butterworth-Heinemann Publication, 2001. |


CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

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

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **EXPERIMENTAL STRESS ANALYSIS** | **Semester** | **VI** |
| **Course Code** | **MVJ20AS632/AE632** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 :1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1.Understand electrical strain gauges and their characteristics

2.Comprehend the stress strainof mechanical systems using electrical resistance strain gauges.

3. Gain knowledge of the photo elastic method to study and characterize the elastic behaviour of solid bodies.

4. Acquire knowledge of stress strain behaviour of solid bodies using methods of coating.

5. Gain knowledge of the Moire`s methods and analysis

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

**Introduction:** Definition of terms, Calibration, Standards, Dimension and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause and types of experimental errors. General consideration in data analysis.

**Electrical Resistance:** Strain Gages: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance' Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone's bridges, Constant current circuits.

**Laboratory Sessions/ Experimental learning:**

Strain sensitivity in metallic alloys, Wheatstone's bridges

**Applications:**

**Usage of Strain gage, Identifying Errors during calibration**

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

16. https://www.youtube.com/watch?v=tkOGqG1Wj8g

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

**Strain Analysis Methods:** Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage.

**Force, Torque and strain measurements:** Mass balance measurement, Elastic element for force measurements, torque measurement.

**Laboratory Sessions/ Experimental learning:**

Force measurements, torque measurement.

**Applications:** Methods to find measuring parameters

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

**5.** https://www.youtube.com/watch?v=ydyVsVk96z8

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

**Two Dimensional Photoelasticity:** Nature of light, Wave theory of light - optical interference, Stress optic law –effect of stressed model in plane and circular polariscopes, Isoclinics&Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photo elastic model materials

Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Materials for 2D photoelasticity.

**Three Dimensional Photo elasticity:** Stress freezing method, Scattered light photoelasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses.

**Digital Photoelasticity:** Introduction, Full field Displacement, Strain displacement data, Advanced Video Extensometer, Dic application and advantages.

**Laboratory Sessions/ Experimental learning:**

optical interference

**Applications: Understanding** stress variation under loading

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

12. https://www.youtube.com/watch?v=5tKPLfZ9JVQ

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

**Photo elastic (Birefringent) Coatings: Birefringence** coating stresses, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings

**Laboratory Sessions/ Experimental learning:**

Scattered light polariscope and stress data Analyses.

**Applications:** Identifying Stress

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

11. https://www.youtube.com/watch?v=bkYqqJa5P8w

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

**Brittle Coatings:** Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.

**Moire Methods:**Moire fringes produced by mechanical interference. Geometrical approach,

(Shearing interferometry, Digital image correlation ,Specal Method, correction factor, calibration tecniques) Displacement field approach to Moire fringe analysis, 0ut of plane displacement measurements, out of plane slope measurements. Applications and advantages

**Laboratory Sessions/ Experimental learning:**

Moire fringe analysis

**Applications:** Understanding holographic technique

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

10. https://www.youtube.com/watch?v=UW5bcsax78I
11. https://www.youtube.com/watch?v=jHb-PM5qH7s&list=PL16JJHgYPkvMyabXO3RVs0YoqwSdMo4YT (NPTEL course )

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO312.2.1 | Analyse electrical strain gaugesand their characteristics. |
| CO312.2.2 | Evaluate stress strain of mechanical systems using electrical resistance strain gauges. |
| CO312.2.3 | Analyse the elastic behavior of solid bodies using photo elastic methods |
| CO312.2.4 | Illustrate tress strain measurements using method of coatings. |
| CO312.2.5 | Analyse moire methods and their applications |

| Reference Books: | |
|---|---|
| 1. | Srinath L.S Experimental stress Analysis, tata Mc Graw Hill, 1st edition 1971 |
| 2. | Sadhu Singh,Experimental Stress Analysis., Khanna publisher. 1st edition 1981 |
| 3. | Dally and Riley,Experimental Stress Analysis, McGraw Hill. 1st edition 1991 |
| 4. | Holman, Experimental Methods for Engineers, Tata McGraw-Hill Companies, 7th Edition, New York, 2007. |

| CIE Assessment: |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| SEE Assessment: |
| - Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.<br>- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.<br>- One question must be set from each unit. The duration of examination is 3 hours. |

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 1 | 2 | 1 | 0 | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO2 | 3 | 3 | 2 | 3 | 3 | 2 | 0 | 0 | 0 | 1 | 2 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 1 | 0 | 0 | 0 | 1 | 2 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 2 | 0 | 0 | 0 | 2 | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 1 | 0 | 0 | 0 | 2 | 2 | 2 | 1 | 1 |

High,3, Medium,2, Low,1

| **Course Title** | **UNMANNED AERIAL VEHICLES** | **Semester** | **6** |
|---|---|---|---|
| **Course Code** | **MVJ20AE633** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 :1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1. Comprehend the basic aviation history and UAV systems
2. Understand the air vehicle basic aerodynamics and performance
3. Acquire knowledge ofStability and Control
4. Understand concepts of Propulsion, Loads and Structures
5. Comprehend the various Mission Planning and Control

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

Introduction to Aviation, Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology UAVs, UAV fundamentals, Examples of UAV systems-very small, Small UAV, Medium UAV, Large UAV, UAV applications.

**Laboratory Sessions/ Experimental learning:**

Design and development of Unmanned Aerial vehicle for real world applications.

**Applications:**

Usage of UAV systems for Aerial monitoring, surveillance systems

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2. NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

**Introduction**: The Air Vehicle Basic Aerodynamics, Basic Aerodynamics equations, Aircraft polar, The real wing and Airplane, Induced drag, The boundary layer, Flapping wings, Total Air-Vehicle Drag, Performance: Overview,Climbing flight, Range for propeller driven aircraft,Range- a jet-driven aircraft, Endurance-for propeller driven aircraft,Guiding Flight.

**Laboratory Sessions/ Experimental learning:**

Conduct the various experiments using the Aerodyanamics lab and its equations.

**Applications:**

Determine the endurance limit for propeller driven shaft.

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

1. NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2. NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

**Stability & Control**: Stability, Longitudinal, lateral, Dynamic stability, Aerodynamics control, Pitch control, lateral control, Autopilots, sensor, Controller, actuator, Airframe control, Inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot.

**Laboratory Sessions/ Experimental learning:**

Determine the longitudinal, lateral and dynamic stability using the Aerodynamics control.

**Applications:**

Various sensors used for the Autopilot system and control systems.

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

| **Module 4** | **L1,L2,L3** | 10Hrs. |
|---|---|---|
| **Propulsion Overview:** Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine,Electric Motors, Sources of Electrical Power.<br><br>**Structures**: Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials Resin Materials, CoreMaterials& Construction Techniques.<br><br>**Laboratory Sessions/ Experimental learning:**<br>Determine the efficiency of the various types engines used in the Unmanned Aerial Vehicle<br>**Applications:**<br>Usage of various applications of the resin material and skin reinforcing materials for the aircraft constructions.<br>**Video link / Additional online information (related to module if any):**<br>**1.**NPTEL- https://nptel.ac.in/courses/101/104/101104073/<br>**2.**NPTEL- https://nptel.ac.in/courses/101/104/101104083/ | | |
| **Module 5** | **L1,L2** | 10Hrs. |
| Mission Planning and Control, Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch, Recovery Trade-offs.<br><br>**Laboratory Sessions/ Experimental learning:**<br>Determine the various payloads used for the various operations of flight<br>**Applications:**<br>Usage of launch and recovery systems used in the Unmanned Aerial Vehicle<br>**Video link / Additional online information (related to module if any):**<br>1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/<br>2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/ | | |

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO312.3.1 | Apply the basic concepts of UAV systems |
| CO312.3.2 | Utilise the knowledge of air vehicle basic aerodynamics and performance |
| CO312.3.3 | Apply the knowledge of Stability and Control |
| CO312.3.4 | Evaluate the Propulsion systems, Loads and Structures |
| CO312.3.5 | Apply the mission, planning and control |

| Reference Books: | |
|---|---|
| 1. | Paul GerinFahlstrom , Thomas James Gleason, INTRODUCTION TO UAV SYSTEMS, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd |
| 2. | Landen Rosen, Unmanned Aerial Vehicle, Publisher: Alpha Editions, ISBN 13 : 9789385505034. |
| 3. | Unmanned Aerial Vehicles: DOD‟s Acquisition Efforts, Publisher : Alpha Editions, ISBN13 : 9781297017544 |

| CIE Assessment: |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| SEE Assessment: |
| - Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.<br>- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.<br>- One question must be set from each unit. The duration of examination is 3 hours. |

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low

| Course Title | MAINTENANCE REPAIR AND OVERHAUL | Semester | VI |
|---|---|---|---|
| Course Code | MVJ20AE641 | CIE | 50 |
| Total No. of Contact Hours | 40 L : T : P :: 3 :1 : 0 | SEE | 50 |
| No. of Contact Hours/week | 4 | Total | 100 |
| Credits | 3 | Exam. Duration | 3 Hrs. |

**The course objective is to:**

1. Comprehend the fundamentals of maintenance and certification.
2. Acquire knowledge of documentation for maintenance.
3. Understand the AircraftManagement Maintenance.
4. Gain knowledge of Hanger maintenance on Aircraft and material support.
5. Acquire knowledge of maintenance safety and trouble shooting in Airlines.

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

**Fundamentals of Maintenance & Certification:**

Types of maintenance, Redesign, Failure rate pattern, Other maintenance considerations. Aviation industry certification requirements, Type certificate (FAA form 8110.9), Airworthiness certificate (FAA form 8100-2), Aviation maintenance certifications, General, Airframe, Power plant, Avionics courses.

**Laboratory Sessions/ Experimental learning:**A demo on maintenance procedure in wind tunnel lab.

**Applications:** Apply the certification process in Aircraft industry.

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

17. https://www.youtube.com/watch?v=KEF2szWaEgg – Introduction about Aircraft Maintenance-NPTEL-IITK
18. https://www.youtube.com/watch?v=CoLWYZP9BkY&list=PLExlUJZK1IOnUv8IeOXLk_njBYhc-Xh6V – Aircraft Maintenance-NPTEL-IITK
19. https://www.youtube.com/watch?v=H45vSzyiXH4 – Airplane Maintenance

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

**Documentation for Maintenance**

Manufacturer's documentation, Airplane maintenance manual, Fault insulation manual, Illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment, Federal Aviation regulation (FAR), Advisory circulars, Airworthiness direction ATA document standards, Technical policies and procedure manuals (TPPM).

**Laboratory Sessions/ Experimental learning:** A demo on Airplane maintenance manual documentation procedure.

**Applications:** Apply the documentation standard procedures for maintenance in aircraft.

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

6. https://www.youtube.com/watch?v=z6607nep8iU-Aircraft - Air worthiness required Inspection &Documentation
7. https://www.youtube.com/watch?v=QxdhMa25MGw – Aircraft structure repair manual
8. https://www.youtube.com/watch?v=WTk3bT01M7c –Aircraft Maintenance guidelines

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

**Aircraft Management Maintenance**

Structure, Role of aviation management, Line supervisory management, Management areas of concern in airlines, Manager of overhaul shops, Line maintenance control centre flight line (preflight& post flight), Aircraft Logbook, Maintenance crew skill requirements.

**Laboratory Sessions/ Experimental learning:**A demo on aircraft logbook.

**Applications:**Implement the aviation management in airlines.

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

13. https://www.youtube.com/watch?v=f6F_ecq1njc – Aviation management
14. https://www.youtube.com/watch?v=P7GfDmd7Nqw-Aircraft line maintenance check example

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

**Hanger Maintenance on Aircraft & Material Support**

Introduction, organization of hanger maintenance, Non- routine item, parts availability, cannibalization, Types of shops- sheet metal shop, Aircraft interior shop, Engine shop, Avionics shop, ground support equipment, outsourcing of shop maintenance work, operation of overhaul shops, Material support, Material management inventory control, Support functions of material, Parts ordering, Storage, Issue, control and handling, Parts receiving quality control, calibration program, stock level adjustments, shelf life, exchanges, warranty & modifications of parts.

**Laboratory Sessions/ Experimental learning:**A demo on maintenance on propulsion lab.

**Applications:** Apply the maintenance system in hanger maintenance, engine shop, avionics shop etc., and perform the materials management and inventory control in aircraft industry.

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

12. https://www.youtube.com/watch?v=-zCTFfn-Fyk – Inside an Aircraft Maintenance hanger
13. https://www.youtube.com/watch?v=TCThd0Vr0cQ –Aircraft Maintenance work
14. https://www.youtube.com/watch?v=U44RQAzf4NI – Introduction to Inventory and materials management

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

**Maintenance Safety & Trouble shooting**

Safety regulations, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, Knowledge of malfunctions.

**Laboratory Sessions/ Experimental learning:**A demo on safety system in wind tunnel lab.

**Applications:** Apply the safety regulations, OSHA safety programs and troubleshooting systems in aircraft.

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

12. https://www.youtube.com/watch?v=aRA7QR2Mr_w – Airlines safety management system
13. https://www.youtube.com/watch?v=5bc1qBtkRWA –How do Airline store aircraft?
14. https://www.youtube.com/watch?v=89IWIG0Uhz0 – trouble shooting procedure for the aircraft systems

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO313.1.1 | Apply the certification procedure for aircraft maintenance. |
| CO313.1.2 | Classify the aircraft maintenance manual and logbook. |
| CO313.1.3 | Apply the management system in aircraft maintenance. |
| CO313.1.4 | Examine the quality control and calibration on Aircraft. |

| | |
|---|---|
| CO313.1.5 | Investigate the safety regulations and rules in Aircraft. |

| Reference Books: | |
|---|---|
| 1. | Harry A Kinnison, Tariq Siddiqui, Aviation Maintenance Management, Mc Graw Hill education (India) Private Ltd, 2013. |
| 2. | Kroes, Watkins, Delp, Aircraft maintenance and repair, Mc Graw Hill,2013. |
| 3. | Larry Reithmaier, Aircraft Repair Manual, Palmar Books, Marquette,1992. |
| 4. | Brimm. DJ,Bogges, HE,AircraftMaintenance,Pitman publishing corp,London,1952. |

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

| CO/ PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 1 | 1 | - | - | 1 | 1 | 1 | 1 | 1 | 2 |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | - | - | 1 | 1 | 1 | 1 | - | - |
| CO3 | 3 | 2 | 2 | 2 | 1 | 1 | - | - | 1 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 3 | 2 | 2 | 2 | 1 | 1 | - | - | 1 | 1 | 2 | 1 | - | - |
| CO5 | 3 | 2 | 2 | 2 | 1 | 1 | - | - | 1 | 1 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **ARTIFICIAL INTELLIGENCE AND ROBOTICS** | **Semester** | **VI** |
| **Course Code** | **MVJ20AE642** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 :1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1. Understand the basic techniques of artificial intelligence
2. Understand Non-monotonic reasoning and statistical reasoning
3. Introduce the electronics and software aspects in the design of robots
4. Introduce the latest state of the art robots
5. Understand the usage of AI in Robots

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

Computerized reasoning - Artificial Intelligence (AI) - characteristics of an AI problem - Problemrepresentation in AI - State space representation - problem reduction-Concept of small talkprogramming

**Laboratory Sessions/ Experimental learning:**Compare the theoretical solution to the forward kinematics problem with a physical implementation on the robot.

**Applications:** Design, Supply chain management, Prediction of in-service damages

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

20. https://nptel.ac.in/courses/106/102/106102220/

| **Module 2Search Process&Knowledge Representation** | **L1, L2, L3,** | 10 Hrs. |
|---|---|---|

**Search Process:**AI and search process - Brute force search techniques - Depth first - Breadth first searchtechniques - Hill climbing - Best first search - AND/OR graphs - A* algorithm - Constraint satisfaction.

**Knowledge Representation:** Logic, Propositional logic - Tautology - Contradiction - Normal forms - Predicate logic - Rules of inference - Resolution - Unification algorithm -Production rules - Semantic networks - Frames – Scripts - Conceptual dependency.

**Laboratory Sessions/ Experimental learning:**Derive and implement a solution to the inversekinematics problem for the robot

**Applications:** Predictive Maintenance, Flight performanceOptimization, Reverse Engineering

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

**9.** https://nptel.ac.in/courses/106/102/106102220/

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

**Scope of Robots:** The scope of industrial Robots - Definition of an industrial robot - Need for industrial robots.

**Robot Components:**Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume- Precision of movement - End effectors - Sensors

**Laboratory Sessions/ Experimental learning:**Controlling the robots using the programming language

**Applications:** Quality control, Smart Factory Building, Repetitive work management

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

15. https://nptel.ac.in/courses/112/105/112105249/

| **Module 4Future Trends in Robots** | **L1, L2, L3** | 10 Hrs. |
|---|---|---|

Telepresence robot - Autonomous mobile robots - Walker Robots – Solarball Robot – Underwaterbots – Aerobots - Advanced robotics in Space - Specific features of space robotics systems – longterm technical developments - Next generation robots.

**Laboratory Sessions/ Experimental learning:**Integrate computer vision and control of the robot

**Applications:** Training, Smart Repairs Management

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

15. https://nptel.ac.in/courses/112/105/112105249/

| **Module 5AI in Robotics** | **L1, L2** | 10 Hrs. |
|---|---|---|

Robotic perception, localization – mapping- configuring space - planning uncertain movements - dynamics and control of movement, Ethics and risks of artificial intelligence in robotics.

**Laboratory Sessions/ Experimental learning:**Integrate forward and inverse kinematics and computer vision to control the robot

**Applications:** AI Autopilot in commercial flights, Knowledge-Based Engineering

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

15. https://nptel.ac.in/courses/106/102/106102220/

| **Course outcomes:** | |
|---|---|
| Upon completion of the course, students will be able to: | |
| CO313.2.1 | Apply the basic techniques of artificial intelligence |
| CO313.2.2 | Compare and contrast Non-monotonic reasoning and statistical reasoning |
| CO313.2.3 | Design and develop robotic based systems |
| CO313.2.4 | Develop automatic solution for replacing humans in life threatening area |
| CO313.2.5 | Interpret basic AI algorithms in Robotics |

| Reference Books: | |
|---|---|
| 1. | Elaine Rich And Kevin Knight,Artificial Intelligence, Tata Mcgraw-Hill, 3rd edition,2008. |
| 2. | Barry Leatham - Jones, Elements of industrial Robotics, Pitman Publishing, 1987 |
| 3. | J. M. Selig, Introductory Robotics, Prentice Hall, 1992 |
| 4. | David Jefferis, Artificial Intelligence: Robotics and Machine Evolution, Crabtree Publishing Company, 1992 |

| CIE Assessment: |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| SEE Assessment: |
| - Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.<br>- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.<br>- One question must be set from each unit. The duration of examination is 3 hours. |

| CO,PO Mapping | | |
|---|---|---|

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | 1 |
| CO2 | 3 | 3 | - | - | 3 | - | - | - | - | - | - | - | 1 | 1 |
| CO3 | - | - | - | - | - | 3 | - | - | - | - | - | - | 1 | 1 |
| CO4 | - | - | 3 | - | - | 2 | 3 | - | - | - | - | 3 | 1 | 1 |
| CO5 | 3 | 3 | 3 | - | 3 | - | 2 | - | - | - | - | 3 | 1 | 1 |

High,3, Medium,2, Low,1

| **Course Title** | **GAS TURBINE TECHNOLOGY** | **Semester** | **VI** |
|---|---|---|---|
| **Course Code** | **MVJ20AE643** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 :1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1. Comprehend the types of engines and its applications.
2. Acquire the knowledge of engine parts.
3. Acquire the knowledge of engine performance.
4. Acquire the knowledge of fuels and various systems.
5. Gainknowledge of engine Testing.

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

**Types, Variation & Applications:** Types of engines showing arrangement of parts. Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Comparison of thrust and specific fuel consumption. Thrust, pressure and velocity diagrams.

**Engine Parts:** Compressor assembly, types of burners: advantages and disadvantages. Influence of design factors on burner performance. Effect of operating variables on burner performance. Performance requirements of combustion chambers. Construction of nozzles. Impulse turbine and reaction turbine. Exhaust system, sound suppression. Thrust reversal: types, design & systems. Methods of thrust augmentation, after burner system.

**Laboratory Sessions/ Experimental learning:**

Demo in Propulsion laboratory

21. Comprehend the cascade testing of axial compressor and axial turbine blade row.
22. Study the performance of propeller and jet engines.

23. Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles.

**Applications:** To understand the different types of Engines and Working.

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

1. Gas Dynamics and Propulsion by Prof. V. Babu,Department of Mechanical Engineering,IIT Madras.

https://youtu.be/30-FdRgygI0

https://youtu.be/iKLRgAgfjKE

2. Aircraft Propulsion Course URL: https://swayam.gov.in/nd1_noc19_me76/... Prof. Vinayak N. Kulkarni Dept. of Mechanical Engineering IIT Guwahati

https://youtu.be/7WFBBE2sKHE

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

**Compressor:** Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation. **Combustor:** Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation. **Turbines:** Turbine MAP. Turbine Testing and Performance Evaluation. **Inlet duct &nozzles:** Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation

**Laboratory Sessions/ Experimental learning:**

1. Study the performance of propeller and jet engines.
2. Measurement of nozzle flow.
3. Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio

**Applications:** To understand the performance characteristics of gas turbine engines.

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay.

https://youtu.be/AOmo98peh6I

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

**Engine Performance:** Design & off-design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process & Wind milling of Engines. Thrust engine start envelope. Starting torque and speed requirements Calculations for design and off-design performance from given test data– (case study for a single shaft Jet Engine). Engine performance monitoring.

**Laboratory Sessions/ Experimental learning:**

1. Study of performance of a propeller.
2. Performance studies on a scaled jet engine
3. Study of Fuel injection characteristics

**Applications:**To understand the performance characteristics of gas turbine engines.

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay.

https://youtu.be/AOmo98peh6I

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

**Fuels:** Combustion Properties of Fuels, Calorific Value, Enthalpy, Spontaneous-Ignition temperature, Limits of Flammability, Smoke Point, Luminometer Number, Smoke Volatility Index, Pressure and Temperature Effects, Sub atmospheric Pressure, Low Temperature, High Temperature.

**Systems:** Fuel systems and components. Sensors and Controls. FADEC interface with engine. Typical fuel system. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas turbine starters.

**Laboratory Sessions/ Experimental learning:**

Demo in Propulsion laboratory

1. Study of Fuel injection characteristics

**Applications:**

1.To understand the properties of fuels used in gas turbines

2. To understand the various fuel, oil and starting systems

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

16. Gas Dynamics and Propulsion by Prof. V. Babu,Department of Mechanical Engineering,IIT Madras.

https://youtu.be/v7UJBqmsNWw

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

**Engine Testing:** Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine - operating limits. Methods of displacing equilibrium lines.

**Types of engine testing's:** Normally Aspirated Testing, Open Air Test Bed, Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in flight. Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft

speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology.

**Laboratory Sessions/ Experimental learning:**

1. Study the performance of propeller and jet engines.
2. Performance studies on a scaled jet engine
3. Measurement of nozzle flow.
4. Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio

**Applications:** To understand the standardflight testing procedures.

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

Introduction to Various Aircraft engines, Engine Performance parameters Aircraft Propulsion Course URL: https://swayam.gov.in/nd1_noc19_me76/...Prof. Vinayak N. Kulkarni Dept. of Mechanical Engineering IIT Guwahati

https://youtu.be/BT9oq73VxC4

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO313.3.1 | Analyse engines for applications |
| CO313.3.2 | Apply the knowledge of engine parts |
| CO313.3.3 | Evaluate engine performance |
| CO313.3.4 | Evaluate various engine systems. |
| CO313.3.5 | Evaluate Engine Testing with different test methods |

Reference Books:


| | |
|---|---|
| 1. | Irwin E. Treager,Gas Turbine Engine Technology, McGraw Hill Education 3rd edition,2013 |
| 2. | P. P Walshand P. Peletcher , Gas Turbine Performance, Blackwell Science Science 1998 |
| 3. | A. W. Morley Jean Fabri Pergamon , Advanced Aero-Engine Testing, 1959 |
| 4. | JP Holman, Experimental methods for Engineers, Tata Mc Graw Hill 7th edition,2007 |
| 5. | Michael J. Kores, and Thomas W. Wild ,Aircraft Power Plant Tata Mc Graw Hill Publishing Co. Ltd7thEdition,2002 |

| CIE Assessment: |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| SEE Assessment: |
| - Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.<br>- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.<br>- One question must be set from each unit. The duration of examination is 3 hours. |

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | - | - | - | 1 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 | 1 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 | 1 |
| CO4 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 | 1 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **GENERAL INTRODUCTION TO AERONAUTICS** | **Semester** | **VI** |
| **Course Code** | **MVJ20AE651** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 :1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

6. Gain knowledge of the History of Aviation
7. Understand the basic Aircraft configurations
8. Understand the aircraft structures and materials.
9. Acquire knowledge of aircraft and rocket power units
10. Learn aircraft stability aspects

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

**Introduction**

Early Developments – Ornithopters, Balloon Flight, Gliders, Wilbur and Orville Wright – Inventors of First Practical Airplane, Aeronautical Triangle – Langley, Wrights and Glenn Curtiss, Problem of Propulsion, Faster and Higher, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

**Laboratory Sessions/ Experimental learning:**

Demo in Aerodynamics laboratory

1. Understand the basics of air flow over airfoil and various other models in the wind tunnel in Aerodynamics Lab

**Applications:**

1. Understanding the basics concepts of flying

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

1. Introduction to Aerospace Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay For more details on NPTEL visithttp://nptel.iitm.ac.in

https://youtu.be/ohmyMEwfp5g

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

**Aircraft Configurations:**

Different types of flight vehicles, classifications. Components of an airplane and their functions.

Conventional control, Powered control, Basic instruments for flying - Typical systems for control actuation.

**Laboratory Sessions/ Experimental learning:**

Demo in Propulsion laboratory

1. Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles)

**Applications:**

1. Understand the aircraft structures and materials.

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

General Introduction: Airplane Performance Characteristics (NPTEL)

https://youtu.be/tEWuP1NVdgE

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

**Airplane Structures and Materials:**

General types of construction, Monocoque, semi-monocoque and geodesic constructions, Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains – Hooke's law – Stress - strain diagrams - elastic constants.

**Laboratory Sessions/ Experimental learning:**

Demo in Aircraft Structures Lab

1. Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions, and operating principles)

**Applications:**

1. Understand the aircraft structures and materials.

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay.

https://youtu.be/AOmo98peh6I

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

**Power Plants:**

Basic ideas about piston, turboprop and jet engines - Use of propeller and jets for thrust production - Comparative merits, Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

**Laboratory Sessions/ Experimental learning:**

Demo in Propulsion laboratory

5. Study the performance of propeller and jet engines.
6. Performance studies on a scaled jet engine
7. Measurement of nozzle flow.
8. Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio

**Applications:**

1. To understand principles of operation of aircraft power plants.

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay. For more details on NPTEL visit http://nptel.iitm.ac.in

https://youtu.be/69Lyna4jcc8

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

**Aircraft Stability:**

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, stalling, gliding, landing, turning, aircraft manoeuvres; stalling, gliding, turning. Simple problems on these.

Laboratory Sessions/ Experimental learning:Creating paper planes to have hands on experience of understanding the concepts

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/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO314.1.1 | Review the historical aspects of Aviation |
| CO314.1.2 | Outline the basic Aircraft configuration and details |
| CO314.1.3 | Summarize the aircraft structures and materials. |
| CO314.1.4 | Illustrate the power units in Aircrafts and Rockets. |

| | |
|---|---|
| CO314.1.5 | Explain stability aspects of aeroplanes |

| Reference Books: | |
|---|---|
| 1. | J.D Anderson, Introduction to Flight, McGraw Hill, 1995 |
| 2. | Stephen A Brandt, Introduction to Aeronautics-A design perspective, AIAA Education series, 2004 |
| 3. | Kermode.A.C, Mechanics of Flight, Himalayan Book, 1997 |
| 4. | Kermode.A.C, Flight without Formulae, Pearson, 2009 |

| CIE Assessment: |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| SEE Assessment: |
| - Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.<br>- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.<br>- One question must be set from each unit. The duration of examination is 3 hours. |

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO5 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| **Course Title** | **AIRCRAFT TRANSPORT SYSTEMS** | **Semester** | **VI** |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **Course Code** | **MVJ20AE652** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 :1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**Course objective is to:**

1. Understand the air transport systems.
2. Acquire the knowledge of aircraft characteristics and manufacturers
3. Acquire the knowledge of airlines, airport, and infrastructure
4. Understand the navigation and environmental systems.
5. Acquire the knowledge of managerial aspects of airlines

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

**Air Transport Systems –Introduction**

Environment, transport, and mobility. Systematic description and current challenges. Development of aircraft design driver-speed and range. Development of Airport, Airlines, ICAO, Regulatory Framework and Market Aspects.

**Laboratory Sessions/ Experimental learning:**how control surfaces behave with change in Cg in lateral, longitudinal and transvers direction.

**Applications:** Development of aircraft design,Airport and Airlines

**Video link / Additional online information**

1. https://nptel.ac.in/courses/101/104/101104075/
2. https://www.youtube.com/watch?v=WUq3uN4MDms
3. https://nptel.ac.in/courses/101/104/101104071/

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

**Aircraft Characteristics and Manufacturers**

Classification of flight vehicles, cabin design, basics of flight physics- structures, mass, and balance. Flight performance and mission. Aircraft manufacturers, development process, production process, supply chain.

**Laboratory Sessions/ Experimental learning:**

**Applications:** Aircraft manufacture ring and development process

**Video link / Additional online information**

1. https://www.youtube.com/watch?v=bn2_NZkYQAo
2. https://nptel.ac.in/courses/101/104/101104075/

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

**Airlines, Airport, and Infrastructure**

Airline types, Network management. Flight strategy and aircraft selection, flight operations, MRO. Role of Airport, Regulatory Issues, Airport operation and services. Airport planning - infrastructure. **Laboratory Sessions/ Experimental learning:**Basic simulation concepts for airport planning and design

**Applications:**Airport operation and planning

**Video link / Additional online information:**

1. https://youtu.be/BhvYofNQUQE?list=PL05C6EFB31D920568
2. https://youtu.be/dzlHwwmca4c?list=PL05C6EFB31D920568
3. https://www.nap.edu/read/25573/chapter/4

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

**Air Navigation System & Environmental Systems**

Principle of operation- Role of Air Navigation services. Air space structures, Airspace and Airport capacity, Aircraft separation. Flight guidance system. runway layout and runway lighting, Communication system. Integrated air traffic management and working system. Air traffic controlEnvironmental aspects-emission, noise, and sound.

**Laboratory Sessions/ Experimental learning:**Basic simulation on Flight guidance system.

**Applications:** Air Navigation servicesand Environmental considerations

**Video link / Additional online information:**

1. https://youtu.be/Th2N_rDfkDw
2. https://youtu.be/shHvE6yV4IM

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

**Managerial Aspects of Airlines**

Airline passenger marketing, forecasting methods, pricing, and demand. Air cargo-market for air freight. Principles of airline scheduling. Fleet planning.

**Laboratory Sessions/ Experimental learning:**

**Applications:** Airline passenger marketing and Air cargo-market

**Video link / Additional online information:**

1. https://nptel.ac.in/courses/101/104/101104075/
2. https://nptel.ac.in/courses/101/104/101104071/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO314.2.1 | Describe the air transport systems. |
| CO314.2.2 | Discuss aircraft characteristics and manufacturers |

| | |
|---|---|
| CO314.2.3 | Describe airlines, airport, and infrastructure |
| CO314.2.4 | Summariesairnavigation and environmental systems |
| CO314.2.5 | Apply the knowledge of managerial aspects of airlines |

| Reference Books: | |
|---|---|
| 1. | Air Transport System, Dieter Schmitt, and ValkerGollnick, Springer, 2016 |
| 2. | Air Transportation-A Management Prospective, Jhon G Wensveen, Ashgate Publishing Ltd, 2011 |
| 3. | The Air Transportation System, Mike Hirst, Woodhead Publishing Ltd, England, 2008 |
| 4. | Transport Category Aircraft Systems, Thomas W. Wild, IAP, Inc, Year: 1990 |

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.
- One question must be set from each unit. The duration of examination is 3 hours.

CO, PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 1 | 1 | | 1 | 1 | 2 | 1 | 2 | 2 | 1 |
| CO2 | 3 | 2 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 2 |
| CO3 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 2 | 2 |
| CO4 | 3 | 2 | 3 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 2 | 1 | 2 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **AIRCRAFT SYSTEMS & INSTRUMENTATION** | **Semester** | **V** |

| | | | |
|---|---|---|---|
| **Course Code** | **MVJ20AE653** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 :1 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**Course objective is to:**

6. Gain knowledge of the aircraft control systems.
7. Understand the applications of hydraulics and pneumatics in aircraft systems.
8. Acquire knowledge regarding aircraft engine systems.
9. Comprehend the aircraft auxiliary systems
10. Acquire the knowledge of aircraft instruments.

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

**Airplane Control Systems:** Conventional Systems, fully powered flight controls, Power actuated systems, Modern control systems, Digital fly by wire systems, Auto pilot system active control Technology.

**LaboratorySessions/ Experimental learning:**

How it works, flight controls PID controls.

**Applications:**

Pilot training, UAV design and piloting, RC aircraft design and piloting.

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

24. https://nptel.ac.in/courses/101/104/101104066
25. https://onlinecourses.nptel.ac.in/noc21_ae05/preview
26. https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1067&context=aerosp

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

**Aircraft Systems:** Hydraulic systems, Study of typical workable system, components, Pneumatic systems, Advantages, Working principles, Typical Air pressure system, Brake system, Typical Pneumatic power system, Components, Landing Gear systems, Classification.

**Laboratory Sessions/ Experimental learning:**

Calculation on force required for hydraulic system and pneumatic system in aircraft applications.

**Applications:**

Hydraulic lifts, pneumatic door openings and closing, landing gears, breaks.

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

**10.** https://nptel.ac.in/courses/112/105/112105047/

**11.** https://nptel.ac.in/courses/112/103/112103249/

12. https://sciencing.com/make-simple-hydraulic-system-7380816.html

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

**Engine Systems:** Fuel systems for Piston and jet engines, Components of multi engines. lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.

**Laboratory Sessions/ Experimental learning:**

Engine Fuel and Fuel Metering Systems (Lab session IIT Kanpur, Virtual lab)

https://www.youtube.com/watch?v=xEssM_sYtd8

**Applications:**

Range and Endurance calculation, actions to take in case of engine failures.

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

17. https://nptel.ac.in/courses/101/101/101101002/
18. https://spocathon.page/video/lecture-06-lubrication-system

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

**Auxiliary System:** Basic Air cycle systems, Vapour Cycle systems, Evaporative vapour cycle systems, Evaporative air cycle systems, Fire protection systems, Deicing and anti-icing systems.

**Laboratory Sessions/ Experimental learning:**

Response time and operations of firefighting systems in case of engine failure.

**Applications:**

Firefighting, precautions, how to fight different classes of fire.

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

16. https://nptel.ac.in/content/storage2/courses/101106035/001_Chapter%201_L1_(01-10-2013)
17. https://nptel.ac.in/courses/103/107/103107156/
18. https://www.draeger.com/en_seeur/ Products/Aircraft-fire-training-systems.

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

**Aircraft Instruments:** Flight Instruments and Navigation Instruments, Gyroscope, Accelerometers, Air speed Indicators, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles.

**Laboratory Sessions/ Experimental learning:**

Gyroscope working and applications, Avionics lab instruments working.

**Applications:**

Understanding readings of the flight instruments, prediction of failure or trouble before actual encounter and taking necessary precautions.

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

16. https://nptel.ac.in/courses/101/108/101108056/

| |
|---|
| 17. https://onlinecourses.nptel.ac.in/noc20_ae01/preview<br>18. https://www.wingbug.com/wingbug-for-experimental-aircraft/ |

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO314.1.1 | Distinguish the conventional and modern control systems. |
| CO314.1.2 | Analyse the aircraft systems. |
| CO314.1.3 | Analyse the working of Aircraft engine systems. |
| CO314.1.4 | Describe aircraft Auxiliary systems |
| CO314.1.5 | Applydifferent aircraft instruments. |

**Reference Books**:

| | |
|---|---|
| 1. | Ian Moirand Allan Seabridge, Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration, Wiley India Pvt Ltd, 3rd edition, 2012. |
| 2. | Lalit Gupta and OP. Sharma, Aircraft Systems (Fundamentals of Flight Vol. IV), Himalayan Books, 2006. |
| 3. | William A Neese, Aircraft Hydraulic Systems, Himalayan Books, 2007 |
| 4. | SR. Majumdar, Pneumatic Systems, Tata McGraw Hill Publishing Co, 1st Edition, 2001 |

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.
- Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

| - One question must be set from each unit. The duration of examination is 3 hours. |
|---|

CO, PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CO2 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CO3 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CO4 | 3 | 2 | 1 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| CO5 | 3 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |

High,3, Medium,2, Low,1

| **Course Title** | **AIRCRAFT PROPULSION LAB** | **Semester** | **VI** |
|---|---|---|---|
| **Course Code** | **MVJ20AEL66** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40** | **SEE** | **50** |
| **No. of Contact Hours/week** | **03** | **Total** | **100** |

| Credits | 02 | Exam. Duration | 3 Hours |
|---|---|---|---|

**Course objective is to:**

- Understandhowtodo the heattransfer
- Comprehendthecascadetestingof axialcompressorandaxialturbinebladerow.
- Learn Pressure measurements using Axial Flow Fan setup

| Sl No | Experiment Name | RBT Level | Hours |
|---|---|---|---|
| 1 | Study of an Aircraft Piston Engine.(Includes Study of Assembly of Sub Systems, VariousComponents,theirFunctionsand OperatingPrinciples) | L1,L2,L3 | 03 |
| 2 | Study of an Aircraft Jet Engine (Includes Study of Assembly of Sub Systems, VariousComponents,theirFunctionsand OperatingPrinciples) | L1,L2,L3 | 03 |
| 3 | Studyof Forced ConvectiveHeat TransferOveraFlat Plate | L1,L2,L3 | 03 |
| 4 | CascadeTestingof aModel ofAxial CompressorBladeRow | L1,L2,L3 | 03 |
| 5 | CascadeTestingofaModel ofAxial TurbineBladeRow | L1,L2,L3 | 03 |
| 6 | StudyofPerformance ofaPropeller | L1,L2,L3 | 03 |
| 7 | DeterminationofHeatofCombustionofAviationFuel | L1,L2,L3 | 03 |
| 8 | StudyofFreeand WallJet | L1,L2,L3 | 03 |
| 9 | MeasurementofBurning VelocityofaPremixedFlame. | L1,L2,L3 | 03 |
| 10 | Studyof the FlameLiftUpand Fall Back PhenomenonforVariedAir/FuelRatio | L1,L2,L3 | 03 |
| 11 | MeasurementofNozzleFlow | L1,L2,L3 | 03 |
| 12 | PressureMeasurementsUsingAxial Flow FanSetup | L1,L2,L3 | 03 |
| 13 | Investigation of Pressure Distribution and Relationship Between Inlet Pressure/Outlet Pressureand Mass Flow Rate in a Convergent-Divergent Nozzle When Working Over a Variety ofOverall PressureRatiosIncludingUnder-ExpandingandOver-Expanding Conditions | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **14** | Investigation of Pressure Distribution and Relationship Between Inlet Pressure/Outlet PressureandMass FlowRate ina Convergent-Divergent Nozzle underChoked Conditions | L1,L2,L3 | 03 |
| | | | |
| **Course outcomes:** | | | |
| CO1 | Analyse heat transfer | | |
| CO2 | Evaluate testing of axial compressor and axial turbine blade row. | | |
| CO3 | Estimate Pressure measurements using Axial Flow Fan setup | | |

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | AIRCRAFT STRUCTURES LAB | **Semester** | VI |
| **Course Code** | MVJ20AEL67 | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |
| **Course objective is to:** | | | |

- Learnaboutthesimplysupportedbeam,cantileverbeam.
- UnderstandtheMaxwell's theorem and Poisson ratio.
- Acquiretheknowledgeabout bucklingload,shear failureandshearcentre

| Sl No | Experiment Name | RBT Level | Hours |
|---|---|---|---|
| 1 | DeflectionofaSimplySupported Beam | L1,L2,L3 | 03 |
| 2 | Deflectionofa CantileverBeam | L1,L2,L3 | 03 |
| 3 | BeamwithCombinedLoadingbyusingSuperpositionTheorem | L1,L2,L3 | 03 |
| 4 | VerificationofMaxwell's ReciprocalTheoremforBeamwith<br>a) Constantcrosssection<br>b) VaryingCrosssection | L1,L2,L3 | 03 |
| 5 | DeterminationofYoung'sModulusandPoissonRatiousingStrainGages. | L1,L2,L3 | 03 |
| 6 | Buckling Load ofSlenderEccentric ColumnsandConstructionofSouthWellPlot | L1,L2,L3 | 03 |
| 7 | Shear FailureofBoltedandRivetedJoint | L1,L2,L3 | 03 |
| 8 | BendingModulus ofSandwichBeam | L1,L2,L3 | 03 |
| 9 | DeterminetheIndexFactor`K`inaTensileField ofWagnerBeam | L1,L2,L3 | 03 |
| 10 | Tensile,Compressiveand FlexuralTesting ofaComposite MaterialPlate | L1,L2,L3 | 03 |
| 11 | DeterminationofNaturalFrequencyand Mode ShapesofaCantileverBeamforthe FollowingCases<br>a) Constantcrosssection<br>b) Varyingcrosssection | L1,L2,L3 | 03 |
| 12 | DeterminationofShear CentreforFollowing CasesThroughDeflection<br>a) Closesection–Symmetricalbending<br>b) Opensection–Unsymmetricalbending | L1,L2,L3 | 03 |
| 13 | DeterminationofShearflowforFollowingCases<br>a) Closesection–Symmetricalbending<br>b) Opensection–Unsymmetricalbending | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| **14** | DeterminingofShearCentreThroughShearFlowMeasurementfor FollowingCases<br>a) Closesection–Symmetricalbending<br>b) Opensection–Unsymmetricalbending | L1,L2,L3 | 03 |

| | |
|---|---|
| **Course outcomes:** | |
| CO1 | Computethedeflectionof simplysupportedbeamandcantilever beam. |
| CO2 | VerifytheMaxwell'stheorem. |
| CO3 | Determinethebucklingload,shearfailureandshearcentre. |

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| Course Title | AIRCRAFT STABILITY AND CONTROL | Semester | VII |
| Course Code | MVJ20AE71 | **CIE** | 50 |
| Total No. of Contact Hours | 50 L : T : P :: 3 :2: 0 | **SEE** | 50 |
| No. of Contact Hours/week | 5 | **Total** | 100 |
| **Credits** | 4 | **Exam Duration** | 3 Hrs. |

| **The course objective is to:** |
|---|

1. Understand the Static Longitudinal stability with Stick fixed condition
2. Gain knowledge of the Static Longitudinal stability with Control stick free conditions
3. Acquire knowledge of Lateral and Directional stability & control
4. Understand concepts of equations of motions and Stability derivatives.
5. Learn the Dynamic Stability of Aircraft.

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

**Static Longitudinal Stability and Control-Stick Fixed**

Definition, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane Introduction, Trim condition. Static Margin. Stick fixed neutral points. Longitudinal control, Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range.

**Laboratory Sessions/ Experimental learning:**

Effect of Static margin on Longitudinal Stability of Aircraft- Flight Simulation Lab

**Applications:**

Determine the Longitudinal stability of Aircraft with Stick fixed

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

27. NPTEL- Aircraft Stability & Control

https://nptel.ac.in/courses/101/104/101104062/

2. MIT open course ware- Aircraft Stability & Control

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/

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

**Static Longitudinal Stability and Control-Stick free**

Introduction, Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G.

**Laboratory Sessions/ Experimental learning:**

Calculate the variation of Trim Tabs during Stick free Neutral point condition

**Applications:**

Determine the Longitudinal stability of Aircraft with controls free

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

1. NPTEL- Aircraft Stability & Control

https://nptel.ac.in/courses/101/104/101104062/

2. MIT open course ware- Aircraft Stability & Control

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/

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

**Static Directional and Lateral Stability and Control**

Static directional stability- rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition. Weather cocking effect.

Static Lateral stability. Estimation of dihedral effect. Effect of wing sweep, flaps, and power. Lateral control, Estimation of lateral control power, Aileron control forces, Balancing the aileron. Coupling between rolling and yawing moments. Adverse yaw effects. Aileron reversal.

**Laboratory Sessions/ Experimental learning:**

Effect of aileron input in lateral and directional motion of Aircraft

**Applications:**

Effect of Directional and Lateral stability on Aircraft

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

1. NPTEL- Aircraft Stability & Control

https://nptel.ac.in/courses/101/104/101104062/

2. MIT open course ware- Aircraft Stability & Control

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/

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

**Equations of Motions**

Derivation of rigid body equations of motion, Orientation and position of the airplane, gravitational and thrust Forces, Small disturbance theory. Aerodynamic force and moment representation, Derivatives due to change in forward speed, Derivatives due to the pitching velocity, Derivatives due to the time rate of change of angle of attack, Derivatives due to rolling rate, Derivatives due to yawing rate.

**Laboratory Sessions/ Experimental learning:**

Estimate the effect of stability derivatives on aircraft due to changes in forward speed, change in angle of attack, change in roll rate and yaw rate

**Applications:**

Stability derivative estimation for a stable aircraft

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

1. NPTEL- Aircraft Stability & Control

https://nptel.ac.in/courses/101/104/101104062/

2. MIT open course ware- Aircraft Stability & Control

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/

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

**Dynamic Stability**

Dynamic longitudinal stability. Types of modes of motion: phugoid motion, short period motion. Routh's stability criteria. Factors affecting period and damping of oscillations. Flying qualities in pitch. Cooper-Harper Scale. Dynamic lateral and directional stability. Response to aileron step-function, side-slip excursion. Dutch roll and Spiral instability. Auto- rotation and spin. Stability derivatives for lateral and directional dynamics.

**Laboratory Sessions/ Experimental learning:**

Determine short period and phugoid oscillations for a given Quartic equation

**Applications:**

Determine relative stability of an Aircraft

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

1. NPTEL- Aircraft Stability & Control

https://nptel.ac.in/courses/101/104/101104062/

2. MIT open course ware- Aircraft Stability & Control

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO401.1 | Analyse Longitudinal stability for Stick fixed conditions. |
| CO401.2 | Evaluate Longitudinal stability for Stick free conditions |
| CO401.3 | Analyse Static Lateral and Directional static stability |
| CO401.4 | Evaluation of various flying modes. |
| CO401.5 | Analyse the dynamic stability of Aircraft |

Reference Books:


| | |
|---|---|
| 1. | Nelson, R.C. Flight Stability and Automatic Control, McGraw-Hill Book Co., 2007. |
| 2. | Perkins, C.D., and Hage, R.E., Airplane Performance stability and Control, John Wiley Son Inc, New York, 1988 |
| 3. | BernardEtkin, Dynamics of Flight Stability and Control, John Wiley & Sons, Second Edition, 1982 |
| 4. | Bandu N. Pamadi, Performance, Stability, Dynamics and Control of Airplanes, AIAA 2nd Edition Series, 2004 |


**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

xlvii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

xlviii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

xlix. One question must be set from each unit. The duration of examination is 3 hours.

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

High 3, Medium 2, Low 1

| | | | |
|---|---|---|---|
| **Course Title** | **AIRCRAFT PERFORMANCE** | **Semester** | **VII** |
| **Course Code** | **MVJ20AE72** | **CIE** | **50** |
| **Total No. of Contact Hours** | **50 L : T : P :: 3 :2: 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **5** | **Total** | **100** |
| **Credits** | **4** | **Exam. Duration** | **3 Hrs.** |

The course objective is to:

1. Understand Steady Unaccelerated Flight
2. Comprehend Steady Performance – Level Flight, Climb & Glide
3. Gain knowledge of Airplane Performance Parameters like Range and Endurance etc.
4. UnderstandAircraft Performance in Accelerated Flight
5. Acquire knowledge of Maneuver Performance of an Aircraft

| | | |
|---|---|---|
| **Module 1** | **L1,L2** | 10 Hrs. |
| **The Equations of Motion in Steady Unaccelerated Flight** | | |

Introduction and four forces of flight, General equations of motion, Power available and power required curves, Thrust available and thrust required curves, Conditions for power required and Thrust required minimum, Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required, Thrust available and Thrust required

**Laboratory Sessions/ Experimental learning:**

Estimation of Thrust and Power of an engine – Aircraft Propulsion Lab

**Applications:** Introduction to Steady Unaccelerated Flight

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

**https://www.youtube.com/watch?v=tEWuP1NVdgE&list=PLtUPB3SCffXP43al7ILIR5qaZF_5fEDXm**

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

**Steady Performance – Level Flight, Climb & Glide**

**Performance**: Equations of motion for Rate of climb- graphical and analytical approach, Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach, Climb performance graph (hodograph diagram), Maximum climb angle and rate of climb, Gliding flight, Range during glide, Minimum rate of sink and shallowest angle of glide

**Laboratory Sessions/ Experimental learning:**

Calculation of Absolute ceiling and Service ceiling and their importance

**Applications:** To understand Steady Performance of an Aircraft – Level Flight, Climb & Glide

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

**https://www.youtube.com/watch?v=QXpO3WIxJx8**

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

**Fundamental Airplane Performance Parameters**

**The fundamental parameters**: Thrust-to-Weight ratio, Wing loading, Drag polar and Lift-to-Drag ratio, Minimum velocity, Aerodynamic relations associated with lift-to-drag ratio

**Range and Endurance:**

**Propellerdriven Airplane**: Physical considerations, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance

**Jet Airplane**: Physical considerations, Quantitative formulation, Equations for Range and Endurance, Conditions for maximum range and endurance, Effect of Head wind and Tail wind

**Laboratory Sessions/ Experimental learning:**

Determination of Range and Endurance for Propeller driven and Jet airplane

**Applications:**Calculation of Range and Endurance of an Aircraft

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

**https://www.youtube.com/watch?v=YOTdaEeA8tM**

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

**Aircraft Performance in Accelerated Flight**

**Take-off Performance**: Calculation of Ground roll, Calculation of distance while airborne to clear an obstacle, Balanced field length

**Landing Performance and Accelerated Climb:** Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, Ground effects, Acceleration in climb

**Laboratory Sessions/ Experimental learning:**

Assessment of Ground roll and Distance while airborne to estimate Total Take-off distance

**Applications:** Understanding Take-off Performance, Landing Performance and Accelerated Climb

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

https://www.youtube.com/watch?v=lzbg9t-6-gA

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

**Maneuver Performance**

**Turning performance**: Level turn, Load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate

**Pull-up and Pull-down maneuvers**: Turning rate, turn radius, Limiting case for large load factor, V-n diagram, Limitations of pull up and push over

**Laboratory Sessions/ Experimental learning:**

Study of Velocity-Load factor (V-n) Diagram for an aircraft

**Applications:** To understand Maneuver Performance of an Aircraft

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

https://www.youtube.com/watch?v=KNPxD7bbMP8

**Course Outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO402.1 | Analyse Steady Unaccelerated Flight |
| CO402.2 | Evaluate Steady Performance of an Aircraft – Level Flight, Climb & Glide |
| CO402.3 | Analyze Range and Endurance of an Aircraft |
| CO402.4 | Illustrate Take-off Performance, Landing Performance and Accelerated Climb |
| CO402.5 | Compute Maneuver Performance of an Aircraft |

Reference Books:


| | |
|---|---|
| 1. | John D. Anderson, Jr,Introduction to Flightby;McGraw-Hill International, Aerospace Science/Technology Editions, 2000 |

| | |
|---|---|
| 2. | John D. Anderson, Jr**;**Aircraft Performance and Design by McGraw-Hill International, Aerospace Science/Technology Editions, 1999 |
| 3. | Perkins, C.D. and Hage, R.E**.;**Airplane Performance, Stability and Control by John Wiley Sons Inc, New York, 1988 |
| 4. | Barnes W. McCormick;Aerodynamics, Aeronautics and Flight Mechanics by John Wiley Sons Inc, New York, 1995 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

l. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

li. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lii. One question must be set from each unit. The duration of examination is 3 hours.

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 0 | 1 | 2 | 0 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 2 | 0 | 1 | 2 | 0 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 1 |
| CO3 | 3 | 2 | 0 | 1 | 2 | 0 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 1 |
| CO4 | 3 | 2 | 0 | 1 | 2 | 0 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 1 |
| CO5 | 3 | 2 | 0 | 1 | 2 | 0 | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 1 |

High:3, Medium:2, Low:1

| | | | |
|---|---|---|---|
| **Course Title** | **COMPUTATIONAL FLUID DYNAMICS** | **Semester** | **VI** |
| **Course Code** | **MVJ20AE731** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3hrs** |

**The Course objective is to:**

1. Gain knowledge of CFDideas, and Flow Equations
2. Learn the Mathematical behaviour of PDEs vis a visnature of flow
3. Know the discretisationtechniques in finite difference
4. Understand grid generation and adaptive grids
5. Acquire knowledge to solve CFD problems through finite volume technique

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

**Introduction**: CFD ideas to understand, CFD Application, Need for high speed Parallel Computing, Substantial derivative, Divergence of velocity. Flow models, Continuity Equation, Momentum Equation, and Energy Equations in various forms. Physical Boundary conditions. Conservative & Non-conservative forms of equations, Integral vrs Differential Forms of Equations. Form of Equations particularly suitable for CFD work. Shock capturing, Shock fitting.

**Laboratory Sessions/ Experimental learning**: Ansys Lab

**Applications:**Flow Analysis

**Nptel Video:** CFD by Prof. S Chakraborty IIT Kharagpur

| **Module-2** | **L3,L4** | 10Hrs. |
|---|---|---|

**Mathematical Behaviour of Partial Differential Equations**: Classification of partial differential equations – Cramer Rule, Eigenvalue method. Hyperbolic, parabolic, and elliptic form of equations. Mixed type of equations. Classification of governing equations for one-dimensional compressible inviscid flow.

Impact of classification on physical and computational fluid dynamics. Case studies-steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, unsteady thermal conduction, and steady subsonic inviscid flow.

**Laboratory Sessions/ Experimental learning**: Ansys Lab

**Applications**: Flow analysis

**Nptel Video**: CFD by Prof. S Chakraborty IIT Kharagpur

| **Module-3** | **L3,L4** | 10Hrs. |
|---|---|---|

**DiscretisationTechniques**Discretization: Essence of discretization- Finite difference method, and difference equations. Explicit and Implicit approach. Errors and stability analysis. Time marching and Space marching. Reflection Boundary condition. Relaxation technique; successive over relaxation/ successive under relaxation. Alternating Direction Implicit (ADI) Method. Upwind and Mid-point leap frog schemes.Numerical and artificial viscosity.

**Laboratory Sessions/ Experimental learning**: Ansys Lab

**Applications:** Finite Difference Techniques for flow analysis

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

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

| **Module-4** | **L3,L4** | 10Hrs. |
|---|---|---|

**Grid generation &Adaptive Grid Methods**: Need for grid generation and Body-fitted coordinate system. Structured grids-essential feature. Structured grids generation techniques-algebraic and numerical methods. Unstructured grid generation Techniques-Delaunay-Voronoi diagram, advancing front method, multi-block grid generation, Grid quality, adaptive grids.

Adaptive Structured Grid Generation, Unstructured adaptive grid Methods.

**Transformation:** Matrices &Jacobian of transformation. Transformation of Equation from physical plane into computational Plane-examples.

**Laboratory Sessions/ Experimental learning**: Ansys Lab

**Applications:** Grid formulation and transformation of planes

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

**Nptel Video:** CFD by Prof. S Chakraborty IIT Kharagpur

| **Module-5** | **L3,L4** | 10Hrs. |
|---|---|---|

**Finite Volume Techniques and some Applications: Spatial**discretisation:-Cell Centred Formulation and Cell vertex Formulation (overlapping control volume, duel control volume). Temporal discretisation: - Explicit time-stepping and Implicit time- stepping, time step calculation

**Applications:** Aspects of numerical dissipation & dispersion. Approximate factorization, Flux Vector splitting. Diffusion problem. Heat through conduction and radiation. Up winding technique. Post-processing and visualization, contour plots, vector plots etc.

**Laboratory Sessions/ Experimental learning**: Ansys Lab

**Applications:** Flow analysis through Finite Volume Technique

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

**Nptel Video:** CFD by Prof. S Chakraborty IIT Kharagpur

**Course outcomes:**

| | |
|---|---|
| CO403.1.1 | Apply knowledge of CFD ideas, and Flow Equations |
| CO403.1.2 | Assimilate Mathematical behaviour of PDEs vis a vis nature of flow |
| CO403.1.3 | Utilisefinite difference techniques. |
| CO403.1.4 | Generate &Utilise grids |
| CO403.1.5 | Apply finite volume techniques |

Reference Books:

| | |
|---|---|
| 1. | F. Wendt (Editor), Computational Fluid Dynamics - An Introduction, Springer – Verlag, Berlin; 1992. |
| 2. | Charles Hirsch, Numerical Computation of Internal and External Flows, Vols. I and II. John Wiley & Sons, New York; 1988. |
| 3 | Fletcher, C.A.J, Computational Techniques for Fluid Dynamics, Springer, Berlin,2nd edition, 2002,ISBN-13: 978-3540543046 |
| 4 | Tapan K. Sengupta, Fundamentals of CFD, Universities Press, 2004. |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

liii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

liv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lv. One question must be set from each unit. The duration of examination is 3 hours.

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | **FATIGUE AND FRACTURE MECHANICS** | **Semester** | **VI** |
| **Course Code** | **MVJ20AE732** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1. Understand the basics of fatigue of structures.
2. Understand the Statistical Aspects of Fatigue Behaviour
3. Acquire knowledge of Physical Aspects of Fatigue
4. Understand concepts of equations of Fracture Mechanics
5. Comprehend the various Fatigue Design and Testing Procedures.

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

**Fatigue of Structures:**S.N. curves, Endurance limit, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, plastic stress concentration factors – Notched S-N curves.Plane stress and plane strain concepts, Dugdale approach

**Laboratory Sessions/ Experimental learning:**

Effect of Stress concentration factors and SNcurves plot in strength of materials lab

**Applications:**

Determine the Endurance limit and Stress concentration factors

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

NPTEL-

1. https://nptel.ac.in/courses/112/106/112106065/
2. https://www.youtube.com/watch?v=o-6V_JoRX1g

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

**Statistical Aspects of Fatigue Behaviour:**Low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, Cyclic Strain hardening and softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory,Fatigueloading,Various stages of crack propagation

**Laboratory Sessions/ Experimental learning:**

Experimental verification of the components can be done for Low cycle and high cycle fatigue

**Applications:**

Determine the cumulative damage of the material

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

1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/

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

**Physical Aspects of Fatigue:**Phase in fatigue life, Crack initiation, Crack growth, Final fracture, Dislocations, Fatigue fracture surfaces.Crack opening displacement,crack tip opening displacement.

**Laboratory Sessions/ Experimental learning:**

To determine the crack initiation and crack growth of the given material using equipment setup.

**Applications:**

To determine the COD and CTOD values of the given material

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

1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/

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

**Fracture Mechanics:** Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin – Orwin extension of Griffith'stheory to ductile materials, Stress analysis of cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries, Linear elastic fracture mechanics.

| | | |
|---|---|---|
| **Laboratory Sessions/ Experimental learning:**<br>Estimate the effect of stress intensity factors and effect of thickness on fracture toughness.<br>**Applications:**<br>To find out the stress analysis of the cracked bodies<br>**Video link / Additional online information (related to module if any):**<br>1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/ | | |
| **Module 5** | **L1, L2** | 10 Hrs. |
| **Fatigue Design and Testing**: Safe life and fail safe design philosophies,Importance of Fracture Mechanics in aerospace structure, Application composite materials and structures.<br>**Laboratory Sessions/ Experimental learning:**<br>Determine short period and phugoid oscillations for a given Quadratic equation<br>**Applications:**<br>Determinethe relative stability of an Aircraft<br>**Video link / Additional online information (related to module if any):**<br>1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/ | | |

| **Course outcomes:** | |
|---|---|
| Upon completion of the course, students will be able to: | |
| CO403.2.1 | Apply the concept of Fatigue analysis of the structures |
| CO403.2.2 | Compare the low cycle fatigue and high cycle fatigue and strain hardening and softening |
| CO403.2.3 | Investigate the reasons for crack initiation, growth, and fracture and for COD and CTOD |
| CO403.2.4 | Evaluate Fracture Toughness |
| CO403.2.5 | Analyse Design for Fatigue |

| Reference Books: | |
|---|---|
| 1. | D. Brock, Elementary Engineering Fracture Mechanics,Noordhoff International Publishing Co.,London, 1994 |
| 2. | J.F. Knott, Fundamentals of Fracture Mechanics, Butterworth & Co., Publishers Ltd., London,1983. |
| 3. | W. Barrois and L. Ripley, Fatigue of Aircraft Structures, Pergamon Press, Oxford, 1983 |
| 4. | C.G.Sih, Mechanics of Fracture, Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989. |
| **CIE Assessment:** | |

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

lvi. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

lvii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lviii. One question must be set from each unit. The duration of examination is 3 hours.

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO5 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,

| | | | |
|---|---|---|---|
| **Course Title** | **CONTROL ENGINEERING** | **Semester** | **7** |
| **Course Code** | **MVJ20AE733/AS733** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1. Understand the basic concepts of control systems and mathematical models.
2. Acquire knowledgeof block diagrams and signal flow graphs.
3. Gain knowledge of stability analysis in Laplace domain through various techniques
4. Apprehend the frequency response specifications and polar plots
5. Understand the requirement for controller and compensation gain.

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

**Introduction to Control Systems and Mathematical Models Introduction:** Concept of controls, Open loop and closed loop systems with examples, Concepts of feedback and basic structure of feedback control system, requirements of an ideal control system.

**Mathematical Models:** Transfer function models of mechanical systems, electrical circuits, DC and AC motors in control systems, Analogous systems: Force voltage and Force current analogy.

**Laboratory Sessions/ Experimental learning:**

**1.** Draw pole zero plot for open and closed loop system for a given transfer function

**Applications:**

1. Aircraft Controls

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

28. https://in.mathworks.com/videos/understanding-control-systems-part-1-open-loop-control-systems-123419.html
29. https://in.mathworks.com/videos/understanding-control-systems-part-2-feedback-control-systems-123501.html
30. https://nptel.ac.in/courses/108/102/108102043/

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

**Block Diagrams and Signal Flow Graphs:** Transfer functions definition and its properties, block representation of control systems and terminologies, block diagram algebra and reduction of block diagrams, Signal flow graph method, Mason's gain formula and its applications.

**Transient and Steady State Response Analysis:** Introduction, type and order of systems, time response specifications, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance.

**Laboratory Sessions/ Experimental learning:**

1. Study the behaviour of second order system with impulse, step and ramp input

**Applications:**

1. simplifies complex control system
2. Analyse the steady and transient behaviour of a system

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

**13.** https://nptel.ac.in/courses/108/102/108102043/

**14.** https://in.mathworks.com/videos/simscape-multibody-overview-117986.html?s_tid=srchtitle

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

**System stability analysis** using Routh's – Hurwitz Criterion Root Locus Plots Definition of root loci, General rules for constructing root loci, Analysis using root locus plots, Determination of desired gain, limit gain, gain margin and conditional stability.

**Frequency Response Analysis** Using Bode Plots: Bode attenuation diagrams for first and second order systems, Simplified Bode diagrams, Stability analysis using Bode plots and determination of phase margin and gain margin and gain

**Laboratory Sessions/ Experimental learning:**

1. Analyse the stability using root locus plot for a dynamic system

2. Analyse the stability using bode plot for transfer function

**Applications:**

1. Stability Analysis of a SISO system
2. Effect of gain in stability of a system
3. Effect of frequency in stability of a system

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

19. https://in.mathworks.com/videos/control-system-design-with-control-system-tuning-app-68749.html?s_tid=srchtitle
20. https://nptel.ac.in/courses/108/102/108102043/

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

**Frequency Response Specification and Analysis using Polar plots**: Specification: Frequency response definition, frequency response specifications and its relationship with time response specifications.

**Analysis:** Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles.

**Laboratory Sessions/ Experimental learning:**

1. Plot Polar plot for a transfer function
2. Determine gain and phase margin from nyquist plot

**Applications:**

1. Determine stability of an aircraft

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

19. https://in.mathworks.com/videos/control-systems-in-practice-part-10-nichols-chart-nyquist-diagram-and-bode-plot-1607596350472.html?s_tid=srchtitle
20. https://nptel.ac.in/courses/108/102/108102043/

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

**Feedback control systems:** Types of controllers – Proportional, Integral, Derivative controllers, Proportional – Integral, Proportional – Integral – Derivative controllers; Compensation methods – Series and feedback compensation, Lead, Lag and Lead-Lag Compensators.

**State Variable Characteristics of Linear Systems:** Introduction to concepts of states and state variable representation of linear systems, Advantages and Disadvantages over conventional transfer function representation, state equations of linear continuous data system. Matrix representation of state equations, Solution of state equation, State transition matrix and its properties, controllability and observability, Kalman and Gilberts test.

**Laboratory Sessions/ Experimental learning:**

1. Design PID controller for non linear system

**Applications:**

Autopilot design for lateral directional motion

Provide suitable controller for non linear or complex system.

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

19. https://in.mathworks.com/videos/pid-control-made-easy-81646.html?s_tid=srchtitle
20. https://nptel.ac.in/courses/108/102/108102043/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO403.3.1 | Apply the concepts of control models |
| CO403.3.2 | Generate block diagrams and signal flow graphs |
| CO403.3.3 | Perform the stability analysis in Laplace domain through various techniques |
| CO403.3.4 | Evaluate the frequency response specifications and Nyquist criteria |
| CO403.3.5 | Determine controller and compensation gain for feedback control system |

Reference Books:


| | |
|---|---|
| 1. | U.A. Bakshi and V.U. Bakshi, "Control Engineering", Technical Publications |
| 2. | A. NagoorKani, "Control Systems Engineering", RBA Publications, 2014 |
| 3. | Katsuhiko Ogatta, "Modern Control Engineering ", Pearson Education, 2004 |
| 4. | N.S. Nise, "Control Systems Engineering", Wiley, 6th Edition,2012 |


**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

lix. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

lx. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lxi. One question must be set from each unit. The duration of examination is 3 hours.

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 1 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,

| | | | |
|---|---|---|---|
| **Course Title** | **AVIONICS** | **Semester** | **VII** |
| **Course Code** | **MVJ20AE741** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **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. Understand the need for avionics in civil, military and space systems.
2. Acquire the knowledge of control and navigation systems
3. Acquire the knowledge of display technologies and avionics system architectures
4. Appreciate the use of microprocessors
5. Understand the functioning of data buses

| **Module 1Power Distribution System** | **L1,L2** | 10 Hrs. |
|---|---|---|

**Power Distribution System:** Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilization-typical application to avionics. Need for Avionics in civil and military aircraft.

**Laboratory Sessions/ Experimental learning:**Programming using microprocessor

**Applications:**Data Transfer, Communication

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

1. https://www.coursera.org/lecture/aeronautics/basics-X8Mvf

| **Module 2Inertial Navigation & Electronic Flight Control System** | **L1,L2,L3,** | 10 Hrs. |
|---|---|---|

**Inertial Navigation System:** Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing.
**Electronic Flight Control System:** Fly-by-wire system: basic concept and features. Pitch and Roll rate: command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis.
**Laboratory Sessions/ Experimental learning:**Validation of truth tables for different logic circuits
**Applications:**Communication, Tracking
**Video link / Additional online information (related to module if any):**

1. https://www.coursera.org/lecture/aeronautics/basics-X8Mvf

| **Module 3Electronic Flight Instrument & Avionics Sub Systems** | **L1,L2,L3** | 10 Hrs. |
|---|---|---|

**Electronic Flight Instrument Systems:** Display-units, presentation, failure, and annunciation. Display of air data.
**Introduction to Avionics Sub Systems and Electronic Circuits:** Typical avionics sub systems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.
**Laboratory Sessions/ Experimental learning:**Construct 7 segment display circuit using IC timer
**Applications:** Attitude Estimation, Navigation, Control
**Video link / Additional online information (related to module if any):**

1. https://nptel.ac.in/courses/101/106/101106042/

| **Module 4Digital Systems & Flight Deck and Cockpits** | **L1,L2,L3** | 10 Hrs. |
|---|---|---|

**Principles of Digital Systems:** Digital Computers, Microprocessors, Memories.
**Flight Deck and Cockpits:** Control and display technologies CRT, LED, LCD, EL and plasma panel, Touch screen, Direct voice input (DVI)-Civil cockpit and military cockpit : MFDS, HUD, MFK, and HOTAS.
**Laboratory Sessions/ Experimental learning:**Data transfer using ARINC420 data bus
**Applications:** Position Estimation, Guidance, Control
**Video link / Additional online information (related to module if any):**

1. https://nptel.ac.in/courses/101/108/101108056/
2. https://nptel.ac.in/courses/101/108/101108056/

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

**Avionics Systems Integration:** Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Flight control systems, Radar, Electronic Warfare, and fire control system. Avionics system architecture, Data buses, MIL–STD1553B
**Laboratory Sessions/ Experimental learning:**Data transfer using MIL-STD 1553B Data bus
**Applications:** Navigation, Guidance, Control
**Video link / Additional online information (related to module if any):**

1. https://nptel.ac.in/courses/101/106/101106042/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO404.1.1 | Understand the necessity of avionics in civil, military and space systems |
| CO404.1.2 | Understand the various aircraft navigation and control schemes |
| CO404.1.3 | Appreciate the use of electronics packages in avionics |
| CO404.1.4 | Understand the principles of various man machine interface devices such as data entry and displays. |
| CO404.1.5 | Get introduced with the avionics systems and work with the various existing aircraft data buses. |

| Reference Books: | |
|---|---|
| 1. | R.P.G. Collinson, Introduction to Avionics Systems, 3rd Edition, 2011, Springer. |
| 2. | Ian Moir, Allan Seabridge and Malcolm Jukes, Civil Avionics Systems, 2nd Edition, 2003, Wiley. |
| 3. | R. Cundy Dale, Introduction to Avionics, 2010, Pearson Education. |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

lxii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

lxiii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lxiv. One question must be set from each unit. The duration of examination is 3 hours.

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | | | | | | | | 2 | | | | 2 | 3 | 2 |
| CO2 | | | | | | | | | | | | 2 | 1 | |
| CO3 | 2 | 2 | 2 | | | | | | | | | 2 | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO4 | 3 | 3 | 2 | | | 2 | 2 | | | | | 3 | 2 | 1 |
| CO5 | 3 | 3 | 3 | | | 2 | 2 | | | | | 3 | 3 | 3 |

High,3, Medium,2, Low,1

| **Course Title** | **FLIGHT VEHICLE DESIGN** | **Semester** | **VII** |
|---|---|---|---|
| **Course Code** | **MVJ20AE742** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1. Understand the overview of Aircraft design process
2. Acquire knowledge of configuration layout and design of structural components
3. Gain knowledge of engine selection.
4. Comprehend the stability and control and sizing of control surfaces.
5. Understand the design aspects of subsystems

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

**Overview of Design Process**

Introduction, Requirements, Phases of design, Conceptual Design Process, Initial Sizing, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take- off weight calculation, Thrust to Weight Ratio & Wing Loading: Thrust to Weight Definitions, Statistical Estimate of T/W. Thrust matching, spread sheet in design, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance, Instantaneous Turn rate, Sustained Turn rate, Climb, & Glide, Maximum ceiling.

**Laboratory Sessions/ Experimental learning:**Design and modelling of the aircraft components based on the requirements chosen in CAAd lab

**Applications:** Apply the design requirements for an aircraft in response to requirements based on fundamental principles and statistical data in the initial phase of design.

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

1. https://nptel.ac.in/courses/101/106/101106035/
2. https://nptel.ac.in/courses/101/106/101106035**/**

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

**Configuration Layout & loft**

Conic Lofting, Conic Fuselage Development, Conic Shape Parameter, Wing-Tail Layout & Loft. Aerofoil Linear Interpolation. Aerofoil Flat-wrap Interpolation. Wing aerofoil layout-flap wrap. Wetted area determination. Special considerations in Configuration Layout: Aerodynamic, Structural, Delectability. Crew station, Passenger, and Payload arrangements. Design of Structural Components: Fuselage, Wing, Horizontal & Vertical Tail. Spreadsheet for fuselage design. Tail arrangements, Horizontal & Vertical Tail Sizing. Tail Placement. Loads on Structure. V-n Diagram, Gust Envelope. Loads distribution, Shear and Bending Moment analysis.

**Laboratory Sessions/ Experimental learning:**Structural analysis and Aerodynamic analysis in Ansys lab

**Applications:** Analyse the various constraints coming from specifications and choose key parameters (total weight, wing plan form, thrust/power required etc.)

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

1.https://nptel.ac.in/courses/101/106/101106035/

2.https://nptel.ac.in/courses/101/106/101106035/

3.https://nptel.ac.in/courses/101/106/101106035/#

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

**Engine Selection & Flight Vehicle Performance**

Turbojet Engine Sizing, Installed Thrust Correction, Spread Sheet for Turbojet Engine Sizing. Propeller Propulsive System. Propeller design for cruise. Take-off, Landing & Enhanced Lift Devices: - Ground Roll, Rotation, Transition, Climb, Balanced Field Length, Landing Approach, Braking. Enhanced lift design -Passive & Active

**Laboratory Sessions/ Experimental learning:**Modelling of engine selected in CAAD lab

**Applications:**Compare different engine configurations and choose the design which meets the requirements.

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

1. https://nptel.ac.in/courses/101101002/

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

**Static Stability & Control:** Longitudinal Static Stability, Pitch Trim Equation. Effect of Airframe components on Static Stability. Lateral stability- Contribution of Airframe components. Directional Static stability. Contribution of Airframe components. Aileron Sizing, Rudder Sizing. Flying qualities. Cooper Harper Scale. Environmental constraints, Aerodynamic requirements.

**Laboratory Sessions/ Experimental learning:**Performance analysis in Matlab

**Applications:** Calculate and compare performance and stability characteristics against design goals and generate a layout

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

3. https://nptel.ac.in/courses/101104062/
4. https://nptel.ac.in/courses/101104062/#

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

**Design Aspects of Subsystems:** Flight Control system, Landing Gear and subsystem, Propulsion and Fuel System Integration, Air Pressurization and Air Conditioning System, Electrical & Avionic Systems, Structural loads, Safety constraints, Material selection criteria. Applications:Calculate and compare performance and stability characteristics against design goals and generate a layout

**Laboratory Sessions/ Experimental learning:**Assemble the CAD models of the components and verify performance using CFD tool in Ansys lab.

**Applications:** Analyse design issues for aerodynamics, propulsion, structure, weights, stability, cost, and performance and generate a layout.

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

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/101108047/lec29.pdf

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO404.2.1 | Define a configuration for given specifications. |
| CO404.2.2 | Evaluate configuration layout & airframe components sizing |
| CO404.2.3. | Determine Engine selection and flight performance |
| CO404.2.4 | Evaluate the stability and control and sizing of control surfaces. |
| CO404.2.5 | Analyse the design aspects of subsystems |

**Reference Books:**

| | |
|---|---|
| 1. | Daniel P. Raymer, Aircraft Design -A Conceptual Approach, AIAA, education Series, IVth Edition, 2006 |
| 2. | Thomas C Corke , Design of Aircraft, Pearson Edition. Inc, 2003 |
| 3. | J Roskam , Airplane Design -VOL 1 to 9 |
| 4. | John Fielding , Introduction to Aircraft Design, Cambridge University Press, 2009 |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

lxv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

lxvi. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lxvii. One question must be set from each unit. The duration of examination is 3 hours.

**CO,PO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |
| CO5 | 3 | 3 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **GUIDANCE NAVIGATION & CONTROL** | **Semester** | **VII** |
| **Course Code** | **MVJ20AE743** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1.Understand the basics of Guidance and Navigation.

2. Gain knowledge of the various types of guidance and control systems

3. Comprehend the control system for missiles

4.Acquire knowledge of the missile guidance performance

5. Understand the requirement for integrating flight and fire control system.

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

**Guidance, Navigation and ControlIntroduction:**Concepts of navigation, guidance and control. Introduction to basic principles. Air data information.

**Radar Systems:**Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector.Limitation of MTI performance. MTI from a moving platform (AMTI).

**Laboratory Sessions/ Experimental learning:**

1. Analyse the flight instruments of aircraft for given flight condition using MATLAB

**Applications:** Guidance system for aircraft, Target detection

**Video link / Additional online information:**

| | | |
|---|---|---|
| https://nptel.ac.in/courses/101/104/101104062/ - IIT Kanpur | | |
| **Module 2** | **L1,L2,L3,** | 10Hrs. |
| **Target Detection and Tracking with Radar:** Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT). Detection avoidance techniques.<br>**Other Guidance Systems:** Gyros and stabilised platforms. Inertial guidance and Laser based guidance. Components of Inertial Navigation System. Imaging Infrared guidance. GPS, SATcom.<br><br>**Laboratory Sessions/ Experimental learning:**<br>1. Calculate the position and velocity of an target for given doppler shift using MATLAB.<br>**Applications:** Target detection and tracking<br>**Video link / Additional online information:**<br>https://nptel.ac.in/courses/101/104/101104062/ -IIT Kanpur | | |
| **Module 3** | **L1,L2,L3** | 10Hrs. |
| **Transfer Functions:** Input-output Transfer function. Basic altitude reference. Concepts of Open loop and Close Loop, Root Locus plot.<br>**Missile Control System:** Guided missile concept. Roll stabilisation. Control of aerodynamic missile. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus.<br>**Laboratory Sessions/ Experimental learning:**<br>**1.** Determine stability of a system using Root locus plot.<br>**Applications:** Stability of a system, Missile autopilot design<br>**Video link / Additional online information:**<br>https://nptel.ac.in/courses/101/104/101104062/ - IIT Kanpur | | |
| **Module 4** | **L1,L2,L3** | 10Hrs. |
| **Missile Guidance:** Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance.<br>**Laboratory Sessions/ Experimental learning:**<br>1. Draw a missile trajectory to hit a slow moving target using Proportional guidance<br>**Applications:** Guidance system for missiles<br>**Video link / Additional online information:**<br>https://nptel.ac.in/courses/101/104/101104062/- IIT Kanpur | | |
| **Module 5** | **L1,L2** | 10Hrs. |
| **Integrated Flight/Fire Control System:** Principal of missile launch from aircraft, Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. Rate of change of Euler angle , Auto Pilot. | | |

**Laboratory Sessions/ Experimental learning:**

**1.** Draw a missile trajectory to hit a combat aircraft using Command guidance.

**Applications:** Simulation of dynamic modes and performance parameters for Aircraft design

**Video link / Additional online information:**

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2005/video-lectures/lecture-16/ - MIT

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO404.3.1 | Apply the concept of guidance and navigation to design guidance system for aircraft. |
| CO404.3.2 | Apply knowledge of the various types of guidance and control systems |
| CO404.3.3 | Evaluate control of missile |
| CO404.3.4 | Analyse missile guidance performance |
| CO404.3.5 | Analyse integrated flight and fire control system |

Reference Books:


| | |
|---|---|
| 1. | P.T. Kabamba and A.R. Girard, Fundamentals of Aerospace Navigation and Guidance, Cambridge Aerospace Series, 2014 |
| 2. | John H Blakelock,Automatic control of Aircraft & Missiles`, Wile –Inter Science Publication, 2nd edition, May 1990. |
| 3. | Merrilh I. Skolnik,`Introduction to Radar Systems`, 3rd edition, Tata Mc Graw Hill, 2001. |
| 4. | George M. Siouris**,** Missile Guidance and Control Systems, Springer, 2004 |


**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

lxviii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

lxix. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lxx. One question must be set from each unit. The duration of examination is 3 hours.

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 1 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 1 | 1 |
| CO4 | 3 | 2 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 2 | 3 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 3 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **AIRCRAFT COMMUNICATION & NAVIGATION AIDS** | **Semester** | **VII** |
| **Course Code** | **MVJ20AE751** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

This course will enable students to

6. Acquire knowledge of aircraft radio communications
7. Understand the principles of primary and secondary radars
8. Understand the radio-based navigation methods
9. Gain knowledge of the inertial navigation systems
10. Comprehend the satellite navigation systems

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

**Transmitters and Receivers:** Propagation of Radio Waves – AM & FM Transmitters - Tuned Radio Frequency Receivers – Superheat Receivers – Selectivity – Image Channel Rejection – Automatic Gain Control – Digital Frequency Synthesis.

**VHF and HF Communications:** VHF Range and Propagation - DSB Modulation - Channel Spacing - Depth of Modulation – Compression – Squelch - Data Modes - VHF Radio Equipment - Aircraft Communications Addressing and Reporting System - HF Range and Propagation - SSB Modulation – SELCAL - HF Data Link - HF Radio Equipment - HF Antennas and Coupling Units – Satellite Communications.

**Laboratory Sessions/ Experimental learning:**To study Pulse Amplitude Modulationusing switching method&by sample and hold circuit

**Applications:**Air to Air Communications, Air to Ground Communications, Aircraft Communications Addressing and Reporting System

| | | |
|---|---|---|
| **Video link / Additional online information (related to module if any):**<br>31. https://nptel.ac.in/courses/108/104/108104098/<br>32. https://nptel.ac.in/courses/117/105/117105132/ | | |
| **Module 2Primary and Secondary Radar** | **L1,L2,L3,** | 10 Hrs. |
| Primary Radar – Ground radar – Airborne Weather Radar – Secondary Surveillance Radar – Interrogation and Reply Pulses: Mode A, Mode C and Modes S - TCAS Principle – TCAS Equipment - Air Traffic Control System Equipment - ATC Transponder Modes – Modes of Operation<br>**Laboratory Sessions/ Experimental learning:**To study sampling and reconstruction of Pulse Amplitude modulation system. To study amplitude demodulation by linear diode detector.<br>**Applications:**Traffic Collision Avoidance System, Air Traffic Control, Weather Radar<br>**Video link / Additional online information (related to module if any):**<br>**15.** https://nptel.ac.in/courses/101/108/101108056/<br>**16.** https://nptel.ac.in/courses/108/105/108105154/ | | |
| **Module 3Radio Navigation** | **L1,L2,L3** | 10 Hrs. |
| **Short Range Radio Navigation Devices:** Automatic Direction Finder (ADF) - VHF Omnidirectional Range (VOR) - Distance Measuring Equipment (DME) – Area Navigation<br>**Landing Aids:** Instrument Landing System (ILS) - Microwave Landing System (MLS)<br>**Hyperbolic Navigation Systems:**Principle of Hyperbolic Navigation - LORAN A – LORAN C – Omega – Decca<br>**Laboratory Sessions/ Experimental learning:**To study DSB/ SSB amplitude modulation & determine its modulation factor & power in side bands. To study frequency modulation and determine its modulation factor.<br>**Applications:** Position Estimation, Guidance, Control<br>**Video link / Additional online information (related to module if any):**<br>21. https://nptel.ac.in/courses/101/108/101108056/ | | |
| **Module 4Inertial Navigation** | **L1,L2,L3** | 10 Hrs. |
| **Inertial Navigation:** Principle of DR Navigation for Position Estimation – Principle of Inertial Navigation and Schuler Tuning –Stable Platform and Strap down INS – Attitude Heading reference System (AHRS).<br>**Doppler Navigation:** Doppler Effect – Doppler Navigation Principles – Doppler Navigation Equipment<br>**Laboratory Sessions/ Experimental learning:**To study PLL 565 as frequency demodulator. To study Pulse Width Modulation and Pulse Position Modulation.<br>**Applications:** Position Estimation, Guidance, Control<br>**Video link / Additional online information (related to module if any):**<br>21. https://nptel.ac.in/courses/101/108/101108056/ | | |
| **Module 5Satellite Navigation** | **L1,L2** | 10 Hrs. |

**Satellite Navigation:** Segments of Satellite Navigation System - Basic Principles –Sources of Errors –Geometric Dilution of Position - Differential GPS – Local Area Augmentation System (LAAS) – Wide Area Augmentation System (WAAS) – Aircraft Based Augmentation System (ABAS) – Receiver Autonomous Integrity Monitoring (RAIM) - Terrain Reference Navigation.

**Laboratory Sessions/ Experimental learning:**To study sensitivity, selectivity, and fidelity characteristics of super heterodyne receiver.

**Applications:** Position Estimation, Guidance, Control, Communication

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

21. https://nptel.ac.in/courses/105/107/105107194/
22. https://nptel.ac.in/courses/105/107/105107062/

**Course outcomes:**

Upon completion of the course, students will be able to:

| | |
|---|---|
| CO405.1.1 | Analyse the principles and devices used in aircraft radio communications |
| CO405.1.2 | Compute the radars and its associated modes of communication |
| CO405.1.3 | Determine the various radio navigation devices |
| CO405.1.4 | Analyse the inertial navigation systems |
| CO405.1.5 | Evaluate satellite communication systems |

Reference Books:


| | |
|---|---|
| 1. | R.P.G. Collinson, Introduction toAvionics Systems, 3rd Edition, 2011, Springer. |
| 2. | Mike Tooley and David Wyatt, Aircraft Communications andNavigationSystems:Principles, Operation and Maintenance, 1st Edition, 2007, Elsevier. |
| 3. | Chris Binns, Aircraft Systems: Instruments, Communications, Navigation and Control, 1st Edition, 2019, John Wiley & Sons, Inc. |


**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

lxxi. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

lxxii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lxxiii. One question must be set from each unit. The duration of examination is 3 hours.

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | | | | | 2 | | | | | | | 1 | 1 |
| CO2 | 2 | | | | | 2 | 2 | | | | | 2 | 1 | 1 |
| CO3 | 2 | | 2 | | | 2 | | | | | | | 1 | 1 |
| CO4 | 3 | | 2 | | | 2 | | | | | | | 1 | 1 |
| CO5 | 3 | | 3 | | | 3 | 2 | | | | | 2 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **AIRCRAFT ARMAMENT STORES AND ESCAPE AID SYSTEMS** | **Semester** | **VII** |
| **Course Code** | **MVJ20AE752** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3hrs** |

**Course objective:**

- Gain knowledge of Guns, Bombs, and Rockets
- Learn the Air Launched missiles classification and its systems
- Learn the Fire Control Systems
- UnderstandEscape Aid Systems
- Acquire the knowledge oftesting of airborne stores

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

**Guns, Bombs, and Rockets**.

Guns-specific design requirements, energy requirements of aircraft guns Gatling gun, barrel design considerations. Aircraft ammunition-classification and type of ammunition, gun ammunition propellant characteristics. Aerial Bombs and Rockets-Introductory, propulsive charges, aerodynamic considerations for carriage and release. Carriage considerations and pylons. Aerodynamic decelerators. Types of war heads. Penetration bombs, Cluster and HE bombs. Fuses and arming devices. Guided bombs.

Ballistics of Stores: precision, accuracy and CEP. Internal and external ballistics of guns, bombs and rockets-launch dynamics, trajectory, dispersion and stability.

Applications: Aircraft stores carriage

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

**Missiles**.

Guided and unguided missiles, types of air launched missile. Launchers and adaptors for carriage of missiles. War head systems of guided and unguided missiles. General requirements of missile- structures, and propulsion

systems. Guided missile systems: classification, interrelationship between various missile subsystems. Choice of subsystem, selection and preliminary design considerations. Guidance systems-classification and phases. Missiles servo systems and Missile instrumentation.

Applications: Airborne Missiles

| **Module-3** | **L3** | 10Hrs. |
|---|---|---|

**Fire Control System**.

Introduction to FCS-Classification and brief description. Fundamental elements of FCS-Acquisition & tracking system, weapon pointing system, command, control and communication element. Fire control testing. Design for reliability, maintainability, ease of operation and safety. Fire control radar.

Applications: Armament stores integration

| **Module-4** | **L3** | 10Hrs. |
|---|---|---|

**Escape –Aid Systems**

Aircrew ejection seat, working of ejection seat. Pyro techniques for seat firing. Pilot's personal clothing, main parachutes, and drogue parachute. Parachute deployment methods, parachute stability, trajectory and motion of deployed parachute, and parachute material. Canopy jettisoning system. Vertical acceleration `g` vrs time during ejection, Ejection sequence in case of multi crew ejections. Zero-zero ejection. Encapsulated seat egress systems. Ergonomics of pilot`s seat.

Applications: Crew safety related

| **Module-5** | **L3,L4** | 10. |
|---|---|---|

**Testing and Certification of Air Armament Stores**.

Ground testing: Guns ammunition, rockets, bombs, fuses, parachutes, and missiles- Procedure and Instrumentation set ups for testing and proof of air armament stores. Environmental testing of air armament stores. Airworthiness certification and failure investigation procedure of air armaments. Carriage and release-effect of external carriage and advance carriage concepts.

Applications: Stores testing related

**Course outcomes:**

| | |
|---|---|
| CO405.2.1 | Apply knowledge of Guns, Bombs, and Rockets |
| CO405.2.2 | Assimilate the Air Launched missiles classification and its systems |
| CO405.2.3 | IntegrateFire Control Systems |
| CO405.2.4 | Utilise Escape Aid Systems |

| | |
|---|---|
| CO405.2.5 | Apply the knowledge for testing of airborne stores |

| Reference Books: | |
|---|---|
| 1. | Joint Services guide on environmental testing of armament stores & missiles, JSG-0102 |
| 2. | Design Development and Procedure of Military Aircraft and Airborne Stores, DDPMAS2002, CEMILAC |
| 3. | MIL-STD-7743 Testing, store suspension and release equipment, general specifications |
| 4. | Reference: Martin J Dougherty, ` Modern Air Launched Weapons`, Amber Books, Ltd,2019. |

**CIE Assessment:**

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

lxxiv. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.

lxxv. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.

lxxvi. One question must be set from each unit. The duration of examination is 3 hours.

| CO-PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 2 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |
| CO2 | 3 | 2 | 3 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| CO3 | 2 | 3 | 2 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 |

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | **COMPOSITE MATERIALS AND APPLICATIONS** | **Semester** | **VII** |
| **Course Code** | **MVJ20AE753** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L : T : P :: 3 : 1:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1.Understand theproperties and advantages of composite materials compared to conventional materials.

2.Comprehend the properties of polymer matrix composites with fibre reinforcements and to learn the fabrication methods used in composites

3. Gain knowledge about the Micro and macro mechanical properties of composite lamina and laminates

4. Understand the applications of composites

5. Learn the NDT and DT methods of Composites with Composite applications

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

**Introduction to Composite Materials**

Definition, classification of composite materials, classification of reinforcement - particulate, short fibers, whiskers, long fibers composites. matrix materials – metals, ceramics, polymers (including thermoplastics and thermosets), Carbon-Carbon Composites

**Metal Matrix Composites:**

MMC with particulate and short fiber reinforcement, liquid and solid state processing of MMC – stir casting, squeeze casting. Properties of MMCs, Applications of Al, Mg, Ti based MMC

**Laboratory Sessions/ Experimental learning:**

**Determination of various composite materials by different types of fibers with application**

**Applications:** Aircraft structural Parts, Automobile Sector and Many Engineering fields

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

33. https://youtu.be/0kB0G6WKhKE?list=PLSGws_74K01-bdEEUElQ9-obrujIKGEhg – IIT Kanpur

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

**Processing of Polymer Matrix Composites:** Thermoset Polymers, Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding,**Resin Transfer Moulding**, Pultrusion, Pulforming, Autoclave Process

**Processing of Polymer Matrix Composites:** Thermoplastic Polymers, Extrusion process, Injection Moulding Process, Thermo-forming process.

**Post Processing of Composites –** Adhesive bonding, drilling, cutting processes.

**Laboratory Sessions/ Experimental learning:**

Preparation of Composite laminates by Hand layup method

**Applications:** Thermosets and Thermoplastics are used in Aircraft Construction, corrosive environment, Common applications include fans, grating, tanks, ducts, hoods, pumps and cabinets.

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

https://youtu.be/tP8JCX87DzI - IIT Roorkee

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

**Micro-Mechanical Behavior of a Lamina**

Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants. **Ultimate Strengths of a Unidirectional Lamina**

**Macro-Mechanical Behaviour of a Lamina:**

Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Global and local axis for angle lamina, Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

**Laboratory Sessions/ Experimental learning:**

Determination of Young's Modulus of a Composite beam

**Applications:**Basics of macro level elastic properties, Scales of analysis of composites. Unidirectional and Woven fibers

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

https://youtu.be/loyeZN5UQT8 - IIT Madras

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

**Applications and Future of Composites**

Application developments – Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.

**Future of Composites: -**General introduction and theory of nanocomposites- History of nanocomposites; Size and shape dependent properties and their uniqueness. Flexible Composites, High Temperature materials.

**Laboratory Sessions/ Experimental learning:**

**1. Evaluate the mechanical properties of a lamina and a laminate**

**Applications:** Specific Aircraft Structural components.

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

| | | |
|---|---|---|
| **https://www.youtube.com/embed/PzdCymgyZ6c** - IIT Kanpur | | |
| **Module 5** | **L1,L2** | 10Hrs. |
| **Composite Testing, Inspection & Quality Control**: Determination of Mechanical properties of composite materials, Testing of composites – Interlaminar Shear testing, Fracture testing, Delamination, Raw material testing. Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan<br><br>**Laboratory Sessions/ Experimental learning:**<br>**1.** Determination of Defects in a composite by NDT Methods<br>**Applications: NDT- DT Methods, Composites in Aerospace sector**<br><br>**Video link / Additional online information (related to module if any):**<br>23. https://youtu.be/ZMJ7O4vs-Q8 - IIT Kanpur | | |

| **Course outcomes:** | |
|---|---|
| Upon completion of the course, students will be able to: | |
| CO405.3.1 | Compare the properties and select material for the given application. |
| CO405.3.2 | Analyse the properties of polymer matrix composites and Fabrication of Composite materials |
| CO405.3.3 | Apply constitutive equations of *composite* materials and understand mechanical behaviour at *micro and macro* levels. |
| CO405.3.4 | Apply the composite materials for a specific application |
| CO405.3.5 | Carry out various inspections in accordance with the established procedures and differentiate various defect types and select the appropriate **NDT** methods for better evaluation |

| Reference Books: | |
|---|---|
| 1. | K.K Chawla, Composite Materials- Science and Engineering, IV edition, Springer International Publishing, 2019: ISBN: 978-3-030-28983-6 |
| 2. | Autar Kaw, Mechanics of Composites, II edition, Taylor & Francis Group CRC Press. 2006, ISBN:978-0-8493-1343-1 |
| 3. | R M Jones,Mechanics of Composite Materials, 2nd Edition, Taylor & Francis, 2015; ISBN:978-1560327127 |
| 4. | Ajay Kapadia**,** Non-Destructive Testing of Composite Materials, National Composites Network, Best Practices Guide, TWI Publications, 2006. |

| **CIE Assessment:** |
|---|
| CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests<br>- Quizzes/mini tests (4 marks)<br>- Mini Project / Case Studies (8 Marks)<br>- Activities/Experimentations related to courses (8 Marks) |
| **SEE Assessment:** |
| lxxvii. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus.<br>lxxviii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions.<br>lxxix. One question must be set from each unit. The duration of examination is 3 hours. |

| CO,PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO1 | 3 | 1 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| CO2 | 3 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| CO5 | 3 | 1 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| **Course Title** | FLIGHT SIMULATION LAB | **Semester** | VII |
|---|---|---|---|
| **Course Code** | MVJ20AEL76 | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |

| Credits | 02 | Exam. Duration | 3 Hours |
|---|---|---|---|

**Course objective is to:**

- Understand the root locus and bode plot.
- Understand the spring mass damper system and the servo mechanism system with feedback.
- Acquiretheknowledgetousecomputationaltoolstomodelaeronautical vehicledynamics

| Sl No | Experiment Name | RBT Level | Hours |
|---|---|---|---|
| 1 | DrawPole-Zeromapof dynamicsystemmodelwithplotcustomizationoption | L1,L2,L3 | 03 |
| 2 | Plotroot locusforadynamicsystemthoughMATLAB | L1,L2,L3 | 03 |
| 3 | DrawBodeplotfromatransfer functioninMATLABandexplainthegainandphase margins | L1,L2,L3 | 03 |
| 4 | Simulateaspring-mass-damper systemwith andwithout aforcingfunctionthoughSIMULINK | L1,L2,L3 | 03 |
| 5 | Simulateasimpleservo-mechanismmotionwith feedback-in thetime domain,and in`s`domain | L1,L2,L3 | 03 |
| 6 | Simulateabomb dropfromanaircraft onamovingtankinpure pursuit motion | L1,L2,L3 | 03 |
| 7 | Developastraightandlevel flightsimulationprogramusingMATLAB | L1,L2,L3 | 03 |
| 8 | SimulateaircraftTake-off and Landingwithtrajectorytracing | L1,L2,L3 | 03 |
| 9 | Simulatestallofaircraft andshowtheeffectofvariationinstaticmarginonstallingcharacteristics | L1,L2,L3 | 03 |
| 10 | Design of proportional navigation trajectory for missile | L1,L2,L3 | 03 |
| 11 | Simulateaircraftlongitudinalmotionanddemonstratetheeffectofstaticmarginvariation forapulseinput inpitchthatis intended to bleed the airspeed. | L1,L2,L3 | 03 |
| 12 | Simulateaircraftlongitudinalmotionanddemonstratetheeffectofstaticmarginvariation foradoubletinputinpitch. | L1,L2,L3 | 03 |
| 13 | Given a Quadratic characteristic equation, determine two quadratics that shall result in poles of short-period oscillations and poles of Phugoid. Vary the coefficients of | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| | polynomial to study the movement ofpoles. | | |
| **14** | GivenaQuarticcharacteristicsequitation,determinePolesandTimeconstantsforRollmode,Spiralmotion,andDutchroll.Varythe coefficientsofpolynomial tostudythemovement of poles. | L1,L2,L3 | 03 |

| **Course outcomes:** | |
|---|---|
| CO1 | Evaluate therootlocusandbodeplot |
| CO2 | Analysethedynamicsresponseof aircraft. |
| CO3 | Usecomputationaltoolstomodel aircrafttrajectory. |

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

High-3, Medium-2, Low-1

| **Course Title** | MODELING AND ANALYSIS LAB | **Semester** | VII |
|---|---|---|---|
| **Course Code** | MVJ20AEL77 | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 | **SEE** | 50 |

| | | | |
|---|---|---|---|
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 02 | **Exam. Duration** | 3 Hours |

- **Course objective is to:**
- Understand the procedure to draw the geometric models of symmetric, cambered aerofoil, nozzle, wingandotherstructures.
- Acquiretheknowledgeoftypesofmeshing.
- Understandthebasicsofflowandstress analysis.

| Sl No | Experiment Name | RBT Level | Hours |
|---|---|---|---|
| **1** | ModelingofSymmetrical/CamberedAerofoilGeometry,andGenerationofBodyFittingAdaptiveMesh. | L1,L2,L3 | 03 |
| **2** | Modelingof2-DIncompressibleandInvisicdFlowoverSymmetrical/CamberedAerofoil,andPlottingof Pressure distributionandVelocityvectors for Subsonic/SupersonicMach numbers. | L1,L2,L3 | 03 |
| **3** | Modelingof2-DCompressibleandViscidFlowoverSymmetrical/CamberedAerofoil,andPlottingofPressuredistribution andVelocityvectors for Subsonic Mach numbers. | L1,L2,L3 | 03 |
| **4** | IsentropicFlowAnalysisina 2-DSubsonicDiffuseranda SubsonicNozzle. | L1,L2,L3 | 03 |
| **5** | IsentropicFlowAnalysisina 2-DSupersonicDiffuseranda SupersonicNozzle. | L1,L2,L3 | 03 |
| **6** | GeometricModelingandMeshGenerationofa2-DConvergent-DivergentNozzleandAnalysesofflow forAdiabaticConditions(FannoFlow). | L1,L2,L3 | 03 |
| **7** | GeometricModelingandMeshGenerationofa2-DPipeandModelingofSteady/UnsteadyHeat ConvectionandConduction(RayleighFlow). | L1,L2,L3 | 03 |
| **8** | StructuralModelingofSandwichBeamofRectangularCross-sectionandAnalysesforStressfor Unsymmetrical bending case | L1,L2,L3 | 03 |
| **9** | StructuralModelingand StressAnalysisofaTorsionBoxofaWing. | L1,L2,L3 | 03 |

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| **10** | StructuralModelingandStressAnalysisofaFuselageFrame. | L1,L2,L3 | 03 |
| **11** | StructuralModelingandStressAnalysisofaTaperedI-SectionSpar. | L1,L2,L3 | 03 |
| **12** | DeterminetheNaturalfrequencyand Modeshapesofa Cantilever beamunderUDL. | L1,L2,L3 | 03 |
| **13** | APlatefixedatoneendhasaholeincentreandhasvaryingthickness,Determinestressesdevelopedduetoapplied staticloads in verticaldirection. | L1,L2,L3 | 03 |
| **14** | ATaperedPlatefixedatoneendhasaholeincentreandhasvaryingthickness,determinestressesdevelopeddueto applied static loadsin verticaldirection. | L1,L2,L3 | 03 |

**Course outcomes:**

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| CO 1 | Drawthegeometricmodelsofsymmetric,camberedaerofoil,nozzle,wingandother structures. |
| CO 2 | Applydifferenttypesof meshing. |
| CO 3 | Performthe flowandstressanalysis. |

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

High-3, Medium-2, Low-1