| | | | |
|---|---|---|---|
| **Course Title** | **Transforms and Statistical Methods** | **Semester** | III |
| **Course Code** | **MVJ22MAS31** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L: T: P: 3: 0: 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.

| **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.

| **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.

| **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.

| **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.

| **Course outcomes:** | |
|---|---|
| CO201.1 | Use Laplace transform and inverse transforms techniques in solving differential equations. |
| CO201.2 | Demonstrate Fourier Transform as a tool for solving Integral equations. |
| CO201.3 | Demonstrate Fourier Transform as a tool for solving Integral equations. |
| CO201.4 | Apply Z Transform to solve Difference Equation.Use Method of Least Square for appropriate Curves. |
| CO201.5 | 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:** |
|---|
| Question paper for the SEE consists of 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 |
| 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

| Semester: III | | |
|---|---|---|
| **MECHANICS OF MATERIALS** | | |
| **Course Code:** | **MVJ22AS32** | **CIE Marks:50+50** |
| **Total No. of Contact Hours:** | **50 L: T: P: 3: 0: 2** | **SEE Marks: 50 +50** |
| **Hours:** | **40 L+ 26 P** | **SEE Duration: 03+03 Hours** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| 1 | Comprehend the basic concepts of strength of materials. |
| 2 | Acquire the knowledge of stresses due to bending |
| 3 | Understand the different failure in materials |
| 4 | Understand the relations among materials and their properties. |
| 5 | Acquire the practical knowledge of metallographic testing of engineering materials. |

| **UNIT-I** | |
|---|---|
| **Basics of linear elasticity:** The concept of stress& strain, state of stress & Strain at a point, Equilibrium equations, The state of plane stress and plane strain. Compatibility equations, Constitutive Laws (Hooke's Law), Stress strain curves for brittle and ductile materials, Allowable stress, Material selection for structural performance.<br>**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 | **10 Hrs** |
| **UNIT-II** | |
| **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). | **10 Hrs** |

| | |
|---|---|
| Laboratory Sessions/ Experimental learning: Different load conditions can be practiced in Structures Lab<br>Applications: Civil Construction with Symmetrical I & T sections | |
| **UNIT-III** | |
| **Deflection of Beams:** Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method.<br>**Torsion of Circular Shafts and Elastic Stability of Columns:** Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts.<br>Laboratory Sessions/ Experimental learning: Beam Experiment in Structures lab and Torsion Test apparatus available in MT Lab.<br>Applications: Civil Construction and Automobile Transmission. | **10 Hrs** |
| **UNIT-IV** | |
| Virtual work principles: Introduction, Equilibrium and work fundamentals, Principle of virtual work, Principle of virtual work applied to mechanical systems, Principle of virtual work applied to truss structures, Principle of virtual work applied to beams. Principle of complementary virtual work, internal virtual work in beams and solids.<br>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<br>Laboratory Sessions/ Experimental learning: Few of the Energy Method Theorems can be explained from Structures Lab.<br>Applications: Virtual work arises in the application of the principle of least action to the study of forces and movement of a mechanical system. | **10 Hrs** |
| **UNIT-V** | |
| **Mechanical Properties of materials**:<br>**Fracture**: Type I, Type II and Type III.<br>**Creep**: Description of the phenomenon with examples. Three stages of creep, creep properties, stress relaxation.<br>**Fatigue**: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram.<br>Laboratory Sessions/ Experimental learning: Impact Tests in MT lab for Fracture.<br>Applications: Boilers, Rotating Machine Elements. | **10 Hrs** |
| **LABORATORY EXPERIMENTS** | |

| |
|---|
| 1.Hardness Testing-Brinell and Rockwell Hardness test |
| 2.Tensile Test |
| 3.Flexural Test |
| 4.Torsional Test |
| 5.Preparation of specimen for metallographic examination of different engineering materials |
| 6.Dye penetration testing |
| 7.Magnetic particle inspection |
| 8.Heat treatment: annealing, normalizing, hardening and tempering of steel |
| 9.Impact Test – Izod and Charpy Test |
| 10.Shear Test |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO202.1 | Apply the basic concepts of strength of materials. |
| CO202.2 | Compute stress, strain under different loadings. |
| CO202.3 | Acquire the knowledge of deflection of beams |
| CO202.4 | Acquire the knowledge of virtual work principle and energy methods |
| CO202.5 | Identify different failures |

| **Textbooks:** | |
|---|---|
| **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. |

| **Reference Books** | |
|---|---|
| **1.** | Timoshenko and Young, Elements of Strength of Materials, East-West Press, 1976, ISBN 10: 8176710199 |
| **2.** | |

**Continuous Internal Evaluation (CIE):**

**Theory for 50 Marks**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes

are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

**Laboratory- 50 Marks**

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

**Semester End Examination (SEE):**

**Total marks: 50+50=100**

**SEE** for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

| **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

| **Semester: III** | | |
|---|---|---|
| **MECHANICS OF FLUIDS** | | |
| **Course Code:** | **MVJ22AS33** | **CIE Marks:50+50** |

| Credits: | L: T: P: 3: 0: 2 | SEE Marks: 50 +50 |
|---|---|---|
| Hours: | 40 L | SEE Duration: 03+03 Hours |

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

| UNIT-I | |
|---|---|
| **Basic Considerations:**<br>Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids.<br>**Fluid Statics:**<br>Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples.<br>Laboratory Sessions/ Experimental learning: Use of piezometer and manometers Applications: For pressure measurements by using different types of manometers. | **10 Hrs** |
| **UNIT-II** | |
| **Fluids in motion:**<br>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.<br>**Fluid Kinematics:**<br>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).<br>Laboratory Sessions/ Experimental learning: An experimental study of the continuity equation and Bernoulli's equation by using Venturimeter, Orificemeter and pitot tube.<br>Applications: For rotational and irrotational fluid flows, laminar and turbulent fluid flows. | **10 Hrs** |
| **UNIT-III** | |

| | |
|---|---|
| **Fluid Dynamics:**<br>Equations of motion: Euler's and Bernoulli's equation of motion for ideal and real fluids. Momentum equation, Fluid flow measurements. Numerical problems.<br>**Dimensional analysis and similarity:**<br>Dimensional homogeneity, methods of dimensional analysis, model analysis, types of similarity and similitude. Dimensionless numbers. Model laws. Numerical problems<br>Laboratory Sessions/ Experimental learning: An experimental study of the continuity equation and Bernoulli's equation by using Venturimeter, Orificemeter and pitot tube.<br>Applications: flow measuring devices and model studies. | **10 Hrs** |
| **UNIT-IV** | |
| **Flow past Immersed bodies:**<br>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.<br>Laboratory Sessions/ Experimental learning: Determination of boundary layer thickness.<br>Applications: Flow over a sloid body, separation point and understanding of lift and drag. | **10 Hrs** |
| **UNIT-V** | |
| **Compressible flow and Boundary Layers theory:**<br>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.<br>Laboratory Sessions/ Experimental learning: Propagation of disturbance for different Mach number<br>Applications: Compressible flows through nozzles, diffusers, turbines etc… Video link / | **10 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO203.1 | Evaluate the effects of fluid properties |
| CO203.2 | Estimate velocity, acceleration and stream function for an incompressible and invisid flow along with governing equations of fluid flow. |
| CO203.3 | Perform dimensional analysis and apply Bernoulli's and Eulers equation for various flow situations involving venturimeter, orificemeter and pitot-tube |

| | |
|---|---|
| CO203.4 | Calculate boundary layer thickness and drag co-efficient for laminar and turbulent flows. |
| CO203.5 | Illustrate the basic concepts of compressible flows. |

| **Textbooks:** | |
|---|---|
| **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. |

| **Reference Books** | |
|---|---|
| **1.** | Rathakrishnan. E, Fluid Mechanics, Prentice-Hall of India Pvt.Ltd, 2010, ISBN 13: 9788120331839. |
| **2.** | Ramamritham. S, Hydraulic Fluid Mechanics and Fluid Machines, Dhanpat Rai& Sons, Delhi, 1988, ISBN 13: 9788187433804 |

**Continuous Internal Evaluation (CIE):**

**Theory for 50 Marks**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the self -study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies are added to get marks out of 100 and report CIE for 50 marks.

**Laboratory- 50 Marks**

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

**Semester End Examination (SEE):**

**Total marks: 50+50=100**

**SEE** for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

**Laboratory- 50 Marks**

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

| **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 | ELEMENS OF AEROSPACE TECHNOLOGY | Semester | III |
|---|---|---|---|
| Course Code | MVJ22AS34 | CIE | 50 |
| Total No. of Contact Hours | 40 L: T : P :: 3: 0 : 0 | SEE | 50 |
| No. of Contact Hours/week | 4 | Total | 100 |
| Credits | 3 | Exam. Duration | 3 Hours |

**Course objective is to:**

1.Understand basic principles of Aircraft and the history of space vehicles.

2.Acquire the basic principles of flight.

3.Learn the basic principle of Aircraft & Rocket propulsion.

4.Understand the Aircraft Structures and Materials.

5.Acquire the basics of Aircraft Instruments & systems.

| Module-1 | RBT Level | Hours |
|---|---|---|

Introduction to Aircrafts: History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, V/STOL machines.

Introduction to Space Flight: History of Space Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere, Introduction to basic orbital mechanics, types of Orbits (LEO, MEO, Geosynchronous and Geostationary, Polar orbits), Kepler's Laws of planetary motion.

Laboratory Sessions/ Experimental learning: Ornithopter modelling, Paper plane.

Applications: Environmental conditions

| Module-2 | RBT Level | Hours |
|---|---|---|

**Basic principles of flight:** Significance of speed of sound, Propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows, Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag components, lift curve, drag curve, types of drag, factors affecting lift and drag; Centre of pressure and its significance, Aerodynamic centre, Aspect ratio, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag.

Laboratory Sessions/ Experimental learning: Aerodynamics lab Applications: Aircraft Flow dynamics

| Module-3 | RBT Level | Hours |
|---|---|---|

**Aircraft Propulsion:** Introduction, Classification, Piston Engine & its application, Brayton cycle, Principle of operation of Turboprop, turbojet and turbofan engines, Introduction to ramjets and scramjets; performance characteristics.

**Rocket Propulsion:** Principles of operation of rocket, Classification of Rockets, Types of rockets and typical applications, Introduction to Space Exploration.

Laboratory Sessions/ Experimental learning: Propulsion lab

Applications: Aircraft engines

| **Module-4** | **RBT Level** | **Hours** |
|---|---|---|

**Aircraft and Spacecraft - 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. Use of aluminum alloy, titanium, stainless steel and composite materials. Materials selection for spacecraft application.

Laboratory Sessions/ Experimental learning: Structures lab

Applications: Material & Structural Dynamics of Aircraft

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

**Instrument:**

Instrument Displays, Introduction to Navigation Instruments, Basic Air data systems & Probes, Mach meter, Air speed indicator, Vertical speed indicator, Altimeter, Gyro based instruments, Introduction to spacecraft instruments. Inertial & GPS based sensors.

**Systems:** Introduction to Hydraulic and pneumatic systems, Air Conditioning and Cockpit pressurization system, Generation and distribution of Electricity on board the airplane, Aircraft Fuel System, Fire Protection, Ice and Rain Protection System

Laboratory Sessions/ Experimental learning: Instrumentation lab.

Applications: Aircraft Instruments.

**Course outcomes:**

| | |
|---|---|
| CO204.1 | Differentiate the different concepts of aircrafts and spacecraft's in flight. |
| CO204.2 | Describe the Principle of aviation and space flight. |
| CO204.3 | Explain the Fundamentals of Rocket Propulsion and Aircraft Propulsion. |
| CO204.4 | Apply the concepts of aircraft materials and structures. |
| CO204.5 | Appreciate the complexities involved during development of flight vehicles systems. |

| Textbooks: | |
|---|---|
| **1** | John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673. |
| **2** | Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006, ISBN: 9788170020752 |

| Reference Books | |
|---|---|
| **1.** | Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206 |
| **2.** | Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition,2016, ISBN: 9781118753910 |

**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 of 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 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 1 | 0 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 3 |
| CO2 | 3 | 3 | 2 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 3 |
| CO3 | 3 | 3 | 2 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 3 |
| CO4 | 3 | 3 | 2 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 3 |
| CO5 | 3 | 0 | 2 | 0 | 0 | 1 | 3 | 0 | 0 | 0 | 0 | 3 |

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| **Course Title** | **MACHINE SHOP** | **Semester** | III |
| **Course Code** | **MVJ19ASL35** | **CIE** | 50 |
| **Total No. of Contact Hours** | **L: T: P: 3: 0: 0** | **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 |
| **12** | 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** | **AEROSPCE MATERIALS** | **Semester** | **III** |
| **Course Code** | **MVJ22AS361** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T: P: 3: 0: 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:**

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

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

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

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

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

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

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

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

**Ferrous materials in aircraft construction**:

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

Maraging Steels: Properties and Applications.

Super Alloys: Use - Nickel base - Cobalt base - Iron base - Forging and Casting of Super alloys -

| | | |
|---|---|---|
| Welding, Heat treatment. | | |
| **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.<br>Introduction to modern ceramic materials, cermets, glass ceramics, Carbon/Carbon composites – properties and applications. Introduction to nano composites. | | |
| **Module-5** | **L1, L2** | **8Hours** |
| **Non-Metals in Aircraft construction:**<br>Wood: Types, properties, and applications. Fabric in aircraft construction and specifications. Glues.<br>Glass: Types, properties, and applications.<br>Plastics &rubber in aircraft: Types, characteristics, and applications. | | |

| **Course outcomes:** | |
|---|---|
| CO206.1.1 | Apply the knowledge about the phase diagrams and microstructure of alloys. |
| CO206.1.2 | Explain the applications of Non-ferrous alloys in Aircraft and Aerospace industry. |
| CO206.1.3 | Gain knowledge about the application of Ferrous alloys in Aircraft construction |
| CO206.1.4 | Explain the applications of Polymer, Metal matrix composites. |
| CO206.1.5 | Get adequate understanding about the application of Non-metals in Aircraft construction |

| **Textbooks:** | |
|---|---|
| **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. |

| **Reference Books** | |
|---|---|
| **1.** | Hill E T, The Materials of Aircraft Construction, Pitman London. |
| **2.** | C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore, 1993 |
| **3.** | H Buhl, Advanced Aerospace Materials, Springer, Berlinl992, ISBN-13: 978- |

| | |
|---|---|
| | 3540558880 |

| **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:** |
| i. Question paper for the SEE consists of 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>i. 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 |
| 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** | **MECHANISM & MACHINE THEORY** | **Semester** | 3 |
| **Course Code** | **MVJ22AS362** | **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.

| **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

| **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.<br>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.<br>Applications: Design Of spur Gear | | |
| **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) | | |
| **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 | | |
| **Course outcomes:** | | |
| CO206.2.1 | Apply the theory of velocity, acceleration, and static force analysis to design of mechanisms. | |
| CO206.2.2 | Analyze static and dynamic force analysis of mechanisms. | |
| CO206.2.3 | Design of spur gears & Gear train. | |
| CO206.2.4 | Evaluate spur gears, gear train, balancing of rotating and reciprocating masses. | |
| CO206.2.5 | Analyse governors and gyroscope | |

| **Textbooks:** | |
|---|---|
| **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 |

| **Reference Books** | |
|---|---|
| **1.** | 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:** |
| Question paper for the SEE consists of 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 |
| 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** | **Introduction to Drone Technologies** | **Semester** | 3 |
| **Course Code** | **MVJ22AS363** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L: T: P: 3: 0: 0** | **SEE** | 50 |
| **No. of Contact Hours/week** | **4** | **Total** | 100 |
| **Credits** | **3** | **Exam. Duration** | 3 Hours |

**Course objective is to:**

Comprehend the basic evolution of Drones / UAV systems.

Acquire the knowledge of basic aerodynamics, performance, stability and control.

Understand the propulsion, loads and structures.

Understand Regulations and Certification aspects

| **Module-1** | **L1, L2, L3** | **8Hours** |
|---|---|---|
| Basics: Introduction, History, UV types: UGV, UAV, USV, UUWV, Drones in India, Future scope. Introduction to nano drones and Swarm Drones<br>Principles, Newton's Laws, Degrees of Freedom, Stick Movements, Flight Modes, Basic Manoeuvres, Take-off, Pitch, Roll, Yaw, Landing. | | |
| **Module-2** | **L1, L2, L3** | **8Hours** |
| Components and Systems: Basic components, Micro controllers, microprocessors, Sensors, Pre-Flight Checks, Flight Planning, Transmitter, Receiver.<br>Introduction to Arduino Sensors, Program Structures, Flight Controllers, Telemetry, Mission Planning, Camera, Binding, etc. | | |
| **Module-3** | **L1, L2, L3** | **8Hours** |
| Air Worthiness: DGCA Rules and Regulations, Pilot Licensing requirements, NPNT Compliance. Certifications. | | |
| **Module-4** | **L1, L2, L3** | **8Hours** |
| **Basics of Structures:** Configurations, Payload Configurations, Design Considerations.<br>**Basics of Propulsion:** Batteries, Hybrid Propulsions, IC Engines, Mini Turbines, Solar, | | |
| **Module-5** | **L1, L2, L3** | **8Hours** |
| Tuning, Testing, Manufacturing Constraints, Simulator Training, Applications CASE Studies: Construction and testing of a basic drone. | | |

**Course outcomes:**

| | |
|---|---|
| CO206.3.1 | Apply the basic concepts of UAV systems. |
| CO206.3.2 | Explain the basic aerodynamics, performance, stability and control required for UAV. |
| CO206.3.3 | Select the propulsion system and materials for structures. |

| | |
|---|---|
| CO206.3.4 | Understand Regulatory and Certification aspects |
| CO206.3.5 | Understand basic flight with experimentation |

| **Textbooks:** | |
|---|---|
| **1** | Introduction to UAV Systems Paul Gerin, Fahlstrom, Thomas James Wiley Publication 4th Edition,2012 |
| **2** | Unmanned Aerial Vehicles: DOD's Acquisition Efforts Alpha Editions. |

| **Reference Books** | |
|---|---|
| **1.** | Handbook of Unmanned Aerial Vehicles Valavanis, K., Vachtsevano S, George J Springer |

**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:**

ii. Question paper for the SEE consists of 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.

. 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** | **AIRCRAFT MATERIALS AND PROCESSES** | **Semester** | 3 |
| **Course Code** | **MVJ22AS364** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L: T: P: 3: 0: 0** | **SEE** | 50 |
| **No. of Contact Hours/week** | **4** | **Total** | 100 |
| **Credits** | **3** | **Exam. Duration** | 3 Hours |

**Course Objectives**:

This course will enable students to:

Acquire knowledge of different aerospace materials & their properties.

Understand the Heat Treatment processes of aircraft metals and alloys

Characteristics and Applications of Aluminium alloys, Ceramics, Composites and Material Testing

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

**Mechanical Behaviour of Engineering Materials:** Introduction to aerospace materials and their classification, Linear and non-linear elastic properties- Stress and Strain Curves-Yielding and strain Hardening, Toughness- Modules of resilience -- Bauchinger's effect- Effect of notches-Testing and flaw detection of materials and components, knowledge of various material testing machines

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

**Non-ferrous materials in aircraft construction:** Aluminum and Its Alloys: Types and identification. Properties -Castings-Heat treatment processes —Surface treatments.

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

**Titanium and its alloys:** Applications, machining, forming, welding and heat treatment, Copper Alloys.Wood and fabric in aircraft construction and specifications- Glues Use of glass, plastics & rubber in aircraft, Introduction to glass & carbon composite

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

Ferrous materials in aircraft construction: Steels: Plain and low carbon steels, various low alloy steels, aircraft steel specifications, corrosion and heat-resistant steels, structural applications.

Maraging Steels: Properties and Applications.

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

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

**Ceramics and Composites:** Introduction, modern ceramic materials, cermets, glass ceramic, production of semi-fabricated forms, Carbon/Carbon composites, Fabrication processes and its aerospace applications involved in metal matrix composites, polymer composites.

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

**Material Testing:**

Corrosion, its detection and prevention. Protective finishes. Testing: Destructive and non - destructive testing techniques. Crack detection, inspection of parts by hot oil and chalk, dye-penetrant, fluorescent and magnetic particles, X-ray, ultrasonic, eddy current and acoustic emission methods

| **Course outcomes:** | |
|---|---|
| CO206.4.1 | Apply the knowledge about the mechanical behaviour of different aircraft & aerospace materials. |
| CO206.4.2 | Explain the applications of Aluminium alloys, Ceramics and Composites Materials. |
| CO206.4.3 | Evaluate the importance of high temperature materials and their characterization. |

| **Textbooks:** | |
|---|---|
| **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. |

| **Reference Books** | |
|---|---|
| **1.** | Hill E T, The Materials of Aircraft Construction, Pitman London. |
| **2.** | C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore, 1993 |
| **3.** | H Buhl, Advanced Aerospace Materials, Springer, Berlinl992, ISBN-13: 978-3540558880 |

**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:**

i. Question paper for the SEE consists of 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** | **PSO1** | **PSO2** |
| **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

| Semester: III | | | |
|---|---|---|---|
| **Course Title** | Ability Enhancement Course **on Astronomy (Level 1)** | | |
| **Course Code** | MVJ22AEC07 | **CIE** | 50Marks |
| **Total No. of Contact Hours** | 30 (L: T: P: 1: 0: 2) | **SEE** | 50 Marks |
| **No. of Contact hours/week** | 03 | **Total** | 100 Marks |
| **Credits** | 2 | **Exam. Duration** | 2 Hours |

**Course objective is to:**

To enhance knowledge on Introduction to Big Bang Theory, Galaxies, Stars, Solar Systems, Electromagnetic Spectrum, Space Communication and Telescopes.

Make the learner to familiarize with the solar systems, origin, composition, surface and structure of planets.

| **Module 1. Introduction to Astronomy** | **RBT Level L1, L2, L3** | **8 Hrs.** |
|---|---|---|

Basics of Astronomy, Nature of Astronomy, Universe, Introduction to the Big Bang Theory, Galaxies, Stars, Solar Systems, Electromagnetic Spectrum, Space Communication, Astronomical Instruments, Types of telescopes.

| **Module 2. Solar Systems** | **RBT Level L1, L2, L3** | **7 Hrs.** |
|---|---|---|

Overview of our planetary system, Composition and structure of planets, origin of the solar system, surface of the planets, Planetary Configurations, Orbit of the earth and visibility of the sun, orbit of the moon.

| **Module 3. Activities/Project work** | **RBT Level L1, L2, L3** | **15 Hrs.** |
|---|---|---|

Newton's universal law of gravitation, Kepler's laws of planetary motion and proof of the laws, Theoretical Calculation of Earth's Properties.

**Course outcomes:** After the completion of course**,** students will be able to

| | |
|---|---|
| COs | Understand the fundamentals of Astronomy<br>Adequate knowledge about our planetary system, orbits of the moon and earth and properties of planets. |

**Textbooks:**

| | |
|---|---|
| **1** | Forest Ray Moulton, "An Introduction to Astronomy Hardcover", The Macmillan Company, New and Revised Edition, 2018. |
| **2** | Sally R. Ball, "Astronomy for Beginners: The Introduction Guide to Space, Cosmos, Galaxies and Celestial Bodies", Blue source and Friends, 2020. |

**Reference Books**

| | |
|---|---|
| **1.** | Johnson B. K "Optics and Optical Instruments", Dover Publications, Inc. New York. 2001. |
| **2.** | Whitlock LA, Pulliam K. "Laboratory exercises for introductory radio astronomy with a small radio telescope". iUniverse. 2008. |

| Semester: III | | |
|---|---|---|
| **Diploma Mathematics-I** | | |
| **Course Code:** | **MVJ22MATDIP31** | **CIE Marks:100** |
| **Credits:** | **L: T: P: 1: 2: 0** | **SEE Marks: 100** |
| **Hours:** | **30L+26T** | **SEE Duration: 3 Hrs** |
| **Course Learning Objectives: The students will be able to** | | |
| 1 | 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. | |

| UNIT-I | |
|---|---|
| **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. | **8 Hrs** |
| **UNIT-II** | |
| **Integral Calculus:**<br>Review of elementary Integral calculus, Reduction formula<br>$\int_0^{\frac{\pi}{2}} sin^m x\, dx$ , $\int_0^{\frac{\pi}{2}} cos^m x\, dx$, $\int_0^{\frac{\pi}{2}} sin^m cos^n x\, dx$ and problems. Evaluation of double and triple integrals and Simples Problems. | **8 Hrs** |
| **UNIT-III** | |
| **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). | **8 Hrs** |
| **UNIT-IV** | |
| **Probability:**<br>Introduction-Conditional Probability, Multiplication theorem, Independent events ,Baye's theorem and Problems. | **8 Hrs** |
| **UNIT-V** | |
| **Differential equation:** Homogenous differential equation, Linear differential equation, Bernoulli's differential equation and Exact differential equation. | **8 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** |
|---|

| | |
|---|---|
| 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. |

| **Textbooks:** | |
|---|---|
| **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 |

**Continuous Internal Evaluation (CIE):**

**Theory for 50 Marks**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

**Semester End Examination (SEE):**

**Total marks: 50+50=100**

**SEE** for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire

unit having same complexity in terms of COs and Bloom's taxonomy level.

| **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

| Semester: IV | | |
|---|---|---|
| **COMPLEX VARIABLES & NUMERICAL METHODS** | | |
| **Course Code:** | **MVJ22MAS41** | **CIE Marks:50** |
| **Credits: L: T: P: S** | **3: 0: 0: 0** | **SEE Marks: 50** |
| **Hours:** | **40** | **SEE Duration: 3 Hrs** |

**Course Learning Objectives: The students will be able to**

| | |
|---|---|
| 1 | Understand the concepts of Complex variables and transformation for solving Engineering Problems. |
| 2 | Understand the concepts of complex integration, Poles and Residuals in the stability analysis of engineering problems. |
| 3 | Apply the concept to find external of functional. |
| 4 | Solve initial value problems using appropriate numerical methods. |
| 5 | Students learn to obtain solution s of ordinary and partial differential equations numerically. |

| **UNIT-I** | |
|---|---|
| **Complex variables - 1:**<br>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).<br>**Transformations:**<br>Bilinear Transformation, Conformal transformation, Discussion of the transformations $w = z^2$, $w = e^z$ and $w = z + \frac{a}{z}, (z \neq 0)$. | **10 Hrs** |
| **UNIT-II** | |
| **Complex variables 2:**<br>Complex integration - Cauchy theorem, Cauchy's Integral Theorem-Problems, Taylor & Laurent series- Problems, Singularities, Types of Singularities, Poles, Residues-definitions, Cauchy residue theorem - Problems. | **10 Hrs** |
| **UNIT-III** | |
| **Numerical methods 1**:<br>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, | **10 Hrs** |

| | |
|---|---|
| Milne's and Adam-Bashforth Predictor and Corrector method. | |
| **UNIT-IV** | |
| **Numerical methods 2**:<br>Numerical solution of Ordinary Differential Equations of second order: Runge-Kutta method of fourth order, Milne's Predictor and Corrector method.<br>**Calculus of variations:**<br>Variation of function and Functional, variational problems, Euler's equation, Geodesics.<br>**Applications**: Hanging Chain problem. | **10 Hrs** |
| **UNIT-V** | |
| **Numerical methods 3**:<br>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. | **10 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO211.1 | State and prove Cauchy - Riemann equation with its consequences and demonstrate Conformal Transformation. |
| CO211.2 | Illustrate Complex Integration using Cauchy's Integral theorem, Cauchy's Integral formula, and Cauchy's Residue theorem. |
| CO211.3 | Identify appropriate numerical methods to solve ODE. |
| CO211.4 | Determine the extremals of functionals and solve the simple problems of the calculus of variations. |
| CO211.5 | Choose appropriate numerical methods to solve Partial Differential Equations. |

| **Textbooks:** | |
|---|---|
| **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. |

**Continuous Internal Evaluation (CIE):**

**Theory for 50 Marks**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

**Semester End Examination (SEE):**

**Total marks: 50+50=100**

**SEE** for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

| **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

| Semester: IV | | |
|---|---|---|
| **INCOMPRESSIBLE AERODYNAMICS** | | |
| **Course Code:** | **MVJ22AS42** | **CIE Marks:50** |
| **Credits: L: T: P: S** | **3: 0: 2: 0** | **SEE Marks: 50** |
| **Hours: 40L** | **40L + 26P** | **SEE Duration: 3 Hrs** |

**Course Learning Objectives: The students will be able to**

| | |
|---|---|
| 1 | Understand the basics of fluid mechanics as a prerequisite to Aerodynamics |
| 2 | Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil |
| 3 | Acquire knowledge of incompressible flows over airfoil |
| 4 | Understand the fundamentals of incompressible flow over finite wings |
| 5 | Assimilate the understanding of application of finite wing theory and high lift systems |

| **UNIT-I** | |
|---|---|
| Review of Basic Fluid Mechanics<br>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.<br>Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds<br>Applications: provides a proper understanding of the flow properties and their characteristics features which helps in the study of flow over airfoils | **10 Hrs** |
| **UNIT-II** | |
| **Airfoil Characteristics**<br>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.<br>Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds<br>Applications: understand the characteristics and the distribution of pressure over the airfoil | **10 Hrs** |

| | |
|---|---|
| | |
| **UNIT-III** | |
| **Two Dimensional Flows & Incompressible Flow Over Airfoil**<br>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.<br>Laboratory Sessions/ Experimental learning: Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey.<br>Applications: study the lifting and non lifting flows over cylinders and arbitrary bodies and understanding the theory behind lift generation | **10 Hrs** |
| **UNIT-IV** | |
| **Incompressible Flow Over Finite Wings**<br>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<br>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.<br>Applications: understanding the theory of lift generation over finite wings and their flow patterns | **10 Hrs** |
| **UNIT-V** | |
| **Applications of Finite Wing Theory & High Lift Systems**<br>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<br>Source panel & vortex lattice method<br>Laboratory Sessions/ Experimental learning: Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various angles of incidence, speed. | **10 Hrs** |

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

| LABORATORY EXPERIMENTS | | | |
|---|---|---|---|
| **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. | | |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO212.1 | Describe the fundamental equations of continuity, momentum & energy of fluid flow. |
| CO212.2 | Evaluate typical airfoil characteristics and two-dimensional flows over airfoil |
| CO212.3 | Analyze the incompressible flow over airfoil |
| CO212.4 | Compute and analyze the incompressible flow over finite wings |
| CO212.5 | Apply finite wing theory and analyze high lift systems |

| **Text 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 |
| **Reference Books** | |
| **1.** | Clancy L. J., Aerodynamics, Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804 |
| **2.** | Louis M. Milne-Thomson, Theoretical Aerodynamics, Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804. |
| **3.** | John J. Bertin (autor.), Russell M. Cummings, Aerodynamics for Engineers, Sixth edition Cambridge University Press (2021) |
| **4.** | Steven H. Collicott, Daniel T. Valentine, E. L. Houghton, P. W. Carpenter, Aerodynamics for Engineering Students, Edition 8, Elsevier (2024), ISBN: 032395815X, 9780323958158 |

**Continuous Internal Evaluation (CIE):**

**Theory for 50 Marks**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are

conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

**Semester End Examination (SEE):**

**Total marks: 50+50=100**

**SEE** for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

| **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 | 1 |
| 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

| Semester: IV | | | |
|---|---|---|---|
| **THERMODYNAMICS** | | | |
| **Course Code** | **MVJ22AS43** | **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 & various types of gas cycles

Acquire the knowledge of Heat transfer.

| **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

| **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.

Laboratory Sessions/ Experimental learning:

Applications:

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

| **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 engine, Carnot cycle, Carnot principles.

**Entropy:**

Clausius 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.

Laboratory Sessions/ Experimental learning:

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

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

**Pure Substances:**

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.

**Gas Cycles:**

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

Laboratory Sessions/ Experimental learning:

Applications: Working fluids and its properties, in power plants for power generations.

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

**Heat Transfer:**

Introduction to heat transfer, Modes of heat transfer, conduction, convection, radiation heat transfer, heat exchangers, types of heat exchangers(shell and tube heat exchanger, plate heat exchanger) Application of heat transfer in Aeronautical and Aerospace engineering.

Applications:

IC engines, Gas turbine engines etc..

LABORATORY EXPERIMENTS

| **Sl No** | **Experiment Name** | **RBT Level** | **Hours** |
|---|---|---|---|
| **1** | Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Martins Apparatus. | L1,L2,L3 | 03 |
| **2** | Determination of Calorific value of solid, liquid and gaseous fuels. | L1,L2,L3 | 03 |
| **3** | Determination of Viscosity of lubricating oil using Torsion viscometers. | L1,L2,L3 | 03 |
| **4** | Valve Timing diagram of 4-stroke IC Engine. | L1,L2,L3 | 03 |
| **5** | Calculation of work done and heat transfer from PV and TS diagram using Planimeter. | L1,L2,L3 | 03 |
| **6** | Performance Teston Four Stroke Petrol Engine and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat balance sheet. | L1,L2,L3 | 03 |
| **7** | Performance Test on Four stroke Multi cylinder Engine and calculations of IP, BP, Thermal efficiencies, SFC, FP and to draw heat balance sheet. | L1,L2,L3 | 03 |
| **8** | Calibration of Venturi meter. | L1,L2,L3 | 03 |
| **9** | Determination of Coefficient of discharge for a small orifice by a constant head method. | L1,L2,L3 | 03 |
| **10** | Verification of Bernoulli's equation. | L1,L2,L3 | 03 |
| **11** | Investigate the effect of changes in hot fluid and cold fluid flow on temperature, efficiency and overall heat transfer coefficient using different working fluids | L1,L2,L3 | 03 |
| **12** | Determination of Convective heat transfer coefficient for the composite materials | L1,L2, L3 | 03 |

**Course outcomes:**

| | |
|---|---|
| CO1 | Operate the instrument and measure the BP, FP, IP and AF ratio. |
| CO2 | Find the efficiency of the engine and Estimate the calorific value of the given fuel. |
| CO3 | Verify the Bernoulli's equation. |

| **Course outcomes:** | |
|---|---|
| CO203.1 | Apply the concepts of thermodynamics in various engineering problems. |
| CO203.2 | Differentiate thermodynamic work and heat and apply I law of thermodynamics to different process |
| CO203.3 | Differentiate thermodynamic work and heat and apply II law of thermodynamics to different process |
| CO203.4 | Apply the concepts of Pure Substances & of various gas cycles |
| CO203.5 | Apply the principles heat transfer |

| **Textbooks:** | |
|---|---|
| **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 |

| **Reference Books** | |
|---|---|
| **1.** | YunusA.Cenegal and Michael A.Boles, Thermodynamics: An Engineering Approach, TataMcGraw Hill publications, 2002, ISBN 13: 9780071072540 |
| **2.** | 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<br>Quizzes/mini tests (4 marks)<br>Mini Project / Case Studies (8 Marks)<br>Activities/Experimentations related to courses (8 Marks) |
| **SEE Assessment:** |

vi. 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 | 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

| Semester: IV | | | |
|---|---|---|---|
| **COMPUTER AIDED AIRCRAFT DRAWING** | | | |
| **Course Code** | MVJ22ASL44 | **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. | | |
| | 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.<br>**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. | | |
| | PART C | L1, L2, L3, L4 | 20Hour |

| | | |
|---|---|---|
| | | s |

| | |
|---|---|
| **1** | Modelling of propeller and hub assembly |
| **2** | Modelling of wing assembly |
| **3** | Modelling of fuselage assembly |
| **4** | Modelling of Engine Mounts |
| **5** | Modelling of main rotor blade assembly of helicopter |
| **6** | Modelling of UAV assembly |
| **7** | Modelling of Landing Gear Assembly |
| | Laboratory Sessions/ Experimental learning: CAAD Lab Applications: To Design an Aircraft Model. |
| | |
| **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 |

| | |
|---|---|
| | **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:** |
| x. | x. Question paper for the SEE consists of 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. |

| | |
|---|---|
| | i. 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>ii. 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 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |

High,3, Medium,2, Low,1

| Semester: IV | | | |
|---|---|---|---|
| **AIRCRAFT SYSTEMS & INSTRUMENTATION** | | | |
| **Course Code** | **MVJ20AS451** | **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:**

Gain knowledge of the aircraft control systems.

Understand the applications of hydraulics and pneumatics in aircraft systems.

Acquire knowledge regarding aircraft engine systems.

Comprehend the aircraft auxiliary systems

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.

| **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.

| **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.

| **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.

| **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.

**Course outcomes:**

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

| | |
|---|---|
| CO315.1.1 | Distinguish the conventional and modern control systems. |
| CO315.1.2 | Analyse the aircraft systems. |
| CO315.1.3 | Analyse the working of Aircraft engine systems. |
| CO315.1.4 | Describe aircraft Auxiliary systems |
| CO315.1.5 | Applydifferent aircraft instruments. |

**Textbooks:**

| | |
|---|---|
| **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. |

**Reference Books**

| | |
|---|---|
| **1.** | William A Neese,Aircraft Hydraulic Systems, Himalayan Books, 2007 |
| **2.** | 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

| Semester: IV | | | |
|---|---|---|---|
| **FINITE ELEMENT METHODS** | | | |
| **Course Code** | **MVJ22AE452** | **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:**

Understand the importance of discretization of domain using different finite elements.

Acquire the knowledge of different loading and boundary conditions.

Understand the governing methods of finite element analysis.

Comprehend the higher order discretization.

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:** Solving practical technical problems using scientific and mathematical tools, Calculating the global stiffness matrix in the finite element method

| **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:** 2D and 3 D elements to apply boundary conditions, The direct stiffness method to compute degrees of freedom at the element nodes.

| | | |
|---|---|---|
| To determine the value of state variable at any point of element based on values of state variable. | | |
| **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<br>**Laboratory Sessions/ Experimental learning:**Analysis of CST Element by using ANSYS<br>**Applications:**<br>To approximate the *shape* of the object and to compute the displacement of points inside the boundary of the object | | |
| **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<br>**Laboratory Sessions/ Experimental learning:** Analysis of Long Cylinder (Axiymmetric Problem) using Quadrilateral Elements in ANSYS<br>**Applications:**<br>To create shape functions that would ensure the compatibility of the displacement between neighboring elements while maintaining the requirements for shape functions<br>Higher-order approximation of the unknown function over a bounding surface described by non-planar elements. | | |
| **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<br>**Laboratory Sessions/ Experimental learning:** Performing Heat Transfer Analysis Using ANSYS<br>**Applications:** Problem involving heat flow ,<br>Structural dynamics | | |
| **Course outcomes:** | | |

| Upon completion of the course, students will be able to: | |
|---|---|
| CO315.2.1 | Apply discretization technique for domain using different finite elements |
| CO315.2.2 | Evaluate the effects of different loading and boundary conditions |
| CO315.2.3 | Analyze the governing equations of finite element analysis |
| CO315.2.4 | Formulating mathematical model using higher order element type |
| CO315.2.5 | Analyze heat flow problem by considering dynamic consideration |

| **Textbooks:** | |
|---|---|
| **1** | Chandru Patla T. R, PHI Finite Elements in engineering, , 3rd edition, 2002 |
| **2** | BhaviKatti, Finite element Analysis, New Age International, 3rd edition,2015 |

| **Reference Books** | |
|---|---|
| **1.** | Zienkiewicz. O.C, The Finite Element Method, Elsevier, 7th edition,2013 |
| **2.** | C.S. Krishnamurthy, Finite Element analysis - Theory and Programming, Tata McGraw Hill Co. Ltd, New Delhi, 2nd edition,2011 |
| **3.** | Rao S. S, Elsevier, Finite Elements Method in Engineering, 5th edition, 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

Quizzes/mini tests (4 marks)

Mini Project / Case Studies (8 Marks)

Activities/Experimentations related to courses (8 Marks)

**SEE Assessment:**

i. Question paper for the SEE consists of 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** | **PSO1** | **PSO2** |
| **CO1** | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO4** | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| **CO5** | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| High,3, Medium,2, Low,1 | | | | | | | | | | | | | | |

| Semester: IV | | | |
|---|---|---|---|
| **INTRODUCTION TO SPACE TECHNOLOGY** | | | |
| **Course Code** | MVJ22AS453 | **CIE** | **50** |
| **Total No. of Contact Hours** | **3 L: T: P: 3: 0: 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

Understand the fundamentals of aerospace propulsion.

Understand the orbit mechanics and orbit maneuvers.

Acquire the knowledge of satellite attitude dynamics and space mission operations.

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

ndamentals of Aerospace Propulsion: Space Mission, Types, Space Environment, Launch Vehicle Selection. Introduction to rocket propulsion-fundamentals of solid propellant rockets, Fundamentals of liquid propellant rockets, Rocket equation, Tsiolkovsky rocket equation, Concepts of Specific Impulse.

vo-dimensional trajectories of rockets and missiles, multi-stage

ckets-Vehicle sizing, two stage Multi-stage Rockets, Trade-off Ratios-Single Stage to Orbit, Sounding Rocket, Aerospace Plane, Gravity Turn Trajectories, Impact point calculation, injection conditions-Flight dispersions, Burnout velocity.

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

**Atmospheric Reentry:** Introduction-Steep Ballistic Reentry, Ballistic Orbital Reentry, Skip Reentry, "Double-Dip" Reentry, Aero-braking, Lifting Body Reentry.

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

**Fundamentals of Orbit Mechanics, Orbit Maneuvers:** Two-body motion, Circular, elliptic, hyperbolic, and parabolic orbits-Basic Orbital Elements, Ground trace In-Plane Orbit changes, Hohmann Transfer, Bielliptical Transfer, Plane Changes, Combined Maneuvers, Propulsion for Maneuvers.

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

**Satellite Attitude Dynamics:** Torque free Axi-symmetric rigid body, Attitude Control for Spinning Spacecraft, Attitude Control for Non-spinning Spacecraft, The Yo-Yo Mechanism, Gravity — Gradient Satellite, Dual Spin Spacecraft, Attitude Determination.

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

**Space Mission Operations:** Supporting Ground Systems Architecture and Team interfaces, Mission phases and Core operations, Team Responsibilities, Mission

| | |
|---|---|
| Diversity, Standard Operations Practices. | |
| **Course outcomes:** | |
| Upon completion of the course, students will be able to: | |
| CO315.3.1 | Distinguish the types of aerospace propulsion. |
| CO315.3.2 | Determine the attitude of the satellites. |
| CO315.3.3 | Support the space mission operations |

**Textbooks:**

| | |
|---|---|
| **1** | W.E. Wiesel," Spaceflight Dynamics",McGraw Hi11,2nd edition,2014,ISBN-13: 978-9332901650 |
| **2** | J.W. Cornelisse, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982. |

**Reference Books**

| | |
|---|---|
| **1.** | Vincet L. Pisacane Fundamentals of Space Systems Oxford University Press 2005 |
| **2.** | Understanding Space: An Introduction to Astronautics J.Sellers McGraw Hill 2nd edition,2000 |

**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:**

i. Question paper for the SEE consists of 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 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 | 2 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **TURBOMCHINES** | **Semester** | IV |
| **Course Code** | **MVJ20AE454** | **CIE** | 50 |
| **Total No. of Contact Hours** | **40 L: T : P :: 3 : 0 : 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.

| **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.

| | | |
|---|---|---|
| **Module-3** | **L1,L2,L3** | **8Hours** |
| **Compression process:**<br>Overall isentropic efficiency of compression; stage efficiency; comparison and relation between overall efficiency and stage efficiency; polytropic efficiency; preheat factor.<br>**Expansion process:**<br>Overall 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.<br>**Laboratory Sessions/ Experimental learning**: Fluid Mechanics lab for compressor and turbines and Aircraft propulsion lab: Study of gas turbine turbojet engine<br>**Applications:** Turbojet, turbofan, turbo shaft engines. | | |
| **Module-4** | **L1,L2,L3** | **8Hours** |
| **Design and performance analysis of Centrifugal compressors:** Types, design parameters, flow analysis in impeller blades, volutes and diffusers, losses, slip factor, characteristic curves, surging, choking. Construction details.<br>**Design and performance analysis of axial 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.<br>**Laboratory Sessions/ Experimental learning**: Aircraft propulsion lab: Study of gas turbine turbojet engine<br>**Applications:** Turbojet, turbofan, turbo shaft engines. | | |
| **Module-5** | **L1,L2** | **8Hours** |
| **Design and performance analysis of axial flow turbines:**<br>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<br>**Design and performance analysis of radial turbines:**<br>Thermodynamics and aerodynamics of radial turbines; radial turbine characteristics; losses and efficiency; design of radial turbine.<br>**Laboratory Sessions/ Experimental learning**: Aircraft propulsion lab and Fluid mechanics lab.<br>**Applications:** Turbojet, turbofan, turbo shaft engines. | | |

| **Course outcomes:** | |
|---|---|
| CO315.4.1 | Compute the energy transfer and energy transformation in turbomachines. |
| CO315.4.2 | Analyse the design of turbomachine blades. |
| CO315.4.3 | Apply hydraulic pumps and turbines for specific requirements |

| | |
|---|---|
| CO315.4.4 | Apply dimensionless parameters for turbomachines |
| CO315.4.5 | Analyse Compression and Expansion process |

| **Textbooks:** | |
|---|---|
| **1** | S.M.Yahya, Turbines, Compressors & Fans, Tata McGrawHill Co. ,2nd Edition (2002),ISBN 13: 9780070707023. |
| **2** | D.G.Shephered,PrinciplesofTurboMachinery,TheMacmillanCompany(1964),ISBN-13: 978-0024096609. |

| **Reference Books** | |
|---|---|
| **1.** | 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:**

i. Question paper for the SEE consists of 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 | 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

| Semester: IV | | | |
|---|---|---|---|
| **Ability Enhancement Course on Astronomy (Level 2)** | | | |
| **Course Code** | MVJ22AEC07 | **CIE** | 50 Marks |
| **Total No. of Contact Hours** | 30 (L: T: P: 1: 0: 2) | **SEE** | 50 Marks |
| **No. of Contact hours/week** | 02 | **Total** | 100 Marks |
| **Credits** | 2 | **Exam. Duration** | 2 Hours |

**Course objective is to:**

Understand the Planets of the solar system, Planetary properties, Planetary orbits, Planetary atmospheres.
Familiarize with the Evolution of Stars, birth and death of stars, Star Formation, The properties of the stars.

| **Module 1. The Planets** | **RBT Level L1, L2, L3** | **8 Hrs.** |
|---|---|---|

Planetary properties, Planetary orbits, Planetary atmospheres, Planets of the solar system – Mercury, Venus, Earth, Moon, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto and other minor planets.

| **Module 2. The Stars** | **RBT Level L1, L2, L3** | **7 Hrs.** |
|---|---|---|

The birth of stars, Star Formation, The properties of the stars, Planets beyond the solar system, Star Clusters, Evolution of Stars, Death of Stars, Variable Stars, Compact Stars.

| **Module 3. Activities/Project work** | **RBT Level L1, L2, L3** | **15 Hrs.** |
|---|---|---|

Theoretical Calculation of Sphere of Influence of Earth, Hohmann Transfer, Bielliptic Transfer, Interplanetary Hohmann Transfer

**Course outcomes:** After the completion of course**,** students will be able to

| | |
|---|---|
| COs | Understand the Planets of the solar system, Planetary properties, Planetary orbits, Planetary atmospheres.<br>Understand the Evolution of Stars, birth and death of stars, Star Formation, The properties of the stars. |

**Textbooks:**

| | |
|---|---|
| **1** | Johnson B. K "Optics and Optical Instruments", Dover Publications, Inc. New York. 2001. |
| **2** | Whitlock LA, Pulliam K. "Laboratory exercises for introductory radio astronomy with a small radio telescope". iUniverse. 2008. |

**Reference Books**

| | |
|---|---|
| **1.** | Forest Ray Moulton, "An Introduction to Astronomy Hardcover", The Macmillan Company, New and Revised Edition, 2018. |
| **2.** | Sally R. Ball, "Astronomy for Beginners: The Introduction Guide to Space, Cosmos, Galaxies and Celestial Bodies", Blue source and Friends, 2020. |

| Semester: IV | | | |
|---|---|---|---|
| **Diploma Mathematics-II** | | | |
| **Course Code** | MVJ22MATDIP-II | **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 engineering problems.

| **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.

| **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.

| **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.

| **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.

| | | |
|---|---|---|
| **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. | | |

| **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:**

i. Question paper for the SEE consists of 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. |

| Course Title | AVIATION MANAGEMENT | Semester | V |
|---|---|---|---|
| Course Code | MVJ22AS51 | CIE | 50 |
| Total No. of Contact Hours | 40 L: T: P: 3: 0 :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.
- Comprehend the fundamentals of maintenance and certification.
- Understand the Aircraft Management Maintenance.
- Acquire knowledge of maintenance safety and trouble shooting in Airlines.

| 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.

| 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.

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

**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.

| Module-4 | L1., L2 | 8Hours |
|---|---|---|
| **Aircraft Management Maintenance**<br>Structure, Role of aviation management, Line supervisory management, Management areas of concern in airlines, Manager of overhaul shops, Line maintenance control center flight line (preflight& post flight), Aircraft Logbook, Maintenance crew skill requirements.<br>**Laboratory Sessions/ Experimental learning:** A demo on aircraft logbook.<br>**Applications:** Implement the aviation management in airlines. | | |
| **Module-5** | **L1., L2** | **8Hours** |
| **Maintenance Safety & Trouble shooting**<br>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.<br>**Laboratory Sessions/ Experimental learning:** A demo on safety system in wind tunnel lab.<br>**Applications:** Apply the safety regulations, OSHA safety programs and troubleshooting systems in aircraft. | | |

| **Course outcomes:** | |
|---|---|
| CO301.1 | Understand the concept of Management |
| CO301.2 | Understand the staffing process |
| CO301.3 | Apply the certification procedure for aircraft maintenance. |
| CO301.4 | Apply the management system in aircraft maintenance. |
| CO301.5 | Examine the quality control and calibration on Aircraft. |

| **Text Books:** | |
|---|---|
| 1 | Stephen P.Robbins & Mary Coulter, Management, Prentice Hall(India)Pvt.Ltd.,10$^{th}$Edition, 2009 |
| 2 | Harry A Kinnison, Tariq Siddiqui, Aviation Maintenance Management, Mc Graw Hill education (India) Private Ltd, 2013. |
| **Reference Books:** | |
| 1 | Kroes, Watkins, Delp, Aircraft maintenance and repair, Mc Graw Hill,2013. |
| 2 | Larry Reithmaier, Aircraft Repair Manual, Palmar Books, Marquette,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:** |

iv. Question paper for the SEE consists of 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 | 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 | **FUNDAMENTALS OF AEROSPACE STRUCTURES** | Semester | V |
|---|---|---|---|
| Course Code | **MVJ22AS52** | CIE | 50 |
| Total No. of Contact Hours | 50 L : T : P :: 3 : 0 : 2 | SEE | 50 |
| No. of Contact Hours/week | 5 | Total | 100 |
| Credits | 4 | Exam. Duration | 3 Hours |

**The course objective is to:**

1. Acquire the knowledge of types of loads on aerospace vehicles.
2. Understand the theory of elasticity and understand the different failure theories and to learn the concept of static strength
3. Illustrate the methods to design a structure against impact and fatigue loads
4. Understand the different methods to analyze columns
5. Describe about symmetrical and unsymmetrical sections

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

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

**Design considerations**, Codes and Standards. Factor of safety, Safe life and fail-safe approach.

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.

| **Module 2** | **L3** | 10 Hrs. |
|---|---|---|

**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. Principal Stresses and Orientation of Principal Directions.

**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

| **Module 3** | **L3** | 10 Hrs. |
|---|---|---|

**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.

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

| **Module 4** | **L3** | 10 Hrs. |
|---|---|---|

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

**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

| **Module 5 Symmetrical and unsymmetrical bending** | **L4** | 10 Hrs. |
|---|---|---|

Introduction: Elementary theory of bending – Introduction to semi-Monocoque structures - Stresses in beams of symmetrical and unsymmetrical sections. 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.

**Course outcomes:**

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

| | |
|---|---|
| CO302.1 | Understand the various loads experienced by an aircraft in flight and functions of different components. |
| CO302.2 | Assess compatibility conditions and boundary conditions to find the stress and strain of an elastic material. |
| CO302.3 | Design a structure against fatigue loads and to design a material for impact load. |
| CO302.4 | Formulate different Energy methods in calculations related to structural components and to understand the different methods to analyse columns. |
| CO302.5 | Analyse the direct stress distribution for unsymmetrical bending section |

LABORATORY EXPERIMENTS

| | |
|---|---|
| 1 | Deflection of a Simply Supported Beam |
| 2 | Deflection of a Cantilever Beam |
| 3 | Beam with Combined Loading by using Superposition Theorem |
| 4 | Verification of Maxwell's Reciprocal Theorem for Beam with |

| | |
|---|---|
| | a) Constant cross section<br>b) varying Cross section |
| 5 | Determination of Young's Modulus and Poisson Ratio using Strain Gages. |
| 6 | Buckling Load of Slender Eccentric Column sand Construction of South Well Plot |
| 7 | Shear Failure of Bolted and Riveted Joint |
| 8 | Bending Modulus of Sandwich Beam |
| 9 | Determine the Index Factor `K `in a Tensile Field of Wagner Beam |
| 10 | Tensile, Compressive and Flexural Testing of a Composite Material Plate |
| 11 | Determination of Natural Frequency and Mode Shapes of a Cantilever Beam for the Following Cases<br>a) Constant cross section<br>b) Varying cross section |
| 12 | Determination of Shear Centre for Following Cases through Deflection<br>a) Close section–Symmetrical bending<br>b) Open section–Unsymmetrical bending |
| 13 | Determination of Shear flow for Following Cases<br>a) Close section–Symmetrical bending<br>b) Open section–Unsymmetrical bending |
| 14 | Determining of Shear Centre Through Shear Flow Measurement for Following Cases<br>a) Close section–Symmetrical bending<br>b) Open section–Unsymmetrical bending |

| **Textbooks:** | |
|---|---|
| **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 |

| **Reference Books** | |
|---|---|
| **1.** | Bruce K Donaldson, "Analysis of Aircraft structures", Cambridge Aerospace Series, reprint 2012, ISBN- 9780511801631 |
| **2.** | Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw, Hill, N.Y, 2nd edition, 1993 |

**CIE Assessment:**

**Theory for 50 Marks**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the project based assignments are 20 (2

presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies are added to get marks out of 100 and report CIE for 50 marks.

**Laboratory- 50 Marks**

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

**SEE Assessment:**

**SEE** for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

**Laboratory- 50 Marks**

Experiment Conduction with proper results is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

| 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 | 0 | 1 | 1 | 0 | 1 | 1 | 2 |
| CO2 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 2 |
| CO3 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 2 |
| CO4 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 2 |
| CO5 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | 2 |
| High,3, Medium,2, Low,1 | | | | | | | | | | | | | | |

| | | | |
|---|---|---|---|
| **Course Title** | **COMPRESSIBLE AERODYNAMICS** | **Semester** | **V** |
| **Course Code** | **MVJ22AS53** | **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** | **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

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

**Normal Shock:** Prandtl Meyer equation and Rankine – Hugonoit relation, Normal shock equations: Property ratios in terms of upstream Mach number, Numerical, 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.

| **Module 3** | **L2** | 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.

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

**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

| **Module 4** | **L2** | 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 | | |
| **Module 5** | **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 | | |

**Course outcomes:**

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

| | |
|---|---|
| CO303.1 | Apply the basic concepts of compressible flow |
| CO303.2 | Evaluate the concepts of normal shock phenomenon |
| CO303.3 | Apply the concepts of oblique shock and expansion wave formation. |
| CO303.4 | Utilize the concepts of Differential Equations of Motion for Steady Compressible Flows |
| CO303.5 | Investigate the parameters of high-speed flow. |

**Textbooks:**

| | |
|---|---|
| 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 |

**Reference Books:**

| | |
|---|---|
| 1. | Ascher.H. Saphiro, Dynamics and Thermodynamics of Compressible fluid flow, John Wiley& Sons,1st edition,1977, ISBN-13: 978-0471066910. |
| 2. | Yahya, S.M., Fundamentals of Compressible flow, NEW AGE, 2009, ISBN-13: 978-8122426687. |
| 3. | Steven H. Collicott, Daniel T. Valentine, E. L. Houghton, P. W. Carpenter, Aerodynamics for Engineering Students, Edition 8, Elsevier (2024), ISBN: 032395815X, 9780323958158 |
| 4. | 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: 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 of 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 | 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** | **MECHANICAL MEASUREMENT AND METROLOGY LAB** | **Semester** | V |
| **Course Code** | **MVJ22ASL54** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 0 : 0 : 2 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 01 | **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 |
| **15** | Measurement of Gear Pitch, Thread Pitch, and Thread Diameter Using a Digital Profilometer. | L1,L2,L3 | 03 |

**Course outcomes:**

| | |
|---|---|
| CO304.1 | Use different measuring tools related to experiments |
| CO304.2 | Identify, define, and explain accuracy, precision, and some additional terminology. |
| CO304.3 | 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 | | | | | | | | | | | | |

**Professional Elective-I**

| | | | |
|---|---|---|---|
| **Course Title** | **THOERY OF VIBRATION** | **Semester** | **V** |
| **Course Code** | **MVJ22AS551** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T: P: 3 :0: 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** | **L3** | 08 Hrs. |
|---|---|---|

Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems.

**Laboratory Sessions/ Experimental learning:**

Simple pendulum experiment to understand concept of wave motion

**Applications:** Various types of vibrations and its real time applications

Concept of wave and its characteristics.

| **Module 2** | L3 | 08 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.

**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, critical and over damping, Logarithmic decrement

**Laboratory Sessions/ Experimental learning:**

Identifying Damping ration experiment allows students to understand behavior of vicious damper. [Design lab]

**Applications:** Various types of dampers and its real time applications**.**

| **Module 3** | L3 | 08 Hrs. |
|---|---|---|

**Forced Vibration:** Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation, transmissibility ratio due to harmonic excitation and support motion.

**Vibration Measuring Instruments & Whirling of Shafts:** Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral, and torsional Vibrations.

**Laboratory Sessions/ Experimental learning:**

Whirling of shaft experiment [Design Lab]

**Applications:**

Isolators and its Application.

| **Module 4** | L3 | 08 Hrs. |
|---|---|---|

**Systems with Two Degrees of Freedom:** Introduction, principle modes and Normal modes of vibration,

coordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Geared systems. 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 of rods, 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.**

| **Module 5** | L2 | 08 Hrs. |
|---|---|---|

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

Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix iteration-Method of determination of all the natural frequencies using sweeping 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.

**Course outcomes:**

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

| | |
|---|---|
| CO305. 1.1 | Apply the principle of super position to Simple Harmonic Motions. |
| CO305. 1.2 | Analyse undamped free and damped free vibration |
| CO305. 1.3 | Perform measurements of vibrations |
| CO305. 1.4 | Evaluate the equations of twodegrees of freedom systems. |
| CO305. 1.5 | Evaluate themulti degree of freedom system. |

| **Textbooks:** | |
|---|---|
| **1** | J.B.K Das, P L Srinivasa Murthy, Mechanical vibrations, Sapna publications |
| **2** | V.P. Singh, Mechanical Vibrations, DhanpatRai& Company Pvt. Ltd, 2016 |

| **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:**

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 | 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** | **INTRODUCTION TO ASTROPHYSICS AND SPACE ENVIRONMENT** | **Semester** | **V** |
| **Course Code** | **MVJ22AS552** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T : P :: 3 :0 : 0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**Course objective is to:**

- Understand the basics of Astrophysics
- Acquire basic knowledge ofStellarAtmosphere.
- Acquire knowledge of types of Astrophysics and related instrumentations
- Acquire knowledge of the sun and solar system.
- Learn the Space Environment

| **Module 1** | **L2** | 08 Hrs. |
|---|---|---|

**Introduction:**Overview of major contents of universe, Black body radiation, specific intensity, flux density,luminosity, Basics of radiative transfer (Emission/absorption coefficients, source functions), Magnitudes,distance modulus, Colour index, Extinction, Colour temperature, effective temperature, Brightness temperature,bolometric magnitude/luminosity, Excitation temperature, kinetic temperature, Utility of stellar spectrum.

**Laboratory Sessions/ Experimental learning:**

1.Lower Solar atmosphere- Waves & transients

**Applications:**

1.Theoretical models of astrophysical objects like Neutron Stars,

2.White Dwarfs, and Black Holes

| **Module 2** | L2 | 08 Hrs. |
|---|---|---|

**Basic knowledge of stellar atmospheres:**Binaries, variable stars, clusters, open and globular clusters, Laws of planetary motion, Motions and Distances of Stars, Statistical and moving cluster parallax, Velocity Dispersion, Compact objects (BH-systems, Accretion rate/efficiency, Eddington luminosity), Shape, size andcontents of our galaxy, Normal and active galaxies, High energy physics (introduction to X-ray and Gamma ray radiation processes), Newtonian cosmology, microwave background, early universe.

**Laboratory Sessions/ Experimental learning:**

1.Solar Terrestrial studies & Radio astronomy

**Applications:**

1.Use the distance of the particle and the brightness of its signal to determine the size and mass of the particle in Space**.**

| **Module 3** | L3 | 08 Hrs. |
|---|---|---|

**Astrophysics**:

Radio astronomy, optical astronomy, infra-red astronomy, ultra violet, x-ray and r-ray astronomy using space

telescopes. Instrumentation aspects-sky mappers, spectrograph, observatories etc.

**Laboratory Sessions/ Experimental learning:**

**1.** observatories

**Applications:**

1. Understanding of formation of universe

| **Module 4** | L3 | 08 Hrs. |
|---|---|---|

**Sun & Solar System**: The sun, helioseismology, convection, solar magnetism: flux tubes, sun spots, dynamo, solar cycle, chromosphere, corona, solar wind, physical processes in the solar system; dynamics of the solar system; physics of planetary atmospheres; individual planets; comets, asteroids, and other constituents of the solar system; extra-solar planets; formation of the solar system, stars, and planets.

**Laboratory Sessions/ Experimental learning:**

1.Solar Interior Dynamics & Helioseismology,

2.Solar Magnetic fields & radiative transfer

**Applications:**

1. Observations of the Sun & predict the eruptions and periods with particular intensive radiation.

| **Module 5** | L2 | 08 Hrs. |
|---|---|---|

**Space Environment:** Introduction, Vacuum Environments and its effect, Neutral environment and its effects, Plasma environment, Radiation Environment and its effects, Debris Environment and its effects.

**Laboratory Sessions/ Experimental learning:**

**1. Study of the chemical & dynamical history of Milky way galaxy**

**Applications:**

1. Measurements and modulations of the space environment and their consequences.

**Course outcomes:**

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

| | |
|---|---|
| CO305. 2.1 | Apply the basics of astrophysics |
| CO305. 2.2 | Evaluate thebasic knowledge on Stellar atmospheres & their properties. |
| CO305. 2.3 | Analyse Astrophysics with related instrumentations |
| CO305. 2.4 | Interpret the Solar system |
| CO305. 2.5 | Evaluate the space environment |

**Textbooks:**

| | |
|---|---|
| **1** | Shu, F , The Physical Universe University of California 1981 |
| **2** | Padmanabhan, T., Theoretical Astrophysics, Cambridge University Press, south Asian edition,2010,ISBN-13: 978-1107400597. |

**Reference Books**

| | |
|---|---|
| **1.** | **Sakurai, JJ., Advanced Quantum Mechanics,Pearson Education India, 1st edition,2002** |
| **2.** | **Stix, The Sun: An Introduction,M,Springer, Reprinted edition,2012** |
| **3.** | **Alan C. Tribble, The Space Environment, Princeton University Press, Revised edition,2003** |

**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-PSO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| 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 | OPTIMIZATION TECHNIQUES AND PROBABILITY THEORY | Semester | V |
|---|---|---|---|
| Course Code | MVJ22AS553 | CIE | 50 |
| Total No. of Contact Hours | 40 L : T : P :: 3: 0 : 0 | SEE | 50 |
| No. of Contact Hours/week | 4 | Total | 100 |
| Credits | 3 | Exam. Duration | 3hrs |

Course objective is to:

- Ability to apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems
- Ability to go in research by applying optimization techniques in problems of Engineering and Technology
- Understand and apply probability distribution, sampling theory and joint probability distributions.

| Module-1 | L3 | 8Hrs. |
|---|---|---|

Linear Programming: Introduction to Linear Programming Problem (LPP): Prototype example, Assumptions of LPP, Formulation of LPP and Graphical method various examples. The simplex method, Two phase method and dual simplex method.
Self study topic: Big-M method
Application: Graphical solution procedure and algorithms to solve problems.

| Module-2 | L3 | 8Hrs. |
|---|---|---|

Unconstrained optimization Techniques:
Introduction, Direct search method-Random Search method, Univariate method, Decent methods- Gradient of a function, conjugate gradient method (Fletcher-Reeves method), Quasi-Newton methods.
Self study topic: Secant method
Applications: Design of aerospace vehicles and aircraft vehicles.

| Module-3 | L4 | 8Hrs. |
|---|---|---|

Constrained optimization Techniques:
Local maxima and minima for single and multi variables, Karush-Kuhn-Tucker conditions, Applications of the FONC, SONC, and SOSC conditions.
Self study topic: Lagrange multiplier method
Applications: Design of aerospace vehicles and aircraft vehicles.

| Module-4 | L3 | 8Hrs. |
|---|---|---|

Probability Distributions: Random variables (discrete and continuous), probability mass/density functions. Binomial distribution, Poisson distribution. Exponential and normal distributions- problems.
Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation, covariance, correlation coefficient.

Self study topic: Joint Probability distribution for two continuous random variables

Application: Finding correlation between random variables.

| Module-5 | L3 | 8Hrs. |
|---|---|---|

Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution and Chi-square distribution.
Self study topic: confidence limits for probabilities.
Application: Testing the level of significance and the goodness of fit for large sample and small sample.

Course outcomes:

| | |
|---|---|
| CO305.3.1 | Solve the mathematical formulation of linear programming problem. |
| CO305.3.2 | Able to analyze external problems and functions and to establish mathematical models |
| CO305.3.3 | Be able to model engineering minima/maxima problems as optimization problems |
| CO305.3.4 | Develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, information theory and design engineering. |
| CO305.3.5 | Demonstrate testing of hypothesis of sampling distributions. |

| Textbooks: | |
|---|---|
| 1. | B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013. |
| 2. | S. S. Rao John Wiley & Sons, "Engineering Optimization Theory and Practice", Fourth Edition, 2009. |
| Reference Books: | |
| 1. | A. D. Belegundu and T.R. Chanrupatla, "Optimisation Concepts and Applications in Engineering", Cambridge University Press 2011. |
| 2. | Joaquim R. R. A. Martins, Andrew Ning, "Engineering Design Optimization ", Cambridg University Press. |

| CO-PO Mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
| CO1 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CO2 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| CO3 | 2 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| CO4 | 3 | 3 | 1 | 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** | **HEAT & MASS TRANSFER IN AEROSPACE APPLICATION** | **Semester** | **V** |
| **Course Code** | **MVJ21AS554** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T: P: 3 :0: 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 different modes of heat transfer.
2. Understand the conduction mode of heat transfer
3. Understand the free convection and forced convection.
4. Acquire the knowledge of heat exchangers.
5. Acquire knowledge on the application of heat exchangers in Aerospace Industry

| **Module 1** | **L2** | 08 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.

| **Module 2** | L3 | 08 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

| **Module 3** | L3 | 08 rs. |
|---|---|---|

**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. | | |
| **Module 4** | L3 | 08 Hrs. |
| **Radiation:**<br>• Introduction to physical mechanism - Radiation properties - Radiation shape factors Heat exchange between non-black bodies – Radiation shields<br>**Heat Exchangers:**<br>• Heat Exchangers used in Aerospace Industry: Classification of heat exchangers; overall heat transfer coefficient, Heat exchanger components, Numerical problems.<br>**Laboratory Sessions/ Experimental learning:** Radiation experiment in HMT lab<br>**Applications:** Combustion chambers in Rockets and varies gas turbine engines. | | |
| **Module 5** | L3 | 08 Hrs. |
| **Heat and Mass Transfer Problems in Aerospace Engineering:**<br>• Ablative heat transfer, heat transfer in rocket thrust chambers. Heat and mass transfer in satellite systems<br>• Spacecraft environmental control. Thermal control in re-entry vehicles.<br>**Laboratory Sessions/ Experimental learning: Basics in Aerospace propulsion lab**<br>**Applications:** Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer turbine and nozzle blades. | | |

**Course outcomes:**

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

| | |
|---|---|
| CO305.4.1 | Analyze the fundamentals of heat and mass transfer |
| CO305.4.2 | Explain the concept of one dimensional steady and transient heat conduction through various systems |
| CO305.4.3 | Evaluate the heat transfer by convection with the flow of fluids |
| CO305.4.4 | Analyzing heat transfer in heat exchangers |
| CO305.4.5 | Analyzing heat transfer problems occurring in aerospace systems. |

**Textbooks:**

| | |
|---|---|
| **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 |

**Reference Books**

| | |
|---|---|
| **1.** | Sachdeva. Fundamentals of Engineering Heat and Mass Transfer, S.C Wiley Eastern Ltd., New Delhi 1981 |
| **2.** | Yunus A- Cengel , Heat transfer, a practical approach, Tata McGraw Hill , 3rd edition, 2007. |
| **3.** | Sutton, Rocket Propulsion Elements, G.P John Wiley and Sons 5th Edn.1986 |
| **4.** | P.K. Nag, Heat transfer, Tata McGraw Hill 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

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

**SEE Assessment:**

i. Question paper for the SEE consists of 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 | 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

| Semester: V | | |
|---|---|---|
| **Innovation & Entrepreneurship (Theory)** | | |
| **Course Code:** | **MVJ22AS555** | **CIE Marks:50** |
| **Credits:** | **L: T:P: 2:1:0** | **SEE Marks: 50** |
| **Hours:** | **40L** | **SEE Duration: 3 Hrs** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| 1 | Inspired; develop entrepreneurial mindset and attributes; entrepreneurial skill sets for venture creation and intrapreneurial leadership |
| 2 | Apply the process of problem-opportunity identification and feasibility assessment by developing a macro perspective of the real market, industries, domains, and customers while using design thinking principles to refine and pivot their venture idea. |
| 3 | Analyze Customer and Market segmentation, estimate Market size, and develop and validate Customer Persona. |
| 4 | Initiate Solution design, develop MVP, and determine Product-Market fit prototypes. |
| 5 | Craft initial Business plan, Develop go-to-market strategies apply storytelling skills in presenting a persuasive and defensible Venture Pitch. |

| **UNIT-I** | |
|---|---|
| **Entrepreneurship Fundamentals & Context**<br><br>Meaning and concept, attributes and mindset of entrepreneurial and intrapreneurial leadership, role models in each and their role in economic development. Gamified role play-based exploration aligned to one's short-term career aspiration and ambition. An understanding of how to build an entrepreneurial mindset, skillsets, attributes, and networks while on campus.<br><br>**Core Teaching Tool:** Simulation, Game, Industry Case Studies (Personalized for students – 16 industries to choose from), Venture Activity | **8Hrs** |
| **UNIT-II** | |
| **Problem & Customer Identification:**<br>Understanding and analyzing the macro-problem and Industry perspective, technological, socio-economic, and urbanization trends and their implication on new opportunities. Identifying passion, identifying and defining problems using Designthinking principles. Analyzing problems and validating with the potential customer. Iterating problem-customer fit. Understanding customer segmentation, creating and validating customer personas. Competition and Industry trends mapping and assessing initial opportunity.<br>**Core Teaching Tool:** Several types of activities including Class, game, Gen AI, 'Get out of the building', and Venture Activities. | **8Hrs** |
| **UNIT-III** | |
| **Solution design & Prototyping:** Understanding Customer Jobs-to-be-done and crafting innovative solution design to map to customers' needs and create a strong value proposition. Developing Problem-solution fit iteratively. Understanding prototyping and MVP. Developing a feasibility prototype with differentiating values, features, and benefits. Initial testing for proof-of-concept and iteration on the prototype.<br>**Core Teaching Tool:** Venture Activity, no code Innovation tools, Class activity | **8Hrs** |

| UNIT-IV | |
|---|---|
| **Opportunity Assessment and Sizing, Business & Financial Model:** Assess relative market position via competition analysis, sizing the market, and assessing the scope and potential scale of the opportunity.<br>**Core Teaching Tool**: Class and Venture Activity<br><br>Introduction to Business model and types, Lean approach, 9 block lean canvas model, riskiest assumptions to Business models. Importance of Build–Measure–Lean approach. Business planning: components of Business plan- Sales plan, People plan, and financialplan. | **8Hrs** |
| **UNIT-V** | |
| **Go-to-Market Plan, Scale Outlook, and Venture Pitch Readiness:**<br>Financial Planning: Types of costs, preparing a financial plan for profitability using a financial template, understanding the basics of Unit economics, and analyzing financialperformance. Introduction to Marketing and Sales, Selecting the Right Channel, creatinga digital presence, and building customer acquisition strategy. Choosing a form of business organization specific to your venture, identifying sources of funds: Debt & Equity, Map the Start-up Lifecycle to Funding Options.<br>**Core Teaching Tool:** Founder Case Studies – Sama and Securely Share; Class activityand discussions; Venture Activities.<br>**Scale Outlook and Venture Pitch readiness**: Understand and identify potential and aspiration for scale vis a vis your venture idea. Persuasive Storytelling and its key components. Build an Investor-ready pitch deck.<br>**Core Teaching Tool**: Expert talks; Cases; Class activity and discussions; Venture Activities | **8Hrs** |

| CO | Course Outcomes | POs |
|---|---|---|
| CO1 | Understand Entrepreneurial Skillset and Mindset | **1,2,3,9,12** |
| CO2 | Understand and analyze industry problems and Enhance customer personas based on market/other feedback | **3,4,5,12** |
| CO3 | Understand and develop MVPs | **3,5,6,9,12** |
| CO4 | Understand and apply Business models and Business planning. | **3,5,9,12** |
| CO5 | Develop a go-to-market strategy and build a Persuasive sales pitch | **3,6,7,8,10,12** |

**Textbooks**


| | |
|---|---|
| 1 | Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha (2020).Entrepreneurship, McGrawHill, 11th Edition. |
| 2 | Ries, E. (2011). The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation to Create Radically Successful Businesses. Crown Business |
| 3 | Osterwalder, A., & Pigneur, Y. (2010). Business Model Generation: A Handbook forVisionaries, Game Changers, and Challengers. John Wiley & Sons. |
| 4 | Chowdhry Ajay, (2023) Just Aspire: Notes on Technology, Entrepreneurship and the Future. |

| | |
|---|---|
| 5 | Simon Sinek (2011) Start with Why, Penguin Books limited. |
| 6 | Brown Tim (2019) Change by Design Revised & Updated: How Design Thinking Transforms Organizations and Inspires Innovation, Harper Business |
| 7 | Namita Thapar (2022) The Dolphin and the Shark: Stories on Entrepreneurship, PenguinBooks Limited. |
| **References** | |
| 1 | Collins Jim, Porras Jerry, (2004) Built to Last: Successful Habits of VisionaryCompanies |
| 2 | Burlington Bo, (2016) Small Giants: Companies That Choose to Be Great Instead of Big3.. Saras D. Sarasvathy, (2008) Effectuation: Elements of Entrepreneurial Expertise, Elgar Publishing Ltd |
| **Web Resources** | |
| 1 | Learning resource- IgniteX Course Wadhwani platform (Includes 200+ components of custom created modular content + 500+ components of the most relevant curated content) |

**OF COs AND POs: MAPPING**

| CO/ POs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | **2** | **2** | **2** | | | | | | **2** | | | **2** | **2** | | |
| CO2 | | | **2** | **2** | **2** | | | | | | | **2** | | | |
| CO3 | | | **2** | | **2** | **2** | | | **2** | | | **2** | | | |
| CO4 | | | **2** | | **2** | | | | **2** | | | **2** | | | |
| CO5 | | | **2** | | | **2** | **2** | **2** | | **2** | | **2** | | | |

| Semester: V | | |
|---|---|---|
| **Essence of Research Methodology and IPR** | | |
| **Course Code:** | **MVJ22RMI57** | **CIE Marks:50** |
| **Credits: L:T:P:S:** | **1:2:0:0** | **SEE Marks: 50** |
| **Hours:** | **30** | **SEE Duration: 3 Hrs** |
| **Course Learning Objectives: The students will be able to** | | |
| 1 | To give an overview of the research methodology and explain the technique of defining a research problem and explain the basic ethics in research. | |
| 2 | To develop a suitable outline for research studies through various sources of information from literature review and data collection. | |
| 3 | To develop an understanding of the results and on analysis of the work carried. | |
| 4 | To Demonstrate enhanced Scientific writing skills. | |
| 5 | To Develop an Understanding on Various Intellectual Property Rights and importance of filing patents. | |

| **UNIT-I** | |
|---|---|
| ***Research Methodology:*** Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem.<br>***Ethics in Engineering Research:*** Ethics in Engineering Research Practice, Types of Research Misconduct, Ethical Issues Related to Authorship. | **6 Hrs** |
| **UNIT-II** | |
| **Research Writing and Journal Publication Skills:**<br>Understanding the importance of quality research papers, Differences between conference papers, journal articles, and other academic publications, criteria for selecting a journal, understanding impact factors and journal rankings. place of the literature review in research, how to review the literature, structure of a research paper, effective use of figures and tables, preparing a cover letter and author contributions, Responding to reviewers' comments.<br>**Attributions and Citations:** Giving Credit Wherever Due, Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge Flow through Citation, Citing Datasets, Styles for Citations, Tools for citation management, Acknowledgments and Attributions, What Should Be Acknowledged, Acknowledgments in, Books Dissertations, Dedication or Acknowledgments. | **6 Hrs** |
| **UNIT-III** | |
| ***Research Design:*** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.<br>***Results and Analysis:*** Importance and scientific methodology in recording results, importance of negative results, different ways of recording, industrial requirement, artifacts versus true results, types of analysis (analytical, objective, subjective), outcome as new idea, hypothesis, concept, theory, model etc. | **6 Hrs** |
| **UNIT-IV** | |
| **Interpretation and Report Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. | **6 Hrs** |
| **UNIT-V** | |

| | |
|---|---|
| Introduction to Intellectual Property Rights: Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights.<br>Kinds of Intellectual property rights—Copy Right, Patent, Trademark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.<br>Patents: Trips Definition, Patentable and Non-Patentable inventions, Legal requirements for patents.<br>Patent application process: Prior art search, Drafting of a patent, Filing of a patent, Patent document: specification and claims, Granting of patent, Management of IP, Commercialization of IP – Assignment, licensing and infringement. | **6 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO1 | formulate the research problem and follow research ethics. |
| CO2 | carry to carrying out a Literature survey for the topic identified |
| CO3 | Analyse the research and interpret the outcomes of the research. |
| CO4 | Enhance their technical writing skills |
| CO5 | Understand the importance of Patenting, Licensing and technology transfer. |

| **Text Books** | |
|---|---|
| **1.** | **C.R. Kothari, Research Methodology, Methods and Techniques, 2nd Revised edition,** New Age International Publishers, 2015 |
| **2.** | **Neeraj Pandey and Khushdeep Dharni, Intellectual Property Rights, PHI Learning Pvt Ltd, 2014** |

| **Reference Books** | |
|---|---|
| **1.** | **Geoffrey Marczyk, David De Matteo, David Festinger (2005) Essentials of Research Design and Methodology, John Wiley & Sons, Inc.** |
| **2.** | **Carol Ellison (2010) McGraw-Hill's Concise Guide to Writing Research Papers, McGraw-Hill** |
| **3.** | **Sinha, S.C. and Dhiman, A.K., (2002). Research Methodology, Ess Publications. 2nd volume.** |
| **4.** | **Wadehra, B.L. (2000). Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing** |

**Assessment Details (both CIE and SEE)**

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%.

The student has to obtain a minimum of 40% of maximum marks in CIE and a minimum of 40% of maximum marks in SEE.

Semester End Exam (SEE) is conducted for 50 marks (2 hours duration).

Based on this grading will be awarded.

The student has to score a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together**.**

**Continuous Internal Evaluation:**

Three Unit Tests each of 30 Marks (30 MCQ's) (duration 01 hour)

1. First test at the end of 5th week of the semester.

2. Second test at the end of the 10th week of the semester.

3. Third test at the end of the 15th week of the semester.

Report Writing /Presentation/ Assignment to attain the COs and POs for 20 Marks, (Students can decide the topic for Mini Project and start doing literature survey, report of literature survey can be considered for assignments) At the end of the 13th week of the semester

The average of three tests and report writing/presentation/Assignment summing to 50 marks

**Semester End Examination:**

Theory SEE will be conducted by College as per the scheduled timetable, with common question paper for the subject

SEE paper will be set for 50 questions of each of 01 marks. The pattern of the question paper is MCQ. The time allotted for SEE is 02 hours

**CO-PO Mapping**

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

High-3, Medium-2, Low-1

| Semester: V | | |
|---|---|---|
| **Environmental Studies**<br>**(Theory)** | | |
| **Course Code: MVJ22ENV58** | | **CIE Marks: 50** |
| **Credits: L:T:P: 2:0:0** | | **SEE Marks: 50** |
| **Hours: 30L** | | **SEE Duration: 3 Hrs.** |

| **Course Learning Objectives: The students will be able to** | |
|---|---|
| 1 | Relate interdisciplinary approach to complex environmental problems using basic tools of the natural and social sciences including geo-systems, biology, chemistry, economics, political science and international processes |
| 2 | Study drinking water quality standards and to illustrate qualitative analysis of water. |
| 3 | Critically evaluate the science and policy ramifications of diverse energy portfolios on air and water quality, climate, weapons proliferation and societal stability. |

| **UNIT-I** | **L1,L2** |
|---|---|
| **Introduction** to environmental studies, Multidisciplinary nature of environmental studies; Scope and importance; Concept of sustainability and sustainable development.<br>**Ecosystems (Structure and Function):** Forest, Desert, Rivers, Ocean **Biodiversity:** Types, Hot spots; Threats and Conservation of biodiversity, Deforestation**.** | **6 Hrs** |
| **UNIT-II** | **L1,L2** |
| **Advances in Energy Systems** (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, Tidal and Wind.<br>**Natural Resource Management (Concept and case-study):** Disaster Management, Sustainable Mining and Carbon Trading. | **6 Hrs** |
| **UNIT-III** | **L1,L2** |
| **Environmental Pollution:** Surface and Ground Water Pollution, Noise pollution, Soil Pollution and Air Pollution.<br>**Waste Management & Public Health Aspects:** Bio-medical Waste, Solid waste, Hazardous waste and E-waste. | **6 Hrs** |
| **UNIT-IV** | **L1,L2** |
| **Global Environmental Concerns** (Concept, policies, and case-studies): Global Warming, Climate Change, Acid Rain, Ozone Depletion and Fluoride problem in drinking water. | **6 Hrs** |
| **UNIT-V** | **L1,L2** |
| **Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications):** G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems. | **6 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO308.1 | Describe the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale. |
| CO308.2 | Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment. |
| CO308.3 | Demonstrate ecology knowledge of a complex relationship between biotic and Abiotic components. |
| CO308.4 | Apply their ecological knowledge to illustrate and graph a problem |

| | |
|---|---|
| CO308.5 | Describe the realities that managers face when dealing with complex issues. |

**Reference Books**


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


**Continuous Internal Evaluation (CIE): Theory for 50 Marks**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

**Semester End Examination (SEE): Total marks: 50+50=100**

**SEE** for 50 marks are executed by means of an examination.

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

**CO-PO Mapping**

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

High-3, Medium-2, Low-1

**VI SEMESTER**

| | | | |
|---|---|---|---|
| **Course Title** | **AEROSPACE PROPULSION** | **Semester** | **VI** |
| **Course Code** | **MVJ22AS61** | **CIE** | **50** |
| **Total No. of Contact Hours** | **50 L : T : P :: 3 : 0 : 2** | **SEE** | **50** |
| **No. of Contact Hours/week** | **5** | **Total** | **100** |
| **Credits** | **4** | **Exam. Duration** | **3 Hours** |

**Course objective is to:**

- Understand the basic principle and working of Air breathing and Non-Air breathing engines
- Acquire knowledge on the significance of Supersonic Inlets
- Acquire knowledge on the design and working of combustion chambers and nozzles
- Understand the fundamentals of rocket propulsion
- Acquire knowledge on Rocket Testing and materials used in Rockets

| **Module-1** | **L3** | **10 Hours** |
|---|---|---|

Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Illustration of working of gas turbine engine–The thrust equation–Factors affecting thrust–Effect of pressure, velocity and temperature changes of air entering compressor– Methods of thrust augmentation–Characteristics of turboprop, turbofan and turbojet– Performance characteristics. – Numerical

**Supersonic inlets**: Supersonic inlets, starting problem in supersonic inlets, Shock swallowing by area variation, External deceleration. Modes of inlet operation.

Laboratory Sessions/ Experimental learning:

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

Applications: Gas turbine industries and Power plants

| **Module-2** | **L2** | **10 Hours** |
|---|---|---|

**Combustion chamber & Nozzles**

**Combustion chamber:** 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-expanded nozzles, Ejector and variable area nozzles, Thrust reversal

Laboratory Sessions/ Experimental learning:

Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles)

Performance studies on a scaled jet engine

Applications: Gas turbine and aircraft engine design industries

| **Module-3** | **L2** | **10 Hours** |
|---|---|---|

**Compressor and Turbine:**

**Compressor:** Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps

**Turbine:** Axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

Laboratory Sessions/ Experimental learning: Study of an aircraft jet engine

Applications: Gas turbine industries

| **Module-4** | **L2** | **10 Hours** |
|---|---|---|

**Rocket Propulsion Fundamentals:** Classification of rockets-principle of rocket propulsion-analysis of ideal chemical rocket, The chemical rocket, **solid propellant rockets**- Basic relations and propellant burning rate, performance issues, propellant grain and grain configuration, propellant grain stress and strain, Classification, propellant characteristics, hazards, propellant ingredients, propellant processing and manufacturing.**liquid propellant rockets**- Types of propellants, propellant tanks, propellant feed systems, propellant properties, liquid oxidizers, liquid fuels, liquid monopropellants, gaseous propellant, safety and environment concern and **hybrid rockets**.

**Fundamentals and Definitions** – Thrust, Exhaust Velocity, Energy and efficiencies, multiple propulsion systems, typical performance values, variable thrust and simple problems.

Laboratory Sessions/ Experimental learning: Computation of burning rate of the propellant.

Applications: Rockets & missile and Testing manufacturing industries

| **Module-5** | **L2** | **10 Hours** |
|---|---|---|

**Advanced Propulsion systems:** Cryogenic rockets, nuclear propulsion, electro thermal – electrostatic – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters-Solar rocket engine. **Rocket Testing:** Ground Testing, Flight Testing, Trajectory monitoring, post -accident procedures. Description of a typical space launch vehicle-launch procedure**.**

Laboratory Sessions/ Experimental learning: Determination of heat of combustion of aviation fuel.

Make Sugar rocket by using potassium nitrate (small size)

Applications: Rockets & missile and Testing manufacturing industries

**Course outcomes:**

| | |
|---|---|
| CO310.1 | Apply the basic thermodynamic principles and theories in aircraft propulsion & performance of Supersonic Inlets |
| CO310.2 | Analyse the performance of Combustion chambers and Nozzles |
| CO310.3 | Understanding how multistage compressors or turbines work and using velocity triangles to estimate their performance |
| CO310.4 | Apply the basic principles of rocket propulsion and Analyse Rocket testing |
| CO310.5 | Examine the propellant based on the application |

**Textbooks:**


| | |
|---|---|
| **1** | Bhaskar Roy, Aircraft propulsion, Elsevier (2011),ISBN-13: 9788131214213 |
| **2** | V. Ganesan, Gas Turbines, Tata McGraw-Hill,2010, New Delhi, India, ISBN: 0070681929 |


**Reference Books**


| | |
|---|---|
| **1.** | G. P. Sutton, Rocket Propulsion Elements, Wiley India Pvt Ltd,7the,2010, ISBN 9781118753651 |

| | |
|---|---|
| **2.** | Hill, Philip G., and Carl R. Peterson. "Mechanics and Thermodynamics of Propulsion, 0201146592." (2010). |
| **3.** | Cohen,H.Rogers,G.F.C.andSaravanamuttoo,H.I.H.,GasTurbineTheory,Longman,1989, ISBN 13: 9780582236325 |


| LABORATORY EXPERIMENTS | |
|---|---|
| **Sl No** | **Experiment Name** |
| **1** | Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions, and operating principles) |
| **2** | Study of forced convective heat transfer over. |
| **3** | Study of free convective heat transfer over a flat plate. |
| **4** | Determination of heat of combustion of aviation fuel. |
| **5** | Measurement of burning velocity of a premixed flame. |
| **6** | Flame stability of pre-mixed flame through flame stability setup. |
| **7** | Study of Free Jet/Wall Jet. |
| **8** | Investigation of the pressure in a convergent-divergent nozzle for under expanding and overexpanding conditions. |
| **9** | Preparation of a Solid Propellant. |
| **10** | Computation of burning rate of the propellant. |
| **11** | Determine the Calorific value of liquid fuel. |
| **12** | Measurement of Ignition delay of a single propellant with different shapes. |
| **13** | Determine the specific impulse of solid motor. |
| **14** | Performance study of Hybrid Motor using a thrust stand |
| **Course outcomes:** | |
| CO310.6 | Analyze heat transfer phenomenon |
| CO310.7 | Investigate flame propagations |
| CO310.8 | Evaluate propellant burning |

**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:**

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 | 1 | 2 | 1 | 1 | 1 | 0 | 1 | 1 | - | 1 |
| CO2 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | - | 1 |
| CO3 | 3 | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 1 | - | 1 |
| CO4 | 3 | 1 | 1 | - | - | 1 | 1 | 0 | 1 | 1 | - | 1 |
| CO5 | 3 | 1 | 1 | - | - | 1 | 1 | 0 | 1 | 1 | - | 1 |
| High-3, Medium-2, Low-1 | | | | | | | | | | | | |

| | | | |
|---|---|---|---|
| **Course Title** | **AEROSPACE SRUCTURAL ANALYSIS** | **Semester** | **VI** |
| **Course Code** | **MVJ22AS62** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T : P :: 3:0:0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**Course objective is to:**

1. To Acquire the knowledge of Structural Idealization on open section tubes
2. To Acquire the knowledge of Structural Idealization on closed section tubes
3. To Acquire the knowledge of Structural Idealization on multi section tubes
4. To illustrate the different types of Buckling of Plates, Joints and Fitting
5. To Comprehend the stress analysis on Launch Vehicle and Spacecraft Structure

| **Module 1** | **L3** | 08 Hrs. |
|---|---|---|

**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 Aerospace Structures laboratory
Applications: To analyze shear flow in aircraft/spacecraft skin panels.

| **Module 2** | **L3** | 8 Hrs. |
|---|---|---|

**Shear Flow Analyses of closed section**: Shear flow in closed sections with stiffeners– Angle of twist. Shear center - Shear flow in thin-walled closed tubes - Bredt-Batho theory.
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/spacecraft.

| **Module 3** | **L3** | 8 Hrs. |
|---|---|---|

**Shear Flow Analyses of multi cell:** Shear flow in two flange and three flange box beams – Shear center - 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/spacecraft**.**

| **Module 4** | **L3** | 8 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 aerospace components**.**

| **Module 5** | **L2** | 8Hrs. |
|---|---|---|

**Launch Vehicle and Spacecraft Structures**: Launch vehicle structures – Loads and stresses, thin-walled pressure vessels, Buckling of beams, thin wall assumption. spacecraft - mini, microstructures, inflatable structures, flying effector, Nano tubing
**Laboratory Sessions/ Experimental learning:** Fuselage Pressure Vessel experiment can be conducted using Ansys Workbench.
**Applications:** Helps to analyze the stress in Aircraft components.

| **Course outcomes:** Upon completion of the course, students will be able to: | |
|---|---|
| CO311.1 | Identify the shear flow distribution for open section structural member. |
| CO311.2 | Investigate shear flow distribution for closed section structural member under torsion. |
| CO311.3 | Investigate shear flow distribution for multi cell idealized structures |
| CO311.4 | Solve different methods to find out buckling load for a given structural panel, Joints and Fittings |
| CO311.5 | Examine the stress distribution in Pressure Vessels and Spacecraft Structures |

| **Textbooks:** | |
|---|---|
| **1** | Megson, T.H.G., AircraftStructures for Engineering Students, Edward Arnold,1995 |
| **2** | Perry D J & Azar J J , Aircraft Structures, 2nd edition, McGraw Hill N.Y.,1993 |

| **Reference Books** | |
|---|---|
| **1.** | BruhnE.F., Analysis and Design of Flight Vehicles Structures, Tri-Stateoffset Co.USA,1985 |
| **2.** | T.H.G Megson Introduction to Aircraft Structural Analysis, Elsevier,2nd Edition,2014 |

**CIE Assessment:**

CIE is based on quizzes, tests, Project/assignments 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:**

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 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 1 | | 1 | | 2 | | 1 | 1 | 2 | 1 | 1 |
| CO2 | 3 | 3 | 2 | 1 | | 1 | | 2 | | 1 | 1 | 2 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 3 | | 1 | | 2 | | 1 | 1 | 2 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | | 1 | | 2 | | 1 | 1 | 2 | 1 | 1 |
| CO5 | 3 | 3 | 2 | 2 | | 1 | | 2 | | 1 | 1 | 2 | 1 | 1 |

High,3, Medium,2, Low,1

**Professional Elective-II**

| ROCKETS AND MISSILES | | |
|---|---|---|
| **Course Code:** | **MVJ22AS631** | **CIE Marks:50** |
| **Credits** | **3 : L:T:P:S: 3:1:0:0** | **SEE Marks: 50** |
| **Hours:** | **40 Hours** | **SEE Duration: 3 Hrs** |

**Course Learning Objectives: The students will be able to**

- **Basics of Rockets and Missiles is an elective course offered in 5th semester Aeronautical Engineering curriculum.**
- **This subject covers extensively regarding design and analysis of rockets and missiles.**
- **The different types of Airframe components, types of propulsion system, and types of guidance systems are also covered in this subject.**
- **This subject will make student to understand advanced problems facing in launch vehicles and missiles.**

| **Module 1** | **L2** | |
|---|---|---|
| **INTRODUCTION**<br>Space launch Vehicles and military missiles, function, types, role, mission, mission profile, thrust profile, propulsion system, payload, staging, control and guidance requirements, performance measures, design, construction, operation, similarities and differences. Some famous space launch vehicles and strategic missiles.<br>**Applications:** | | **8 Hrs** |
| **Module 2** | **L3** | |
| Solid Propellant Rocket Motor Systems: Solid Propellant rocket motors, principal features, applications. Solid propellants, types, composition, properties, performance. Propellant grain, desirable properties, grain configuration, preparation, loading, structural design of grain. Liners, insulators and inhibitors, function, requirements, materials. Rocket motor casing – materials. Nozzles, types, design, construction, thermal protection. Igniters, types, construction. Description of modern solid boosters I) Space Shuttle SRB, II) the Arienne SRB<br>Liquid Propellant Rocket Motor Systems: Liquid propellants, types, composition, properties, performance. Propellant tanks, feed systems, pressurization, turbo-pumps, valves and feed lines, injectors, starting and ignition. Engine cooling, support structure. Control of engine Starting and thrust build up, system calibration, integration and optimisation – safety and environmental | | **8 Hrs** |

| | |
|---|---|
| concerns. Description of the space shuttle main engine. Propellant slosh, propellant hammer, geysering effect in cryogenic rocket engines.<br>**Applications:** | |
| **Module 3** **L2** | |
| **AERODYNAMICS OF ROCKETS AND MISSILES**<br>Classification of missiles. Airframe components of rockets and missiles, Forces acting on a missile while passing through atmosphere, method of describing aerodynamic forces and moments, lift and drag forces, drag estimation, body upwash and downwash in missiles. Rocket dispersion, re-entry body design considerations.<br>**Applications:** | **8 Hrs** |
| **Module 4** **L2** | |
| **LAUNCH VEHICLE DYNAMICS & ATTITUDE CONTROL OF ROCKETS**<br>Launch Vehicle Dynamics: Tsiolskovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging. Earth launch trajectories – vertical segment, the gravity turn, constant pitch trajectory, orbital injection. Actual launch vehicle trajectories, types. Examples, the Mu 3-S-II, Ariane, Pegasus launchers. Reusable launch vehicles, future launchers, launch assist technologies.<br>Attitude Control Of Rockets And Missiles: Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques<br>**Applications** | **8 Hrs** |
| **Module 5** **L2** | |
| **ROCKET TESTING AND MATERIALS**<br>Rocket Testing: Ground Testing and Flight Testing, Types of Tests facilities and safeguards, monitoring and control of toxic materials, instrumentation and data management. Ground Testing, Flight Testing, Trajectory monitoring, post -accident procedures. Description of atypical space launch vehicle launch procedure.<br>Materials: Criteria for selection of materials for rockets and missiles, requirements for choice of materials for propellant tanks, liners, insulators, inhibitors, at cryogenic temperatures, requirements of materials at extremely high temperatures, requirements of materials for Thermal protection and for pressure vessels.<br>**Applications:** | **8 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| CO312.1.1 | Identify the types of space launch vehicles and missiles. |
| CO312.1.2 | Distinguish the solid and liquid propellant motors. |
| CO312.1.3 | Classify different types of missiles, understand missile aerodynamics. |
| CO312.1.4 | Acquire the knowledge on launch vehicle dynamics, Attitude control |

| | |
|---|---|
| CO312.1.5 | Identify different types of materials used in rockets, missiles and acquire knowledge on rocket testing |

| **Textbooks:** | |
|---|---|
| **1** | George P Sutton and Oscar Biblarz,‘ Rocket Propulsion Element‘, John Wiley and Sons Inc,7th edition,2010,ISBN-13: 978-8126525775 |
| **2** | Jack N Neilson, ‘Missile Aerodynamics‘, AIAA, 1st edition, 1988, ISBN-13: 978-0962062902 |
| **Reference Books** | |
| **1.** | SS Chin, ‘Missile Configuration Design’. |
| **2.** | Cornelisse, J.W., Schoyer H.F.R. and Wakker, K.F., Rocket Propulsion and Space-Flight Dynamics, Pitman, 1979,ISBN-13: 978-0273011415 |
| **3.** | Turner, M.J.L., Rocket and Spacecraft propulsion, Springer, 3rd edition, 2010, ISBN-13: 978-3642088698. |

**Continuous Internal Evaluation (CIE):** Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

**Semester End Examination (SEE):** Theory for 50 Marks

SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom’s taxonomy level.

CO-PO Mapping

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

High-3, Medium-2, Low-1

| Course Title | **REUSABLE LAUNCH VEHICLE** | Semester | VI |
|---|---|---|---|
| Course Code | **MVJ22AS632** | **CIE** | 50 |
| Total No. of Contact Hours | 40 L: T:P: 3 :0 :0 | **SEE** | 50 |
| No. of Contact Hours/week | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs. |

**The course objective is to:**

1. Learn thelaunch vehicle dynamics and stage separation techniques
2. Understand the basics of reusable launch vehicles
3. Study the primary structure of the reusable launch vehicles
4. Acquire knowledge on the operation of re-entry vehicles and its applications
5. Comprehend knowledge on mission and flight dynamics operations

| **Module 1: Launch Vehicle Dynamics** | **L3** | 08Hrs. |
|---|---|---|

Launch Vehicle Dynamics: Tsiolskovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging. Earth launch trajectories – vertical segment, the gravity turn, constant pitch trajectory, orbital injection. Actual launch vehicle trajectories, types. Examples, the Mu 3-S-II, Ariane, Pegasus launchers. Reusable launch vehicles, future launchers, launch assist technologies. Attitude Control Of Rockets And Missiles: Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques

**Laboratory Sessions/ Experimental learning:**

Simulation of the mission profile of a launch vehicle using simulation software

**Applications:** Aerospace Industry

| **Module 2: Introduction to Reusable Launch Vehicle** | **L3** | 08Hrs. |
|---|---|---|

Understanding the Development of Reusable Launch Vehicles -Recent History and Current Programs – Technical challenges - Economic Considerations - Legal and Policy Issues - Threat Considerations, Reusable Launch Vehicle Missions and Applications, Military Utility of Reusable Launch Vehicles, Commercial Utility of Reusable Launch Vehicles, fully and partially reusable launch systems -lift-off stages, orbital insertion stages, Reusable orbiter. Introduction to space shuttle, docking in space.

**Laboratory Sessions/ Experimental learning:**

Simulation of the mission profile of a reusable launch vehicle using simulation software

**Applications: Aerospace Industry**

| **Module 3: Primary Vehicle Structure** | **L3** | 08Hrs. |
|---|---|---|

Introduction, Components of Major Structures, Reusable Cryogenic Tank System- Al-Li cryogenic tanks- LOX Tank- LH2 Tank- Organic-Matrix Composite Tanks, Thermal Protection System, propulsion- Existing AND New Engines-Engine Performance- Throttling- Revolutionary Reusable Technology Turbopump (RRTT) and

Other Advanced Turbopump- Health Monitoring-High reliability Sensors

**Laboratory Sessions/ Experimental learning:**Case study on RLV-TD

**Applications:** Aerospace Industry

| **Module 4 : Reentry Mission** | **L3** | 08Hrs. |
|---|---|---|

**Operating environment and reentry system design guidelines**

Reentry flight environment- system design process - system mission management,

**Re-entry Dynamics and Re-entry Vehicle Configurations**

Re-entry Dynamics, Ballistic Bodies Re-entry, Influence of Re-entry Flight Path Angle, Influence of Vehicle Lift on the Re-entry System, Skipping Trajectory Reentry System, Range Capabilities and Reentry Foot-Print, Winged-Reentry Vehicles

**Laboratory Sessions/ Experimental learning:**Thermal Simulation of Reentry heat shield using simulation software.

**Applications: Aerospace industry**

| **Module 5: Space operations** | **L2** | 08Hrs. |
|---|---|---|

**Overview Space Segment**

The Space Environment, Space Systems Objectives and Requirements, Design Drivers and Trade-offs, Fundamentals of Space Communications

**Mission Operations:** Mission Operations Preparation, Mission Operations Execution, Flight Experience

**Flight Dynamic Operations:** Orbital Dynamics, Attitude Dynamics, mission planning, mission planning for unmanned systems, Mission Planning for Human Spaceflight Missions

**Laboratory Sessions/ Experimental learning:** Flow Simulation of Reentry heat shield using simulation software

**Applications:** Aerospace industry

**Course outcomes:**

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

| | |
|---|---|
| CO312.2.1 | Evaluate the launch vehicle dynamics and stage separation techniques |
| CO312.2.2 | Explain the basics of reusable launch vehicle |
| CO312.2.3 | Configure reusable launch vehicle |
| CO312.2.4 | Analyse Re-entry vehicle dynamics and configurations |
| CO312.2.5 | Analyse the mission and flight dynamics operations |

**Textbooks:**


| | |
|---|---|
| **1** | Ward, J.E., Reusable launch vehicles and space operations. 2000. |
| **2** | Suresh, B. and K. Sivan, Integrated design for space transportation system. 2015: Springer. |


**Reference Books**


| | |
|---|---|
| **1.** | Council, N.R., Reusable launch vehicle: Technology development and test program. 1996: National Academies Press. |


**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 | 3 | | | | | | | | 1 | 3 | 1 |
| CO2 | 3 | 3 | 1 | | | | | | | | | 1 | 3 | 1 |
| CO3 | 3 | 3 | 2 | 2 | | | | | | | | 1 | 3 | 1 |
| CO4 | 3 | 3 | 2 | 3 | | | | | | | | 1 | 3 | 1 |
| CO5 | 3 | 3 | 2 | 3 | | | | | | | | 1 | 3 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **AEROSPACE SYSTEMS AND AVIONICS** | **Semester** | VI |
| **Course Code** | **MVJ22AS633** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L : T : P :: 3 : 0: 0 | **SEE** | 50 |
| **No. of Contact Hours/week** | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs. |

**The course objective is to:**

6. Understand the power distribution system and need for avionics.
7. Acquire knowledge of control and navigation systems
8. Gain knowledge of display technologies and avionics system architectures
9. Understand the Microprocessors and cockpit display technologies
10. Apprehend the functioning of data buses

| **Module 1Power Distribution System** | **L2** | 08 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. Introduction to integrated avionics and 5G systems.

**Laboratory Sessions/ Experimental learning:** Programming using microprocessor

**Applications:** Data Transfer, Communication

| **Module 2 Inertial Navigation &Electronic Flight Control System** | **L3** | 08 Hrs. |
|---|---|---|

**Inertial Navigation System:** Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing. Navigation System in Aerospace Industries

**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. Avionics system architecture generations - Data buses: MILSTD-1553B, ARINC 429, AFDX/ARINC 664 - Fiber optic Data buses: IEEE STD 1393, MIL STD 1773.

**Laboratory Sessions/ Experimental learning:** Validation of truth tables for different logic circuits

**Applications:** Communication, Tracking

| **Module 3 Electronic Flight Instrument &Avionics Sub Systems** | **L3** | 08 Hrs. |
|---|---|---|

**Electronic Flight Instrument Systems:** Display-units, presentation, failure, and annunciation. Display of air data. Typical avionics sub systems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.

**Modelling of Physical Systems:** Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems.

**Laboratory Sessions/ Experimental learning:** Construct 7 segment display circuit using IC timer

**Applications:** Attitude Estimation, Navigation, Control

| **Module 4 Digital Systems & Flight Deck and Cockpits** | **L3** | 08 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

| **Module 5 Avionics Systems Integration** | **L3** | 08 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

**Course outcomes:**

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

| | |
|---|---|
| CO312.3.1 | Analyse the power distribution system in avionics. |
| CO312.3.2 | Apply the knowledge of control and navigation systems |
| CO312.3.3 | Utilise the knowledge of display technologies and avionics system architectures |
| CO312.3.4 | Evaluate the Microprocessors and cockpit display technologies |
| CO312.3.5 | Analyse the functioning of data buses |

**Textbooks:**

| | |
|---|---|
| **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. |

**Reference Books**

| | |
|---|---|
| **1.** | 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:**

- Question paper for the SEE consists of 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 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO10 | PO11 | PO12 | PSO 1 | PSO 2 |
| CO1 | 2 | 2 | 2 | | | | | 2 | | | | 2 | 3 | 2 |
| CO2 | 2 | 2 | 2 | | | | | | | | | 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** | **ARTIFICIAL INTELLIGENCE AND ROBOTICS** | **Semester** | **VI** |
| **Course Code** | **MVJ22AS634** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T:P: 3 :0 :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 1 Introduction to AI** | **L3** | 08 Hrs. |
|---|---|---|

Computerized reasoning - Artificial Intelligence (AI) - characteristics of an AI problem – Problem representation in AI - State space representation - problem reduction-Concept of small talk programming

**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

| **Module 2Search Process &Knowledge Representation** | **L3** | 08 Hrs. |
|---|---|---|

**Search Process:**AI and search process - Brute force search techniques - Depth first - Breadth first search techniques - 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 inverse kinematics problem for the robot

**Applications:** Predictive Maintenance, Flight performance Optimization, Reverse Engineering

| **Module 3 Introduction to Robotics** | **L3** | 08 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

| **Module 4 Future Trends in Robots** | **L3** | 08 Hrs. |
|---|---|---|

Telepresence robot - Autonomous mobile robots - Walker Robots – Solar ball Robot – Under water bots – Aerobots - Advanced robotics in Space - Specific features of space robotics systems – long term technical

developments - Next generation robots.

**Laboratory Sessions/ Experimental learning:** Integrate computer vision and control of the robot

**Applications:** Training, Smart Repairs Management

| **Module 5 AI in Robotics** | **L2** | 08 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

**Course outcomes:**

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

| | |
|---|---|
| CO312.4.1 | Apply the basic techniques of artificial intelligence |
| CO404.4.2 | Compare and contrast non-monotonic reasoning and statistical reasoning |
| CO404.4.3 | Design and develop robotic based systems |
| CO404.4.4 | Develop automatic solution for replacing humans in life threatening area |
| CO404.4.5 | Interpret basic AI algorithms in Robotics |

**Textbooks:**

| | |
|---|---|
| **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 |

**Reference Books**

| | |
|---|---|
| **1.** | J. M. Selig, Introductory Robotics, Prentice Hall, 1992 |
| **2.** | 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

- 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 |
| CO1 | 2 | 2 | - | - | - | - | - | - | - | - | - | - |
| CO2 | 3 | 3 | - | - | 3 | - | - | - | - | - | - | - |
| CO3 | - | - | - | - | - | 3 | - | - | - | - | - | - |
| CO4 | - | - | 3 | - | - | 2 | 3 | - | - | - | - | 3 |
| CO5 | 3 | 3 | 3 | - | 3 | - | 2 | - | - | - | - | 3 |
| High,3, Medium,2, Low,1 | | | | | | | | | | | | |

**Open Elective-I**

| Semester: VI | | |
|---|---|---|
| **BASICS OF AEROSPACE ENGINEERING** | | |
| **Course Code:** | **MVJ22AS641** | **CIE Marks:50** |
| **Credits:** | **3 L:T:P:S: 3:0:0:0** | **SEE Marks: 50** |
| **Hours:** | **40L** | **SEE Duration: 3 Hrs** |
| **Course Learning Objectives: The students will be able to** | | |
| 1 | Understand basic principles of Aircraft and the history of space vehicles. | |
| 2 | Acquire the basic principles of flight. | |
| 3 | Learn the basic principle of Aircraft & Rocket propulsion. | |
| 4 | Understand the Aircraft Structures and Materials. | |
| 5 | Acquire the basics of Aircraft Instruments & systems. | |

| **UNIT-I** | **L2** |
|---|---|
| Introduction to Aircrafts: History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, V/STOL machines.<br>Introduction to Space Flight: History of Space Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere, Introduction to basic orbital mechanics, types of Orbits (LEO, MEO, Geosynchronous and Geostationary, Polar orbits), Kepler's Laws of planetary motion.<br>Laboratory Sessions/ Experimental learning: Ornithopter modelling, Paper plane.<br>Applications: Environmental conditions | **8 Hrs** |
| **UNIT-II** | **L2** |
| **Basic principles of flight:** Significance of speed of sound, Propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows, Bernoulli's theorem, Aerodynamic forces and moments on an Airfoil, Lift and drag components, lift curve, drag curve, types of drag, factors affecting lift and drag; Centre of pressure and its significance, Aerodynamic centre, Aspect ratio, Airfoil nomenclature, Basic characteristics of airfoils, NACA nomenclature, Simple problems on lift and drag.<br>Laboratory Sessions/ Experimental learning: Aerodynamics lab Applications: Aircraft Flow dynamics | **8 Hrs** |
| **UNIT-III** | **L2** |
| **Aircraft Propulsion:** Introduction, Classification, Piston Engine & its application, Brayton cycle, Principle of operation of Turboprop, turbojet and turbofan engines, | **8 Hrs** |

| | |
|---|---|
| Introduction to ramjets and scramjets; performance characteristics.<br>**Rocket Propulsion:** Principles of operation of rocket, Classification of Rockets, Types of rockets and typical applications, Introduction to Space Exploration.<br>Laboratory Sessions/ Experimental learning: Propulsion lab<br>Applications: Aircraft engines | |
| **UNIT-IV** **L2** | |
| **Aircraft and Spacecraft - Structures and Materials:**<br>Introduction- General types of construction, Monocoque, Semi-Monocoque and Geodesic structures. Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminium alloy, titanium, stainless steel and composite materials. Materials selection for spacecraft application.<br>Laboratory Sessions/ Experimental learning: Structures lab<br>Applications: Material & Structural Dynamics of Aircraft | **8 Hrs** |
| **UNIT-V** **L2** | |
| **Instrument:** Instrument Displays, Introduction to Navigation Instruments, Basic Air data systems & Probes, Mach meter, Air speed indicator, Vertical speed indicator, Altimeter, Gyro based instruments, Introduction to spacecraft instruments. Inertial & GPS based sensors.<br>**Systems:** Introduction to Hydraulic and pneumatic systems, Air Conditioning and Cockpit pressurization system, Generation and distribution of Electricity on board the airplane, Aircraft Fuel System, Fire Protection, Ice and Rain Protection System<br>Laboratory Sessions/ Experimental learning: Instrumentation lab.<br>Applications: Aircraft Instruments. | **8 Hrs** |

**Course Outcomes: After completing the course, the students will be able to**

| | |
|---|---|
| CO313.1.1 | Differentiate the different concepts of aircrafts and spacecrafts in flight. |
| CO313.1.2 | Describe the Principle of aviation and space flight. |
| CO313.1.3 | Explain the Fundamentals of Rocket Propulsion and Aircraft Propulsion. |
| CO313.1.4 | Apply the concepts of aircraft materials and structures. |
| CO313.1.5 | Appreciate the complexities involved during development of flight vehicles systems. |

**Textbooks:**

| | |
|---|---|
| **1** | John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673. |
| **2** | Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006, ISBN: 9788170020752 |

| **Reference Books** | |
|---|---|
| **1.** | Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206 |
| **2.** | Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition,2016,ISBN: 9781118753910 |

**Continuous Internal Evaluation (CIE):**

**Theory for 50 Marks**

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

**Semester End Examination (SEE): Total marks: 50+50=100**

**SEE** for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

**CO-PO Mapping**

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

High-3, Medium-2, Low-1

| | | | |
|---|---|---|---|
| Course Title | **INTRODUCTION TO SPACE VEHICLES AND SATELLITE TECHNOLOGIES.** | Semester | **VI** |
| Course Code | **MVJ22AS642** | **CIE** | 50 |
| Total No. of Contact Hours | 40 L: T : P :: 3 :0 : 0 | **SEE** | 50 |
| No. of Contact Hours/week | 4 | **Total** | 100 |
| **Credits** | 3 | **Exam. Duration** | 3 Hrs. |

**The course objective is to:**

1. Gain basic knowledge of developments in history of spacecraft flight.
2. Understand the basic rocket propulsion fundamentals.
3. Learn the spacecraft basic structure and materials used.
4. Understand the satellite mission and configuration.
5. Acquire knowledge of satellite attitude and orbit control

| **Module 1** | **L2** | 08 Hrs. |
|---|---|---|

**Introduction to Space Flight:** History of Space Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere, Introduction to basic orbital mechanics, types of Orbits (LEO, MEO, Geosynchronous and Geostationary, Polar orbits), Kepler's Laws of planetary motion.

Laboratory Sessions/ Experimental learning: aerospace simulation lab

Applications: Spacecraft technologies

| **Module 2** | **L2** | 08 Hrs. |
|---|---|---|

**Rocket Propulsion Fundamentals**

Classification of rockets-principle of rocket propulsion-analysis of ideal chemical rocket, The chemical rocket, solid propellant rockets- grain configuration, liquid propellant rockets, hybrid rockets, cryogenic rockets nuclear propulsion, electro dynamic propulsion, photon propulsion, propulsive efficiency

Laboratory Sessions/ Experimental learning:

1.Make Sugar rocket by using potassium nitrate (small size)

Applications: Rockets and missile manufacturing industries

| **Module 3** | **L2** | 08 Hrs. |
|---|---|---|

**Spacecraft - Structures and Materials:**

Loads experienced by spacecraft. Introduction- General types of construction, Monocoque, Semi-Monocoque and Geodesic structures. Typical spacecraft structure; Metallic and non-metallic materials for spacecraft application. Use of aluminium alloy, titanium, stainless steel and composite materials. Materials selection for spacecraft application.

Laboratory Sessions/ Experimental learning: Structures lab

Applications: Material & Structures of spacecraft

| **Module 4** | **L2** | 08 Hrs. |
|---|---|---|

**Satellite Mission and Configuration:** Mission overview, requirements for different missions, space

environment, spacecraft configuration, spacecraft bus, payloads, requirements and constraints, initial configuration decisions and trade-offs, spacecraft configuration process, broad design of spacecraft bus, subsystem layout, and types of satellites, constellations, and applications.

**Laboratory Sessions/ Experimental learning:** Spacecraft Simulation Lab

**Applications:** Spacecraft mission analysis and overview of configuration process.

| **Module 5** | **L2** | 08 Hrs. |
|---|---|---|

**Attitude and Orbit Control System:** Coordinate systems, Requirements of attitude and orbit control systems (AOCS), Environment effects, Attitude stabilization, Attitude sensors and actuators,

**Laboratory Sessions/ Experimental learning:** Aerospace simulation lab

**Applications:** Place a satellite into orbit and bring the deviated satellite back into its correct orbit

**Course outcomes:**

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

| | |
|---|---|
| CO313.2.1 | Explain developments in history of spacecraft flight. |
| CO313.2.2 | Analyse the basic rocket propulsion. |
| CO313.2.3 | Explain the spacecraft basic structure and materials used |
| CO313.2.4 | Identify satellite mission and configuration. |
| CO313.2.5 | Analyze satellite attitude and orbit control |

**Textbooks:**

| | |
|---|---|
| **1** | E. Stuhlinger and G. Mesmer. Space Science and Engineering. 1st Edition, McGraw-Hill, New York (1965). |
| **2** | Megson, T.H.G., "*Aircraft Structures for Engineering Students"*, Edward Arnold, 6thEdition 2017, Elsevier Aerospace Engineering series, ISBN-13: 978-0081009147, ISBN10: 9780081009147. |

**Reference Books**

| | |
|---|---|
| **1.** | Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition,2016, ISBN: 9781118753910 |
| **2.** | Marcel J.S., Spacecraft Dynamics and control, Cambridge University Press, UK, 2000 |

**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:**

i. Question paper for the SEE consists of 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 must 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 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO5 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| Semester VI | | |
|---|---|---|
| **INTRODUCTION TO ROCKETS AND MISSILES** | | |
| **Course Code:** | **MVJ22AS643** | **CIE Marks:50** |
| **Credits** | **3 : L:T:P:S: 3:0:0:0** | **SEE Marks: 50** |
| **Hours:** | **40 Hours** | **SEE Duration: 3 Hrs** |

**Course Learning Objectives: The students will be able to**

- **Basics of Rockets and Missiles is an elective course offered in 5th semester Aeronautical Engineering curriculum.**
- **This subject covers extensively regarding design and analysis of rockets and missiles.**
- **The different types of Airframe components, types of propulsion system, and types of guidance systems are also covered in this subject.**
- **This subject will make student to understand advanced problems facing in launch vehicles and missiles.**

| **Module 1** | **L2** |
|---|---|
| **INTRODUCTION**<br>Space launch Vehicles and military missiles, function, types, role, mission, mission profile, thrust profile, propulsion system, payload, staging, control and guidance requirements, performance measures, design, construction, operation, similarities and differences. Some famous space launch vehicles and strategic missiles.<br>Applications: | **8 Hrs** |
| **Module 2** | **L3** |
| Solid Propellant Rocket Motor Systems: Solid Propellant rocket motors, principal features, applications. Solid propellants, types, composition, properties, performance. Propellant grain, desirable properties, grain configuration, preparation, loading, structural design of grain. Liners, insulators and inhibitors, function, requirements, materials. Rocket motor casing – materials. Nozzles, types, design, construction, thermal protection. Igniters, types, construction. Description of modern solid boosters I) Space Shuttle SRB, II) the Arienne SRB<br>Liquid Propellant Rocket Motor Systems: Liquid propellants, types, composition, properties, performance. Propellant tanks, feed systems, pressurization, turbo-pumps, valves and feed lines, injectors, starting and ignition. Engine cooling, support structure. Control of engine Starting and thrust build up, system calibration, integration and optimisation – safety and environmental concerns. Description of the space shuttle main engine. Propellant slosh, propellant hammer, geysering effect in cryogenic rocket engines.<br>Applications: | **8 Hrs** |
| **Module 3** | **L2** |
| **AERODYNAMICS OF ROCKETS AND MISSILES** | **8** |

| | |
|---|---|
| Classification of missiles. Airframe components of rockets and missiles, Forces acting on a missile while passing through atmosphere, method of describing aerodynamic forces and moments, lift and drag forces, drag estimation, body upwash and downwash in missiles. Rocket dispersion, re-entry body design considerations.<br>Applications: | **Hrs** |
| **Module 4** **L2** | |
| **LAUNCH VEHICLE DYNAMICS & ATTITUDE CONTROL OF ROCKETS**<br>Launch Vehicle Dynamics: Tsiolskovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging. Earth launch trajectories – vertical segment, the gravity turn, constant pitch trajectory, orbital injection. Actual launch vehicle trajectories, types. Examples, the Mu 3-S-II, Ariane, Pegasus launchers. Reusable launch vehicles, future launchers, launch assist technologies.<br>Attitude Control Of Rockets And Missiles: Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques<br>Applications | **8 Hrs** |
| **Module 5** **L2** | |
| **ROCKET TESTING AND MATERIALS**<br>Rocket Testing: Ground Testing and Flight Testing, Types of Tests facilities and safeguards, monitoring and control of toxic materials, instrumentation and data management. Ground Testing, Flight Testing, Trajectory monitoring, post -accident procedures. Description of atypical space launch vehicle launch procedure.<br>Materials: Criteria for selection of materials for rockets and missiles, requirements for choice of materials for propellant tanks, liners, insulators, inhibitors, at cryogenic temperatures, requirements of materials at extremely high temperatures, requirements of materials for Thermal protection and for pressure vessels.<br>**Applications:** | **8 Hrs** |

| **Course Outcomes: After completing the course, the students will be able to** | |
|---|---|
| **CO313.3.1** | **Identify the types of space launch vehicles and missiles.** |
| **CO313.3.2** | **Distinguish the solid and liquid propellant motors.** |
| **CO313.3.3** | **Classify different types of missiles, understand missile aerodynamics.** |
| **CO313.3.4** | **Acquire the knowledge on launch vehicle dynamics, Attitude control** |
| **CO313.3.5** | **Identify different types of materials used in rockets, missiles and acquire knowledge on rocket testing** |

| **Textbooks:** | |
|---|---|
| **1** | George P Sutton and Oscar Biblarz,' Rocket Propulsion Element', John Wiley and Sons Inc,7th edition,2010,ISBN-13: 978-8126525775 |

| | |
|---|---|
| **2** | Jack N Neilson, 'Missile Aerodynamics', AIAA, 1st edition, 1988, ISBN-13: 978-0962062902 |

| **Reference Books** | |
|---|---|
| **1.** | SS Chin, 'Missile Configuration Design'. |
| **2.** | Cornelisse, J.W., Schoyer H.F.R. and Wakker, K.F., Rocket Propulsion and Space-Flight Dynamics, Pitman, 1979,ISBN-13: 978-0273011415 |
| **3.** | Turner, M.J.L., Rocket and Spacecraft propulsion, Springer, 3rd edition, 2010, ISBN-13: 978-3642088698. |

| **Continuous Internal Evaluation (CIE):** Theory for 50 Marks |
|---|
| CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks. |
| **Semester End Examination (SEE):** Theory for 50 Marks |
| SEE for 50 marks is executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the entire syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level. |
| **Total marks: 50+50=100** |

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

| Course Title | Airline and Airport management | Semester | VI |
|---|---|---|---|
| Course Code | MVJ22AS644 | CIE | 50 |
| Total No. of Contact Hours | 40 | SEE | 50 |
| No. of Contact Hours/week | 4 | Total | 100 |
| Credits | 3 | Exam. Duration | 3 Hrs. |

**The course objective is to:**

1. To understand and acquire a sound understanding on basic management aspect of airport and airlines system
2. To understand and acquire a sound understanding on Airports layout
3. To understand and acquire a sound understanding on Air traffic control
4. To understand and acquire a sound understanding on Landing procedure
5. To understand and acquire a sound understanding on Scheduling
6. Flight planning and other economic and commercial activities.

| Module 1 | L2 | 8 Hrs. |
|---|---|---|

**AIRPORTS AND AIRPORT SYSTEMS** Introduction-Airport Management on an international level- Rules that govern airport management- Organization and administration Airport ownership and organization, responsibilities of Airport manager. Component of an airport-The Airfield-Navigation aids (NAVAIDS) located on airfields-Air traffic Control and surveillance facilities located on the airfield.

**Laboratory Sessions/ Experimental learning**: Case study on Operating at scale

**Applications**: Airport Management includes all airport and airline operations such as managing, supervising, maintaining, and coordinating

| Module 2 | L2 | 8 Hrs. |
|---|---|---|

**AIRPORT OPERATIONS MANAGEMENT**: Airspace and air traffic management, Airport operations management under FAR Part 139, Airport terminals and ground access, Airport security and Administration - Security at commercial service airports-Security at general aviation airports.

**Laboratory Sessions/ Experimental learning**: Case study on Passenger transportation

**Applications**: airport operations encompass all the processes involved at an airport to ensure your experience runs as smoothly as possible.

| Module 3 | L3 | 8 Hrs. |
|---|---|---|

**AIRPORT ADMINISTRATION AND FINANCIAL MANAGEMENT, CAPACITY AND DELAY** concept of Airport planning and financial accounting-Revenue strategies at commercial airports- Pricing of airport facilities and services, , The future of airport management. Defining capacity-Factors affecting capacity and delay-estimating capacity-Simulation Models- Defining delay-Estimating delay-Analytical estimates of delay.

**Laboratory Sessions/ Experimental learning**:

| | | |
|---|---|---|
| **Applications**: Airport Management includes all airport and airline operations such as managing, supervising, maintaining, and coordinating | | |
| **Module 4** | **L3** | 8 Hrs. |
| **INTRODUCTION TO AIRLINE PLANNING:** Structure of Airline Industry (Domestic & International) - Growth and Regulation-Deregulation-Major and National Carriers-Regional Carriers-Economic characteristics of the Airlines Airline Planning Process-Airline Terminology and Measures: airline demand, airline supply, average load factor, unit revenue, Airline Planning Decisions<br>**Laboratory Sessions/ Experimental learning**: Case study on Operating at scale<br>**Applications**: Airline planning and scheduling | | |
| **Module 5** | **L3** | 8 Hrs. |
| **FLEET PLANNING AND ROUTE EVALUATION**: Factors in Fleet Planning-Hub-and-Spoke System-Technical Aspects-Fleet Rationalization-Fleet Commonality-Long Range Aircraft-Noise Restrictions- Factors in Design and Development-Fleet Planning Process; Route Evaluation in Hub Networks-Route profitability estimation issues-Demand Driven Dispatch.<br>**Laboratory Sessions/ Experimental learning**: route planning evaluation<br>**Applications**: Airport Management includes all airport and airline operations such as managing, supervising, maintaining, and coordinating | | |

**Course outcomes:**

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

| | |
|---|---|
| CO313.4.1 | Understand the functioning of the airline industry. |
| CO313.4.2 | Focus on the underlying marketing, financial, operational and competitive factors that influence airline viability. |
| CO313.4.3 | Investigate how the sensitivity of airline profitability impacts airline management decisions. |
| CO313.4.4 | Analyse the principles of airline economics, costs and pricing. |
| CO313.4.5 | The student and assess the individual characteristics of low-cost carriers and business only airlines |

**Textbooks:**

| | |
|---|---|
| **1** | Airport Planning and Management 6/E 0006 Edition by Young Seth, Mc GRAW Hills |
| **2** | Airport Management by Ravindran P.C.K, Asian Law House. |

**Reference Books**

| | |
|---|---|
| **1.** | Aviation Maintenance Management, Second Edition by Harry A. Kinnison, Tariq Siddiqui Published: November 13th 2012 , ISBN: 9780071805025 |
| **2.** | Air Transportation: A Management Perspective (Fifth Edition) by Alexander T.Wells and John G.Wensveen, Brooks Cole,2003 |
| **3.** | Business and Corporate Aviation Management, Second Edition, John J. Sheehan Published: April 23rd 2013 and ISBN: 9780071801904 |
| **4.** | Airport Management by C. Daniel Prather |

**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 of 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 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 1 |
| CO2 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 1 |
| CO3 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 1 |
| CO4 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 1 |
| CO5 | 2 | 3 | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 2 | 3 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **DESIGN, MODELING AND ANALYSIS LAB** | **Semester** | VI |
| **Course Code** | **MVJ22ASL66** | **CIE** | 50 |
| **Total No. of Contact Hours** | 40 L:T:P:0:0:2 | **SEE** | 50 |
| **No. of Contact Hours/week** | 03 | **Total** | 100 |
| **Credits** | 01 | **Exam. Duration** | 3 Hours |

**Course objective is to:**

- Understand the procedure to draw the geometric models of symmetric, cambered aerofoil, nozzle, wing and other structures.
- Acquire the knowledge of types of meshing.
- Understand the basics of flow and stress analysis.

| Sl No | Experiment Name | RBT Level | Hours |
|---|---|---|---|
| **1** | Study of FEA package. Modeling and stress analysis of Trusses | L3 | 03 |
| **2** | Bars of constant cross section area, tapered cross section area and stepped bars | L3 | 03 |
| **3** | Beams: Cantilever, simply supported, overhanging beams with self-weight, Concentrated loads, UDL, Direct moment and UVL with different support conditions | L3 | 03 |
| **4** | Stress analysis of rectangular plate with circular hole | L3 | 03 |
| **5** | Stress analysis of taper plate with circular hole | L3 | 03 |
| **6** | Stress analysis under defined load conditions on a spar of 3D wing. | L3 | 03 |
| **7** | Stress analysis under defined load conditions in a bulkhead. | L3 | 03 |
| **8** | Stress analysis 3D wing. | L3 | 03 |
| **9** | Dynamic Analysis: Modal analysis of Beams | L3 | 03 |
| **10** | Geometric Modeling and Mesh Generation of 2-D Convergent Divergent Nozzle and Analyses of Flow for Adiabatic Conditions. | L3 | 03 |
| **11** | Thermal Analysis of 2-D pipe for conduction and convection heat transfer | L3 | 03 |
| **12** | Heat transfer analysis through composite plate. | L3 | 03 |
| **13** | Study of FEA package. Modeling and stress analysis of Trusses | L3 | 03 |
| **14** | Bars of constant cross section area, tapered cross section area and stepped bars | L3 | 03 |

**Course outcomes:**

| | |
|---|---|
| CO315.1 | Draw the geometric models of symmetric, cambered aerofoil, nozzle, wing and other structures. |
| CO315.2 | Apply different types of meshing. |

| | |
|---|---|
| CO315.3 | Perform the flow and stress analysis. |

| **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 | | | | | | | | | | | | |

**Ability Enhancement Course / Skill Enhancement Course-V**

| | | | |
|---|---|---|---|
| **Course Title** | **Astronomy – Explore the space** | | |
| **Course Code** | **MVJ22A6053** | **CIE** | **50 Marks** |
| **Total No. of Contact Hours** | **30 (L: T: P: 1: 0: 2)** | **SEE** | **50 Marks** |
| **No. of Contact hours/week** | **03** | **Total** | **100 Marks** |
| **Credits** | **2** | **Exam. Duration** | **2 Hours** |

**Course objective is to:**

- Understand the Galaxies and Observing the Universe
- To empower students with skills of creativity, innovation, critical thinking, design thinking, social and cross-cultural collaboration, and ethical leadership
- To help build a small optical telescope

| **Module 1. Galaxies and Observing the Universe** | **RBT Level L3** | **8 Hrs.** |
|---|---|---|

Observing the sky, Observations outside earth's atmosphere, Orbits and gravity, The milky way galaxy, Types of galaxies, Properties of Galaxies, Evolution and distribution of galaxies.

| **Module 2. Astronomical Instruments** | **RBT Level L3** | **7 Hrs.** |
|---|---|---|

Optical Telescope: Theoretical working principle of optical telescope. Elementary geometrical optics, refractive index; reflection and refraction at a plane boundary; total internal reflection. Image formation by reflection at a spherical boundary; concave and convex mirrors. Real and virtual images. Magnification. Image formation by refraction at a spherical boundary by converging and diverging lenses.

| **Module 3. Project work** | **RBT Level L3** | **15 Hrs.** |
|---|---|---|

Fabrication of small optical telescope (Reflective telescope, materials, measurements, lens Etc...)

**Course outcomes:** After the completion of course, students will be able to

| | |
|---|---|
| **CO316.5.1** | Familiarize and understand the fundamentals of Astronomy |
| **CO316.5.2** | Adequate knowledge to select a specific material for the fabrication of small optical Telescope |
| **CO316.5.3** | Understand the innovative product development cycle of Optical Telescope |

**Textbooks:**

| | |
|---|---|
| **1** | Johnson B. K "Optics and Optical Instruments", Dover Publications, Inc. New York. 2001. |
| **2** | Whitlock LA, Pulliam K. "Laboratory exercises for introductory radio astronomy with a small radio telescope". iUniverse. 2008. |

**Reference Books**

| | |
|---|---|
| **1.** | Forest Ray Moulton, "An Introduction to Astronomy Hardcover", The Macmillan Company, New and Revised Edition, 2018. |
| **2.** | Sally R. Ball, "Astronomy for Beginners: The Introduction Guide to Space, Cosmos, Galaxies and Celestial Bodies", Blue source and Friends, 2020. |

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

**Semester: VI**

**INDIAN KNOWLEDGE SYSTEMS**

**(Theory)**

**(Common to All UG Programs)**

| | | | | | | |
|---|---|---|---|---|---|---|
| **Course Code** | **:** | **MVJ22IKK68** | | **CIE** | **:** | **50 Marks** |
| **Credits: L:T:P** | **:** | **1: 0: 0** | | **SEE** | **:** | **50 Marks** |
| **Total Hours** | **:** | **15L** | | **SEE Duration** | **:** | **02 Hours** |

**Course Learning Objectives:** The students will be able to

| | |
|---|---|
| **1** | To facilitate the students with the concepts of Indian traditional knowledge and to makethem understand the Importance of roots of knowledge system. |
| **2** | To make the students understand the traditional knowledge and analyse it and apply it to their day-to-day life. |

| **Unit-I** | **05 Hrs** |
|---|---|

**Introduction to Indian Knowledge Systems (IKS):** Overview, Vedic Corpus, Philosophy,Character scope and importance, traditional knowledge vis-a-vis indigenous knowledge, traditional knowledge vs. western knowledge.

| **Unit – II** | **05 Hrs** |
|---|---|

**Traditional Knowledge in Humanities and Science**s: Lingistics, Number and measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Crafts and Tradein India and Engineering and Technology.

| **Unit -III** | **05 Hrs** |
|---|---|

**Traditional Knowledge in Professional domain:** Town planning and architecture-Construction, Health, wellness and Psychology-Medicine, Agriculture, Governance and public administration, United Nations Sustainable development goals.

**Course Outcomes: After completing the course, the students will be able to**

| | |
|---|---|
| **CO1:** | Provide an overview of the concept of the Indian Knowledge System and its importance. |
| **CO2:** | Appreciate the need and importance of protecting traditional knowledge. |
| **CO3:** | Recognize the relevance of Traditional knowledge in different domains. |
| **CO4:** | Establish the significance of Indian Knowledge systems in the contemporary world. |

**Reference Books**


| | |
|---|---|
| **1** | **Introduction to Indian Knowledge System- concepts and applications**, B Mahadevan,Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0 |
| | **Traditional Knowledge System in India**, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN-13: 978-8126912230, |
| **2** | **Knowledge Traditions and Practices of India**, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334, |

| | |
|---|---|
| | **Suggested Web Links:** |
| **1.** | **https://www.youtube.com/watch?v=LZP1StpYEPM** |
| **2.** | **http://nptel.ac.in/courses/121106003/** |
| **3.** | http://www.iitkgp.ac.in/department/KS;jsessionid=C5042785F727F6EB46CBF432D7683B63 (Centre of Excellence for Indian Knowledge System, IIT Kharagpur) |
| **4.** | https://www.wipo.int/pressroom/en/briefs/tk_ip.html |
| **5.** | https://unctad.org/system/files/official-document/ditcted10_en.pdf |
| **6.** | http://nbaindia.org/uploaded/docs/traditionalknowledge_190707.pdf |
| **7.** | https://unfoundation.org/what-we-do/issues/sustainable-development-goals/?gclid=EAIaIQobChMInp-Jtb_p8gIVTeN3Ch27LAmPEAAYASAAEgIm1vD_BwE |

**ASSESSMENT AND EVALUATION PATTERN**

| **WEIGHTAE** | **50% (CIE)** | **50%(SEE)** |
|---|---|---|
| **QUIZZES** | | |
| Quiz-I<br>Quiz-II | Each quiz is evaluated for 05 marks adding up to **10 Marks.** | ***** |
| **THEORY COURSE -** (Bloom's Taxonomy Levels: Remembering, Understanding,<br>Applying, Analyzing, Evaluating, and Creating) | | |
| Test – I<br>Test – II | Each test will be conducted for 25 Marks adding upto 50 marks.Final test marks will be reduced to **20 Marks** | ***** |
| **EXPERIENTIAL LEARNING** | **20** | ***** |
| Case Study-based Teaching-Learning | -- | ***** |
| Sector wise study & consolidation (viz., Engg.Semiconductor Design, Healthcare & Pharmaceutical, FMCG, Automobile, Aerospaceand IT/ ITeS) | -- | |
| Video based seminar (4-5 minutes perstudent) | -- | |
| **Maximum Marks for the Theory** | **---** | **50 Marks** |
| **Practical** | **--** | **--** |
| **Total Marks for the Course** | **50** | **50** |

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

| | | | |
|---|---|---|---|
| **Course Title** | **SPACE FLIGHT MECHANICS** | **Semester** | **VII** |
| **Course Code** | **MVJ22AS71** | **CIE** | **50** |
| **Total No. of Contact Hours** | **50 L: T: P: 3 :0: 2** | **SEE** | **50** |
| **No. of Contact Hours/week** | **5** | **Total** | **100** |
| **Credits** | **4** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

- Understand the basic concepts of space environment and its effects on space missions
- Acquire knowledge of orbit mechanics and orbit maneuvers.
- Gain knowledge of satellite injection and satellite attitude dynamics
- Understand interplanetary trajectories and atmospheric re-entry problems.
- Comprehend ballistic missile trajectory

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

**Space Environment:** Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere. Peculiarities of space environment and its description, effect of space environment on materials of spacecraft structure and astronauts, manned space missions, effect on satellite lifetime. The solar system, reference frames and coordinate systems, terminology related to the celestial sphere and its associated concepts

**Laboratory Sessions/ Experimental learning: Determination of satellite lifetime.**

**Applications: Spacecraft**

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

**Basic Concepts and the General N-Body of Orbit Mechanics, Orbit Manoeuvres**: Kepler's laws of planetary motion and proof of the laws, Newton's universal law of gravitation, the many body problem, Lagrange-Jacobi identity, the circular restricted three body problem, liberation points, the general N-body problem, two body problem, relations between position and time. Types of Orbits (LEO, MEO, Geosynchronous, and Geostationary, Polar orbits) Two-body motion: Circular, elliptic, hyperbolic, and parabolic orbits-Basic Orbital Elements, Ground trace In-Plane Orbit changes, Hohmann Transfer, Bielliptic Transfer, Plane Changes, Combined Manoeuvres, Propulsion for Manoeuvres

**Laboratory Sessions/ Experimental learning: Perform Hohmann transfer orbit simulation.**

**Applications: Spacecraft**

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

**Satellite Injection and Satellite Perturbations**: General aspects of satellite injection, satellite orbit transfer, various cases, orbit deviations due to injection errors, special and general perturbations, Cowell's method and Encke's method, method of variations of orbital elements, general perturbations approach, Injection conditions - Flight dispersions, Burnout velocity.

**Satellite Attitude Dynamics**: Torque free axisymmetric rigid body, Attitude Control for Spinning Spacecraft, Attitude Control for Non-spinning Spacecraft, The Yo-Yo Mechanism, Gravity – Gradient Satellite, Dual Spin Spacecraft, Attitude Determination.

**Laboratory Sessions/ Experimental learning:** Perform Torque free axisymmetric rigid body satellite attitude simulation.

**Applications: Orbital Mechanics**

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

**Interplanetary Trajectories**: Two-dimensional interplanetary trajectories, fast interplanetary trajectories, three dimensional interplanetary trajectories, launch of interplanetary spacecraft, trajectory estimation about the target planet, concept of sphere of influence, Lambert's theorem. Gravity Turn Trajectories

**Atmospheric Re-entry**: Introduction-Steep Ballistic Re-entry, Ballistic Orbital Re-entry, Skip Re-entry, "Double-Dip" Re-entry, Aero-braking, Lifting Body Re-entry.

**Laboratory Sessions/ Experimental learning: Perform trajectory simulation for small atmospheric reentry module**

**Applications: Spacecraft (Re-entry)**

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

**Ballistic Missile Trajectories:** Introduction to ballistic missile trajectories, boost phase, the ballistic phase, trajectory geometry, optimal flights, time of flight, re-entry phase, the position of impact point and calculation, influence coefficients. Sounding Rocket, Aerospace Plane

**Laboratory Sessions/Experimental learning: Perform trajectory simulation for small atmospheric reentry module**

**Applications: Missile Trajectories**

**Course outcomes:**

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

| | |
|---|---|
| CO401.1 | Apply the basic concepts of space environment |
| CO401.2 | Apply the knowledge of orbital mechanics of satellite. |
| CO401.3 | Analyze satellite injection and satellite dynamics |
| CO401.4 | Determine inter-planetary trajectories and atmospheric re-entry problems |
| CO401.5 | Evaluate ballistic missile trajectory |

| Lab Component | | | |
|---|---|---|---|
| **Sl** | **Experiment Name** | **RBT** | **Hours** |

| No | | Level | |
|---|---|---|---|
| **1** | Draw Pole – Zero map of dynamics system model with plot customization option. | L1,L2,L3 | 03 |
| **2** | Plot root locus for a given Transfer Function and find Gain and Phase Margins | L1,L2,L3 | 03 |
| **3** | Plot root locus for a higher order system taking unity feedback. | L1,L2,L3 | 03 |
| **4** | Draw Bode plot from a transfer function in MATLAB and find gain and phase margin. | L1,L2,L3 | 03 |
| **5** | Demonstrate the effect of lead and lag phase compensations on close-loop performance of a linear system. | L1,L2,L3 | 03 |
| **6** | Simulate a model space craft (space shuttle) landing with parachute deployed. | L1,L2,L3 | 03 |
| **7** | Simulate Hohmann transfer orbit. | L1,L2,L3 | 03 |
| **8** | Perform a planetary orbit simulation. | L1,L2,L3 | 03 |
| **9** | Model and simulate RCS signature. | L1,L2,L3 | 03 |
| **10** | Model a satellite motion and determine time period for its orbital motion. | L1,L2,L3 | 03 |
| **11** | Perform trajectory simulation of a small atmospheric re-entry module. | L1,L2,L3 | 03 |
| **12** | Perform 3-DOF Gyroscope experiment for System Identification. | L1,L2,L3 | 03 |
| **13** | Perform 2- DOF Rotor System experiment for Coupled Dynamic Analysis | L1,L2,L3 | 03 |
| **14** | Model and simulate a simple Magnetic Levitation system and validate with the experimental setup. | L1,L2,L3 | 03 |

**Course outcomes:**

| | |
|---|---|
| CO401.6 | Determine system stability through MATLAB. |
| CO401.7 | Simulate the Satellite orbit manoeuvring. |
| CO401.8 | Analyses the gyroscope experiments |

**Textbooks:**


| | |
|---|---|
| **1** | George P. Sutton and Oscar Biblarz , Rocket Propulsion Elements, 7th Edition,2010 |
| **2** | Thomson, Introduction to Space Dynamics, Dover publications, Revised edition, 2012 |


**Reference Books**


| | |
|---|---|
| **1.** | Vandekamp, Elements of Astro mechanics, Pitman, 1979 |
| **2.** | William E wiesel, Space Flight Dynamics, Create space Independent Pub; 3rd edition (3 June 2010) |

**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:**

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 must 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 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 0 | 1 | 1 | 2 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 1 | 3 | 1 | 2 | 2 | 1 | 2 | 0 | 1 | 3 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 2 | 0 | 0 | 2 | 0 | 0 | 3 | 1 | 1 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 2 | 0 | 0 | 1 | 0 | 0 | 2 | 1 | 1 |
| CO5 | 3 | 2 | 2 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **COMPUTATIONAL FLUID DYNAMICS** | **Semester** | **VII** |
| **Course Code** | **MVJ22AS72** | **CIE** | **50** |
| **Total No. of Contact Hours** | **50 L : T : P :: 3 : 0:2** | **SEE** | **50** |
| **No. of Contact Hours/week** | **5** | **Total** | **100** |
| **Credits** | **4** | **Exam. Duration** | **3hrs** |

**The Course objective is to:**

1. Gain knowledge of CFD ideas, and Flow Equations
2. Learn the Mathematical behaviour of PDEs vis a visnature of flow
3. Know the discretization techniques in finite difference
4. Understand grid generation and adaptive grids
5. Acquire knowledge to solve CFD problems through finite volume technique

| **Module-1** | **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

| **Module-2** | **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

| **Module-3** | **L4** | 10Hrs. |
|---|---|---|

**Discretisation Techniques** 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

| Module-4 | 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.<br>Adaptive Structured Grid Generation, Unstructured adaptive grid Methods.<br>**Transformation:** Matrices & Jacobian of transformation. Transformation of Equation from physical plane into computational Plane-examples.<br>**Laboratory Sessions/ Experimental learning**: Ansys Lab<br>**Applications:** Grid formulation and transformation of planes | | |
| **Module-5** | **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:<br>- Explicit time-stepping and Implicit time- stepping, time step calculation<br>**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.<br>**Laboratory Sessions/ Experimental learning**: Ansys Lab<br>**Applications:** Flow analysis through Finite Volume Technique | | |

| **Course outcomes:** | |
|---|---|
| CO402.1 | Apply knowledge of CFD ideas, and Flow Equations |
| CO402.1 | Assimilate Mathematical behaviour of PDEs vis a vis nature of flow |
| CO402.2 | Utilise finite difference techniques. |
| CO402.3 | Generate &Utilise grids |
| CO402.4 | Apply finite volume techniques |

| Lab Component | | | |
|---|---|---|---|
| **Sl No** | **Experiment Name** | **RBT Level** | **Hours** |
| **1** | Modeling of Symmetric Aerofoil Geometry and Generation of Body Fitting Adaptive Mesh. | L1,L2,L3 | 03 |
| **2** | Modeling of Cambered Aerofoil Geometry and Generation of Body Fitting Adaptive Mesh. | L1,L2,L3 | 03 |
| **3** | Modeling of 2D incompressible and Inviscid flow over symmetrical airfoil and plotting of pressure distribution and velocity vectors for subsonic Mach | L1,L2,L3 | 03 |

| | | | |
|---|---|---|---|
| | nos. | | |
| **4** | Modeling of 2D incompressible and Inviscid flow over cambered airfoil and plotting of pressure distribution and velocity vectors for subsonic Mach nos. | L1,L2,L3 | 03 |
| **5** | Modeling of 2D viscous flow over symmetrical airfoil and plotting of pressure distribution and velocity vectors for subsonic Mach nos. | L1,L2,L3 | 03 |
| **6** | Modeling of 2D viscous flow over cambered airfoil and plotting of pressure distribution and velocity vectors for subsonic Mach nos. | L1,L2,L3 | 03 |
| **7** | Modeling of 2D incompressible and Inviscid flow over symmetrical airfoil and plotting of pressure distribution and velocity vectors for supersonic Mach nos. | L1,L2,L3 | 03 |
| **8** | Modeling of 2D incompressible and Inviscid flow over cambered airfoil and plotting of pressure distribution and velocity vectors for supersonic Mach nos. | L1,L2,L3 | 03 |
| **9** | Isentropic flow analysis in a 2D subsonic diffuser and a subsonic nozzle. | L1,L2,L3 | 03 |
| **10** | Isentropic flow analysis in a 2D supersonic diffuser and a supersonic nozzle. | L1,L2,L3 | 03 |

| **Textbooks** | |
|---|---|
| 1. | John D. Anderson, Computational Fluid Dynamics – The Basics with Application, Indian Edition, McGraw Hill Education (India) Private Limited (1995). |
| 2. | S C Gupta, Applied Computational Fluid Dynamics, first edition, Wiley India Pvt. Ltd (2019) |
| **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. | H. K. Versteeg, W. Malalasekera, An Introduction to Computational Fluid Dynamics, A finite volume approach, Second Edition, 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:**

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-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** | **AEROSPACE VEHICLE DESIGN** | **Semester** | **VII** |
| **Course Code** | **MVJ22AS73** | **CIE** | **50** |
| **Total No. of Contact Hours** | **50 L: T:P:: 3 :0 :0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **4** | **Exam. Duration** | **3 Hrs.** |

Course objective is to:

1. Understand the concepts of launch vehicles.
2. Acquire the knowledge of Aerospace propulsion and re-entry vehicles.
3. Acquire the knowledge of Aerospace launch vehicle structure.
4. Illustrate the different types of vibration taking place in the launch vehicle.
5. Explore the future space technologies and its working principles.

| **Module 1** | **L3** | **10 Hrs.** |
|---|---|---|

Introduction to Launch Vehicle: Launch Vehicles Available, Launch Vehicle Capabilities Deciding, Which Launch Vehicle to Use. Characteristics of Spacecraft Necessary to Choose a Launch Vehicle Structures. Primary Structural Design Other Functional Divisions Mechanisms Used by the Other Subsystem. Materials for Constructing Spacecraft Manufacturing Techniques Applicable to the Structure.

**Laboratory Sessions/ Experimental learning**: Basic stress analysis on launch vehicle components can be analyzed using Ansys workbench.

**Applications**: Used in the launch vehicles design

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

Propulsion: Rocket Propulsion Fundamentals, Ascent Flight Mechanics, Launch Vehicle selection, Entry flight Mechanics, Entry heating, entry vehicle design, Aero assisted orbit transfer.

**Laboratory Sessions/ Experimental learning**: Different types of nozzle analysis can be done using Ansys workbench.

**Applications:** Used in rocket and spacecraft engines.

| **Module 3** | **L3** | **10 Hrs.** |
|---|---|---|

Launch Vehicle structures: Loads on the vehicle structures, Stages, Motor case, Base shroud, Inter stages, Heat shield, Equipment Bay and their functions Modeling and Analysis Structures. Loads and Stresses Thin-Walled Pressure Vessels Buckling of Beams Thin-Wall Assumption. Finite Element Analysis.

**Laboratory Sessions/ Experimental learning**: Static and dynamic analysis can be analyzed using Ansys workbench software.

**Applications**: Used in launch vehicle structural components.

| **Module 4** | **L3** | **10 Hrs.** |
|---|---|---|

Vehicle Dynamics: Mode shape and frequencies of launch vehicles, Vibrations. Flexible Body Dynamics of Liquid propellant in Moving containers Sloshing, POGO Orbital Vibration Mitigation Vibrations Aero elastic phenomenon of launch vehicles.

**Laboratory Sessions/ Experimental learning**: Vibrational analysis can be conducted using Ansys workbench.

**Applications:** Used to find the aeroelasticity(vibration) and to damp the vibration in the Launch vehicles.

**Module 5** **L2** **10 Hrs**

Advanced Aerospace Technologies: Available Technologies, Available Launch Vehicles, New Technologies. Magnetically Inflated Cable System Flying Effector Nano tubing Example, Load and Deflection Nodal Analysis Example, Material Selection Analysis Example, Strained Example, Reaction Wheel Example, Space Shuttle Landing Example, Vibrations Example.

**Laboratory Sessions/ Experimental learning**: Virtual experiments can be used to demonstrate the technologies.

**Applications:** Used in Aerospace vehicles.

| **Course outcomes:** | |
|---|---|
| CO401.1 | Classify the space mission analysis and design process. |
| CO401.2 | Explain the working principle of rocket propulsion and re-entry mission. |
| CO401.3 | Investigate the launch vehicle structural components for product lifecycle management. |
| CO401.4 | Apply the concepts of space craft attitude control and instrumentation. |
| CO401.5 | Summarize spacecraft configuration and advance technologies. |

| Text Books: | |
|---|---|
| 1. | Space Vehicle Design M.D. Griffin,J.R. French AIAA Series1 9 9 1. |
| 2 | Spacecraft Systems Engineering P. Fortescue, J. stark, and G. Swinerd Wiley-Blackwell 4th revised edition,2011 |

| Reference Books: | |
|---|---|
| 1. | Space Mission Analysis and designW.J. Larson andJ. R. Wertz.,Springer2nd edition,1992. |
| 2. | Rocket and Spacecraft PropulsionM.J.L. TurnerSpringer3rd edition,2009. |
| 3. | Sutton, Rocket 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:**

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 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 1 |
| CO2 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 1 |
| CO3 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 1 |
| CO4 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 1 |
| CO5 | 3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 1 | 1 |

High,3, Medium,2, Low,1

**Professional Elective-III**

| | | | |
|---|---|---|---|
| **Course Title** | **HYPERSONIC FLOWS** | **Semester** | VII |
| **Course Code** | **MVJ22AS741** | **CIE** | 50 |

| | | | |
|---|---|---|---|
| **Total No. of Contact Hours** | 40 L: T: P: 3 :0 :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 hypersonic flows.
2. Understand the surface inclination methods for inviscid hypersonic flows.
3. Learn the Approximate Methods For Inviscid Hypersonic Flows
4. Acquire the knowledge of viscous interactions in hypersonic flows.
5. Acquire knowledge on the Testing facilities & measurements of Hypersonic flows.

| **Module 1** | **L3** | 08 Hrs. |
|---|---|---|

**Basics of Hypersonic Flows:** Thin shock layers, entropy layers, low density and high-density flows, hypersonic flight paths hypersonic flight similarity parameters, shock wave and expansion wave relations of inviscid hypersonic flows.

**Laboratory Sessions/ Experimental learning:**

1. High speed flow analysis past blunt object in presence of a bow shock wave (DESIGN, MODELLING & ANALYSIS LAB)

**Applications:**

1. Investigation of the parameters of wake flow at high speeds

| **Module 2** | **L3** | 08 Hrs. |
|---|---|---|

**Surface Inclination Methods for Hypersonic Inviscid Flows**: Local surface inclination methods, modified Newtonian Law, Newtonian theory – tangent wedge or tangent cone and shock expansion methods, Calculation of surface flow properties.

**Laboratory Sessions/ Experimental learning:**

1. Experimental analysis of Hypersonic flow over an Elliptic Cone.

**Applications:**

1. Obtain the total force and moment structure on the high-speed vehicle

| **Module 3** | **L3** | 08 Hrs. |
|---|---|---|

**Approximate Methods For Inviscid Hypersonic Flows**: Approximate methods hypersonic small disturbance equation and theory, thin shock layer theory, blast wave theory, entropy effects, rotational method of characteristics, hypersonic shock wave shapes and correlations

**Laboratory Sessions/ Experimental learning:**

1. Experimental characterization of the hypersonic flow around a cuboid

**Applications:**

1. Design and operation of a practical hypersonic vehicle

| **Module 4** | **L3** | 08 Hrs. |
|---|---|---|

**Viscous Interactions In Hypersonic Flows:** Strong and weak viscous interactions, hypersonic shockwaves and boundary layer interactions, Estimation of hypersonic boundary layer transition, Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow

**Laboratory Sessions/ Experimental learning:**

1. Grid generation on fore portion of a spacecraft model (DESIGN, MODELLING & ANALYSIS LAB).

**Applications:**

1. In**engine inlet & Inward-turning inlet of High speed vehicles.**

| **Module 5** | **L2** | 08 Hrs. |
|---|---|---|

**Hypersonic Flows: Testing facilities & Measurements:** Hypersonic Test facilities-Hypersonic Wind Tunnel, Types of Hypersonic Wind Tunnel, Calibration, Hypersonic Flow Parameter estimation in Wind tunnel, Hypersonic Impulse Facilities, Shock Tunnel & its types, Other Hypersonic test facilities-Hot Shot tunnel & Launcher test facility, Heat transfer rate Measurement, Flow Visualization for High Speeds

**Laboratory Sessions/ Experimental learning:**

1. Experimental investigation on drag and heat flux reduction in supersonic/hypersonic flows:

**Applications:**

1. Design &Operation of a practical hypersonic vehicle

**Course outcomes:**

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

| | |
|---|---|
| CO404.1.1 | Interpret the basics of Hypersonic flows |
| CO404.1.2 | Analyse the surface inclination methods for inviscid hypersonic flows. |
| CO404.1.3 | Evaluate the Approximate methods for inviscid hypersonic flows |
| CO404.1.4 | Evaluate the hypersonic boundary layers & effects involved with hypersonic aerodynamic heating |
| CO404.1.5 | Illustrate the hypersonic Flow Parameters & Hypersonic Testing facilities |

**Text Books:**

| | |
|---|---|
| 1. | John D Anderson Jr., Hypersonic & High Temperature Gas dynamics, AIAA series, 2nd revised edition,2006 |

| | |
|---|---|
| 2. | John D Anderson Jr., Modern Compressible flow & Historical perspective Hypersonic Series, McGraw Hill, 3rd edition, 2012. |
| **Reference Books:** | |
| 1. | William H Heiser and David T Pratt, Hypersonic Air Breathing Propulsion, AIAA, 1994. |
| 2. | John T. Bertin, Hypersonic Aerothermodynamics, AIAA Inc, 1994 |

**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 | 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,1

| Course Title | CRYOGENICS | Semester | VII |
|---|---|---|---|
| Course Code | MVJ22AS742 | CIE | 50 |
| Total No. of Contact Hours | 40 L: T:P: 3 :0 :0 | SEE | 50 |
| No. of Contact Hours/week | 4 | Total | 100 |
| Credits | 3 | Exam. Duration | 3 Hrs. |

**The course objective is to:**

1. Study the basics of cryogenic technology and applications
2. Learn the properties of cryogenic materials and their process
3. Understand the techniques of cryogenic insulation
4. Acquire knowledge on storage and instrumentation of cryogenic liquids
5. Learn the basics of cryogenic equipment

| **Module 1-Introduction to cryogenic Engineering** | **L3** | 08 Hrs. |
|---|---|---|

Thermo-Physical and Fluid Dynamics Properties of Liquid and Gas Hydrogen, Thermo-Physical and Fluid Dynamics Properties of Liquid and Gas Helium, Liquefaction System of Hydrogen and Helium Gases, Refrigeration and Liquefaction Principles, Joule Thomson Effect and Inversion Curve, Adiabatic and Isenthalpic Expansion and Their Comparison

**Applications:**

Aerospace and chemical Industry

| **Module 2 – Properties** | L3 | 08 Hrs. |
|---|---|---|

Cryogenic Fluids, Solids at Cryogenic Temperatures, Superconductivity, Recuperative–Linde–Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon, Regenerative – Sterling Cycle and Refrigerator, Slovay Refrigerator, Gifford-Mcmahon Refrigerator, Vulilleumier Refrigerator, Pulse Tube Refrigerator, Liquefaction of Natural Gas

**Applications:**

Aerospace and chemical Industry

| **Module 3 -Cryogenic Insulation** | **L3** | 08 Hrs. |
|---|---|---|

Vacuum Insulation, Evacuated Porous Insulation, Gas Filled Powders and Fibrous Materials, Solid Foams, Multilayer Insulation, Liquid and Vapor Shields, Composite Insulations

**Applications:**

Aerospace and chemical Industry

| **Module 4 – Storage and instrumentation of cryogenic liquids** | **L3** | 08 Hrs. |
|---|---|---|

Design Considerations of Storage Vessel-Dewar Vessels- Industrial Storage Vessels, Storage of Cryogenic Fluids in Space, Transfer Systems and Lines for Cryogenic Liquids, Cryogenic Valves and Transfer Lines, Two Phase System in Transfer Systems, Cool-Down of Storage and Transfer Systems, Measurement of Strain , Pressure , Flow, Liquid Level and Temperature in Cryogenic Environment, Cryostats **Applications:**

Aerospace and chemical Industry

| **Module 5 – Cryogenic Equipment** | **L3** | 08 Hrs. |
|---|---|---|

Cryogenic Heat Exchangers, Recuperative and Regenerative, Variables Affecting Heat Exchangers and System Performance, Cryogenic Compressors, Pumps, Expanders, Turbo Altimators, Effect of Component Inefficiencies, System Optimization, Magneto-Caloric Refrigerator, 3He-4He Dilution Refrigerator,

Cryopumping, Cryogenic Engineering Application in Energy, Aeronautics, Space, Industry, Biology, Preservation Application of Cryogenic Engineering in Transport

**Applications:**

Aerospace and chemical Industry

**Course outcomes:**

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

| | |
|---|---|
| CO404.2.1 | Analyze cryogenic technology and its applications |
| CO404.2.2 | Apply the properties of cryogenic materials and their process |
| CO404.2.3 | Demonstrate the different cryogenic insulation methods |
| CO404.2.4 | Apply the knowledge of storage and instrumentation of cryogenic liquids |
| CO404.2.5 | Evaluate cryogenic equipment for their application |

**Textbooks:**

| | |
|---|---|
| **1** | Flynn T. Cryogenic Engineering revised and expanded. CRC Press; 2004 Nov 30. |
| **2** | Weisend, J. G. Handbook of cryogenic engineering. Vol. 325. Philadelphia: Taylor & Francis, 1998. |

**Reference Books**

| | |
|---|---|
| **1.** | Barron, Randall F. "Cryogenic systems." Monographs on cryogenics (1985). |
| **2.** | Timmerhaus, Klaus D., and Richard P. Reed, eds. Cryogenic engineering: fifty years of progress. Springer Science & Business Media, 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 of 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 must 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 | | | 1 | | | | | | 1 | 3 | 1 |
| CO2 | 3 | 3 | 2 | | | 1 | | | | | | 1 | 3 | 1 |
| CO3 | 3 | 3 | 2 | | | 1 | | | | | | 1 | 3 | 1 |
| CO4 | 3 | 3 | 2 | | | 1 | | | | | | 1 | 3 | 1 |
| CO5 | 3 | 3 | 2 | | | 1 | | | | | | 1 | 3 | 1 |

High,3, Medium,2, Low,1

| Course Title | **CONTROL ENGINEERING** | Semester | VII |
|---|---|---|---|
| Course Code | **MVJ22AS743** | **CIE** | 50 |
| Total No. of Contact Hours | 40 L: T:P: 3 :0 :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 knowledge of 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** | **L3** | 08 Hrs. |
|---|---|---|

**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:**Aircraft Controls

| **Module 2** | **L3** | 08 Hrs. |
|---|---|---|

**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

| **Module 3** | **L3** | 08 Hrs. |
|---|---|---|

**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

Effect of frequency in stability of a system

| **Module 4** | **L3** | 08 Hrs. |
|---|---|---|

**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:**

Determine stability of an aircraft

| **Module 5** | **L2** | 08 Hrs. |
|---|---|---|

**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:**

1. Autopilot design for lateral directional motion

Provide suitable controller for non linear or complex system.

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

| | |
|---|---|
| CO404.3.1 | Apply the concepts of control models |
| CO404.3.2 | Generate block diagrams and signal flow graphs |
| CO404.3.3 | Perform the stability analysis in Laplace domain through various techniques |
| CO404.3.4 | Evaluate the frequency response specifications and Nyquist criteria |
| CO404.3.5 | Determine controller and compensation gain for feedback control system |

**Textbooks:**


1. U.A. Bakshi and V.U. Bakshi, "Control Engineering", Technical Publications
2. A. NagoorKani, "Control Systems Engineering", RBA Publications, 2014


**Reference Books**

| | |
|---|---|
| **1.** | Katsuhiko Ogatta, "Modern Control Engineering", Pearson Education, 2004 |
| **2.** | 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:**

- Question paper for the SEE consists of 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 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO1 0 | PO1 1 | PO1 2 | PSO 1 | PSO 2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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** | **ATMOSPHERIC FLIGHT MECHANICS** | **Semester** | **VII** |
| **Course Code** | **MVJ22AS744** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T: P :: 3 :0 : 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 Flight environment and Steady Performance – Level Flight, Climb & Glide
2. Understand airplane's range and endurance, and gain the knowledge of take-off, landing, and maneuvering flights.
3. Understand the static longitudinal stability with Control stick fixed & free conditions
4. Acquire the knowledge of Static Directional and Lateral stability &control
5. Gain the knowledge of equations of motions and dynamic Stability derivatives.

| **Module 1** | **L3** | 08 Hrs. |
|---|---|---|

Atmosphere: ISA, Geopotential and Geometric altitude, Troposphere and Stratosphere, stability of atmosphere. Airplane Performance in Steady and Level Flight: Equations of motion of aircraft, variation of drag with flight, power required and power available, minimum drag and minimum power conditions, climbing and gliding performance.

**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

| **Module 2** | **L3** | 08 Hrs. |
|---|---|---|

Airplane Performance in Accelerated Flight: Take off and landing distances, Jet Assisted Take off, Range and Endurance. Turning flight performance

**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

| **Module 3 .** | **L3** | **08 Hrs** |
|---|---|---|

Static longitudinal stability: Stick fixed static longitudinal stability, neutral point, power effects, stick free static longitudinal stability. Hinge moments, Aerodynamic Balancing, Static Margin. In flight measurement of stick fixed and stick free neutral points.

**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

| **Module 4** | **L3** | 08 Hrs. |
|---|---|---|
| Lateral and Directional Stability and Control: Asymmetric flight, weather cock stability, Rudder fixed and Rudder free static directional stability - Rudder lock, dihedral effect. Control in Roll, Aileron control power. Cross coupling of lateral and directional effects. Numerical problems<br>**Laboratory Sessions/ Experimental learning:**<br>Effect of aileron input in lateral and directional motion of Aircraft<br>**Applications:**<br>Effect of Directional and Lateral stability on Aircraft | | |
| **Module 5** | **L3** | 10Hrs. |
| Dynamic Stability: Equations of motion of airplane, stability derivatives. 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.<br>**Laboratory Sessions/ Experimental learning:**<br>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 & determine short period and phugoid oscillations for a given Quartic equation<br>**Applications:**<br>Stability derivative estimation for a stable aircraft & determine relative stability of an Aircraft | | |

**Course outcomes:**

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

| | |
|---|---|
| CO404.4.1 | Describe the Flight environment and apply the basic concepts of aircraft performance. |
| CO404.4.2 | Analyze range and endurance, and illustrate take-off, landing, and maneuvering |
| CO404.4.3 | Compare the longitudinal stability for stick fixed &stick free case. |
| CO404.4.4 | Analyze static lateral and directional stability |
| CO404.4.5 | Estimate the dynamic stability derivatives. |

Textbooks

| | |
|---|---|
| 1. | John D. Anderson, Jr, Introduction to Flight by; McGraw-Hill International, Aerospace Science/Technology Editions, 2000 |
| 2 | Nelson, R.C. Flight Stability and Automatic Control, McGraw-Hill Book Co., 2007. |
| | |

Reference Books:

| | |
|---|---|
| 1 | Perkins, C.D., and Hage, R.E., Airplane Performance stability and Control, John Wiley Son Inc, New York, 1988 |
| 2 | Bernard Etkin, Dynamics of Flight Stability and Control, John Wiley & Sons, Second Edition, 1982 |

| | |
|---|---|
| 3 | 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:**

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-PSO Mapping

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

High,3, Medium,2, Low,1

**Open Elective-II**

| | | | |
|---|---|---|---|
| **Course Title** | **EARTH AND SPACE SCIENCES** | **Semester** | **VII** |
| **Course Code** | **MVJ22AS751** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T:P: 3 :0 :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 Earth Science**
2. **Acquire the knowledge of Space Science**
3. **Connect the concepts of Earth and Space Science for Aerospace Engineering**
4. **Understand the basics of planets, comets, plasma physics.**
5. **Acquire the knowledge of space, solar activity, physics of sun**

| | | |
|---|---|---|
| **Module 1** | **L2** | 08 Hrs. |
| Earth System Science, Doing Science, Earth in Space, Near-Earth Objects, Plate tectonics, Continental Drift, Plate Boundaries, The Science of Earth Quakes, Seismic Waves, Earth quake hazards | | |
| **Module 2** | **L2** | 08 Hrs. |
| Volcanoes and Mountains, Rocks and Minerals, weathering and Soils, Physical Weathering, weathering rates, Oceans and Coastlines, Ocean Waters, Oceanic Circulations, Shoreline feature and protection, The atmosphere, Earth's climate System. | | |
| **Module 3** | **L2** | 08 Hrs. |
| A brief History of discovery, Exploration of Solar System, The Sun and the Beyond, Remote Sensing of The Earth's Climate System, Remote Sensing Methodology, Measurement by remote sensing, Atmospheric factors, Instrumental factors, Using Reflected Sunlight, Using Thermal Emission, Using Radar | | |
| **Module 4** | **L2** | 08 Hrs. |

| | | |
|---|---|---|
| Planetary Science, Terrestrial Planets, Outer Planets, Comets, Asteroids, Magnetosphere, Missions, Space Plasma Physics | | |
| **Module 5** | **L2** | 08 Hrs. |
| Space Weather, Solar Activity, The Solar Wind, Aurora, Solar flares, The Ionosphere, Coronal Mass Ejections and Geomagnetic Storms, The Physics of the Sun, X-Ray Astronomy | | |

**Course outcomes:**

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

| | |
|---|---|
| CO405.1.1 | Appreciate the foundations of Earth Science |
| CO405.1.2 | Apply the knowledge of Space Science |
| CO405.1.3 | Analyse Earth and Space Sciences for Aerospace Engineering |
| CO405.1.4 | Apply the knowledge of plasma physics in space science. |
| CO405.1.5 | Apply the knowledge of physics of sun. |

**Textbooks:**

| | |
|---|---|
| **1** | Exploring Earth Science - 16 edition ISBN13: 978-0078096143 by Stephen Reynolds |
| **2** | Space Science by Louise K Harra and K O Mason , Imperial College Press |

**Reference Books**

| | |
|---|---|
| **1.** | Principles of Environmental Science: Inquiry and Applications. William Cunningham, Mary Cunningham ISBN13: 9780073532516 |
| **2.** | Earth Science / Edition 13 by Edward J. Tarbuck |
| **3.** | Concepts in Space Science by RR Daniel |

**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 of 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 | 2 | | | 1 | | | | | | 1 | 3 | 1 |
| CO2 | 3 | 3 | 2 | | | 1 | | | | | | 1 | 3 | 1 |
| CO3 | 3 | 3 | 2 | | | 1 | | | | | | 1 | 3 | 1 |
| CO4 | 3 | 3 | 2 | | | 1 | | | | | | 1 | 3 | 1 |
| CO5 | 3 | 3 | 2 | | | 1 | | | | | | 1 | 3 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **AVIATION AND INTERNET INFRASTRUCTURE** | **Semester** | **VII** |
| **Course Code** | **MVJ22AS752** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T:P: 3 :0 :0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

7. Understanding the importance of the customer service
8. Understanding the knowledge of air cargo.
9. Apply supply chain management in aviation.
10. Understanding the customer
11. Know the reasons for complaints and their redressal

| **Module 1** | **L2** | 08 Hrs. |
|---|---|---|

Introduction – Customer Service – A better standard of Customer Service – Airline Industry Changes – Airline Deregulation – Global Alliances – The Rise of Low Cost Carrier – The Role of the Internet – Airline Industry Challenges – Customer Service in the Age of the Customer – Age of the Customer – Customer Service as a Key Differentiator – Operational Excellence – The Customer Centric Culture – Mission Statement – Airline Customer Service – On the Front Line – Duties and Responsibilities of Front Line Staff – Who is a Customer – The High Cost of Losing a Customer – Customer Expectations of Service – What is Customer Service – The Peripheral Services – Objectives of Customer Service - Benefits of Customer Service.

**Laboratory session /Experimental Learning:** A case study on improving customer satisfaction and travel ease

**Applications –** Travel time and customer ease of travel to be improved

| **Module 2** | **L2** | 08 Hrs. |
|---|---|---|

| | | |
|---|---|---|
| Operations and Industry Regulations – Service Function – Organization & Liability – SLI – Types of Cargo – Handling of Perishable, Valuable & Special Cargo – Air Cargo Tariff, Rates & Charges – Valuation Charges and Disbursement Airway Bill – Function, Purpose & Validation.<br>**Laboratory session /Experimental Learning:** A case study on improving the cargo services<br>**Applications –** Effectively handling cargo and see that reaches destination in time . | | |
| **Module 3** | **L2** | 08 Hrs. |
| Definition – Objectives of SCM – Key Issues in SCM – Supply Chain Drivers – Demand – Forecasting – 3 PLs – Advantages – 4 PLs – Benefits – Difference between Logistics & Supply Chain Management – SCM Processes – 7 Principles of SCM – 6 Components of SCM – Stages of Supply Chain.<br>**Laboratory session /Experimental Learning:** SCM concepts and their importance in aviation through Internet<br>**Applications –** Good understanding of the travel time and its importance from the customer end | | |
| **Module 4** | **L2** | 08 Hrs. |
| Customer Contact Techniques – Making a Good First Impression – Self Presentation Skills – Preparing to receive the Customer – Steps to receive the Customer – Telephone Communication – How to Answer the Telephone – Hints for Developing Better Telephone Listening Skills – Email Etiquette – Handling Common Questions from Customers – Communication with Customers through Social Media – How Airlines are Using social media – Responding to Customer Complaints through Social Media – Social System and Tact : Cross Cultural Awareness – The Importance of Self Awareness – Personality – Assertive vs Responsive Behaviours – What is Your Social Style? – Characteristics of the Four Social Styles – Social Style and Customer Service – Identifying a Customer's Social Service – Flexing Strategies – Cross Cultural Awareness – What is Culture – Cultural Differences – The Importance of Cross-Cultural Awareness.<br>**Laboratory session /Experimental Learning:** A case study for improving customer service<br>**Applications –** Good customer service a key for airline growth | | |
| **Module 5** | **L2** | 08 Hrs. |
| Dealing with Complaints – Lack of Complaints – Why do Customer Complain – Developing a Customer | | |

Service Strategy – Legitimate vs Illegitimate Complaints – Preventing Complaints – How to Handle Complaints effectively – The Five Types of Customers who complain and How to Handle them – The Complaints System – Dealing with Disengagement – Handling Customer Aggression as Airline Employee.

**Laboratory session /Experimental Learning:** A case study for addressing and mitigate complaints

**Applications** – Steps to understand how to mitigate the complaints .

**Course outcomes:**

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

| | |
|---|---|
| CO405.2.1 | Importance of customer service |
| CO405.2.2 | Handling of cargo and their functions |
| CO405.2.3 | Importance of the supply chain management |
| CO405.2.4 | Knowing the customer contact techniques |
| CO405.2.5 | Knowing the complaints and the reasons and their redressal |

**Textbooks:**

| | |
|---|---|
| **1** | Aink Kumar Hai, Customer Relationship Management Concept & Cases Prentice Hall of India Private Limited |
| **2** | Shangustaram, Customer Relationship Management, Prentice Hall of India Private Limited |

**Reference Books**

| | |
|---|---|
| **1.** | Kaushik Mukherjee. Customer Relationship Management, Prunicu Hall of India Private Limited. |

**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 of 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 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO2 | 2 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 1 | 3 | 2 | 1 |
| CO3 | 1 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 1 |
| CO4 | 2 | 3 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 3 | 1 | 2 | 3 | 1 |
| CO5 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 1 | 1 |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **INDUSTRIAL AERODYNAMICS** | **Semester** | **VII** |
| **Course Code** | **MVJ22AS753** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T:P: 3 :0 :0** | **SEE** | **50** |
| **No. of Contact Hours/week** | **4** | **Total** | **100** |
| **Credits** | **3** | **Exam. Duration** | **3 Hrs.** |

**The course objective is to:**

1. Familiarize the learner with the atmosphere and its effect on the structures.
2. Understand the effect of wind on different structures.
3. Familiarize non-aeronautical uses of aerodynamics in road vehicles.
4. Familiarize non-aeronautical uses of aerodynamics in buildings and to Understand methods for constructing various tall structures.
5. Understand the problems of flow induced vibrations.

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

ATMOSPHERE: Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows. Case Study – Measurement of basic wind parameters in open atmospheric condition

Applications:

1. Measurement of wind parameters in given atmospheric condition.

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

WIND ENERGY COLLECTORS Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

Applications:

1. Power generation and reducing carbon footprint.

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

VEHICLE AERODYNAMICS Power requirements and drag coefficients of automobiles, Effects of cut back

| | | | |
|---|---|---|---|
| angle, Aerodynamics of trains and Hovercraft.<br>Applications:<br>1. To understand flow of air through the vehicle's body.<br>2. To understand flow processes within the vehicle's machinery. | | | |
| **Module 4** | | **L2** | 8 Hrs. |
| BUILDING AERODYNAMICS Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, Building ventilation and architectural aerodynamics. Case Study – Experimental analysis of high-rise buildings.<br>Applications:<br>1. To understand fluid and structure interaction. | | | |
| **Module 5** | | **L2** | 8 Hrs. |
| FLOW INDUCED VIBRATIONS Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.<br>Applications: To understand low frequency vibrations due to fluid flow. | | | |
| **Course outcomes:** Upon completion of the course, students will be able to: | | | |
| CO405.3.1 | To familiarize the learner with atmosphere and its effect on the structures. | | |
| CO405.3.2 | To understand the effect of wind on different structures. | | |
| CO405.3.3 | To Familiarize non-aeronautical uses of aerodynamics in road vehicles. | | |
| CO405.3.4 | To Familiarize non-aeronautical uses of aerodynamics in buildings and to Understand methods for constructing various tall structures. | | |
| CO405.3.5 | To Understand the problems of flow induced vibrations. | | |
| **Text Books:** | | | |
| 1. | M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and road vehicles", Plenum press, New York, 1978. | | |
| 2. | N.G. Calvent, "Wind Power Principles", Charles Griffin & Co., London, 1979. | | |
| **Reference Books:** | | | |

| | |
|---|---|
| 1. | P. Sachs, “Winds forces in engineering”, Pergamon Press, 1978. |
| 2. | R.D. Blevins, “Flow induced vibrations”, Van Nostrand, 1990 |
| 3. | M Kaushik “Theoretical and experimental aerodynamics”, Springer,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:**

- The question paper for the SEE consists of 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 a 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 | 2 | | | | | | | | | | |
| CO2 | 3 | 2 | 2 | 2 | 1 | 1 | | | | | | | | |
| CO3 | 3 | 2 | 2 | 2 | 1 | 1 | | | | | | | | |
| CO4 | 3 | 2 | 2 | 2 | 1 | 1 | | | | | | | | |
| CO5 | 3 | 2 | 2 | 2 | | 1 | | | | | | | | |

High,3, Medium,2, Low,1

| | | | |
|---|---|---|---|
| **Course Title** | **AVIONICS** | **Semester** | **VII** |
| **Course Code** | **MVJ22AS754** | **CIE** | **50** |
| **Total No. of Contact Hours** | **40 L: T:P: 3 :0 :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 power distribution system and need for avionics.
2. Acquire knowledge of control and navigation systems
3. Gain knowledge of display technologies and avionics system architectures
4. Understand the Microprocessors and cockpit display technologies
5. Apprehend the functioning of data buses

| | | |
|---|---|---|
| **Module 1 Power Distribution System** | **L2** | 08 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

| | | |
|---|---|---|
| **Module 2 Inertial Navigation &Electronic Flight Control System** | **L3** | 08 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

| | | |
|---|---|---|
| **Module 3 Electronic Flight Instrument &Avionics Sub Systems** | **L3** | 08 Hrs. |

| | | |
|---|---|---|
| **Electronic Flight Instrument Systems:** Display-units, presentation, failure, and annunciation. Display of air data.<br>**Introduction to Avionics Sub Systems and Electronic Circuits:** Typical avionics sub systems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.<br>**Laboratory Sessions/ Experimental learning:** Construct 7 segment display circuit using IC timer<br>**Applications:** Attitude Estimation, Navigation, Control | | |
| **Module 4 Digital Systems& Flight Deck and Cockpits** | **L3** | 08 Hrs. |
| **Principles of Digital Systems:** Digital Computers, Microprocessors, Memories.<br>**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.<br>**Laboratory Sessions/ Experimental learning:** Data transfer using ARINC420 data bus.<br>**Applications:** Position Estimation, Guidance, Control | | |
| **Module 5 Avionics Systems Integration** | **L3** | 08 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<br>**Laboratory Sessions/ Experimental learning:** Data transfer using MIL-STD 1553B Data bus<br>**Applications:** Navigation, Guidance, Control | | |
| **Course outcomes:**<br>Upon completion of the course, students will be able to: | | |
| CO405.4.1 | Analyse the power distribution system in avionics. | |
| CO405.4.2 | Apply the knowledge of control and navigation systems | |
| CO405.4.3 | Utilise the knowledge of display technologies and avionics system architectures | |
| CO405.4.4 | Evaluate the Microprocessors and cockpit display technologies | |
| CO405.4.5 | Analyse the functioning of data buses | |

| **Textbooks:** | |
|---|---|
| **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. |
| **Reference Books** | |
| **1.** | 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:**

- 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 | | | | 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 | | | | | | | | | | | | | | |

HOD

Dean Academics.