Semester: III		
TRASNFORMS & STATISTICAL METHODS		
Course Code:	**MVJ21MAE31/ MAS31/MME31**	**CIE Marks:100**
Credits: L:T:P:S: 3:2:0:0		**SEE Marks: 100**
Hours: 40L+26T		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Comprehend and use of analytical and numerical methods in different engineering fields.	
2	Apprehend and apply Fourier Series.	
3	Realize and use of Fourier transforms.	
4	Realize and use of Z-Transforms.	
5	Use of statistical methods in curve fitting applications.	

UNIT-I	
Laplace Transform: Definition and Laplace transforms of elementary functions. Laplace transforms of Periodic functions and unit-step function and problems. **Inverse Laplace Transform:** Definition and problems, Convolution theorem to find the inverse Laplace transforms and problems. **Applications**: Solution of linear differential equations using Laplace transforms. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=8oE1shAX96U https://www.intmath.com/laplace-transformation/7-inverse-laplace-transform.php	**10 Hrs**
UNIT-II	
Fourier series: Recapitulation of Series, Continuous and Discontinuous functions, Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period	**10 Hrs**

2π and arbitrary period $2l$, Half-range Fourier sine and cosine series, Practical Harmonic Analysis and Problems. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=Sq2FhCxcyI8 https://www.youtube.com/watch?v=4N-IwHUCFa0	
UNIT-III	
Fourier transforms: Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse Fourier sine and cosine transforms, Convolution theorem. **Web Link and Video Lectures:** https://www.youtube.com/watch?v=spUNpyF58BY https://www.youtube.com/watch?v=6spPyJH6dkQ	**10 Hrs**
UNIT-IV	
Z-Transforms: Z-transform: Difference equations, basic definition, z-transform -definition, Standard z-transforms, Damping rule, Shifting rule, Initial value and final value theorems (without proof) and problems, Inverse Z-transform. **Applications**: Application of Z- transforms to solve difference equations. **Web Link and Video Lectures:** http://www.eas.uccs.edu/~mwickert/ece2610/lecture_notes/ece2610_chap7.pdf https://electricalbaba.com/final-value-theorem-and-its-application/	**10 Hrs**
UNIT-V	
Curve Fitting: Curve fitting by the method of least squares. Fitting of the curves of the form $y = ax + b$, $y = ax^2 + bx + c$, $y = ae^{bx}$. **Statistical Methods:** Introduction, Correlation and coefficient of correlation, Regression, lines of regression and problems. **Web Link and Video Lectures:** https://mathbits.com/MathBits/TISection/Statistics2/correlation.htm https://www.youtube.com/watch?v=xTpHD5WLuoA	**10 Hrs**

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

Reference Books	
1.	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
3.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition,2014.
4.	Ramana B. V., "Higher Engineering Mathematics", Tata McGraw-Hill, 2006.
5.	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th 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: III		
THERMODYNAMICS		
Course Code:	**MVJ21AE32/ MVJ21AS32**	**CIE Marks:100**
Credits: L:T:P:S: 3:2:0:0		**SEE Marks: 100**
Hours: 40L+26T		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand various concepts and definitions of thermodynamics.	
2	Comprehend the I-law of thermodynamics.	

3	Comprehend the II-law of thermodynamics
4	Acquire the knowledge of Pure Substances & Ideal Gases
5	Acquire the knowledge of various types of gas cycles.

UNIT-I	
Fundamental Concepts & Definitions: Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and Modules, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements. **Work and Heat:** Mechanics-definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work Laboratory Sessions / Experimental learning: To determine the unknown area of a given drawing using planimeter Applications: 1.For temperature measurements 2.To obtain displacement work Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/104/101104067/	**10 Hrs**
UNIT-II	
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	**10 Hrs**

applications, analysis of unsteady processes such as film and evacuation of vessels with and without heat transfer Laboratory Sessions/ Experimental learning: https://www.youtube.com/watch?v=suuTC9uGLrIhttps://www.youtube.com/watch?v=7bJywbP7ZIU Applications: 1. Conservation of energy principle to Heat and Thermodynamic processes 2. Compressors, Blowers, Steam or Gas Turbines, IC engines Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/104/101104067/	
UNIT-III	
Second Law of Thermodynamics: Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Reversible and Irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles. **Entropy:** Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy. Laboratory Sessions/ Experimental learning: https://www.youtube.com/watch?v=7OJG-ZHrbD8https://www.youtube.com/watch?v=7bJywbP7ZIUhttps://www.youtube.com/watch?v=2vHLJjlinjw Applications: 1. All types of heat engine cycles including Otto, Diesel, etc 2. Refrigerators and heat pumps based on the Reversed Carnot Cycle	**10 Hrs**

3. Mixing of two fluids, heat transfer through a finite temperature difference Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/104/101104067/	
UNIT-IV	
Pure Substances & Ideal Gases: Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and HS diagrams, representation of various processes on these diagrams. **Thermodynamic relations:** Maxwell`s equations, Tds relations, ratio of heat capacities, evaluation of thermodynamic properties from an equation of state Laboratory Sessions/ Experimental learning: https://www.youtube.com/watch?v=Juz9pVVsmQQhttps://www.youtube.com/watch?v=L1AHGHRvv9s Applications: Working fluids and its properties, in power plants for power generations. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/104/101104067/	**10 Hrs**
UNIT-V	
Gas Cycles: Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency, Numerical **vapour power cycle:** Carnot vapour power cycle, simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle. Laboratory Sessions/ Experimental learning: To determine the unknown area of a given drawing using planimeter to calculate the thermal efficiency of Petrol cycle. To calculate the thermal efficiency of Diesel cycle. Applications:	**10 Hrs**

IC engines, Gas turbine engines etc.. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/104/101104067/	

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the concepts of thermodynamics in various engineering problems.
CO2	Differentiate thermodynamic work and heat and apply I law of thermodynamics to different process
CO3	Differentiate thermodynamic work and heat and apply II law of thermodynamics to different process
CO4	Apply the concepts of Pure Substances & Ideal Gases
CO5	Apply the principles of various gas cycles

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

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	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		
ELEMENTS OF AERONAUTICS		
Course Code:	**MVJ21AE33**	**CIE Marks:100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 40L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To know the history and basic principle of aviation	
2	To understand the foundation of flight, aircraft structures, material aircraft propulsion	
3	To develop an understanding stability of an aircraft along with its different systems	

UNIT-I	
Introduction to Aircrafts History of aviation; Atmosphere and its properties; Classification of aircrafts; Basic components of an aircraft; structural members; aircraft axis system; aircraft motions; control surfaces and high lift devices; classification of aircraft; conventional design configurations; principle of operation of each major part; Helicopters, their parts and functions. **Aircraft Structures and Materials:** Introduction; general types of construction; monocoque, semi-monocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application. Laboratory Sessions/ Experimental learning: Visualization of structural members of a wing in Structural Lab Applications: Identify and describe various components of an aircraft. Video link 1. https://nptel.ac.in/courses/101/101/101101079/	**8 Hrs**
UNIT-II	
Basic principles of flight – significance of speed of sound; airspeed and groundspeed; standard atmosphere; Bernoulli's theorem and its application for generation of lift and measurement of airspeed; forces over wing section, aerofoil nomenclature, pressure distribution over a wing section. Lift and drag components – generation of lift and drag; lift curve, drag curve, types of drag, factors affecting lift and drag; centre of pressure and its significance;	**8 Hrs**

aerodynamic centre, aspect ratio, Mach number and supersonic flight effects; simple problems on lift and drag. Laboratory Sessions/ Experimental learning: Visualization of airfoil cross-section in Aerodynamics Lab Applications: Understand and explain lift production theories for 2-D and their extension to 3-D Video link: https://nptel.ac.in/courses/101/101/101101079/ https://nptel.ac.in/courses/101/101/101101079/	
UNIT-III	
Aircraft Propulsion: Aircraft power plants, classification based on power plant and location and principle of operation. Turboprop, turbojet and turbofan engines; ramjets and scramjets; performance characteristics. Aircraft power plants – basic principles of piston, turboprop and jet engines; Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation. Laboratory Sessions/ Experimental learning: Visualization of engines in Propulsion Lab Applications: Understand various configurations layouts, power-plant options available. Video link: https://nptel.ac.in/courses/101/101/101101079/ https://nptel.ac.in/courses/101/101/101101079/	**8 Hrs**
UNIT-IV	
Aircraft Stability : Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Effect of flaps and stats on lift, control tabs,stalling, gliding, landing, turning, aircraft maneuvers; stalling, gliding, turning. Simple problems on these. Performance of aircraft – power curves, maximum and minimum speeds for horizontal flight at a given altitude; effect of changes in engine power and altitude on performance; correct and incorrect angles of bank; aerobatics, inverted manoeuvre, manoeuvrability. Simple problems.	**8 Hrs**

Laboratory Sessions/ Experimental learning: Creating paper planes to have hands on experience of understanding the concepts Applications: Identify the required performance characteristics of different class of aircraft Video link: https://nptel.ac.in/courses/101/101/101101079/ https://nptel.ac.in/courses/101/101/101101079/	
UNIT-V	
Aircraft Systems: Mechanical systems and their components; hydraulic and pneumatic systems; oxygen System; environmental Control System; fuel system. Electrical systems, flight deck and cockpit systems; navigation system, communication system. **Aircraft systems (Mechanical)** – hydraulic and pneumatic systems and their applications; environment control system; fuel system, oxygen system. **Aircraft systems (Electrical)** – flight control system, cockpit instrumentation and displays; communication systems; navigation systems; power generation systems – engine driven alternators, auxiliary power Module, ram air turbine; power conversion, distribution and management. Applications:Identify the main components, subsystems of aircraft and their functionality and various flight control systems, fuel and hydraulic control systems Video link: https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraftsystems-engineering-fall-2005/video-lectures/lecture-7/	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Appreciate and apply the basic principle of aviation.
CO2	Apply the concepts of fundamentals of flight, basics of aircraft structures.
CO3	Aircraft propulsion and aircraft materials during the development of an aircraft.
CO4	Understand the basic concepts of aircraft stability and control
CO5	Understand and Comprehend the complexities involved during development of flight vehicles

Reference Books	
1.	John D. Anderson, Introduction to Flight, McGraw-Hill Education, 2011. ISBN 9780071086059.
2.	Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books, 2006, ISBN: 706.
3.	A.C. Kermode, Flight without formulae, Pearson Education India, 1989. ISBN: 9788131713891.
4.	Nelson R.C., Flight stability and automatic control, McGraw-Hill International Editions, 1998. ISBN 9780071158381

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: III		
MECHANICS OF MATERIALS + MATERIAL TESTING LAB (Theory and Practice)		
Course Code:	**MVJ21AE34/ MVJ21AS34**	**CIE Marks:50+50**
Credits: 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), Stressstrain	**10 Hrs**

curves for brittle and ductile materials, Allowable stress, Material selection for structural performance. **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. Laboratory Sessions/ Experimental learning: UTM in Material Testing Lab Applications: Testing of Mild steel components, Bricks Video link / Additional online information (related to module if any): Prof.Dr.Suraj Prakash Harsha,Indian Institute of Technology, Roorkee. Lecture – 12 for Ductile and Brittle Materials	
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. **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). Laboratory Sessions/ Experimental learning: Different load conditions can be practiced in Structures Lab Applications: Civil Construction with Symmetrical I & T sections Video link / Additional online information (related to module if any): Prof: S .K.Bhattacharya, IIT, Kharagpur, Lecture no 24. Bending of Beams- III	**10 Hrs**
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. **Torsion of Circular Shafts and Elastic Stability of Columns:** Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts. Laboratory Sessions/ Experimental learning: Beam Expt in Structures lab and Torsion Test apparatus available in MT Lab. Applications: Civil Construction and Automobile Transmission. Video link / Additional online information (related to module if any): Prof. S. K. Bhattacharyya Indian Institute of Technology, Kharagpur Lecture - 33 Deflection of Beams – IV Prof. S. K. Bhattacharya Dept. of Civil Engineering I.I.T Kharagpur Lecturer#20 Torsion-III	**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. Energy methods: Conservative forces, Principle of minimum total potential energy, Strain energy in springs, Strain energy in beams, Strain energy in solids, Applications to trusses, Development of a finite element formulation for trusses, Principle of minimum complementary, Energy theorems, Reciprocity theorems, Saint-Venant's principle Laboratory Sessions/ Experimental learning: Few of the Energy Method Theorems can be explained from Structures Lab. Applications: Virtual work arises in the application of the principle of least action to the study of forces and movement of a mechanical system. Video link / Additional online information (related to module if any): Energy Methods in Structural Analysis Version 2 CE IIT, Kharagpur	**10 Hrs**

UNIT-V	
Mechanical Properties of materials: **Fracture**: Type I, Type II and Type III. **Creep**: Description of the phenomenon with examples. Three stages of creep, creep properties, stress relaxation. **Fatigue**: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram. Laboratory Sessions/ Experimental learning: Impact Tests in MT lab for Fracture. Applications: Boilers, Rotating Machine Elements Video link / Additional online information (related to module if any): Creep Deformation of Materials Dr.SrikantGollapudi Indian Institute of Technology, Bhubaneswar Prof.K.Gopinath&Prof.M.M.Mayuram, Machine Design II, Indian Institute of Technology Madras	**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	
CO1	Apply the basic concepts of strength of materials.
CO2	Compute stress, strain under different loadings.
CO3	Acquire the knowledge of deflection of beams
CO4	Acquire the knowledge of virtual work principle and energy methods
CO5	Identify different failures
CO6	Examine the relations among materials properties.
CO7	Apply the knowledge of metallographic testing in aircraft materials.

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

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 + FLUID MECHANICS LAB (Theory and Practice)		
Course Code:	**MVJ21AE35/ MVJ21AS35**	**CIE Marks:50+50**
Credits: 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	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: Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids. **Fluid Statics:** Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples. Laboratory Sessions/ Experimental learning: Use of piezometer and manometers	**10 Hrs**

Applications: For pressure measurements by using different types of manometers. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/103/101103004/	
UNIT-II	
Fluids in motion: Methods of describing fluid motion, types of fluid flow, continuity equation in 3 dimensions, velocity potential function and stream function. Types of motion, Source sink, doublet, plotting of stream lines and potential lines Numerical problems. **Fluid Kinematics:** Kinematics of fluid motion and the constitutive equations, Integral (global) form of conservation equations (mass, momentum, energy) and applications, Differential form of conservation equations (continuity, Navier-Stokes equations, energy equation). Laboratory Sessions/ Experimental learning: An experimental study of the continuity equation and Bernoulli's equation by using Venturimeter, Orificemeter and pitot tube. Applications: For rotational and irrotational fluid flows, laminar and turbulent fluid flows. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/103/101103004/	**10 Hrs**
UNIT-III	
Fluid Dynamics: Equations of motion: Euler's and Bernoulli's equation of motion for ideal and real fluids. Momentum equation, Fluid flow measurements. Numerical problems. **Dimensional analysis and similarity:** Dimensional homogeneity, methods of dimensional analysis, model analysis, types of similarity and similitude. Dimensionless numbers. Model laws. Numerical problems Laboratory Sessions/ Experimental learning: An experimental study of the continuity equation and Bernoulli's equation by using Venturimeter, Orificemeter and pitot tube. Applications: flow measuring devices and model studies.	**10 Hrs**

Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/103/101103004/	
UNIT-IV	
Flow past Immersed bodies: Introduction to boundary layer, boundary layer thickness, karman's integral momentum theory, drag on a flat plate for laminar and turbulent flow, Drag on immersed bodies. Expression for drag and lift. Kutta –joukowsky theorem; Fundamentals of airfoil theory Numerical problems. Laboratory Sessions/ Experimental learning: Determination of boundary layer thickness. Applications: Flow over a sloid body, separation point and Understanding of lift and drag. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/103/101103004/	**10 Hrs**
UNIT-V	
Compressible flow and Boundary Layers theory: Steady, one-dimensional gas dynamics, Propagation of pressure waves in a compressible medium, velocity of sound , Mach number, Mach cone, Stagnation properties , Bernoulli's eqn for isentropicflow, normal shock waves . Numerical Problem; Laminar and turbulent boundary layers. Laboratory Sessions/ Experimental learning: Propagation of disturbance for different Mach number Applications: Compressible flows through nozzles, diffusers, turbines etc… Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/103/101103004/	**10 Hrs**
LABORATORY EXPERIMENTS	
1.Calibration of Venturimeter.	
2.Determination of Coefficient of discharge for a small orifice by a constant head method.	
3.Determination of coefficient of friction of flow in a pipe	
4.Calibration of contracted Rectangular Notch.	

5.Verification of Bernoulli's equation.
6.Pipe friction apparatus with loss of head on pipe fittings.
7.Estimate performance of hydraulic Pumps -Single stage centrifugal pumps
8.Estimate performance of hydraulic Pumps –Multi- stage centrifugal pumps
9.Calibration of contracted V-Notch.
10.Determination of Coefficient of loss of head in a sudden contraction and friction factor.

Course Outcomes: After completing the course, the students will be able to	
CO1	Evaluate the effects of fluid properties
CO2	Estimate velocity, acceleration and stream function for an incompressible and invisid flow along with governing equations of fluid flow.
CO3	Perform dimensional analysis and apply Bernoulli's and Eulers equation for various flow situations involving venturimeter, orificemeter and pitot-tube
CO4	Calculate boundary layer thickness and drag co-efficient for laminar and turbulent flows.
CO5	Illustrate the basic concepts of compressible flows.

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

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

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

Semester: III		
Balike Kannada		
Course Code:	**MVJ21BK36**	**CIE Marks:50**
Credits: L:T:P:S: 1:0:0:0		**SEE Marks: 50**
Hours: 20L		**SEE Duration: 3 Hrs**
Course Learning Objectives: This course will enable students to understand Kannada and communicate in Kannada language		
1	Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada)	
2	Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation.	
3	Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).	
4	Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)	
5	Activities in Kannada	

UNIT-I	
Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada)	**8 Hrs**
UNIT-II	
Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation	**8 Hrs**
UNIT-III	
Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication)	**8 Hrs**
UNIT-IV	
Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)	**8 Hrs**
UNIT-V	
Activities in Kannada	**8 Hrs**

Scheme of Evaluation:

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

Semester: III		
SAMSKRUTHIKA KANNADA		
Course Code:	**MVJ21SK36**	**CIE Marks:50**
Credits: L:T:P:S: 1:0:0:0		**SEE Marks: 50**
Hours: 20L		**SEE Duration: 3 Hrs**
Course Learning Objectives: This course will enable students to understand Kannada and communicate in Kannada language		
1	Samskruthika Kannada –Parichaya (Introduction to Adalitha kannada)	
2	Kannada Kavyagala parichaya (Kannada D Ra Bendre, Siddalingaiha)	
3	Adalithdalli Kannada Padagalu (Kannada Kagunitha Balake, Patra Lekhana, Prabhandha)	
4	Kannada Computer Gnyana (Kannada Shabdha Sangraha, Computer Paribashika padagalu)	
5	Activities in Kannada.	

UNIT-I	
PÀ£ÀßqÀ ¨sÁµÉ-¸ÀAQë¥ÀÛ «ªÀgÀuÉ.	**8 Hrs**
UNIT-II	
¨sÁµÁ ¥ÀæAiÉÆÃUÀ¯ÁèUÀÄªÀ ¯ÉÆÃ¥ÀzÉÆÃµÀUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À ¤ªÁgÀuÉ.	**8 Hrs**
UNIT-III	
¯ÉÃR£À aºÉßUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À G¥ÀAiÉÆÃU.À	**8 Hrs**
UNIT-IV	
¥ÀvÀæ ªÀåªÀºÁgÀ.	**8 Hrs**
UNIT-V	
DqÀ½vÀ ¥ÀvÀæUÀ¼ÀÄ.	**8 Hrs**
UNIT-VI	
¸ÀPÁðgÀzÀ DzÉÃ±À ¥ÀvÀæUÀ¼ÀÄ	**8 Hrs**
UNIT-VII	
¸ÀAQÃ¥ÀÛ ¥Àæ§AzsÀ gÀZÀ£É, ¥Àæ§AzsÀ ªÀÄvÀÄÛ ¨sÁµÁAvÀgÀ	**8 Hrs**
UNIT-VIII	
PÀ£ÀßqÀ ±À§Ý¸ÀAUÀæºÀ	**8 Hrs**

UNIT-IX	
PÀA¥ÀÆålgï ºÁUÀÆ ªÀiÁ»w vÀAvÀæeÁÕ£À	**8 Hrs**
UNIT-X	
¥Áj¨sÁ¶PÀ DqÀ½vÀ PÀ£ÀßqÀ ¥ÀzÀUÀ¼ÀÄ ªÀÄvÀÄÛ vÁAwæPÀ/PÀA¥ÀÆålgï ¥Áj¨sÁ¶PÀ ¥ÀzÀUÀ¼ÀÄ.	**8 Hrs**

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

Semester: III		
CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW		
Course Code:	**MVJ21CPH36/46**	**CIE Marks:50**
Credits: L:T:P:S: 1:0:0:0		**SEE Marks: 50**
Hours: 20L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.	
2	To provide overall legal literacy to the young technograts to manage complex societal issues in the present scenario.	
3	To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.	

UNIT-I	
Introduction to Indian Constitution The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.	**8 Hrs**
UNIT-II	
Union Executive and State Executive Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives –	**8 Hrs**

Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.	
UNIT-III	
Elections, Amendments and Emergency Provisions Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements). Emergency Provisions, types of Emergencies and it's consequences. **Constitutional Special Provisions:** Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.	**8 Hrs**
UNIT-IV	
Professional / Engineering Ethics Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India) : Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. **Responsibilities in Engineering** - Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility.Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.	**8 Hrs**
UNIT-V	
Internet Laws, Cyber Crimes and Cyber Laws: Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.	**8 Hrs**

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

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

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (40 marks each), the final IA marks to be awarded will be the average of three tests

- Assignment (10 marks)

SEE Assessment:

i. Question paper for the SEE consists one part. It is compulsory and consists of objective type 1 mark each for total of 50 marks covering the whole syllabus.

ii. Ten questions must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping

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

CO2	1	2	2	1	1	2	1	1	1	1	1	2
CO3	2	1	2	1	1	1	1	1	1	1	1	2
CO4	2	2	1	1	1	1	1	1	1	1	1	2
CO5	2	2	1	1	1	2	1	1	1	1	1	2

High-3, Medium-2, Low-1

Semester: III		
AEROSAPCE MATERIALS		
Course Code:	**MVJ21AE37/AS37**	**CIE Marks:100**
Credits: L:T:P:S: 2:0:0:0		**SEE Marks: 100**
Hours: 22L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To impart knowledge on the basics of phase diagrams and their applications.	
2	To make the students to understand the use of non-ferrous materials in aircraft construction:	
3	To introduce various ferrous materials for aircraft construction	

UNIT-I	
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. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/103/101103004/	**8 Hrs**

https://www.youtube.com/watch?v=woNUlqu8ReE	
UNIT-II	
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. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/113/105/113105021/ https://www.intechopen.com/books/aluminium-alloys-recent-trends-in-processing-characterization-mechanical-behavior-and-applications	**7 Hrs**
UNIT-III	
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. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/113/105/113105057/ https://nptel.ac.in/courses/113/104/113104059/	**7 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the knowledge about the phase diagrams and microstructure of alloys.
CO2	Explain the applications of Non-ferrous alloys in Aircraft and Aerospace industry.
CO3	Gain knowledge about the application of Ferrous alloys in Aircraft construction

Reference Books	
1.	Titterton G F, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition, 1998, ISBN-13: 978-8175980136

2.	Introduction to Physical Metallurgy by Sydney Avner, Tata McGraw-Hill Edition 1997.
3.	Hill E T, The Materials of Aircraft Construction, Pitman London.
4.	C G Krishnadas Nair, Handbook of Aircraft materials, Interline publishers, Bangalore, 1993

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	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

High-3, Medium-2, Low-1

Semester: III		
Diploma Mathematics-I		
Course Code:	**MVJ21MATDIP31**	**CIE Marks:100**
Credits: L:T:P:S: 1:2:0:0		**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. Video Link: https://users.math.msu.edu/users/gnagy/teaching/ode.pdf	**8 Hrs**
UNIT-II	
Integral Calculus: Review of elementary Integral calculus, Reduction formula $\int_0^{\frac{\pi}{2}} sin^m x\, dx$, $\int_0^{\frac{\pi}{2}} cos^m x\, dx$, $\int_0^{\frac{\pi}{2}} sin^m cos^n x\, dx$ and problems. Evaluation of double and triple integrals and Simples Problems. Video Link: https://www.youtube.com/watch?v=rCWOdfQ3cwQ	**8 Hrs**

https://nptel.ac.in/courses/111/105/111105122/	
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). Video Link: https://www.whitman.edu/mathematics/calculus_online/chapter16.html https://www.math.ust.hk/~machas/vector-calculus-for-engineers.pdf	**8 Hrs**
UNIT-IV	
Probability: Introduction-Conditional Probability, Multiplication theorem ,Independent events ,Baye's theorem and Problems. Video Link: https://www.khanacademy.org/math/statistics-probability/probability-library https://nptel.ac.in/courses/111/105/111105041/	**8 Hrs**
UNIT-V	
Differential equation: Homogenous differential equation, Linear differential equation, Bernoulli's differential equation and Exact differential equation. Video Link: https://www.mathsisfun.com/calculus/differential-equations.html	**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.

Reference 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.
3.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10th edition,2014.
4.	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:	**MVJ21MAE41/MAS41/MME41**	**CIE Marks:100**
Credits: L:T:P:S: 2:2:0:0		**SEE Marks: 100**
Hours: 30L+26T		**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: Functions of complex variables, Analytic function, Cauchy-Riemann Equations in Cartesian and polar coordinates, Consequences of Cauchy-Riemann Equations, Construction of analytic functions (Using Milne-Thomson method). **Transformations:** Bilinear Transformation, Conformal transformation, Discussion of the transformations $w = z^2$, $w = e^z$ and $w = z + \frac{a}{z}, (z \neq 0)$. **Video Link:** https://www.youtube.com/watch?v=oiK4gTgncww https://www.youtube.com/watch?v=WJOf4PfoHow	**10 Hrs**
UNIT-II	
Complex variables-2: Complex integration - Cauchy theorem, Cauchy's Integral Theorem-Problems, Taylor & Laurent series- Problems, Singularities, Types of Singularities, Poles,	**10 Hrs**

Residues-definitions, Cauchy residue theorem - Problems. **Video Link:** https://math.mit.edu/~jorloff/18.04/notes/topic4.pdf https://math.mit.edu/~jorloff/18.04/notes/topic10.pdf	
UNIT-III	
Numerical methods-1: Numerical solution of Ordinary Differential Equations of first order and first degree, Taylor's series method, Modified Euler's method, Runge-Kutta method of fourth order, Milne's and Adam-Bashforth Predictor and Corrector method. **Video Link:** https://youtu.be/b5VUnapu-qs http://www.nptelvideos.in/	**10 Hrs**
UNIT-IV	
Numerical methods-2: Numerical solution of Ordinary Differential Equations of second order: Runge-Kutta method of fourth order, Milne's Predictor and Corrector method. **Calculus of variations:** Variation of function and Functional, variational problems, Euler's equation, Geodesics. **Applications** : Hanging Chain problem. **Video Link:** https://www.khanacademy.org/ http://www.nptelvideos.in/	**10 Hrs**
UNIT-V	
Numerical methods-3: Numerical solution of Partial Differential Equations: Introduction, Finite difference approximations to derivatives, Numerical Solution of Laplace Equation, Numerical solution of one-dimensional heat equation by Bender - Schmidt's method and by Crank-Nicholson Method, Numerical solution of one-dimensional wave equation. Video Links: https://youtu.be/nNnnBMF03lI	**10 Hrs**

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

Reference 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.
3.	B.V.Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill, 2006
4.	N.P. Bali & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition.
5.	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:	**MVJ21AE42/AS42**	**CIE Marks:100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 40L		**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 Continuity, momentum and energy equation, Control volume approach to Continuity, momentum and energy equation, Types of flow, pathlines, streamlines, and streaklines, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes. Vorticity, Angular velocity, Stream function, velocity potential function, Circulation, Numericals, Mach cone and Mach angle, Speed of sound. Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds Applications: provides a proper understanding of the flow properties and their characteristics features which helps in the study of flow over airfoils Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101105059/	**10 Hrs**
UNIT-II	
Airfoil Characteristics Fundamental aerodynamic variables, Airfoil nomenclature, airfoil characteristics. wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, aerodynamic center, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. Types of drag-Definitions. Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds Applications: understand the characteristics and the distribution of pressure over the airfoil Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101105059/	**10 Hrs**
UNIT-III	

Two Dimensional Flows & Incompressible Flow Over Airfoil Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D'Alembert's paradox, Numericals,Incompressible flow over airfoils: Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. KuttaJoukowski theorem. and generation of Lift, Numerical. Laboratory Sessions/ Experimental learning: Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey. Applications: study the lifting and non lifting flows over cylinders and arbitrary bodies and understanding the theory behind lift generation Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101105059/	**10 Hrs**
UNIT-IV	
IncompressibleFlowOverFiniteWings Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory:Downwash and induced drag. Elliptical and modified elliptical lift distribution.Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory-lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane Laboratory Sessions/ Experimental learning: Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag. Applications: understanding the theory of lift generation over finite wings and their flow patterns Video link / Additional online information (related to module if any): http://web.iaa.ncku.edu.tw/~aeromems/Aerodynamics/Ch5.pdf	**10 Hrs**
UNIT-V	
Applications of Finite Wing Theory & High Lift Systems Simplified horse-shoe vortex model, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, and typical aerodynamic characteristics. Introduction to high-lift systems, flaps,	**10 Hrs**

leading-edge slats and typical high – lift characteristics. Effects of thickness, camber and aspect ratio of wings, tip effects. Introduction to Source panel & vortex lattice method Laboratory Sessions/ Experimental learning: Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various angles of incidence, speed. Applications: study the typical aerodynamics characteristics of swept wings and different types of high lift devices Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/106/101106035/	

Course Outcomes: After completing the course, the students will be able to	
CO1	Describe the fundamental equations of continuity, momentum & energy of fluid flow.
CO2	Evaluate typical airfoil characteristics and two-dimensional flows over airfoil
CO3	Analyze the incompressible flow over airfoil
CO4	Compute and analyze the incompressible flow over finite wings
CO5	Apply finite wing theory and analyze high lift systems

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

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	11
CO2	3	3	2	3	0	1	1	0	1	1	0	1
CO3	3	3	3	3	1	1	1	0	1	1	0	1
CO4	3	3	3	3	1	1	1	0	1	1	0	1
CO5	3	3	3	2	1	1	1	0	1	1	0	1

High-3, Medium-2, Low-1

Semester: IV		
FINITE ELEMENT METHODS		
Course Code:	**MVJ21AE53/AS43**	**CIE Marks:100**
Credits: L:T:P:S: 2:2:0:0		**SEE Marks: 100**
Hours: 30L+26T		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the importance of discretization of domain using different finite elements.	
2	Acquire the knowledge of different loading and boundary conditions.	
3	Understand the governing methods of finite element analysis.	
4	Comprehend the higher order discretization.	
5	Gain the knowledge offield problems.	

UNIT-I	
Introduction: Basic Concepts, Background Review: Introduction,Stresses and Equilibrium, Plane stress, Plane strain, Boundary Conditions, Strain-Displacement Relations, simple elements for the FEM, Potential Energy and Equilibrium, The Rayleigh-Ritz Method, Galerkin's Method, Saint Venant's Principle, Von Mises Stress, Finite Element Modeling, node, element, Coordinates and Shape Functions, Element Stiffness Matrix and assembly, Properties of K, Use of local and natural coordinates, compatibility, and convergence requirements of shape functions. **Laboratory Sessions/ Experimental learning:**2D plane stress analysis using ANSYS **Applications:** 1. Solving practical technical problems using scientific and mathematical tools, 2. Calculating the global stiffness matrix in the finite element method **Video link / Additional online information** 1. https://nptel.ac.in/courses/112/104/112104193/ 2. https://nptel.ac.in/courses/112/104/112104116/	**10 Hrs**

https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/	
UNIT-II	
Analysis of bars, truss, frames, and beams: Construction of shape functions for bar element and beam element, Plane trusses, Three-Dimensional trusses, Three-dimensional Frames Construction of shape functions for bar element and beam element, Bar elements, uniform bar elements, uniform section, mechanical and thermal loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary **Laboratory Sessions/ Experimental learning:**To determine maximum deflection and bending stress for given cantilever beam using ANSYS **Applications:** 1. 2D and 3 D elements to apply boundary conditions, 2. The direct stiffness method to compute degrees of freedom at the element nodes. 3. To determine the value of state variable at any point of element based on values of state variable. **Video link / Additional online information** 1. https://nptel.ac.in/courses/112/104/112104193/ 2. https://nptel.ac.in/courses/112/104/112104116/ https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/	**10 Hrs**
UNIT-III	
Analysis of Two- and Three-dimensional Elements: Shape functions of Triangular, Rectangular and Quadrilateral elements, different types of higher order elements, constant and linear strain triangular elements, stiffness matrix Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family. Numerical **Laboratory Sessions/ Experimental learning:**Analysis of CST Element by using ANSYS **Applications:**	**10 Hrs**

To approximate the *shape* of the object and to compute the displacement of points inside the boundary of the object **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/104/112104193/ 2. https://nptel.ac.in/courses/112/104/112104116/ https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/	
UNIT-IV	
Theory of Isoparametric Elements and Axisymmetric: Isoparametric, sub parametric and super-parametric elements, characteristics of Isoparametric quadrilateral elements, structure of computer program for FEM analysis, description of different modules, pre and post processing, Axisymmetric formulation finite element modeling of triangular and quadrilateral element. Numerical **Laboratory Sessions/ Experimental learning:**Analysis of Long Cylinder (Axiymmetric Problem) using Quadrilateral Elements in ANSYS **Applications:** 1. To create shape functions that would ensure the compatibility of the displacement between neighbouringelements while maintaining the requirements for shape functions 2. Higher-order approximation of the unknown function over a bounding surface described by non-planar elements. **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/104/112104193/ 2. https://nptel.ac.in/courses/112/104/112104116/ 3. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/	**10 Hrs**
UNIT-V	
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	**10 Hrs**

Laboratory Sessions/ Experimental learning: Performing Heat Transfer Analysis Using ANSYS **Applications:** 1. Problem involving heat flow 2. Structural dynamics **Video link / Additional online information:** 1. https://nptel.ac.in/courses/112/104/112104193/ 2. https://nptel.ac.in/courses/112/104/112104116/ https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/study-materials/	

Course Outcomes: After completing the course, the students will be able to	
CO202.1	Apply discretization technique for domain using different finite elements
CO202.2	Evaluate the effects of different loading and boundary conditions
CO202.3	Analyse the governing equations of finite element analysis
CO202.4	Formulating mathematical model using higher order element type
CO202.5	Analyse heat flow problem by considering dynamic consideration

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

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	1	1	2	1	1	1	2	2	1	2
CO2	3	3	2	2	2	1	1	1	2	2	1	2
CO3	3	3	2	2	2	1	1	1	2	2	1	2

MECHANISM AND MACHINE THEORY + MACHINE SHOP AND MMM LAB (Theory and Practice)		
Course Code:	**MVJ21AE44/MVJ21AS44**	**CIE Marks:50+50**
Credits: L:T:P: 3:0:1		**SEE Marks: 50 +50**
Hours:40 L+ 26 P		**SEE Duration: 03+03 Hours**
Course Learning Objectives: The students will be able to		

1	Understand the theory of mechanisms including velocity, acceleration and static force analysis.
2	Acquire knowledge of spur gears, gear train, balancing of rotating and reciprocating masses.
3	Understand the concept of governors and gyroscope.
4	Learn the concepts of mechanical measurements and metrology
5	Acquire the knowledge of basic metrological instruments

UNIT-I	
Introduction to Mechanisms: Types of constrained motion, Link and its types, joints and its types, kinematic pair and its types, degrees of freedom, Grubler's criterion, Types of kinematic chains and inversions: Inversions of Four bar chain: Beam engine, coupling rod of a locomotive, Watt's indicator mechanism. Inversions of Single Slider Crank Chain: Pendulum pump or Bull engine, Oscillating cylinder engine, Rotary internal combustion engine, Crank and slotted lever quick return motion mechanism, Whitworth quick return motion mechanism. Inversions of Double Slider Crank Chain: Elliptical trammels, Scotch yoke mechanism, Oldham's coupling. Straight line motion mechanisms: Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism and Ratchet and Pawl mechanism, Ackerman steering gear mechanism. Laboratory Sessions/ Experimental learning: Whitworth quick return motion mechanism. (Machine Shop) Applications: Ackerman steering gear mechanism. Video link / Additional online information: https://www.youtube.com/watch?v=g8uqeru2LQw	**10 Hrs**
UNIT-II	
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:	**10 Hrs**

Introduction: Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction Video link / Additional online information: https://www.youtube.com/watch?v=CTcdQzH5e04	
UNIT-III	
Spur Gears and Gear Trains Spur Gears: Gear terminology, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear, Interference in involute gears, Methods of avoiding interference. Gear Trains: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains. Applications: Design Of spur Gear Video link / Additional online information: https://www.youtube.com/watch?v=N0hTFnvIE7A	**10 Hrs**
UNIT-IV	
Balancing of Rotating and Reciprocating Masses Balancing of Rotating Masses: Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes (only Graphical Methods). Balancing of Reciprocating Masses: Primary and Secondary Unbalanced Forces of Reciprocating Masses, Partial Balancing of Unbalanced Primary Force in a Reciprocating Engine, Balancing of Primary and secondary Forces of Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods) Video link / Additional online information: https://www.youtube.com/watch?v=N0hTFnvIE7A	**10 Hrs**
UNIT-V	
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 Laboratory Sessions/ Experimental learning: Porter and Hartnell governors	**10 Hrs**

(Design lab) Applications:: Working Of Governors Links https://www.youtube.com/watch?v=FydJu1A1oeM	

LABORATORY EXPERIMENTS
1.Machining and machining time estimation for plain turning and step turning & taper turning.
2.Machining and machining time estimation for drilling, boring and knurling operation
3.Machining and machining time estimation for thread cutting
4.Cutting of gear teeth using milling machine
5.Calibration of Pressure Gauge and Thermocouple
6.Calibration of Load Cell and LVDT
7.Calibration of micrometer using slip gauges.
8.Measurements of angle using: a. Sine Centre b. Sine Bar c. Bevel protractor
9.Machining of hexagon in shaping machine
10.Measurements of alignment using Autocollimator

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the theory of velocity, acceleration and static force analysis to design of mechanisms.
CO2	Analyze static and dynamic force analysis of mechanisms.
CO3	Design of spur gears & Gear train.

CO4	Evaluate spur gears, gear train, balancing of rotating and reciprocating masses.
CO5	Analyse governors and gyroscope
CO6	Use different measuring tools related to experiments
CO7	Conduct, Analyse, interpret, and present measurement data from measurements Identify, define, and explain accuracy, precision, and some additional terminology

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

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	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: IV		
FUNDAMENTALS OF AIRCRAFT STRUCTURES + CAAD LAB (Theory and Practice)		
Course Code:	**MVJ21AE45**	**CIE Marks:50+50**
Credits: 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 stress strain and understand the different failure theories and to learn the concept of static strength	
2	Illustrate the methods to design a structure against impact and fatigue loads.	
3	Acquire the knowledge of types of loads on aerospace vehicles.	
4	Understand the theory of elasticity.	
5	Apply different Energy methods in calculations related to structural components and to understand the different methods to analyse columns	

UNIT-I	
Design for Static Strength: Introduction: Normal, shear, biaxial and tri-axial stresses, Stress tensor, Principal Stresses, Stress Analysis, Design considerations, Codes and Standards. Static Strength: Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, and Distortion energy theory, failure of brittle and ductile materials, Stress concentration, and Determination of Stress concentration factor. Laboratory Sessions/ Experimental learning: 1. Determination of Stress concentration factor for static load. 2. Determine the strain in x-y-z directions using strain gauge for a given beam Applications: Stress Analysis, Theory of failures	**10 Hrs**

Video link / Additional online information (related to module if any): https://www.youtube.com/watch?v=NnvImUMfYyc	
UNIT-II	
Design for Impact and Fatigue Strength: Impact Strength: Introduction, Impact stresses due to axial, bending and torsional loads, effect of inertia. Fatigue Strength: Introduction, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, modifying factors: size effect, surface effect, Stress concentration effects, Fluctuating stresses, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage. Laboratory Sessions/ Experimental learning: 1. Determine the notch sensitivity and impact toughness of engineering materials**.** 2. Demonstrate how fatigue tests are conducted and how to interpret results Applications: Fatigue Testing, Combined Loading Video link / Additional online information (related to module if any): https://www.youtube.com/watch?v=ZsIwEp574ho https://www.youtube.com/watch?v=X-_qUQ3xaTA	**10 Hrs**
UNIT-III	
Loads on Aircraft and Spacecrafts: Structural nomenclature, Types of loads, load factor, Aerodynamic loads, Symmetric manoeuvre loads, Velocity diagram, Function of structural components. **Spacecraft Structures:** StaticallyDeterminate and Indeterminate structures, Analysis of plane truss, Method of joints, 3D Truss, Plane frames, Composite beam, Clapeyron's Three Moment Equation. Laboratory Sessions/ Experimental learning: 1. Determination of Deflection in a beam by applying point load and combined loading. 2. Determine the deflection of composite beam Applications: Analysis of Loads, Determinate and Indeterminate structures. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/105105166/https://www.youtube.com/watch?v=q0_piF4-eNc	**10 Hrs**
UNIT-IV	

Theory of Elasticity: Theory of Elasticity: Concept of stress and strain, derivation of Equilibrium equations, strain displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity. Principle Stresses and Orientation of Principle Directions. **Columns**: Columns with various end conditions, Euler's Column curve, Rankine's formula, Column with initial curvature, Eccentric loading, southwell plot, Beam-column. Laboratory Sessions/ Experimental learning: 1. Determine the Spring Stiffness for the given spring. 2. Buckling load of slender Eccentric Columns and Construction of Southwell Plot Applications: Stress and Strain displacement, Columns Video link / Additional online information (related to module if any): http://www.digimat.in/nptel/courses/video/112101095/L02.htmlhttps://www.digimat.in/nptel/courses/video/105105177/L01.html	**10 Hrs**
UNIT-V	
Energy Methods: Strain Energy due to axial, bending and Torsional loads. Castigliano's theorem, Maxwell's Reciprocal theorem. **Introduction to Shear Flow:** Symmetrical and Unsymmetrical bendingConcept of shear flow – The shear centre and its determination – Shear flow distribution in symmetrical and unsymmetrical thin-walled sections. Laboratory Sessions/ Experimental learning: 1. Verify Maxwell's Reciprocal theorem 2. Determining of Shear centre location for open sections-unsymmetrical bending Applications: Maxwell's Theorem, Shear Flow and Shear Center Video link / Additional online information (related to module if any): https://www.youtube.com/watch?v=149j7Ys0F58http://www.nptelvideos.com/video.php?id=1637	**10 Hrs**
LABORATORY EXPERIMENTS	
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.	

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.

Laboratory Sessions/ Experimental learning: CAAD Lab

Applications: Helps to understand Engineering Drawing.

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

https://www.youtube.com/watch?v=f1Hdtf_iAWk

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

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

Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover strap.

https://www.youtube.com/watch?v=70hESLwUhME

https://www.youtube.com/watch?v=Gdvtw0pTAOs

Part C - Assembly Drawings

1. Modeling of propeller and hub assembly
2. Modeling of wing assembly
3. Modeling of fuselage assembly
4. Modeling of Engine Mounts
5. Modeling of Landing Gear Assembly

Laboratory Sessions/ Experimental learning: CAAD Lab Applications: To Design an Aircraft Model.

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

https://www.youtube.com/watch?v=rmlUXhvJHt0

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

CO1	Apply the different failure theories to understand the concept of static strength.
CO2	Design a structure against fatigue loads and to design a material for impact load.
CO3	Analyze various loads experienced by an aircraft in flight and to understand the usage of different materials.
CO4	Assess compatibility conditions and boundary conditions to find the stress and strain of an elastic material.
CO5	Formulate different Energy methods in calculations related to structural components and to understand the different methods to analyse columns.
CO6	Distinguish drawings of machine and aircraft components
CO7	Identify assembly drawings either manually or by using standard CAD packages.

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

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

High-3, Medium-2, Low-1

Semester: III		
Balike Kannada		
Course Code:	**MVJ21BK36**	**CIE Marks:50**
Credits: L:T:P:S: 1:0:0:0		**SEE Marks: 50**
Hours: 20L		**SEE Duration: 3 Hrs**
Course Learning Objectives: This course will enable students to understand Kannada and communicate in Kannada language		
1	Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada)	
2	Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation.	
3	Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication).	
4	Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)	
5	Activities in Kannada	

UNIT-I	
Vyavharika Kannada –Parichaya (Introduction to Vyavharikakannada)	**8 Hrs**
UNIT-II	
Kannada Aksharamaalehaaguuchcharane(Kannada Alphabets and Pronounciation	**8 Hrs**
UNIT-III	
Sambhashanegaagi Kannada Padagalu (Kannada Vocubulary for Communication)	**8 Hrs**

UNIT-IV	
Kannada Grammer in Conversations(Sambhasaneyalli Kannada Vyakarana)	**8 Hrs**
UNIT-V	
Activities in Kannada	**8 Hrs**

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

Semester: III		
SAMSKRUTHIKA KANNADA		
Course Code:	**MVJ21SK36**	**CIE Marks:50**
Credits: L:T:P:S: 1:0:0:0		**SEE Marks: 50**
Hours: 20L		**SEE Duration: 3 Hrs**
Course Learning Objectives: This course will enable students to understand Kannada and communicate in Kannada language		
1	Samskruthika Kannada –Parichaya (Introduction to Adalitha kannada)	
2	Kannada Kavyagala parichaya (Kannada D Ra Bendre, Siddalingaiha)	

3	Adalithdalli Kannada Padagalu (Kannada Kagunitha Balake, Patra Lekhana, Prabhandha)
4	Kannada Computer Gnyana (Kannada Shabdha Sangraha, Computer Paribashika padagalu)
5	Activities in Kannada.

UNIT-I	
PÀ£ÀßqÀ ¨sÁµÉ-¸ÀAQë¥ÀÛ «ªÀgÀuÉ.	**8 Hrs**
UNIT-II	
¨sÁµÁ ¥ÀæAiÉÆÃUÀ¯ÁèUÀÄªÀ ¯ÉÆÃ¥ÀzÉÆÃµÀUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À ¤ªÁgÀuÉ.	**8 Hrs**
UNIT-III	
¯ÉÃR£À aºÉßUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À G¥ÀAiÉÆÃU.À	**8 Hrs**
UNIT-IV	
¥ÀvÀæ ªÀåªÀºÁgÀ.	**8 Hrs**
UNIT-V	
DqÀ½vÀ ¥ÀvÀæUÀ¼ÀÄ.	**8 Hrs**
UNIT-VI	
¸ÀPÁðgÀzÀ DzÉÃ±À ¥ÀvÀæUÀ¼ÀÄ	**8 Hrs**
UNIT-VII	
¸ÀAQÃ¥ÀÛ ¥Àæ§AzsÀ gÀZÀ£É, ¥Àæ§AzsÀ ªÀÄvÀÄÛ ¨sÁµÁAvÀgÀ	**8 Hrs**
UNIT-VIII	
PÀ£ÀßqÀ ±À§Ý¸ÀAUÀæºÀ	**8 Hrs**
UNIT-IX	
PÀA¥ÀÆålgï ºÁUÀÆ ªÀiÁ»w vÀAvÀæeÁÕ£À	**8 Hrs**
UNIT-X	
¥Áj¨sÁ¶PÀ DqÀ½vÀ PÀ£ÀßqÀ ¥ÀzÀUÀ¼ÀÄ ªÀÄvÀÄÛ vÁAwæPÀ/PÀA¥ÀÆålgï ¥Áj¨sÁ¶PÀ ¥ÀzÀUÀ¼ÀÄ.	**8 Hrs**

Scheme of Evaluation:	
Details	**Marks**

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

Semester: IV		
CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW		
Course Code:	**MVJ21CPH36/46**	**CIE Marks:50**
Credits: L:T:P:S: 1:0:0:0		**SEE Marks: 50**
Hours: 20L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To know the fundamental political codes, structure, procedures, powers, and duties of Indian constitution, Indian government institutions, fundamental rights, directive principles and the duties of the citizens.	
2	To provide overall legal literacy to the young technograts to manage complex societal issues in the present scenario.	
3	To understand engineering ethics & their responsibilities, identify their individual roles and ethical responsibilities towards society.	

UNIT-I	
Introduction to Indian Constitution The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian Constitution, The Making of the Constitution, The role of the Constituent Assembly – Preamble and Salient features of the	**8 Hrs**

Constitution of India. Fundamental Rights and its Restriction and Limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and Significance in Nation Building.	
UNIT-II	
Union Executive and State Executive Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Article 370, 371, 371J) for some States.	**8 Hrs**
UNIT-III	
Elections, Amendments and Emergency Provisions Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44,61,73,74,75,86, and 91,94,95,100,101,118 and some important Case Studies. Recent Amendments with explanation. Important Judgements with Explanation and its impact on society (from the list of Supreme Court Judgements). Emergency Provisions, types of Emergencies and it's consequences. **Constitutional Special Provisions:** Special Constitutional Provisions for SC & ST, OBC, Special Provision for Women, Children & Backward Classes.	**8 Hrs**
UNIT-IV	
Professional / Engineering Ethics Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India) : Profession, Professionalism, Professional Responsibility. Clash of Ethics, Conflicts of Interest. **Responsibilities in Engineering** - Responsibilities in Engineering and Engineering Standards, the	**8 Hrs**

impediments to Responsibility.Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.	
UNIT-V	
Internet Laws, Cyber Crimes and Cyber Laws: Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship, Cybercrimes and enforcement agencies.	**8 Hrs**

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

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

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (40 marks each), the final IA marks to be awarded will be the average of three tests

- Assignment (10 marks)

SEE Assessment:
i. Question paper for the SEE consists one part. It is compulsory and consists of objective type 1 mark each for total of 50 marks covering the whole syllabus. ii. Ten questions must be set from each unit. The duration of examination is 3 hours.

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

High-3, Medium-2, Low-1

Semester: IV		
TURBOMACHINES		
Course Code:	**MVJ21AEC47**	**CIE Marks:100**
Credits: L:T:P:S: 2:0:0:0		**SEE Marks: 100**
Hours: 22L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the basics of turbomachines, classification and energy transfer in turbomachines.	
2	Acquire the knowledge on analysis of centrifugal and axial compressors.	
3	Acquire the knowledge on analysis of centrifugal and axial turbines.	

UNIT-I	
Introduction and Energy transfer in turbomachines:	**8 Hrs**

Classification and parts of a turbo machines, comparison with positive displacement machines. Euler turbine equation and its alternate form; components of energy transfer; general expression for degree of reaction; construction of velocity triangles for different values of degree of reaction. **Laboratory Sessions/ Experimental learning:** Aircraft propulsion lab for acquiring knowledge of Gas turbine engine. **Applications**: Study of Turbomachines, components of gas turbine engines. **Video link / Additional online information:** https://nptel.ac.in/courses/112/106/112106200/	
UNIT-II	
Analysis of centrifugal and axial flow compressors **Centrifugal compressors:** Parts of centrifugal compressor, principle operation, energy transfer, h-s diagram, blade shapes and velocity triangles, analysis of flow through the compressor, performance parameter and characteristics, and illustrative examples **Axial compressors:** Geometry and working principle, stage velocity triangles, h-s diagram, work input, work done factor, performance coefficients degree of reaction (low, fifty percent and high), and illustrative examples. **Laboratory Sessions/ Experimental learning**: Aircraft Propulsion lab and Fluid Mechanics lab for compressor and turbines. **Applications**: Compressors and Turbines in Aircraft engines. **Video link / Additional online information**: https://nptel.ac.in/courses/101/101/101101058/ https://www.youtube.com/watch?v=oitC03G-QYE	**7 Hrs**
UNIT-III	
Analysis of centrifugal and axial flow turbines **Radial flow turbines:** Elements of radial turbine stage, stage velocity triangles, energy transfer, h-s diagram, degree of reaction, performance characteristics, outward flow radial stages, and illustrative examples.	**7 Hrs**

Axial flow turbines: Stage velocity triangles, energy transfer, h-s diagram, impulse and reaction stages (zero, fifty percent, hundred percent and negetive), performance chats, and illustrative examples. **Laboratory Sessions/ Experimental learning**: Aircraft propulsion lab and Fluid mechanics lab, **Applications:** Turbojet, turbofan, turbo shaft engines. **Video link / Additional online information**: http://www.infocobuild.com/education/audio-video-courses/aeronautics-and-astronautics/TurbomachineryAerodynamics-IIT-Bombay/lecture-22.html **https://www.youtube.com/watch?v=h4LYyUOtQow**	

Course Outcomes: After completing the course, the students will be able to	
CO1	Illustrate the classification of turbomachines and compute the energy transfer in turbomachines.
CO2	Illustrate the knowledge on centrifugal and axial flow compressors.
CO3	Illustrate the knowledge on radial and axial flow turbines.

Reference Books	
1.	S.M. Yahya, Turbines, Compressors & Fans, Tata-McGraw Hill, 2nd Edition, ISBN 13: 9780070707023.
2.	V Ganesan, Gas Turbines, Tata-McGraw Hill, 3rd Edition, ISBN 13: 9780070681927

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	1	1	1	1	1	0	1	0	0	1
CO2	3	3	3	2	1	1	1	0	1	0	0	1
CO3	3	3	3	2	1	1	1	0	1	0	0	1

High-3, Medium-2, Low-1

Semester: IV		
Diploma Mathematics-II		
Course Code:	**MVJ21MATDIP41**	**CIE Marks:100**
Credits: L:T:P:S: 1:2:0:0		**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	
Linear Algebra: Introduction, Rank of a matrix-echelon form. Solution of system of linear equations – consistency. Gauss-elimination method and problems. Eigen values and Eigen vectors of square matrix and Problems. Video Link: **https://www.math.ust.hk/~machas/matrix-algebra-for-engineers.pdf** **https://nptel.ac.in/content/storage2/courses/122104018/node18.html**	**8 Hrs**
UNIT-II	
Differential calculus: **Tangent and normal, sub tangent and subnormal both Cartesian and polar forms. Increasing and decreasing functions, Maxima and Minima for a function of one variable. Point of inflections and Problems** **Beta and Gamma functions:** **Beta functions, Properties of Beta function and Gamma function ,Relation Between beta and Gamma function-simple problems.** **Video Link:** **https://www.youtube.com/watch?v=6RwOoPN2zqE** **https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWlUqBoTCQDtYlloI-o-9hxp11** **http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx**	**8 Hrs**
UNIT-III	
Analytical solid geometry : Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two line, shortest distance between two line, plane and equation of plane in different forms and problems. Video Link: https://www.toppr.com/guides/maths/three-dimensional-geometry/	**8 Hrs**

https://www.toppr.com/guides/maths/three-dimensional-geometry/distance-between-skew-lines/	
UNIT-IV	
Probability: Random variable, Discrete probability distribution, Mean and variance of Random Variable, Theoretical distribution-Binomial distribution, Mean and variance Binomial distribution -Problems. Poisson distribution as a limiting case of Binomial distribution, Mean and variance of Poisson distribution. Normal Distribution-Basic properties of Normal distribution –standard form of normal distribution and Problems. Video Link: https://nptel.ac.in/courses/111/105/111105041/ https://www.mathsisfun.com/data/probability.html	**8 Hrs**
UNIT-V	
Partial differential equation: Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only. Video Link: http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx https://www.studyyaar.com/index.php/module-video/watch/233-cauchys-legendres-de-a-method- of- variation-of-parameters	**8 Hrs**

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

Reference 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.
3.	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition,2014.
4.	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

MVJ College of Engineering, Whitefield, Bangalore 560067

An Autonomous Institution, Affiliated to VTU, Belagavi

Scheme of Teaching and Examination

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

Effective from the academic year 2021-22

Department of Aeronautical Engineering

Semester V

Sl. No.	Course		Course Title	BoS	Teaching hrs./week				Examination				Credits
	Type	Code			Lecture L	Tutorial T	Practical P	Self-Study S	Duration Hrs.	CIE Marks	SEE Marks	Total Marks	
1	HSMC	MVJ21AE51/ MVJ21AS51	Aviation Management	AE	3	-	-	-	3	50	50	100	3
2	PCC	MVJ21AE52	Aircraft Performance	AE	3	-	-	-	3	50	50	100	3
3	IPCC	MVJ21AE53/ MVJ21AS53	Compressible Aerodynamics (+Aerodynamic Lab)	AE	3	-	2	-	3	100	100	200	4
4	IPCC	MVJ21AE54	Aircraft Propulsion (+Aircraft Propulsion Lab)	AE	3	-	2	-	3	100	100	200	4
5	PEC	MVJ21AE55X	PEC 1	AE	3	-	-	-	3	50	50	100	3
6	HSMC	MVJ21XX56	Environmental Studies	CV	1	-	-	-	2	50	50	100	1
7	AEC	MVJ21XX57	Research Methodology &IPR/Life Science AEC5	AE	1	2	-		2	50	50	100	2
8	UHV	MVJ21UHVI58	Universal Human Values	AE	2	-			3	50	50	100	2
			Total		19	2	4			500	500	1000	22

Course Code	Professional Elective-I
MVJ21AE551	Aircraft Systems and Instrumentation
MVJ21AE552/ MVJ21AS552	Theory of Vibration
MVJ21AE553	Gas Turbine Technology
MVJ21AE554/ MVJ21AS554	Optimisation Techniques and Probability Theory

Course Title	**Aviation Management**	**Semester**	V
Course Code	MVJ21AE51/ MVJ21AS51	**CIE**	50
Total No. of Contact Hours	40L: T: P::3: 1 :0	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	3	**Exam. Duration**	3 Hours

Course objective is to: This course will enable students to

- Introduce the field of management, task of the manager, importance of planning and types of planning, staff recruitment and selection process.
- Explain need of coordination between the manager and staff, the social responsibility of business and leadership.
- 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.

Web Link and Video Lectures

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

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

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

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

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

Laboratory Sessions/ Experimental learning

Case study of steel plant departmentalization.

Applications: Effective communication in a corporate.

Web Link and Video Lectures

https://nptel.ac.in/content/storage2/courses/122106031/slides/3_2s.pdf

https://www.slideshare.net/100005130728571/27-nature-of-directing

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.

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

1. https://www.youtube.com/watch?v=KEF2szWaEgg – Introduction about Aircraft Maintenance-NPTEL-IITK
2. https://www.youtube.com/watch?v=CoLWYZP9BkY&list=PLExlUJZK1IOnUv8IeOXLk_njBYhc-Xh6V –Aircraft Maintenance-NPTEL-IITK
3. https://www.youtube.com/watch?v=H45vSzyiXH4 – Airplane Maintenance

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

Aircraft Management Maintenance

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.

Laboratory Sessions/ Experimental learning: A demo on aircraft logbook.

Applications: Implement the aviation management in airlines.

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

1. https://www.youtube.com/watch?v=f6F_ecq1njc – Aviation management

https://www.youtube.com/watch?v=P7GfDmd7Nqw-Aircraft line maintenance check example

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

Maintenance Safety & Trouble shooting

Safety regulations, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, Knowledge of malfunctions.

Laboratory Sessions/ Experimental learning: A demo on safety system in wind tunnel lab.

Applications: Apply the safety regulations, OSHA safety programs and troubleshooting systems in aircraft.

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

1. https://www.youtube.com/watch?v=aRA7QR2Mr_w – Airlines safety management system
2. https://www.youtube.com/watch?v=5bc1qBtkRWA –How do Airline store aircraft?

https://www.youtube.com/watch?v=89IWlG0Uhz0 – trouble shooting procedure for the aircraft systems

Course outcomes:

CO1	Understand the concept of Management
CO2	Understand the staffing process
CO3	Apply the certification procedure for aircraft maintenance.
CO4	Apply the management system in aircraft maintenance.
CO5	Examine the quality control and calibration on Aircraft.

Reference Books:

1	StephenP.Robbins&MaryCoulter,Management‖,PrenticeHall(India)Pvt.Ltd.,10th Edition, 2009
2	Harry A Kinnison, Tariq Siddiqui, Aviation Maintenance Management, Mc Graw Hill education (India) Private Ltd, 2013.
3	Kroes, Watkins, Delp, Aircraft maintenance and repair, Mc Graw Hill,2013.
4	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.

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

High:3, Medium:2, Low:1

Course Title	**AIRCRAFT PERFORMANCE**	**Semester**	**V**
Course Code	**MVJ21AE52**	**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 Steady Unaccelerated Flight
2. Comprehend Steady Performance – Level Flight, Climb & Glide
3. Gain knowledge of Airplane Performance Parameters like Range and Endurance etc.
4. UnderstandAircraft Performance in Accelerated Flight

5. Acquire knowledge of Maneuver Performance of an Aircraft		
Module 1	**L1,L2**	10 Hrs.
The Equations of Motion in Steady Unaccelerated Flight Introduction and four forces of flight, General equations of motion, Power available and power required curves, Thrust available and thrust required curves, Conditions for power required and Thrust required minimum, Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required, Thrust available and Thrust required **Laboratory Sessions/ Experimental learning:** Estimation of Thrust and Power of an engine – Aircraft Propulsion Lab **Applications:** Introduction to Steady Unaccelerated Flight **Video link / Additional online information (related to module if any):** **https://www.youtube.com/watch?v=tEWuP1NVdgE&list=PLtUPB3SCffXP43al7ILIR5qaZF_5fEDXm**		
Module 2	**L1,L2**	10 Hrs.
Steady Performance – Level Flight, Climb & Glide **Performance**: Equations of motion for Rate of climb- graphical and analytical approach, Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach, Climb performance graph (hodograph diagram), Maximum climb angle and rate of climb, Gliding flight, Range during glide, Minimum rate of sink and shallowest angle of glide **Laboratory Sessions/ Experimental learning:** Calculation of Absolute ceiling and Service ceiling and their importance **Applications:** To understand Steady Performance of an Aircraft – Level Flight, Climb & Glide **Video link / Additional online information (related to module if any):** **https://www.youtube.com/watch?v=QXpO3WIxJx8**		
Module 3	**L1,L2**	10 Hrs.
Fundamental Airplane Performance Parameters **The fundamental parameters**: Thrust-to-Weight ratio, Wing loading, Drag polar and Lift-to-Drag ratio, Minimum velocity, Aerodynamic relations associated with lift-to-drag ratio **Range and Endurance:** **Propellerdriven Airplane**: Physical considerations, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance **Jet Airplane**: Physical considerations, Quantitative formulation, Equations for Range and Endurance, Conditions for maximum range and endurance, Effect of Head wind and Tail wind **Laboratory Sessions/ Experimental learning:**		

Determination of Range and Endurance for Propeller driven and Jet airplane

Applications: Calculation of Range and Endurance of an Aircraft

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

https://www.youtube.com/watch?v=YOTdaEeA8tM

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

Aircraft Performance in Accelerated Flight

Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear an obstacle, Balanced field length

Landing Performance and Accelerated Climb: Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, Ground effects, Acceleration in climb

Laboratory Sessions/ Experimental learning:

Assessment of Ground roll and Distance while airborne to estimate Total Take-off distance

Applications: Understanding Take-off Performance, Landing Performance and Accelerated Climb

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

https://www.youtube.com/watch?v=lzbg9t-6-gA

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

Maneuver Performance

Turning performance: Level turn, Load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate

Pull-up and Pull-down maneuvers: Turning rate, turn radius, Limiting case for large load factor, V-n diagram, Limitations of pull up and push over

Laboratory Sessions/ Experimental learning:

Study of Velocity-Load factor (V-n) Diagram for an aircraft

Applications: To understand Maneuver Performance of an Aircraft

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

https://www.youtube.com/watch?v=KNPxD7bbMP8

Course Outcomes:

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

CO402.1	Analyse Steady Unaccelerated Flight
CO402.2	Evaluate Steady Performance of an Aircraft – Level Flight, Climb & Glide
CO402.3	Analyze Range and Endurance of an Aircraft
CO402.4	Illustrate Take-off Performance, Landing Performance and Accelerated Climb
CO402.5	Compute Maneuver Performance of an Aircraft

Reference Books:	
1.	John D. Anderson, Jr,Introduction to Flightby;McGraw-Hill International, Aerospace Science/Technology Editions, 2000
2.	John D. Anderson, Jr**;**Aircraft Performance and Design by McGraw-Hill International, Aerospace Science/Technology Editions, 1999
3.	Perkins, C.D. and Hage, R.E**.;**Airplane Performance, Stability and Control by John Wiley Sons Inc, New York, 1988
4.	Barnes W. McCormick;Aerodynamics, Aeronautics and Flight Mechanics by John Wiley Sons Inc, New York, 1995

CIE Assessment:

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

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

SEE Assessment:

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

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

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

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

High:3, Medium:2, Low:1

Course Title	**Compressible Aerodynamics (+Aerodynamic Lab)**	**Semester**	**V**
Course Code	**MVJ21AE53/ MVJ21AS53**	**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:

1. Understand the concepts of compressible flow

2. Acquire knowledge of normal shock waves

3. Comprehend the phenomenon of oblique shocks and expansion waves

4.Understand the concepts of Differential Equations of Motion for Steady Compressible Flows

5. Gain knowledge of flow measurement techniques

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

One Dimensional Compressible Flow: Energy, Momentum, continuity and state equations, velocity of sound, Adiabatic steady state flow equations, Flow through converging, diverging passages, Performance under various back pressures. Numerical

Laboratory Sessions/ Experimental learning: Visualization of Flow analysis in Ansys Lab

Applications: Understanding the close coupling of thermodynamics and fluid dynamics and analyse typical aircraft systems like nozzles, diffusers, intakes

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

4. https://www.youtube.com/watch?v=mS3ZVuOn_lU&list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0&index=2
5. https://youtu.be/mS3ZVuOn_lU?list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0
6. https://youtu.be/HfZ5gfybJK4?list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0

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

Normal Shock: Prandtl Meyer equation and Rankine – Hugonoit relation, Normal shock equations: Property ratios in terms of upstream Mach number, Numericals, Moving Normal Shock wave. Shock tube.

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

Applications: Analyzing the supersonic flow problems involving normal shock waves to design and analyze aircraft systems like nozzles, diffusers, intakes, shock tubes, wind tunnels, pipe flows.

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

1. https://nptel.ac.in/courses/112/106/112106166/
2. https://nptel.ac.in/courses/101/108/101108086/#

Module 3	**L1,L2**	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

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

2. https://nptel.ac.in/courses/112/106/112106056/
3. https://nptel.ac.in/courses/112/106/112106056/
4. https://nptel.ac.in/courses/112/106/112106056/

Module 4	**L1,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

Laboratory Sessions/ Experimental learning: Flow Problems using Ansys Lab

Applications: Analyze and interpret the flow behavior

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

1. https://nptel.ac.in/courses/101/106/101106044/
2. https://nptel.ac.in/courses/112/106/112106056/

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

Measurements in High-speed Flow: Types of subsonic wind tunnels Balances and measurements - Interference effects transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance – Shock tubes and shock tunnels - Free flight testing - Measurements of pressure, velocity and Mach number -Flow visualization methods of subsonic and supersonic flows.

Laboratory Sessions/ Experimental learning: Wind Tunnel model force measurements

Applications: Understand the significance of wind tunnels in Aeronautics/Aerospace and perform experiments on appropriate model's wind tunnel

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

1. https://nptel.ac.in/courses/101/106/101106040/
2. https://nptel.ac.in/courses/101/106/101106044/

Course outcomes:

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

CO302.1	Apply the basic concepts of compressible flow
CO302.2	Evaluate the concepts of normal shock phenomenon
CO302.3	Apply the concepts of oblique shock and expansion wave formation.
CO302.4	Utilize the concepts of Differential Equations of Motion for Steady Compressible Flows
CO302.5	Investigate the parameters of high-speed flow.

Reference Books:

1.	John D Anderson, Modern Compressible Flow, McGraw Hill,3rd edition,2012,ISBN-13: 978-1259027420.
2.	Radhakrishnan, E., Gas Dynamics, Prentice Hall of India,5th edition,2014,ISBN-13: 978-8120348394
3.	Ascher.H. Saphiro, Dynamics and Thermodynamics of Compressible fluid flow, John Wiley& Sons,1st edition,1977, ISBN-13: 978-0471066910.
4.	Yahya, S.M., Fundamentals of Compressible flow, NEW AGE, 2009, ISBN-13: 978-8122426687.
5.	H.W. Liepmann and A. Roshko, Elements of Gas Dynamics, Dover Publications Inc,2003,ISBN-13: 978-0486419633.

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO,PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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	AERODYNAMICS LAB	**Semester**	V

Course objective is to:

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

Sl No	**Experiment Name**	**RBT Level**	**Hours**
1	Calibration of a subsonic wind tunnel: test section static pressure and total head distributions.	L1,L2,L3	03
2	Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.	L1,L2,L3	03
3	Smokeflowvisualizationstudiesonatwodimensionalairfoilatdifferentanglesofincidenceatlowspeeds	L1,L2,L3	03
4	Smoke flow visualization studies on a two-dimensional wing with flaps and slats at different angles of incidence at low speeds	L1,L2,L3	03

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

Course outcomes:

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**Aircraft Propulsion (+Aircraft Propulsion Lab)**	**Semester**	**V**
Course Code	**MVJ21AE54**	**CIE**	**50**
Total No. of Contact Hours	**50 L: T: P: 3 : 0 : 2**	**SEE**	**50**
No. of Contact Hours/week	**50**	**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	**L1,L2**	**8Hours**

Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two–stroke and four–stroke piston engines, Gas turbine engines, Cycle analysis of reciprocating engines and jet engines , advantages and disadvantages, Non Air-breathing engines- introduction, numerical problems

Laboratory Sessions/ Experimental learning:

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

Applications: Automobile industries , Gas turbine industries and Power plants

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

1. https://nptel.ac.in/courses/101/101/101101001/
2. https://youtu.be/XKcRf2R5h4o3. https://youtu.be/fTAUq6G9apg

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

Jet propulsion and Supersonic Inlets

Jet Propulsion: 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.

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

Laboratory Sessions/ Experimental learning:

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

Performance studies on a scaled jet engine

Applications: Gas turbine and aircraft engine design industries

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

https://nptel.ac.in/courses/101/101/101101001/

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

https://youtu.be/KjiUUJdPGX0

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

Combustion chamber and 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:

Measurement of nozzle flow.

Make a model and explain thrust reversal technique

Applications: Gas turbine industries

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

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

https://www.youtube.com/watch?v=3u7d-IlvRqs&feature=youtu.be

https://www.youtube.com/watch?v=nvDoiHQXXJk&feature=youtu.be

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

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:

Make Sugar rocket by using potassium nitrate (small size)

Applications: Rockets and missile manufacturing industries

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

https://nptel.ac.in/courses/101/104/101104078/ https://nptel.ac.in/courses/101/104/101104019/ https://nptel.ac.in/courses/101106033/		
Module-5	**L1,L2**	**8Hours**
Rocket testing and Rocket materials **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 a typical space launch vehicle-launch procedure**.** **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. Laboratory Sessions/ Experimental learning: Find the specific impulse of the sugar rocket Applications: Testing and material manufacturing facilities Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/104/101104078/ https://nptel.ac.in/courses/101/104/101104019/		

Course outcomes:	
CO213.1	Apply the basic thermodynamic principles and theories in aircraft propulsion.
CO213.2	Evaluate Thrust and performance of Supersonic Inlets
CO213.3	Analyze the performance of Combustion chambers and Nozzles
CO213.4	Apply the basic principles of rocket propulsion.
CO213.5	Analyze Rocket testing and materials used in rockets

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

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
x. Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. xi. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. xii. One question must be set from each unit. The duration of examination is 3 hours.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	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	**AIRCRAFT PROPULSION LAB**	**Semester**	**V**
Course objective is to: • Understand how to do the heat transfer • Comprehend the cascade testing of axial compressor and axial turbine blade row. • Learn Pressure measurements using Axial Flow Fan setup			
Sl No	**Experiment Name**	**RBT Level**	**Hours**

1	Study of an Aircraft Piston Engine.(Includes Study of Assembly of Sub Systems, Various Components, their Functions and Operating Principles)	L1,L2,L3	03
2	Study of an Aircraft Jet Engine (Includes Study of Assembly of Sub Systems, Various Components, their Functions and Operating Principles)	L1,L2,L3	03
3	Study of Forced Convective Heat Transfer Over a Flat Plate	L1,L2,L3	03
4	Cascade Testing of a Model of Axial Compressor Blade Row	L1,L2,L3	03
5	Cascade Testing of a Model of Axial Turbine Blade Row	L1,L2,L3	03
6	Study of Performance of a Propeller	L1,L2,L3	03
7	Determination of Heat of Combustion of Aviation Fuel	L1,L2,L3	03
8	Study of Free and Wall Jet	L1,L2,L3	03
9	Measurement of Burning Velocity of a Premixed Flame.	L1,L2,L3	03
10	Study of the Flame Lift Up and Fall Back Phenomenon for Varied Air/Fuel Ratio	L1,L2,L3	03
11	Measurement of Nozzle Flow	L1,L2,L3	03
12	Pressure Measurements Using Axial Flow Fan Setup	L1,L2,L3	03
13	Investigation of Pressure Distribution and Relationship Between Inlet Pressure/Outlet Pressure and Mass Flow Rate in a Convergent-Divergent Nozzle When Working Over a Variety of Overall Pressure Ratios Including Under-Expanding and Over-Expanding Conditions	L1,L2,L3	03
14	Investigation of Pressure Distribution and Relationship Between Inlet Pressure/Outlet Pressure and Mass Flow Rate in a Convergent-Divergent Nozzle under Choked Conditions	L1,L2,L3	03

Course outcomes:

CO1	Analyse heat transfer
CO2	Evaluate testing of axial compressor and axial turbine blade row.

CO3	Estimate Pressure measurements using Axial Flow Fan setup

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

High-3, Medium-2, Low-1

Course Title	**Aircraft Systems and Instrumentation**	**Semester**	V
Course Code	**MVJ21AE551**	**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. Gain knowledge of the aircraft control systems.
2. Understand the applications of hydraulics and pneumatics in aircraft systems.
3. Acquire knowledge regarding aircraft engine systems.
4. Comprehend the aircraft auxiliary systems
5. Acquire the knowledge of aircraft instruments.

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

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

LaboratorySessions/ Experimental learning:

How it works, flight controls PID controls.

Applications:

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

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

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

8. https://onlinecourses.nptel.ac.in/noc21_ae05/preview
9. https://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1067&context=aerosp

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

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

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

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

Laboratory Sessions/ Experimental learning:

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

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

Applications:

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

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

5. https://nptel.ac.in/courses/101/101/101101002/
6. https://spocathon.page/video/lecture-06-lubrication-system

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

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

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

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

Laboratory Sessions/ Experimental learning:

Gyroscope working and applications, Avionics lab instruments working.

Applications:

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

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

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

Course outcomes:

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

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

Reference Books:

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

CIE Assessment:

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

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

SEE Assessment:

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

CO, PO Mapping

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

Course Title	**Theory of Vibration**	**Semester**	**V**
Course Code	**MVJ21AE552/ MVJ21AS552**	**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	**L1,L2,L3**	10 Hrs.

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

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.

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

https://www.youtube.com/watch?v=9r630K5HmJc&list=PLSGws_74K01_pG3R7rgtDtrDZBjcTgPdR

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

Undamped Free Vibrations: Single degree of freedom systems. Undamped free vibration, natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.

Damped Free Vibrations: Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, criticaland over damping, Logarithmic decrement

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**.**

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

https://www.youtube.com/watch?v=tJNaPt5aPmg

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

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

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.

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

https://www.youtube.com/watch?v=XGQr1uEX-Dc

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

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

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

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

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

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

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

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

Numerical Methods for Multi-Degree Freedom Systems:

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

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

Laboratory Sessions/ Experimental learning:

Plotting displacement curve using Analytical Approach**.**

Applications:

Understanding non linear behavior of waves or vibration.

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

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

Course outcomes:

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

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

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

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO,PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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	**GAS TURBINE TECHNOLOGY**	**Semester**	**V**
Course Code	**MVJ21AE553**	**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. Comprehend the types of engines and its applications.
2. Acquire the knowledge of engine parts.
3. Acquire the knowledge of engine performance.
4. Acquire the knowledge of fuels and various systems.
5. Gainknowledge of engine Testing.

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

Types, Variation & Applications: Types of engines showing arrangement of parts. Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Comparison of thrust and specific fuel consumption. Thrust, pressure and velocity diagrams.

Engine Parts: Compressor assembly, types of burners: advantages and disadvantages. Influence of design factors on burner performance. Effect of operating variables on burner performance. Performance requirements of combustion chambers. Construction of nozzles. Impulse turbine and reaction turbine. Exhaust system, sound suppression. Thrust reversal: types, design & systems. Methods of thrust augmentation, after burner system.

Laboratory Sessions/ Experimental learning:

Demo in Propulsion laboratory

10. Comprehend the cascade testing of axial compressor and axial turbine blade row.

11. Study the performance of propeller and jet engines.
12. Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles.

Applications: To understand the different types of Engines and Working.

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

1. Gas Dynamics and Propulsion by Prof. V. Babu,Department of Mechanical Engineering,IIT Madras.
https://youtu.be/30-FdRgygI0
https://youtu.be/iKLRgAgfjKE

2. Aircraft Propulsion Course URL: https://swayam.gov.in/nd1_noc19_me76/... Prof. Vinayak N. Kulkarni Dept. of Mechanical Engineering IIT Guwahati
https://youtu.be/7WFBBE2sKHE

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

Compressor: Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation. **Combustor:** Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation. **Turbines:** Turbine MAP. Turbine Testing and Performance Evaluation. **Inlet duct &nozzles:** Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation

Laboratory Sessions/ Experimental learning:

1. Study the performance of propeller and jet engines.
2. Measurement of nozzle flow.
3. Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio

Applications: To understand the performance characteristics of gas turbine engines.

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay.

https://youtu.be/AOmo98peh6I

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

Engine Performance: Design & off-design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process & Wind milling of Engines. Thrust engine start envelope. Starting torque and speed requirements Calculations for design and off-design performance from given test data– (case study for a single shaft Jet Engine). Engine performance monitoring.

Laboratory Sessions/ Experimental learning:

1. Study of performance of a propeller.
2. Performance studies on a scaled jet engine
3. Study of Fuel injection characteristics

Applications: To understand the performance characteristics of gas turbine engines.

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay.

https://youtu.be/AOmo98peh6I

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

Fuels: Combustion Properties of Fuels, Calorific Value, Enthalpy, Spontaneous-Ignition temperature, Limits of Flammability, Smoke Point, Luminometer Number, Smoke Volatility Index, Pressure and Temperature Effects, Sub atmospheric Pressure, Low Temperature, High Temperature.

Systems: Fuel systems and components. Sensors and Controls. FADEC interface with engine. Typical fuel system. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas turbine starters.

Laboratory Sessions/ Experimental learning:

Demo in Propulsion laboratory

1. Study of Fuel injection characteristics

Applications:

1.To understand the properties of fuels used in gas turbines

2. To understand the various fuel, oil and starting systems

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

7. Gas Dynamics and Propulsion by Prof. V. Babu,Department of Mechanical Engineering,IIT Madras.

https://youtu.be/v7UJBqmsNWw

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

Engine Testing: Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine - operating limits. Methods of displacing equilibrium lines. **Types of engine testing's:** Normally Aspirated Testing, Open Air Test Bed, Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in flight. Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of

turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology.

Laboratory Sessions/ Experimental learning:

1. Study the performance of propeller and jet engines.
2. Performance studies on a scaled jet engine
3. Measurement of nozzle flow.
4. Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio

Applications: To understand the standardflight testing procedures.

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

Introduction to Various Aircraft engines, Engine Performance parameters Aircraft Propulsion Course URL: https://swayam.gov.in/nd1_noc19_me76/...Prof. Vinayak N. Kulkarni Dept. of Mechanical Engineering IIT Guwahati

https://youtu.be/BT9oq73VxC4

Course outcomes:

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

CO313.3.1	Analyse engines for applications
CO313.3.2	Apply the knowledge of engine parts
CO313.3.3	Evaluate engine performance
CO313.3.4	Evaluate various engine systems.
CO313.3.5	Evaluate Engine Testing with different test methods

Reference Books:

1.	Irwin E. Treager,Gas Turbine Engine Technology, McGraw Hill Education 3rd edition,2013
2.	P. P Walshand P. Peletcher , Gas Turbine Performance, Blackwell Science Science 1998
3.	A. W. Morley Jean Fabri Pergamon , Advanced Aero-Engine Testing, 1959
4.	JP Holman, Experimental methods for Engineers, Tata Mc Graw Hill 7th edition,2007
5.	Michael J. Kores, and Thomas W. Wild ,Aircraft Power Plant Tata Mc Graw Hill Publishing Co. Ltd7thEdition,2002

CIE Assessment:

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

- 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.

Course Title	**Optimization techniques and probability theory**	Semester	VI
Course Code	MVJ21AE554/ 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**	3hrs

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

High,3, Medium,2, Low,1

Course 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	L1, L2 & 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.

Web Link and Video Lectures:

1. https://www.youtube.com/watch?v=Hdd_TCIJS3Q&t=322s
2. https://www.youtube.com/watch?v=jn9PmuUvUws&t=673s
3. https://www.digimat.in/nptel/courses/video/111105100/L21.html

Module-2	L2, L3 & L4	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.

Web Link and Video Lectures:

1. https://www.youtube.com/watch?v=RcXzyT8lk-w
2. https://www.youtube.com/watch?v=8kPUI5HoVxg
3. https://www.youtube.com/watch?v=dPQKltPBLfc

Module-3	L2, L3 & 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.

Web Link and Video Lectures:

1. https://www.digimat.in/nptel/courses/video/111105100/L48.html		
Module-4	L1, L2 & 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. **Web Link and Video Lectures:** 1. http://nptel.ac.in/courses.php?disciplineID=111 2. http://www.class-central.com/subject/math(MOOCs) 3. http://academicearth.org/		
Module-5	L1, L2& 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. **Web Link and Video Lectures:** 1. http://nptel.ac.in/courses.php?disciplineID=111 2. http://www.class-central.com/subject/math(MOOCs) 3. http://academicearth.org/		

Course outcomes:	
CO1	Solve the mathematical formulation of linear programming problem.
CO2	Able to analyze external problems and functions and to establish mathematical models
CO3	Be able to model engineering minima/maxima problems as optimization problems
CO4	Develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, information theory and design engineering.
CO5	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 ", Cambridge 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	**ENVIRONMENTAL STUDIES**	Semester	V
Course Code	MVJ21XX56	**CIE**	50
Total No. of Contact Hours	**40 L : T : P :: 3 : 0: 0**	**SEE**	50
No. of Contact Hours/week	1	**Total**	100
Credits	1	**Exam. Duration**	3 Hrs.

Course objective is to:

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

Module 1	**L1,L2,**	04 Hrs.
Introduction to environmental studies, Multidisciplinary nature of environmental studies;		

Scope and importance; Concept of sustainability and sustainable development. **Ecosystems (Structure and Function):** Forest, Desert, Rivers, Ocean **Biodiversity:** Types, Hot spots; Threats and Conservation of biodiversity, Deforestation**.** **Video link:** https://nptel.ac.in/courses/127/106/127106004/		
Module 2	**L1,L2,L3,**	10 Hrs.
Advances in Energy Systems (Merits, Demerits, Global Status and Applications): Hydrogen, Solar, OTEC, Tidal and Wind. **Natural Resource Management (Concept and case-study):** Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading. **Video link:** https://nptel.ac.in/courses/121/106/121106014/		
Module 3	**L1,L2,L3**	10 Hrs.
Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): SurfaceandGroundWaterPollution;Noisepollution;SoilPollutionand Air Pollution. **Waste Management & Public Health Aspects:** Bio-medical Waste; Solid waste; Hazardous waste; E-waste. **Video link**: • https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/105/103/105103205/		
Module 4	**L1,L2,L3**	10 Hrs.
. **Global Environmental Concerns (Concept, policies, and case-studies**): Global Warming Climate Change; Acid Rain; Ozone Depletion; Fluoride problem In drinking water. **Video link:** • https://nptel.ac.in/courses/122/106/122106030/ • https://nptel.ac.in/courses/120108004/		
Module 5	**L1,L2**	10 Hrs.
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO 14001. **Video link:** • https://nptel.ac.in/courses/105/102/105102015/ https://nptel.ac.in/courses/120/108/120108004/		
Course outcomes:		

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

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

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

High,3, Medium,2, Low,1

Course Title	**RESEARCH METHODOLOGY AND IPR**	**Semester**	**V**
Course Code	MVJ21AE57/AS57	**CIE**	**50**
Total No. of Contact Hours	**30 L: T: P: 1:2:0**	**SEE**	**50**

No. of Contact Hours/week	**1**	**Total**	**100**
Credits	**2**	**Exam. Duration**	**2Hrs.**

The course objective is to:

To give an overview of the research methodology and explain the technique of defining a research problem

• To explain the functions of the literature review in research.

• To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks

and writing a review.

• To explain various research designs and their characteristics.

• To explain the details of sampling designs, measurement and scaling techniques and also different methods of data collections.

• To explain several parametric tests of hypotheses and Chi-square test.

• To explain the art of interpretation and the art of writing research reports.

• To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.

• To discuss leading International Instruments concerning Intellectual Property Rights.

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

Module-1

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, Technique Involved in Defining a Problem,

Reviewing the literature: Place of the literature review in research, Review of the literature, searching the existing literature, reviewing the selected literature, developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed.

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

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.

Design of Sample Surveys: Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing

Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale.

Data Collection: Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection,

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

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, World Intellectual Property Organisation (WIPO),WIPO and WTO, Paris Convention for the Protection of Industrial Property, National Treatment, Right of Priority, Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights(TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits,

Course outcomes:

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

CO302.1	To explain the functions of the literature review in research.
CO302.2	• To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks
CO302.3	and writing a review.
CO302.4	• To explain various research designs and their characteristics.
CO302.5	To explain the functions of the literature review in research.

Reference Books:

1.	Research Methodology: Methods and Techniques C.R. Kothari, Gaurav Garg New Age International 4th Edition, 2018
2.	Research Methodology a step-by step guide for beginners. (For the topic Reviewing the literature under module 2) Ranjit Kumar SAGE Publications Ltd 3rd Edition, 2011
3.	Study Material (For the topic Intellectual Property under module 5) Professional Program Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO,PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	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

MVJ College of Engineering, Whitefield, Bangalore 560067

An Autonomous Institution, Affiliated to VTU, Belagavi

Scheme of Teaching and Examination

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

Effective from the academic year 2021-22

Department of Aeronautical Engineering

Semester VI

Sl. No.	Course		Course Title	BoS	Teaching hrs./week				Examination				Credits
	Type	Code			Lecture L	Tutorial T	Practical P	Self-Study S	Duration Hrs.	CIE Marks	SEE Marks	Total Marks	
1	HSMC	MVJ21AE61	Computational Fluid Dynamics	AE	2	2	-	-	3	50	50	100	3
2	IPCC	MVJ21AE62	Aircraft Structural Analysis (+Aircraft Structures lab)	AE	3	-	2	-	3	100	100	200	4
3	IPCC	MVJ21AE63	Aircraft Stability and Control (+ Flight Simulation Lab)	AE	3	-	2	-	3	100	100	200	4
4	OEC	MVJ21AE64X	OEC I	AE	3	-	-	-	3	50	50	100	3
5	OEC	MVJ21AE65	MOOC Courser (OEC 2)	AE	3	-	-	-	3	50	50	100	3
6	AEC	MVJ21AE66	Aircraft Maintenance Repair and Overhaul	AE	2	-	-	-	2	50	50	100	1
7	PRJ	MVJ21XXPRJ67	Mini project	AE	-	-	4	-	3	50	50	100	2
8	INT	MVJ21INT68I	Summer Internship II	AE	-	-	-		3	50	50	100	2
Total					16	2	8			500	500	1000	22

Research /IndustrialInternship- shall be carried out during VI and VII-semester for 24 weeks duration. The **Research /IndustrialInternship**shall be on Industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. **Research Internship**must be taken up at Centers of Excellence (CoE)/ Study Centers established in the institute/ at the reputed research organizations. The viva-voce examinations for **Research /IndustrialInternship** shall be carried out during VIII semester.

Under open elective ,departments shall offer only one course. Student will have option to select one course from any of the departments.

Course Code	Open Elective-I
MVJ21AE641	General Introduction to Aeronautics
MVJ21AE642	Introduction to Helicopters
MVJ21AE643	Introduction to Composite Structures

Course Title	**Computational Fluid Dynamics**	**Semester**	**VI**
Course Code	**MVJ21AE61**	**CIE**	**50**
Total No. of Contact Hours	**40 L : T : P :: 3 : 1:0**	**SEE**	**50**
No. of Contact Hours/week	**4**	**Total**	**100**
Credits	**3**	**Exam. Duration**	**3hrs**

The Course objective is to:

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

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

Introduction: CFD ideas to understand, CFD Application, Need for high speed Parallel Computing, Substantial derivative, Divergence of velocity. Flow models, Continuity Equation, Momentum Equation, and Energy Equations in various forms. Physical Boundary conditions. Conservative & Non-conservative forms of equations, Integral vrs Differential Forms of Equations. Form of Equations particularly suitable for CFD work. Shock capturing, Shock fitting.

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Flow Analysis

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Module-2	**L3,L4**	10Hrs.

Mathematical Behaviour of Partial Differential Equations: Classification of partial differential equations – Cramer Rule, Eigenvalue method. Hyperbolic, parabolic, and elliptic form of equations. Mixed type of equations. Classification of governing equations for one-dimensional compressible inviscid flow.

Impact of classification on physical and computational fluid dynamics. Case studies-steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, unsteady thermal conduction, and steady subsonic inviscid flow.

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Flow analysis

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Module-3	**L3,L4**	10Hrs.

DiscretisationTechniquesDiscretization: Essence of discretization- Finite difference method, and difference equations. Explicit and Implicit approach. Errors and stability analysis. Time marching and Space marching. Reflection Boundary condition. Relaxation technique; successive over relaxation/ successive under relaxation. Alternating Direction Implicit (ADI) Method. Upwind and Mid-point leap frog schemes.Numerical and artificial viscosity.

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Finite Difference Techniques for flow analysis

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

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Module-4	**L3,L4**	10Hrs.

Grid generation &Adaptive Grid Methods: Need for grid generation and Body-fitted coordinate system. Structured grids-essential feature. Structured grids generation techniques-algebraic and numerical methods. Unstructured grid generation Techniques-Delaunay-Voronoi diagram, advancing front method, multi-block grid generation, Grid quality, adaptive grids.

Adaptive Structured Grid Generation, Unstructured adaptive grid Methods.

Transformation: Matrices &Jacobian of transformation. Transformation of Equation from physical plane into computational Plane-examples.

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Grid formulation and transformation of planes

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

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Module-5	**L3,L4**	10Hrs.

Finite Volume Techniques and some Applications: Spatialdiscretisation:-Cell Centred Formulation and Cell vertex Formulation (overlapping control volume, duel control volume). Temporal discretisation: - Explicit time-stepping and Implicit time- stepping, time step calculation

Applications: Aspects of numerical dissipation & dispersion. Approximate factorization, Flux Vector splitting. Diffusion problem. Heat through conduction and radiation. Up winding technique. Post-processing and visualization, contour plots, vector plots etc.

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Flow analysis through Finite Volume Technique

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

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Course outcomes:

CO403.1.1	Apply knowledge of CFD ideas, and Flow Equations
CO403.1.2	Assimilate Mathematical behaviour of PDEs vis a vis nature of flow
CO403.1.3	Utilisefinite difference techniques.

CO403.1.4	Generate &Utilise grids
CO403.1.5	Apply finite volume techniques

Reference Books:	
1.	F. Wendt (Editor), Computational Fluid Dynamics - An Introduction, Springer – Verlag, Berlin; 1992.
2.	Charles Hirsch, Numerical Computation of Internal and External Flows, Vols. I and II. John Wiley & Sons, New York; 1988.
3	Fletcher, C.A.J, Computational Techniques for Fluid Dynamics, Springer, Berlin,2nd edition, 2002,ISBN-13: 978-3540543046
4	Tapan K. Sengupta, Fundamentals of CFD, Universities Press, 2004.

CIE Assessment:

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

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

SEE Assessment:

xix. 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.

xx. 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.

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

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

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

High-3, Medium-2, Low-1

Course Title	**Aircraft Structural Analysis (+Aircraft Structures lab**	**Semester**	**VI**
Course Code	**MVJ21AE62**	**CIE**	**50**
Total No. of Contact Hours	**50 L : T : P :: 3:2: 0**	**SEE**	**50**
No. of Contact Hours/week	**5**	**Total**	**100**
Credits	**4**	**Exam. Duration**	**3 Hrs.**

The courseobjective is to:

1. Understand symmetrical and unsymmetrical sections.
2. Acquire the knowledge of Structural Idealization on open section tubes.
3. Acquire the knowledge of Structural Idealization on closed section tubes.
4. Gain knowledge of the failure modes in structures
5. Comprehend the stress analysis on Spar box beams and fuselage frames.

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

Introduction: Elementary theory of bending – Introduction to semi-Monocoque structures - Stresses in beams of symmetrical and unsymmetrical sections -Box beams – General formula for bending stresses-principal axes method – Neutral axis method.

Laboratory Sessions/ Experimental learning: Stress analysis on a flat plate using Ansys.

Applications: To differentiate and analyze the components of aircraft components.

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

13. https://swayam.gov.in/nd1_noc19_ae05/previewhttps://youtu.be/bQQMIy7Dlt0
14. https://nptel.ac.in/courses/101/101/101101079/
15. https:52/2013/AAE%20352%20Course%20Text%20Weisshaar%202011.pdf

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

Shear Flow: Shear stresses in beams – Shear flow in stiffened panels - Shear flow in thin-walled open tubes –Shear center – Shear flow in open sections with stiffeners.

Laboratory Sessions/ Experimental learning: Shear center and angle of twist in Aircraft Structures laboratory

Applications: To analyze shear flow in aircraft/spacecraft skin panels.

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

8. https://cosmolearning.org/courses/introduction-aerospace-structures/video-lectures/
9. https://ocw.tudelft.nl/course-lectures/shear-flow-thin-walled-section-2/
10. https://www.ae.msstate.edu/tupas/SA2/chA14.7_text.html

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

Shear Flow Analyses: Shear flow in closed sections with stiffeners– Angle of twist - Shear flow in two flange and three flange box beams – Shear center - Shear flow in thin-walled closed tubes - Bredt-Batho theory - Torsional shear flow in multi cell tubes - Flexural shear flow in multi cell stiffened structures.

Laboratory Sessions/ Experimental learning: Shear flow analyses for closed section in Ansys workbench.

Applications: To analyze the shear flow in closed thin-walled section of the aircraft.

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

1. https://swayam.gov.in/nd1_noc19_ae05/previewhttps://youtu.be/bQQMIy7Dlt0
2. https://www.popsci.com/story/technology/best-aerospace-innovations-2019/
3. https://nptel.ac.in/courses/101/101/101101079/

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

Failure concepts: Stability problems of thin-walled structures– Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham's and Gerard's methods–Sheet stiffener panels- Effective width, Inter rivet and sheet wrinkling failures-Tension field web beams (Wagner's).

Laboratory Sessions/ Experimental learning: Fatigue analysis can be analyzed using Ansys workbench.

Applications: Used to predict the product life cycle management of aircraft components.

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

4. https://www.youtube.com/watch?v=3HE3A_vUZnw
5. https://www.youtube.com/watch?v=aivDhiLwu8E
6. https://www.youtube.com/results?search_query=unsw+aerospace+structures

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

Stress Analysis in Wing Spars and Box beams:

Tapered wing spar, open and closed section beams, beams having variable stringer areas, three- boom shell, torsion and shear, tapered wings, cut-outs in wings.

Stress Analysis in Fuselage Frames:

Bending, shear, torsion, cut-outs in fuselages, principles of stiffeners construction, fuselage frames, shear flowdistribution.

Laboratory Sessions/ Experimental learning: Fuselage Pressure Vessel experiment can be conducted using Ansys Workbench.

Applications: Helps to analyze the stress in Aircraft components.

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

6. https://youtu.be/bQQMIy7Dlt0
7. https://nptel.ac.in/courses/101/101/101101079/

Course outcomes:

CO311.1	Analyse symmetrical and unsymmetrical sections
CO311.2	Perform structural idealization and analysis on open section tubes.
CO311.3	Perform structural idealization and analysis on closed section tubes.
CO311.4	Analyse failure of structures
CO311.5	Estimatethe stress analysis in wing spar and box beams.

Reference Books:

1.	Megson, T.H.G., Aircraft Structures for Engineering Students, Edward Arnold,1995
2.	Perry D J & Azar J J , Aircraft Structures, 2nd edition, McGraw Hill N.Y.,1993
3.	BruhnE.F., Analysis and Design of Flight Vehicles Structures, Tri-Stateoffset Co.USA,1985
4.	T.H.G Megson, Introduction to Aircraft Structural Analysis, Elsevier,2nd Edition,2014

CIE Assessment:

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

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

SEE Assessment:

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

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

CO, PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2.6	2.2	1.6	2.4	1	0	0	0.6	1.4	0.2	3	1	1
CO2	3	2.6	2.2	1.6	2.4	1	0	0	0.6	1.4	0.2	3	1	1
CO3	3	2.6	2.2	1.6	2.4	1	0	0	0.6	1.4	0.2	3	1	1
CO4	3	2.6	2.2	1.6	2.4	1	0	0	0.6	1.4	0.2	3	1	1
CO5	3	2.6	2.2	1.6	2.4	1	0	0	0.6	1.4	0.2	3	1	1

High,3, Medium,2, Low,1

Course Title	**AIRCRAFT STRUCTURES LAB**	**Semester**	**VI**

Course objective is to:

- Learn about the simply supported beam, cantilever beam.
- Understand the Maxwell's theorem an d Poisson ratio.
- Acquire the knowledge about buckling load, shear failure and shear centre

Sl No	**Experiment Name**	**RBT Level**	**Hours**
1	Deflection of a Simply Supported Beam	L1,L2,L3	03
2	Deflection of a Cantilever Beam	L1,L2,L3	03
3	Beam with Combined Loading by using Superposition Theorem	L1,L2,L3	03
4	Verification of Maxwell's Reciprocal Theorem for Beam with a) Constant cross section b) Varying Cross section	L1,L2,L3	03
5	Determination of Young's Modulus and Poisson Ratio using Strain Gages.	L1,L2,L3	03
6	Buckling Load of Slender Eccentric Columns and Construction of South	L1,L2,L3	03

	Well Plot		
7	Shear Failure of Bolted and Riveted Joint	L1,L2,L3	03
8	Bending Modulus of Sandwich Beam	L1,L2,L3	03
9	Determine the Index Factor `K` in a Tensile Field of Wagner Beam	L1,L2,L3	03
10	Tensile, Compressive and Flexural Testing of a Composite Material Plate	L1,L2,L3	03
11	Determination of Natural Frequency and Mode Shapes of a Cantilever Beam for the FollowingCases a) Constant cross section b) Varying cross section	L1,L2,L3	03
12	Determination of Shear Centre for Following Cases Through Deflection a) Close section–Symmetrical bending b) Open section–Unsymmetrical bending	L1,L2,L3	03
13	Determination of Shear flow for Following Cases a) Close section–Symmetrical bending b) Open section–Unsymmetrical bending	L1,L2,L3	03
14	Determining of Shear Centre Through Shear Flow Measurement for Following Cases a) Close section–Symmetrical bending b) Open section–Unsymmetrical bending	L1,L2,L3	03

Course outcomes:

CO1	Compute the deflection of simply supported beam and cantilever beam.
CO2	Verify the Maxwell's theorem.
CO3	Determine the buckling load ,shear failure and shear centre.

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12

CO1	3	3	3	3	3	1	1	1	1	1	1	1
CO2	3	3	3	3	3	1	1	1	1	1	1	1
CO3	3	3	3	3	3	1	1	1	1	1	1	1

High-3, Medium-2, Low-1

Course Title	**Aircraft Stability and Control (+ Flight Simulation Lab)**	Semester	**VI**
Course Code	**MVJ21AE63**	**CIE**	50
Total No. of Contact Hours	50 L : T : P :: 3 :2: 0	**SEE**	50
No. of Contact Hours/week	5	**Total**	100
Credits	4	**Exam Duration**	3 Hrs.

The course objective is to:

1. Understand the Static Longitudinal stability with Stick fixed condition
2. Gain knowledge of the Static Longitudinal stability with Control stick free conditions
3. Acquire knowledge of Lateral and Directional stability & control
4. Understand concepts of equations of motions and Stability derivatives.
5. Learn the Dynamic Stability of Aircraft.

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

Static Longitudinal Stability and Control-Stick Fixed

Definition, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane Introduction, Trim condition. Static

Margin. Stick fixed neutral points. Longitudinal control, Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range.

Laboratory Sessions/ Experimental learning:

Effect of Static margin on Longitudinal Stability of Aircraft- Flight Simulation Lab

Applications:

Determine the Longitudinal stability of Aircraft with Stick fixed

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

16. NPTEL- Aircraft Stability & Control

https://nptel.ac.in/courses/101/104/101104062/

2. MIT open course ware- Aircraft Stability & Control

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-

2004/		
Module 2	**L1,L2,L3,**	10 Hrs.
Static Longitudinal Stability and Control-Stick free Introduction, Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G. **Laboratory Sessions/ Experimental learning:** Calculate the variation of Trim Tabs during Stick free Neutral point condition **Applications:** Determine the Longitudinal stability of Aircraft with controls free **Video link / Additional online information (related to module if any):** 1. NPTEL- Aircraft Stability & Control https://nptel.ac.in/courses/101/104/101104062/ 2. MIT open course ware- Aircraft Stability & Control https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/		
Module 3	**L1,L2**	10 Hrs.
Static Directional and Lateral Stability and Control Static directional stability- rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition. Weather cocking effect. Static Lateral stability. Estimation of dihedral effect. Effect of wing sweep, flaps, and power. Lateral control, Estimation of lateral control power, Aileron control forces, Balancing the aileron. Coupling between rolling and yawing moments. Adverse yaw effects. Aileron reversal. **Laboratory Sessions/ Experimental learning:** Effect of aileron input in lateral and directional motion of Aircraft **Applications:** Effect of Directional and Lateral stability on Aircraft **Video link / Additional online information (related to module if any):** 1. NPTEL- Aircraft Stability & Control https://nptel.ac.in/courses/101/104/101104062/ 2. MIT open course ware- Aircraft Stability & Control https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/		
Module 4	**L1,L2,L3**	10 Hrs.

Equations of Motions

Derivation of rigid body equations of motion, Orientation and position of the airplane, gravitational and thrust Forces, Small disturbance theory. Aerodynamic force and moment representation, Derivatives due to change in forward speed, Derivatives due to the pitching velocity, Derivatives due to the time rate of change of angle of attack, Derivatives due to rolling rate, Derivatives due to yawing rate.

Laboratory Sessions/ Experimental learning:

Estimate the effect of stability derivatives on aircraft due to changes in forward speed, change in angle of attack, change in roll rate and yaw rate

Applications:

Stability derivative estimation for a stable aircraft

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

1. NPTEL- Aircraft Stability & Control

https://nptel.ac.in/courses/101/104/101104062/

2. MIT open course ware- Aircraft Stability & Control

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/

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

Dynamic Stability

Dynamic longitudinal stability. Types of modes of motion: phugoid motion, short period motion. Routh's stability criteria. Factors affecting period and damping of oscillations. Flying qualities in pitch. Cooper-Harper Scale. Dynamic lateral and directional stability. Response to aileron step-function, side-slip excursion. Dutch roll and Spiral instability. Auto- rotation and spin. Stability derivatives for lateral and directional dynamics.

Laboratory Sessions/ Experimental learning:

Determine short period and phugoid oscillations for a given Quartic equation

Applications:

Determine relative stability of an Aircraft

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

1. NPTEL- Aircraft Stability & Control

https://nptel.ac.in/courses/101/104/101104062/

2. MIT open course ware- Aircraft Stability & Control

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-333-aircraft-stability-and-control-fall-2004/

Course outcomes:

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

CO401.1	Analyse Longitudinal stability for Stick fixed conditions.
CO401.2	Evaluate Longitudinal stability for Stick free conditions
CO401.3	Analyse Static Lateral and Directional static stability
CO401.4	Evaluation of various flying modes.
CO401.5	Analyse the dynamic stability of Aircraft

Reference Books:	
1.	Nelson, R.C. Flight Stability and Automatic Control, McGraw-Hill Book Co., 2007.
2.	Perkins, C.D., and Hage, R.E., Airplane Performance stability and Control, John Wiley Son Inc, New York, 1988
3.	BernardEtkin, Dynamics of Flight Stability and Control, John Wiley & Sons, Second Edition, 1982
4.	Bandu N. Pamadi, Performance, Stability, Dynamics and Control of Airplanes, AIAA 2nd Edition Series, 2004

CIE Assessment:

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

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

SEE Assessment:

xxii. 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.

xxiii. 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.

xxiv. 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	**FLIGHT SIMULATION LAB**	**Semester**	**VI**

Course objective is to:

- Understand the root locus and bode plot.
- Understand the spring mass damper system and the servo mechanism system with feedback.
- Acquire the knowledge to use computational tools to model aeronautical vehicle dynamics

Sl No	**Experiment Name**	**RBT Level**	**Hours**
1	Draw Pole-Zero map of dynamic system model with plot customization option	L1,L2,L3	03
2	Plot root locus for adynamic system though MATLAB	L1,L2,L3	03
3	Draw Bode plot from a transfer function in MATLAB and explain the gain and phase margins	L1,L2,L3	03
4	Simulate spring-mass-damper system with and without a forcing function though SIMULINK	L1,L2,L3	03
5	Simulate a simple servo-mechanism motion with feedback-in the time domain, and in `s` domain	L1,L2,L3	03
6	Simulate a bomb drop from an aircraft on a moving tank in pure pursuit motion	L1,L2,L3	03
7	Develop a straight and level flight simulation program using MATLAB	L1,L2,L3	03
8	Simulate aircraft Take-off and Landing with trajectory tracing	L1,L2,L3	03

9	Simulate stall of aircraft andshowtheeffectofvariationinstaticmarginonstallingcharacteristics	L1,L2,L3	03
10	Design of proportional navigation trajectory for missile	L1,L2,L3	03
11	Simulateaircraftlongitudinalmotionanddemonstratetheeffectofstaticmarginvariationforapulseinput in pitch that is intended to bleed the airspeed.	L1,L2,L3	03
12	Simulateaircraftlongitudinalmotionanddemonstratetheeffectofstaticmarginvariationforadoubletinputinpitch.	L1,L2,L3	03
13	Given a Quadratic characteristic equation, determine two quadratics that shall result in poles of short-period oscillations and poles of Phugoid. Vary the coefficients of polynomial to study the movement of poles.	L1,L2,L3	03
14	Given a Quartic characteristics equitation, determinePolesandTimeconstantsforRollmode,Spiralmotion,andDutchroll.Varythe coefficients of polynomial to study the movement of poles.	L1,L2,L3	03

Course outcomes:

CO1	Evaluate the root locus and bode plot
CO2	Analyse the dynamics response of aircraft.
CO3	Use computational tools to model aircraft trajectory.

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**GENERAL INTRODUCTION TO AERONAUTICS**	**Semester**	**VI**
Course Code	**MVJ21AE641**	**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. Gain knowledge of the History of Aviation
7. Understand the basic Aircraft configurations
8. Understand the aircraft structures and materials.
9. Acquire knowledge of aircraft and rocket power units
10. Learn aircraft stability aspects

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

Introduction

Early Developments – Ornithopters, Balloon Flight, Gliders, Wilbur and Orville Wright – Inventors of First Practical Airplane, Aeronautical Triangle – Langley, Wrights and Glenn Curtiss, Problem of Propulsion, Faster and Higher, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

Laboratory Sessions/ Experimental learning:

Demo in Aerodynamics laboratory

1. Understand the basics of air flow over airfoil and various other models in the wind tunnel in Aerodynamics Lab

Applications:

1. Understanding the basics concepts of flying

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

1. Introduction to Aerospace Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay For more details on NPTEL visithttp://nptel.iitm.ac.in

https://youtu.be/ohmyMEwfp5g

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

Aircraft Configurations:

Different types of flight vehicles, classifications. Components of an airplane and their functions. Conventional control, Powered control, Basic instruments for flying - Typical systems for control actuation.

Laboratory Sessions/ Experimental learning:

Demo in Propulsion laboratory

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

Applications:

1. Understand the aircraft structures and materials.

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

General Introduction: Airplane Performance Characteristics (NPTEL)

https://youtu.be/tEWuP1NVdgE

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

Airplane Structures and Materials:

General types of construction, Monocoque, semi-monocoque and geodesic constructions, Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials. Stresses and strains – Hooke's law – Stress - strain diagrams - elastic constants.

Laboratory Sessions/ Experimental learning:

Demo in Aircraft Structures Lab

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

Applications:

1. Understand the aircraft structures and materials.

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay.

https://youtu.be/AOmo98peh6I

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

Power Plants:

Basic ideas about piston, turboprop and jet engines - Use of propeller and jets for thrust production - Comparative merits, Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

Laboratory Sessions/ Experimental learning:

Demo in Propulsion laboratory

5. Study the performance of propeller and jet engines.
6. Performance studies on a scaled jet engine
7. Measurement of nozzle flow.
8. Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio

Applications:

1. To understand principles of operation of aircraft power plants.

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay. For more details on NPTEL visit http://nptel.iitm.ac.in

https://youtu.be/69Lyna4jcc8

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

Aircraft Stability:

Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Effect of flaps and stats on lift, control tabs, stalling, gliding, landing, turning, aircraft manoeuvres; stalling, gliding, turning. Simple problems on these.

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

Applications: Identify the required performance characteristics of different class of aircraft Video link: https://nptel.ac.in/courses/101/101/101101079/ https://nptel.ac.in/courses/101/101/101101079/

Course outcomes:

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

CO314.1.1	Review the historical aspects of Aviation
CO314.1.2	Outline the basic Aircraft configuration and details
CO314.1.3	Summarize the aircraft structures and materials.
CO314.1.4	Illustrate the power units in Aircrafts and Rockets.

CO314.1.5	Explain stability aspects of aeroplanes

Reference Books:	
1.	J.D Anderson, Introduction to Flight, McGraw Hill, 1995
2.	Stephen A Brandt, Introduction to Aeronautics-A design perspective, AIAA Education series, 2004
3.	Kermode.A.C, Mechanics of Flight, Himalayan Book, 1997
4.	Kermode.A.C, Flight without Formulae, Pearson, 2009

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - 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	1	1	1	1	1	1	1	1	1	1	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO3	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO4	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	1	1

High,3, Medium,2, Low,1

Course Title	Introduction to Helicopters	Semester	VI
Course Code	MVJ21AE642	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 the basic elements, kinematics of helicopter.
2. Remember the equations of motions for helicopter.
3. Gain knowledge on aerodynamics of propeller.

Module-1	**L1, L2, L3**	**10 Hours**
Introduction, Elements of a helicopter, Performance, Components, Vectors and Vector Resolutions.		
Module-2	**L1, L2, L3**	**10Hours**
Axis Systems, Kinematics and Flight Dynamics, Quaternions, Mass Properties, Equations of Motion.		
Module-3	**L1, L2, L3**	**10Hours**
Applied forces and moments, Longitudinal Equations of Motion, Atmosphere, Bernoulli's Equation, Compressibility and Wing lift, Wing Drag.		
Module-4	**L1, L2, L3**	**10Hours**
Aerodynamic Velocity, Inertial Velocity, Wash Velocity, and Gusts, Aerodynamics of Airfoils, Wings, and Fins.		
Module-5	**L1, L2, L3**	**10Hours**
Aerodynamics of Propellers, Propeller Analysis, Introduction to Aeroelastic Rotor Models, Rotor Downwash Modelling, Aerodynamic Interference, Engines Drive Trains, Controls, Landing Gear, Trimming.		

Course outcomes:

CO1	1. Apply the basic elements, kinematics of helicopter.
CO2	2. Analyse the equations of motions for helicopter.
CO3	3. Implement aerodynamics of propeller.

Reference Books:

1	Introduction to Helicopter Aerodynamics by Wieslaw Zenon Stepniewski.
2	Fundamentals of Helicopter Dynamics by C. Venkatesan.
3	Basic Helicopter Aerodynamics by J Seddon

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

High-3, Medium-2, Low-1

Course Title	**Introduction to Composite Structures**	Semester	VI
Course Code	MVJ21AE643	**CIE**	50
Total No. of Contact Hours	40 L : T : P :: 30 :0 : 0	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	3	**Exam. Duration**	3 Hrs.

Course objective is to:

This course will enable students to

1. Understand the properties and advantages of composite materials compared to conventional materials.
2. Evaluate the properties of polymer matrix composites with fiber reinforcements and to learn the fabrication methods used in composites
3. Gain the knowledge about Micro and macro mechanical properties of composite lamina and laminates
4. Understand the applications and future of composites
5. Learn the NDT and DT methods of Composites with applications.

Module 1	L1,L2,L3	8 Hrs.

Introduction to Composite Materials
Definition, classification of composite materials, classification of reinforcement - particulate, short fibers, whiskers, long fibers composites. matrix materials – metals, ceramics, polymers (including thermoplastics and thermosets), Carbon-Carbon Composites
Metal Matrix Composites:
MMC with particulate and short fiber reinforcement, liquid and solid state processing of MMC – stir casting, squeeze casting. Properties of MMCs, Applications of Al, Mg, Ti based MMC
Laboratory Sessions/ Experimental learning:

1.Determination of various composite materials by different types of fibers with application

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

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

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

Module 2	L1,L2,L3,	8 Hrs.

Processing of Polymer Matrix Composites: Thermoset Polymers, Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding, **Resin Transfer Moulding**, Pultrusion, Pulforming, Autoclave Process
Processing of Polymer Matrix Composites: Thermoplastic Polymers, Extrusion process, Injection Moulding Process, Thermo-forming process.
Post Processing of Composites – Adhesive bonding, drilling, cutting processes.

Laboratory Sessions/ Experimental learning:
1. Preparation of Composite laminates by Hand layup method

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

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

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

Module 3	L1,L2,L3	8 Hrs.

Micro-Mechanical Behavior of a Lamina
Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants. Ultimate Strengths of a Unidirectional Lamina
Macro-Mechanical Behavior of a Lamina:
Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix, Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.

Laboratory Sessions/ Experimental learning:

1.Determination of Young's Modulus of a Composite beam

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

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

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

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

Applications and Future of Composites

Application developments – Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites.

Future of Composites:- General introduction and theory of nanocomposites- History of nanocomposites; Size and shape dependent properties and their uniqueness. Flexible Composites, High Temperature materials.

Laboratory Sessions/ Experimental learning:

1. Evaluate the mechanical properties of a lamina and a laminate

Applications: Specific Aircraft Structural components.

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

7. **https://www.youtube.com/embed/PzdCymgyZ6c** - IIT Kanpur

Module 5	**L1,L2**	8 Hrs.

Composite Testing, Inspection & Quality Control: Determination of Mechanical properties of composite materials, Testing of composites – Interlaminar Shear testing, Fracture testing, Delamination, Raw material testing. Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan

Laboratory Sessions/ Experimental learning:

1. Determination of Defects in a composite by NDT Methods

Applications: NDT- DT Methods, Composites in Aerospace sector

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

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

Course outcomes:

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

CO211.1	Compare the properties and select a material for the given application.
CO211.2	Analyse the properties of polymer matrix composites and Fabrication of Composite materials
CO211.3	Apply constitutive equations of *composite* materials and understand mechanical behavior at *micro and macro* levels.

CO211.4	Apply the composite materials for a specific application
CO211.5	Carry out various inspection in accordance with the established procedures and Differentiate various defect types and select the appropriate **NDT** methods for better evaluation

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

CIE Assessment:

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

- 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	1	1	1	1	1	1	1	1	1	1	1
CO2	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO3	3	2	1	1	1	1	1	1	1	1	1	1	1	1

CO4	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO5	3	2	1	1	1	1	1	1	1	1	1	1	1	1

High,3, Medium,2, Low,1

Course Title	Aircraft Maintenance Repair and Overhaul	**Semester**	VI
Course Code	MVJ21AE66	**CIE**	50
Total No. of Contact Hours	20 L : T : P :: 1 :0 : 0	**SEE**	50
No. of Contact Hours/week	2	**Total**	100
Credits	1	**Exam. Duration**	3 Hrs.

The course objective is to:

1. Comprehend the fundamentals of maintenance and certification.
2. Acquire knowledge of documentation for maintenance.
3. Understand the AircraftManagement Maintenance.
4. Gain knowledge of Hanger maintenance on Aircraft and material support.
5. Acquire knowledge of maintenance safety and trouble shooting in Airlines.

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

Fundamentals of Maintenance & Certification:

Types of maintenance, Redesign, Failure rate pattern, Other maintenance considerations. Aviation industry certification requirements, Type certificate (FAA form 8110.9), Airworthiness certificate (FAA form 8100-2), Aviation maintenance certifications, General, Airframe, Power plant, Avionics courses.

Laboratory Sessions/ Experimental learning:A demo on maintenance procedure in wind tunnel lab.

Applications: Apply the certification process in Aircraft industry.

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

18. https://www.youtube.com/watch?v=KEF2szWaEgg – Introduction about Aircraft Maintenance-NPTEL-IITK
19. https://www.youtube.com/watch?v=CoLWYZP9BkY&list=PLExlUJZK1IOnUv8IeOXLk_njBYhc-Xh6V –Aircraft Maintenance-NPTEL-IITK
20. https://www.youtube.com/watch?v=H45vSzyiXH4 – Airplane Maintenance

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

Documentation for Maintenance

Manufacturer's documentation, Airplane maintenance manual, Fault insulation manual, Illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment, Federal Aviation regulation (FAR), Advisory circulars, Airworthiness direction ATA document standards, Technical policies and procedure manuals (TPPM).

Laboratory Sessions/ Experimental learning: A demo on Airplane maintenance manual documentation procedure.

Applications: Apply the documentation standard procedures for maintenance in aircraft.

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

5. https://www.youtube.com/watch?v=z6607nep8iU-Aircraft - Air worthiness required Inspection &Documentation
6. https://www.youtube.com/watch?v=QxdhMa25MGw – Aircraft structure repair manual
7. https://www.youtube.com/watch?v=WTk3bT01M7c –Aircraft Maintenance guidelines

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

Aircraft Management Maintenance

Structure, Role of aviation management, Line supervisory management, Management areas of concern in airlines, Manager of overhaul shops, Line maintenance control centre flight line (preflight& post flight), Aircraft Logbook, Maintenance crew skill requirements.

Laboratory Sessions/ Experimental learning:A demo on aircraft logbook.

Applications: Implement the aviation management in airlines.

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

12. https://www.youtube.com/watch?v=f6F_ecq1njc – Aviation management
13. https://www.youtube.com/watch?v=P7GfDmd7Nqw-Aircraft line maintenance check example

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

Hanger Maintenance on Aircraft & Material Support

Introduction, organization of hanger maintenance, Non- routine item, parts availability, cannibalization, Types of shops- sheet metal shop, Aircraft interior shop, Engine shop, Avionics shop, ground support equipment, outsourcing of shop maintenance work, operation of overhaul shops, Material support, Material management inventory control, Support functions of material, Parts ordering, Storage, Issue, control and handling, Parts receiving quality control, calibration program, stock level adjustments, shelf life, exchanges, warranty & modifications of parts.

Laboratory Sessions/ Experimental learning:A demo on maintenance on propulsion lab.

Applications: Apply the maintenance system in hanger maintenance, engine shop, avionics shop etc., and perform the materials management and inventory control in aircraft industry.

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

8. https://www.youtube.com/watch?v=-zCTFfn-Fyk – Inside an Aircraft Maintenance hanger
9. https://www.youtube.com/watch?v=TCThd0Vr0cQ –Aircraft Maintenance work
10. https://www.youtube.com/watch?v=U44RQAzf4NI – Introduction to Inventory and materials management

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

Maintenance Safety & Trouble shooting

Safety regulations, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, Knowledge of malfunctions.

Laboratory Sessions/ Experimental learning:A demo on safety system in wind tunnel lab.

Applications: Apply the safety regulations, OSHA safety programs and troubleshooting systems in aircraft.

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

9. https://www.youtube.com/watch?v=aRA7QR2Mr_w – Airlines safety management system
10. https://www.youtube.com/watch?v=5bc1qBtkRWA –How do Airline store aircraft?
11. https://www.youtube.com/watch?v=89IWlG0Uhz0 – trouble shooting procedure for the aircraft systems

Course outcomes:

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

CO313.1.1	Apply the certification procedure for aircraft maintenance.
CO313.1.2	Classify the aircraft maintenance manual and logbook.
CO313.1.3	Apply the management system in aircraft maintenance.
CO313.1.4	Examine the quality control and calibration on Aircraft.
CO313.1.5	Investigate the safety regulations and rules in Aircraft.

Reference Books:

1.	Harry A Kinnison, Tariq Siddiqui, Aviation Maintenance Management, Mc Graw Hill education (India) Private Ltd, 2013.
2.	Kroes, Watkins, Delp, Aircraft maintenance and repair, Mc Graw Hill,2013.
3.	Larry Reithmaier, Aircraft Repair Manual, Palmar Books, Marquette,1992.
4.	Brimm. DJ,Bogges, HE,AircraftMaintenance,Pitman publishing corp,London,1952.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
- Question paper for the SEE consists two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. - Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. - One question must be set from each unit. The duration of examination is 3 hours.

CO/ PO	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	2	2	1	1	-	-	1	1	1	1	1	2
CO2	3	2	2	1	1	1	-	-	1	1	1	1	-	-
CO3	3	2	2	2	1	1	-	-	1	1	1	1	1	1
CO4	3	2	2	2	1	1	-	-	1	1	2	1	-	-
CO5	3	2	2	2	1	1	-	-	1	1	1	1	1	1

High,3, Medium,2, Low,1

MVJ College of Engineering, Whitefield, Bangalore 560067

An Autonomous Institution, Affiliated to VTU, Belagavi

Scheme of Teaching and Examination

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

Effective from the academic year 2021-22

Department of Aeronautical Engineering

Semester VII

Sl. No.	Course		Course Title	BoS	Teaching hrs./week				Examination				Credits
	Type	Code			Lecture L	Tutorial T	Practical P	Self-Study S	Duration Hrs.	CIE Marks	SEE Marks	Total Marks	
1	IPCC	MVJ21AE71	Aircraft Design (+Design Modelling and Analysis Lab)		3	-	2	-	3	100	100	200	4
2	PEC	MVJ21AE72X	Professional Elective-II		3	-	-	-	3	50	50	100	3
3	PEC	MVJ21AE73X	Professional Elective-III		3	-	-	-	3	50	50	100	3
4	OEC	MVJ21AE74X	OEC 3		3	-	-	-	3	50	50	100	3
5	PRJ	MVJ21AEPR76	Project Phase I		-	-	4		3	50	50	100	2
6	AEC	MVJ21AE77	AEC (online minimum of 4 weeks duration)		1	-	-	-	2	50	50	100	1
Total					13	-	6			350	350	700	16

Course Code	Professional Elective-II	Course Code	Professional Elective-III
MVJ21AE721	Helicopter Aerodynamics	MVJ21AE731	Flight Testing
MVJ21AE722/	Composite Structures	MVJ21AE732	Fatigue and Fracture Mechanics

MVJ21AS722			
MVJ21AE723	Rocket and Missiles	MVJ21AE733/ MVJ21AS733	Artificial Intelligence and Robotics
MVJ21AE724	Experimental Stress Analysis	MVJ21AE734	Unmanned Aerial Vehicles
MVJ21AE725/ MVJ21AS725	Control Engineering	MVJ21AE735/ MVJ21AS735	Guidance Navigation and Control

Course Code	Open Elective-III
MVJ21AE741	Aircraft Propulsion
MVJ21AE742	Aircraft Transport System
MVJ21AE743	Rocket and Missiles
MVJ21AE744	Aircraft Systems and Instrumentation
MVJ21AE745	Unmanned Aerial Vehicles

Course Title	**Aircraft Design (+Design Modelling and Analysis Lab)**	**Semester**	**VII**
Course Code	**MVJ21AE71**	**CIE**	**50**
Total No. of Contact Hours	**50 L : T : P :: 3 : 1: 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 overview of Aircraft design process
2. Acquire knowledge of configuration layout and design of structural components
3. Gain knowledge of engine selection.
4. Comprehend the stability and control and sizing of control surfaces.
5. Understand the design aspects of subsystems

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

Overview of Design Process

Introduction, Requirements, Phases of design, Conceptual Design Process, Initial Sizing, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take- off weight calculation, Thrust to Weight Ratio & Wing Loading: Thrust to Weight Definitions, Statistical Estimate of T/W. Thrust matching, spread sheet in design, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance, Instantaneous Turn rate, Sustained Turn rate, Climb, & Glide, Maximum ceiling.

Laboratory Sessions/ Experimental learning: Design and modelling of the aircraft components based on the requirements chosen in CAAd lab

Applications: Apply the design requirements for an aircraft in response to requirements based on fundamental principles and statistical data in the initial phase of design.

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

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

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

Configuration Layout & loft

Conic Lofting, Conic Fuselage Development, Conic Shape Parameter, Wing-Tail Layout & Loft. Aerofoil Linear Interpolation. Aerofoil Flat-wrap Interpolation. Wing aerofoil layout-flap wrap. Wetted area determination. Special considerations in Configuration Layout: Aerodynamic, Structural, Delectability.

Crew station, Passenger, and Payload arrangements. Design of Structural Components: Fuselage, Wing, Horizontal & Vertical Tail. Spreadsheet for fuselage design. Tail arrangements, Horizontal & Vertical Tail Sizing. Tail Placement. Loads on Structure. V-n Diagram, Gust Envelope. Loads distribution, Shear and Bending Moment analysis.

Laboratory Sessions/ Experimental learning: Structural analysis and Aerodynamic analysis in Ansys lab

Applications: Analyse the various constraints coming from specifications and choose key parameters (total weight, wing plan form, thrust/power required etc.)

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

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

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

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

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

Engine Selection & Flight Vehicle Performance

Turbojet Engine Sizing, Installed Thrust Correction, Spread Sheet for Turbojet Engine Sizing. Propeller Propulsive System. Propeller design for cruise. Take-off, Landing & Enhanced Lift Devices: - Ground Roll, Rotation, Transition, Climb, Balanced Field Length, Landing Approach, Braking. Enhanced lift design - Passive & Active

Laboratory Sessions/ Experimental learning: Modelling of engine selected in CAAD lab

Applications: Compare different engine configurations and choose the design which meets the requirements.

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

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

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

Static Stability & Control: Longitudinal Static Stability, Pitch Trim Equation. Effect of Airframe components on Static Stability. Lateral stability- Contribution of Airframe components. Directional Static stability. Contribution of Airframe components. Aileron Sizing, Rudder Sizing. Flying qualities. Cooper Harper Scale. Environmental constraints, Aerodynamic requirements.

Laboratory Sessions/ Experimental learning: Performance analysis in Matlab

Applications: Calculate and compare performance and stability characteristics against design goals and generate a layout

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

3. https://nptel.ac.in/courses/101104062/

4. https://nptel.ac.in/courses/101104062/#		
Module 5	**L1,L2**	10Hrs.

Design Aspects of Subsystems: Flight Control system, Landing Gear and subsystem, Propulsion and Fuel System Integration, Air Pressurization and Air Conditioning System, Electrical & Avionic Systems, Structural loads, Safety constraints, Material selection criteria. Applications:Calculate and compare performance and stability characteristics against design goals and generate a layout

Laboratory Sessions/ Experimental learning: Assemble the CAD models of the components and verify performance using CFD tool in Ansys lab.

Applications: Analyse design issues for aerodynamics, propulsion, structure, weights, stability, cost, and performance and generate a layout.

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

https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/101108047/lec29.pdf

Course outcomes:

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

CO404.2.1	Define a configuration for given specifications.
CO404.2.2	Evaluate configuration layout & airframe components sizing
CO404.2.3.	Determine Engine selection and flight performance
CO404.2.4	Evaluate the stability and control and sizing of control surfaces.
CO404.2.5	Analyse the design aspects of subsystems

Reference Books:

1.	Daniel P. Raymer, Aircraft Design -A Conceptual Approach, AIAA, education Series, IVth Edition, 2006
2.	Thomas C Corke , Design of Aircraft, Pearson Edition. Inc, 2003
3.	J Roskam , Airplane Design -VOL 1 to 9
4.	John Fielding , Introduction to Aircraft Design, Cambridge University Press, 2009

CIE Assessment:

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

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

SEE Assessment:

xxv. 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.

xxvi. 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.

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

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

High,3, Medium,2, Low,1

Course Title	Aircraft Design (+Design Modelling and Analysis Lab)	**Semester**	VII

- **Course objective is to:**
- Understand the procedure to draw the geometric models of symmetric, cambered aerofoil, nozzle, wingand 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	Modeling of Symmetrical/Cambered Aerofoil Geometry , and Generation of Body Fitting AdaptiveMesh.	L1,L2,L3	03
2	Modeling of 2-D Incompressible and Invisicd Flow over Symmetrical/Cambered Aerofoil, and Plottingof Pressure distribution and Velocity vectors for Subsonic/Supersonic Mach numbers.	L1,L2,L3	03
3	Modeling of 2-D Compressible and Viscid Flow over Symmetrical/Cambered Aerofoil, and Plotting ofPressure distribution and Velocity vectors for Subsonic Mach numbers.	L1,L2,L3	03
4	Isentropic Flow Analysis in a 2-D Subsonic Diffuser and a Subsonic Nozzle.	L1,L2,L3	03
5	Isentropic Flow Analysis in a 2-D Supersonic Diffuser and a Supersonic Nozzle.	L1,L2,L3	03
6	Geometric Modeling and Mesh Generation of a 2-D Convergent-Divergent Nozzle and Analyses of flow for Adiabatic Conditions (Fanno Flow).	L1,L2,L3	03
7	Geometric Modeling and Mesh Generation of a 2-D Pipe and Modeling of Steady/Unsteady Heat Convection and Conduction (Rayleigh Flow).	L1,L2,L3	03
8	Structural Modeling of Sandwich Beam of Rectangular Cross-section and Analyses for Stress for Unsymmetrical bending case	L1,L2,L3	03
9	Structural Modeling and Stress Analysis of a Torsion Box of a Wing.	L1,L2,L3	03
10	Structural Modeling and Stress Analysis of a Fuselage Frame.	L1,L2,L3	03
11	Structural Modeling and Stress Analysis of a Tapered I-Section Spar.	L1,L2,L3	03
12	Determine the Natural frequency and Mode shapes of a Cantilever beam under UDL.	L1,L2,L3	03
13	A Plate fixed at one end has a hole in centre and has varying thickness, Determine stresses developeddue to applied static loads in vertical direction.	L1,L2,L3	03

14	A Tapered Plate fixed at one end has a hole in centre and has varying thickness, determine stressesdeveloped due to applied static loads in vertical direction.	L1,L2,L3	03
Course outcomes:			
CO1	Draw the geometric models of symmetric, cambered aerofoil, nozzle, wing and other structures.		
CO2	Apply different types of meshing.		
CO3	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

`Course Title	**HELICOPTER AERODYNAMICS**	**Semester**	**VII**
Course Code	**MVJ21AE721**	**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. Comprehend the basic concepts of helicopter dynamics.
2. Acquire knowledge of helicopter performance and rotor bearing system.

3. Understand the Aerodynamics of Rotor Airfoil and rotor wake phenomenon
4. Gain knowledge on the stability and control of Helicopter and its flight test requirements
5. Comprehend the design of Helicopter and its standards and specifications

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

Introduction: History of helicopter flight. Fundamentals of Rotor Aerodynamics; Momentum theory analysis in hovering flight. Disk loading, power loading, thrust and power coefficients. Figure of merit, rotor solidity and blade loading coefficient. Power required in flight. Axial climb, descent, and autorotation.

Blade Element Analysis: Blade element analysis in hovering and forward flight. Rotating blade motion. Types of rotors. Concept of blade flapping, lagging and coning angle. Equilibrium about the flapping hinge, lead/lag hinge, and drag hinge.

Laboratory Sessions/ Experimental learning:

Study of Performance of Propeller

Applications:

Understand the fundamentals of Helicopters dynamics

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

21. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

https://nptel.ac.in/courses/101/104/101104017/

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

Basic Helicopter Performance: Forces acting on helicopters in forward flight. Methods of achieving translatoryflight. Controlling cyclic pitch: Swash-plate system. Lateral tilt with and without conning. Lateral and longitudinal asymmetry of lift in forward flight. Forward flight performance- total power required effects of gross weight, effect of density altitude. Speed for minimum power, and speed for maximum range. Factors affecting forward speed, and ground effects.

Laboratory Sessions/ Experimental learning:

Study of the Surface pressure distribution on a 2-D cambered airfoil

Applications:

Study the performance of helicopter and the mechanism of swash plate assembly

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

https://nptel.ac.in/courses/101/104/101104017/

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

Rotor Airfoil Aerodynamics: Rotor airfoil requirements, effects of Reynolds number and Mach number. Airfoil shape definition, Airfoil pressure distribution. Pitching moment. Maximum lift and stall characteristics, high angle of attack range.

Rotor Wakes and Blade Tip Vortices: Flow visualization techniques, Characteristics of rotor wake in hover, and forward flight. Other characteristics of rotor wake.

Laboratory Sessions/ Experimental learning:

Smoke Flow visualization studies on 2-D airfoil and Circular cylinder

Tuft Flow visualization studies on 2-D airfoil

Applications:

Learn the aerodynamics of helicopter rotor

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics
   https://nptel.ac.in/courses/101/104/101104017/

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

Helicopter Stability and Control. Introductory concepts of stability.Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. Static stability of helicopters: longitudinal, lateral-directional and directional. Dynamic stability aspects. Main rotor and tail rotor control. Flight and Ground Handling Qualities-General requirements and definitions. Control characteristics, Levels of handling qualities.

Flight Testing- General handing flight test requirements and, basis of limitations.

Laboratory Sessions/ Experimental learning:

Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various angles of incidence

Applications:

Understand the stability & control aspects of helicopter and flight test requirements

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

https://nptel.ac.in/courses/101/104/101104017/

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

Standards and Specifications: Scope of requirements. General and operational requirements. Military derivatives of civil rotorcraft. Structural strength and design for operation on specified surfaces. Rotorcraft vibration classification.

Conceptual Design of Helicopters: Overall design requirements. Design of main rotors-rotor diameter, tip speed, rotor solidity, blade twist and aerofoil selection, Fuselage design, Empennage design, Design of tail rotors, High speed rotorcraft.

Laboratory Sessions/ Experimental learning:

Measurement of typical boundary layer velocity profile on the airfoil from leading edge to trailing edge

Applications:

Learn the design requirements of helicopter and its standards & specifications **Video link / Additional online information (related to module if any):** 1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics https://nptel.ac.in/courses/101/104/101104017/

Course outcomes:	
Upon completion of the course, students will be able to:	
CO312.1.1	Apply the basic concepts of helicopter dynamics.
CO312.1.2	Evaluate the helicopter performance.
CO312.1.3	Outline the Aerodynamics of rotor Airfoil and rotor wake
CO312.1.4	Generalize the helicopter stability and control and its test requirements
CO312.1.5	Illustrate the design of a helicopter and its standards and specifications

Reference Books:	
1.	J. Gordon Leishman, Principles of Helicopter Aerodynamics, Cambridge University Press, 2002.
2.	George H. Saunders, Dynamics of Helicopter Flight, John Wiley & Sons, Inc, NY,1975.
3.	W Z Stepniewski and C N Keys, Rotary Wing Aerodynamics, Dover Publications, Inc, New York, 1984.
4.	ARS Bramwell, George Done, and David Balmford, Helicopter Dynamics, 2nd Edition, Butterworth-Heinemann Publication, 2001.

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

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

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

High,3, Medium,2, Low,1

Course Title	**COMPOSITE STRUCTURES**	**Semester**	**VII**
Course Code	**MVJ21AE722/ MVJ21AS722**	**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 properties and advantages of composite materials compared to conventional materials.
2. Comprehend the properties of polymer matrix composites with fibre reinforcements and to learn the fabrication methods used in composites
3. Gain knowledge about the Micro and macro mechanical properties of composite lamina and laminates
4. Understand the failure theories for predicting the failure of a composite lamina
5. Learn the NDT and DT methods of Composites with Composite applications

Module 1	**L1,L2,L3**	10Hrs.
Introduction to Composite Materials Definition, classification of composite materials, classification of reinforcement - particulate, short fibers, whiskers, long fibers composites. matrix materials – metals, ceramics, polymers (including thermoplastics and thermosets), Carbon-Carbon Composites **Metal Matrix Composites:** MMC with particulate and short fiber reinforcement, liquid and solid state processing of MMC – stir casting, squeeze casting. Properties of MMCs, Applications of Al, Mg, Ti based MMC **Laboratory Sessions/ Experimental learning:** **Determination of various composite materials by different types of fibers with application** **Applications:** Aircraft structural Parts, Automobile Sector and Many Engineering fields **Video link / Additional online information (related to module if any):** 22. https://youtu.be/0kB0G6WKhKE?list=PLSGws_74K01-bdEEUElQ9-obrujIKGEhg – IIT Kanpur		
Module 2	**L1,L2,L3,**	10Hrs.
Processing of Polymer Matrix Composites: Thermoset Polymers, Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding,**Resin Transfer Moulding**, Pultrusion, Pulforming, Autoclave Process **Processing of Polymer Matrix Composites:** Thermoplastic Polymers, Extrusion process, Injection Moulding Process, Thermo-forming process. **Post Processing of Composites –** Adhesive bonding, drilling, cutting processes. **Laboratory Sessions/ Experimental learning:** Preparation of Composite laminates by Hand layup method **Applications:** Thermosets and Thermoplastics are used in Aircraft Construction, corrosive environment, Common applications include fans, grating, tanks, ducts, hoods, pumps and cabinets. **Video link / Additional online information (related to module if any):** https://youtu.be/tP8JCX87DzI - IIT Roorkee		
Module 3	**L1,L2,L3**	10Hrs.
Micro-Mechanical Behavior of a Lamina Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants. **Ultimate Strengths of a Unidirectional Lamina** **Macro-Mechanical Behavior of a Lamina:** Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Global and local axis for angle lamina, Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.		

Laboratory Sessions/ Experimental learning:

Determination of Young's Modulus of a Composite beam

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

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

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

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

Failure Theory

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

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

Laboratory Sessions/ Experimental learning:

Evaluate the mechanical properties of a lamina and a laminate

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

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

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

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

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

Applications of Composites Materials

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

Laboratory Sessions/ Experimental learning:

Determination of Defects in a composite by NDT Methods

Applications: NDT- DT Methods, Composites in Aerospace sector

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

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

Course outcomes:

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

CO305.2.1	Compare the properties and select material for the given application.
CO305.2.2	Analyse the properties of polymer matrix composites and Fabrication of Composite materials
CO305.2.3	Apply constitutive equations of *composite* materials and understand mechanical behaviour at *micro and macro* levels.

CO305.2.4	Design and failure *analysis* for manufacturing *composite* materials and Determine stresses and strains relation in composites materials.
CO305.2.5	Carry out various inspectionsin accordance with the established procedures and differentiate various defect types and select the appropriate **NDT** methods for better evaluation

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

CIE Assessment:

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

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

SEE Assessment:

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

CO,PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2

CO1	3	1	2	1	2	2	1	2	2	2	2	2	1	1
CO2	3	1	3	2	2	2	2	2	2	2	2	2	1	1
CO3	3	3	3	3	2	2	1	2	2	2	1	1	1	1
CO4	3	3	3	3	2	2	1	2	2	2	1	1	1	1
CO5	3	1	3	2	2	2	2	2	2	2	2	1	1	1

High,3, Medium,2, Low,1

Semester: VII		
ROCKETS AND MISSILES		
Course Code:	**MVJ21AE723**	**CIE Marks:100**
Credits:3 L:T:P:S:	**3:0:0:0**	**SEE Marks: 100**
Hours:	**40 Hours**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Basics of Rockets and Missiles is an elective course offered in 5th semester Aeronautical Engineering curriculum.	
2	This subject covers extensively regarding design and analysis of rockets and missiles.	
3	The different types of Airframe components, types of propulsion system, and types of guidance systems are also covered in this subject.	
4	This subject will make student to understand advanced problems facing in launch vehicles and missiles.	
5		

UNIT-I	
INTRODUCTION 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. **Applications**: **Web Link and Video Lectures:** https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-512-rocket-propulsion-fall-2005/ https://www.isro.gov.in/launchers	**8 Hrs**
UNIT-II	
Solid Propellant Rocket Motor Systems: Solid Propellant rocket motors, principal features, applications. Solid propellants, types, composition, properties, performance.	**8 Hrs**

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 **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. **Applications**: **Web Link and Video Lectures:** https://www.esa.int/Our_Activities/Space_Transportation/Launch_vehicles/Ariane_5 https://www.nasa.gov/centers/glenn/about/history/lvpo.html	
UNIT-III	
AERODYNAMICS OF ROCKETS AND MISSILES 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. **Applications**: **Web Link and Video Lectures:** https://www.nasa.gov/connect/ebooks/aeronautics_ebooks_archive_1.html	**8 Hrs**
UNIT-IV	
LAUNCH VEHICLE DYNAMICS & ATTITUDE CONTROL OF ROCKETS **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.Λ **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 **Applications** **Web Link and Video Lectures:** http://nptel.ac.in/courses/101104019/	**8 Hrs**
UNIT-V	

ROCKET TESTING AND MATERIALS **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. **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. **Applications**: **Web Link and Video Lectures:** http://nptel.ac.in/courses/101105030/33	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the types of space launch vehicles and missiles.
CO2	Distinguish the solid and liquid propellant motors.
CO3	Classify different types of missiles, understand missile aerodynamics.
CO4	Acquire the knowledge on launch vehicle dynamics, Attitude control
CO5	Identify different types of materials used in rockets, missiles and acquire knowledge on rocket testing

Reference Books	
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
3.	SS Chin, 'Missile *Configuration Design'*.
4.	Cornelisse, J.W., Schoyer H.F.R. and Wakker, K.F., *Rocket Propulsion and Space-Flight Dynamics*, Pitman, 1979,ISBN-13: 978-0273011415
5.	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):

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												
CO2												
CO3												
CO4												
CO5												

High-3, Medium-2, Low-1

Course Title	**EXPERIMENTAL STRESS ANALYSIS**	**Semester**	**VII**
Course Code	**MVJ21724**	**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 electrical strain gauges and their characteristics

2.Comprehend the stress strainof mechanical systems using electrical resistance strain gauges.

3. Gain knowledge of the photo elastic method to study and characterize the elastic behaviour of solid bodies.

4. Acquire knowledge of stress strain behaviour of solid bodies using methods of coating.

5. Gain knowledge of the Moire`s methods and analysis

Module 1	**L1,L2**	10 Hrs.
Introduction: Definition of terms, Calibration, Standards, Dimension and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause and types of experimental errors. General consideration in data analysis. **Electrical Resistance:** Strain Gages: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance' Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone's bridges, Constant current circuits. **Laboratory Sessions/ Experimental learning:** Strain sensitivity in metallic alloys, Wheatstone's bridges **Applications:** **Usage of Strain gage, Identifying Errors during calibration** **Video link / Additional online information (related to module if any):** 23. https://www.youtube.com/watch?v=tkOGqG1Wj8g		
Module 2	**L1,L2,L3,**	10 Hrs.
Strain Analysis Methods: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage. **Force, Torque and strain measurements:** Mass balance measurement, Elastic element for force measurements, torque measurement. **Laboratory Sessions/ Experimental learning:** Force measurements, torque measurement. **Applications:** Methods to find measuring parameters **Video link / Additional online information (related to module if any):** **8.** https://www.youtube.com/watch?v=ydyVsVk96z8		
Module 3	**L1,L2,L3**	10 Hrs.
Two Dimensional Photoelasticity: Nature of light, Wave theory of light - optical interference, Stress optic law –effect of stressed model in plane and circular polariscopes, Isoclinics&Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photo elastic model materials Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Materials for 2D photoelasticity. **Three Dimensional Photo elasticity:** Stress freezing method, Scattered light photoelasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses. **Digital Photoelasticity:** Introduction, Full field Displacement, Strain displacement data, Advanced Video Extensometer, Dic application and advantages. **Laboratory Sessions/ Experimental learning:**		

optical interference

Applications: Understanding stress variation under loading

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

14. https://www.youtube.com/watch?v=5tKPLfZ9JVQ

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

Photo elastic (Birefringent) Coatings: Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings

Laboratory Sessions/ Experimental learning:

Scattered light polariscope and stress data Analyses.

Applications: Identifying Stress

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

11. https://www.youtube.com/watch?v=bkYqqJa5P8w

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

Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications.

Moire Methods: Moire fringes produced by mechanical interference. Geometrical approach, (Shearing interferometry, Digital image correlation ,Specal Method, correction factor, calibration tecniques) Displacement field approach to Moire fringe analysis, 0ut of plane displacement measurements, out of plane slope measurements. Applications and advantages

Laboratory Sessions/ Experimental learning:

Moire fringe analysis

Applications: Understanding holographic technique

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

12. https://www.youtube.com/watch?v=UW5bcsax78I
13. https://www.youtube.com/watch?v=jHb-PM5qH7s&list=PL16JJHgYPkvMyabXO3RVs0YoqwSdMo4YT (NPTEL course)

Course outcomes:

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

CO312.2.1	Analyse electrical strain gaugesand their characteristics.
CO312.2.2	Evaluate stress strain of mechanical systems using electrical resistance strain gauges.
CO312.2.3	Analyse the elastic behavior of solid bodies using photo elastic methods
CO312.2.4	Illustrate tress strain measurements using method of coatings.

CO312.2.5	Analyse moire methods and their applications

Reference Books:	
1.	Srinath L.S Experimental stress Analysis, tata Mc Graw Hill, 1st edition 1971
2.	Sadhu Singh,Experimental Stress Analysis., Khanna publisher. 1st edition 1981
3.	Dally and Riley,Experimental Stress Analysis, McGraw Hill. 1st edition 1991
4.	Holman, Experimental Methods for Engineers, Tata McGraw-Hill Companies, 7th Edition, New York, 2007.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - 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	2	1	0	0	0	0	2	2	2	1	1
CO2	3	3	2	3	3	2	0	0	0	1	2	2	1	1
CO3	3	3	2	3	3	1	0	0	0	1	2	2	1	1
CO4	3	3	2	3	3	2	0	0	0	2	1	2	1	1
CO5	3	3	2	2	3	1	0	0	0	2	2	2	1	1

High,3, Medium,2, Low,1

Course Title	CONTROL ENGINEERING	Semester	VII
Course Code	MVJ21AE725/ MVJ21AS725	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 knowledgeof block diagrams and signal flow graphs.
3. Gain knowledge of stability analysis in Laplace domain through various techniques
4. Apprehend the frequency response specifications and polar plots
5. Understand the requirement for controller and compensation gain.

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

Introduction to Control Systems and Mathematical Models Introduction: Concept of controls, Open loop and closed loop systems with examples, Concepts of feedback and basic structure of feedback control system, requirements of an ideal control system.

Mathematical Models: Transfer function models of mechanical systems, electrical circuits, DC and AC motors in control systems, Analogous systems: Force voltage and Force current analogy.

Laboratory Sessions/ Experimental learning:

1. Draw pole zero plot for open and closed loop system for a given transfer function

Applications:

1. Aircraft Controls

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

24. https://in.mathworks.com/videos/understanding-control-systems-part-1-open-loop-control-systems-123419.html
25. https://in.mathworks.com/videos/understanding-control-systems-part-2-feedback-control-systems-123501.html
26. https://nptel.ac.in/courses/108/102/108102043/

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

Block Diagrams and Signal Flow Graphs: Transfer functions definition and its properties, block representation of control systems and terminologies, block diagram algebra and reduction of block diagrams, Signal flow graph method, Mason's gain formula and its applications.

Transient and Steady State Response Analysis: Introduction, type and order of systems, time response specifications, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance.

Laboratory Sessions/ Experimental learning:

1. Study the behaviour of second order system with impulse, step and ramp input

Applications:

1. simplifies complex control system
2. Analyse the steady and transient behaviour of a system

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

9. https://nptel.ac.in/courses/108/102/108102043/
10. https://in.mathworks.com/videos/simscape-multibody-overview-117986.html?s_tid=srchtitle

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

System stability analysis using Routh's – Hurwitz Criterion Root Locus Plots Definition of root loci, General rules for constructing root loci, Analysis using root locus plots, Determination of desired gain, limit gain, gain margin and conditional stability.

Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams for first and second order systems, Simplified Bode diagrams, Stability analysis using Bode plots and determination of phase margin and gain margin and gain

Laboratory Sessions/ Experimental learning:

1. Analyse the stability using root locus plot for a dynamic system
2. Analyse the stability using bode plot for transfer function

Applications:

1. Stability Analysis of a SISO system
2. Effect of gain in stability of a system
3. Effect of frequency in stability of a system

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

15. https://in.mathworks.com/videos/control-system-design-with-control-system-tuning-app-68749.html?s_tid=srchtitle
16. https://nptel.ac.in/courses/108/102/108102043/

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

Frequency Response Specification and Analysis using Polar plots: Specification: Frequency response definition, frequency response specifications and its relationship with time response specifications.

Analysis: Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles.

Laboratory Sessions/ Experimental learning:

1. Plot Polar plot for a transfer function
2. Determine gain and phase margin from nyquist plot

Applications:

1. Determine stability of an aircraft

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

12. https://in.mathworks.com/videos/control-systems-in-practice-part-10-nichols-chart-nyquist-diagram-and-bode-plot-1607596350472.html?s_tid=srchtitle
13. https://nptel.ac.in/courses/108/102/108102043/

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

Feedback control systems: Types of controllers – Proportional, Integral, Derivative controllers, Proportional – Integral, Proportional – Integral – Derivative controllers; Compensation methods – Series and feedback compensation, Lead, Lag and Lead-Lag Compensators.

State Variable Characteristics of Linear Systems: Introduction to concepts of states and state variable representation of linear systems, Advantages and Disadvantages over conventional transfer function representation, state equations of linear continuous data system. Matrix representation of state equations, Solution of state equation, State transition matrix and its properties, controllability and observability, Kalman and Gilberts test.

Laboratory Sessions/ Experimental learning:

1. Design PID controller for non linear system

Applications:

1. Autopilot design for lateral directional motion
2. Provide suitable controller for non linear or complex system.

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

14. https://in.mathworks.com/videos/pid-control-made-easy-81646.html?s_tid=srchtitle
15. https://nptel.ac.in/courses/108/102/108102043/

Course outcomes:

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

CO403.3.1	Apply the concepts of control models
CO403.3.2	Generate block diagrams and signal flow graphs
CO403.3.3	Perform the stability analysis in Laplace domain through various techniques

CO403.3.4	Evaluate the frequency response specifications and Nyquist criteria
CO403.3.5	Determine controller and compensation gain for feedback control system

Reference Books:	
1.	U.A. Bakshi and V.U. Bakshi, "Control Engineering", Technical Publications
2.	A. NagoorKani, "Control Systems Engineering", RBA Publications, 2014
3.	Katsuhiko Ogatta, "Modern Control Engineering ", Pearson Education, 2004
4.	N.S. Nise, "Control Systems Engineering", Wiley, 6th Edition,2012

CIE Assessment:

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

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

SEE Assessment:

xxviii. 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.

xxix. 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.

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

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

High,3, Medium,2, Low 1

Course Title	FLIGHT TESTING	Semester	VII
Course Code	MVJ21AE731	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:

- Comprehend the basic concepts of flight test instrumentation.
- Acquire the knowledge of performance flight testing and stability control.
- Understand the flying qualities.

Module 1	**L1,L2**	1. rs.

Introduction: Sequence, Planning and governing regulations of flight testing. Aircraft weight and center of gravity, flight testing tolerances. Method of reducing data uncertainty in flight test data - sources and magnitudes of error, avoiding and minimizing errors.

Flight test instrumentation: Planning flight test instrumentation, Measurement of flight parameters. Onboard and ground based data acquisition system. Radio telemetry.

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

Performance flight testing - range, endurance and climb: Airspeed – in flight calibration. Level flight performance for propeller driven aircraft and for Jet aircraft - Techniques and data reduction. Estimation of range, endurance and climb performance.

Performance flight testing -take-off, landing, turning flight: Maneuvering performance estimation. Take-offand landing -methods, procedures and data reduction.

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

Stability and control - longitudinal and maneuvering

Static & dynamic longitudinal stability: - methods of flight testing and data reduction techniques. Stick free stability methods. Maneuvering stability methods & data reduction.

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

Stability and control - lateral and directional

Lateral and directional static & dynamic stability: - Coupling between rolling and yawing moments. Steadyheading slide slip. Definition of Roll stability. Adverse yaw effects. Aileron reversal. Regulations, test techniques and method of data reduction.

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

Flying qualities: MIL and FAR regulations. Cooper-Harper scale. Pilot Rating. Flight test procedures. **Hazardous flight testing:** Stall and spin- regulations, test and recovery techniques. Test

techniques for flutter,vibration and buffeting.	
Course outcomes: Upon completion of the course, students will be able to:	
CO403.2.1	Measure the flight parameters.
CO403.2.2	Estimate the performance of flight.
CO403.2.3	Apply the FAR regulations

Reference Books:	
1.	Flight Testing of Fixed Wing Aircraft Ralph D Kimberlin AIAA educational Series 2003
2.	Flight Testing- Conventional and Jet-Propelled Airplanes, Benson HamlinMac Millan1946
3.	Flight Test Manual AGARD

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:

xxxi. 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.

xxxii. 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.

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

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

CO3	3	3	3	3	2	2	1	1	1	1	1	1	1	1
CO4	3	3	3	3	2	2	1	1	1	1	1	1	1	1
CO5	3	3	3	3	2	2	1	1	1	1	1	1	1	1

High,3, Medium,2, Low

Course Title	**FATIGUE AND FRACTURE MECHANICS**	**Semester**	**VII**
Course Code	**MVJ21AE732**	**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 fatigue of structures.
2. Understand the Statistical Aspects of Fatigue Behaviour
3. Acquire knowledge of Physical Aspects of Fatigue
4. Understand concepts of equations of Fracture Mechanics
5. Comprehend the various Fatigue Design and Testing Procedures.

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

Fatigue of Structures:S.N. curves, Endurance limit, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, plastic stress concentration factors – Notched S-N curves.Plane stress and plane strain concepts, Dugdale approach

Laboratory Sessions/ Experimental learning:

Effect of Stress concentration factors and SNcurves plot in strength of materials lab

Applications:

Determine the Endurance limit and Stress concentration factors

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

NPTEL-

1. https://nptel.ac.in/courses/112/106/112106065/
2. https://www.youtube.com/watch?v=o-6V_JoRX1g

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

Statistical Aspects of Fatigue Behaviour: Low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, Cyclic Strain hardening and softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory,Fatigueloading,Various stages of crack propagation **Laboratory Sessions/ Experimental learning:** Experimental verification of the components can be done for Low cycle and high cycle fatigue **Applications:** Determine the cumulative damage of the material **Video link / Additional online information (related to module if any):** 1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/		
Module 3	**L1, L2**	10Hrs.
Physical Aspects of Fatigue: Phase in fatigue life, Crack initiation, Crack growth, Final fracture, Dislocations, Fatigue fracture surfaces.Crack opening displacement,crack tip opening displacement. **Laboratory Sessions/ Experimental learning:** To determine the crack initiation and crack growth of the given material using equipment setup. **Applications:** To determine the COD and CTOD values of the given material **Video link / Additional online information (related to module if any):** 1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/		
Module 4	**L1, L2**	10 Hrs.
Fracture Mechanics: Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin – Orwin extension of Griffith'stheory to ductile materials, Stress analysis of cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries, Linear elastic fracture mechanics. **Laboratory Sessions/ Experimental learning:** Estimate the effect of stress intensity factors and effect of thickness on fracture toughness. **Applications:** To find out the stress analysis of the cracked bodies **Video link / Additional online information (related to module if any):** 1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/		
Module 5	**L1, L2**	10 Hrs.
Fatigue Design and Testing: Safe life and fail safe design philosophies,Importance of Fracture Mechanics in aerospace structure, Application composite materials and structures. **Laboratory Sessions/ Experimental learning:** Determine short period and phugoid oscillations for a given Quadratic equation **Applications:**		

Determinethe relative stability of an Aircraft **Video link / Additional online information (related to module if any):** 1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/	
Course outcomes: Upon completion of the course, students will be able to:	
CO403.2.1	Apply the concept of Fatigue analysis of the structures
CO403.2.2	Compare the low cycle fatigue and high cycle fatigue and strain hardening and softening
CO403.2.3	Investigate the reasons for crack initiation, growth, and fracture and for COD and CTOD
CO403.2.4	Evaluate Fracture Toughness
CO403.2.5	Analyse Design for Fatigue

Reference Books:	
1.	D. Brock, Elementary Engineering Fracture Mechanics,Noordhoff International Publishing Co.,London, 1994
2.	J.F. Knott, Fundamentals of Fracture Mechanics, Butterworth & Co., Publishers Ltd., London,1983.
3.	W. Barrois and L. Ripley, Fatigue of Aircraft Structures, Pergamon Press, Oxford, 1983
4.	C.G.Sih, Mechanics of Fracture, Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.
CIE Assessment:	
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)	
SEE Assessment:	
xxxiv. 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.	

xxxv. 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.

xxxvi. 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
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CO2	3	3	3	3	2	2	1	1	1	1	1	1	1	1
CO3	3	3	3	3	2	2	1	1	1	1	1	1	1	1
CO4	3	3	3	3	2	2	1	1	1	1	1	1	1	1
CO5	3	3	3	3	2	2	1	1	1	1	1	1	1	1

High,3, Medium,2, Low

Course Title	**ARTIFICIAL INTELLIGENCE AND ROBOTICS**	**Semester**	**VII**
Course Code	**MVJ21AE733/ MVJ21AS733**	**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 1Introduction to AI	**L1,L2,L3**	10 Hrs.
Computerized reasoning - Artificial Intelligence (AI) - characteristics of an AI problem - Problemrepresentation in AI - State space representation - problem reduction-Concept of small talkprogramming		

Laboratory Sessions/ Experimental learning: Compare the theoretical solution to the forward kinematics problem with a physical implementation on the robot. **Applications:** Design, Supply chain management, Prediction of in-service damages **Video link / Additional online information (related to module if any):** 27. https://nptel.ac.in/courses/106/102/106102220/		
Module 2Search Process&Knowledge Representation	**L1, L2, L3,**	10 Hrs.
Search Process:AI and search process - Brute force search techniques - Depth first - Breadth first searchtechniques - Hill climbing - Best first search - AND/OR graphs - A* algorithm - Constraint satisfaction. **Knowledge Representation:** Logic, Propositional logic - Tautology - Contradiction - Normal forms - Predicate logic - Rules of inference - Resolution - Unification algorithm -Production rules - Semantic networks - Frames – Scripts - Conceptual dependency. **Laboratory Sessions/ Experimental learning:**Derive and implement a solution to the inversekinematics problem for the robot **Applications:** Predictive Maintenance, Flight performanceOptimization, Reverse Engineering **Video link / Additional online information (related to module if any):** **11.** https://nptel.ac.in/courses/106/102/106102220/		
Module 3 Introduction to Robotics	**L1, L2, L3**	10 Hrs.
Scope of Robots: The scope of industrial Robots - Definition of an industrial robot - Need for industrial robots. **Robot Components:**Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume- Precision of movement - End effectors - Sensors **Laboratory Sessions/ Experimental learning:**Controlling the robots using the programming language **Applications:** Quality control, Smart Factory Building, Repetitive work management **Video link / Additional online information (related to module if any):** 17. https://nptel.ac.in/courses/112/105/112105249/		
Module 4Future Trends in Robots	**L1, L2, L3**	10 Hrs.
Telepresence robot - Autonomous mobile robots - Walker Robots – Solarball Robot – Underwaterbots – Aerobots - Advanced robotics in Space - Specific features of space robotics systems – longterm technical developments - Next generation robots. **Laboratory Sessions/ Experimental learning:**Integrate computer vision and control of the robot **Applications:** Training, Smart Repairs Management **Video link / Additional online information (related to module if any):** 14. https://nptel.ac.in/courses/112/105/112105249/		
Module 5AI in Robotics	**L1, L2**	10 Hrs.

Robotic perception, localization – mapping- configuring space - planning uncertain movements - dynamics and control of movement, Ethics and risks of artificial intelligence in robotics. **Laboratory Sessions/ Experimental learning:**Integrate forward and inverse kinematics and computer vision to control the robot **Applications:** AI Autopilot in commercial flights, Knowledge-Based Engineering **Video link / Additional online information (related to module if any):** 16. https://nptel.ac.in/courses/106/102/106102220/

Course outcomes:	
Upon completion of the course, students will be able to:	
CO313.2.1	Apply the basic techniques of artificial intelligence
CO313.2.2	Compare and contrast Non-monotonic reasoning and statistical reasoning
CO313.2.3	Design and develop robotic based systems
CO313.2.4	Develop automatic solution for replacing humans in life threatening area
CO313.2.5	Interpret basic AI algorithms in Robotics

Reference Books:	
1.	Elaine Rich And Kevin Knight,Artificial Intelligence, Tata Mcgraw-Hill, 3rdedition,2008.
2.	Barry Leatham - Jones, Elements of industrial Robotics, Pitman Publishing, 1987
3.	J. M. Selig, Introductory Robotics, Prentice Hall, 1992
4.	David Jefferis, Artificial Intelligence: Robotics and Machine Evolution, Crabtree Publishing Company, 1992

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - 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	-	-	-	-	-	-	-	-	-	-	1	1
CO2	3	3	-	-	3	-	-	-	-	-	-	-	1	1
CO3	-	-	-	-	-	3	-	-	-	-	-	-	1	1
CO4	-	-	3	-	-	2	3	-	-	-	-	3	1	1
CO5	3	3	3	-	3	-	2	-	-	-	-	3	1	1

High,3, Medium,2, Low,1

Course Title	**UNMANNED AERIAL VEHICLES**	**Semester**	**VII**
Course Code	**MVJ21AE734**	**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. Comprehend the basic aviation history and UAV systems
2. Understand the air vehicle basic aerodynamics and performance
3. Acquire knowledge ofStability and Control
4. Understand concepts of Propulsion, Loads and Structures
5. Comprehend the various Mission Planning and Control

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

Introduction to Aviation, Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology UAVs, UAV fundamentals, Examples of UAV systems-very small, Small UAV, Medium UAV, Large UAV, UAV applications.

Laboratory Sessions/ Experimental learning:

Design and development of Unmanned Aerial vehicle for real world applications.

Applications:

Usage of UAV systems for Aerial monitoring, surveillance systems

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2. NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

Introduction: The Air Vehicle Basic Aerodynamics, Basic Aerodynamics equations, Aircraft polar, The real wing and Airplane, Induced drag, The boundary layer, Flapping wings, Total Air-Vehicle Drag, Performance: Overview,Climbing flight, Range for propeller driven aircraft,Range- a jet-driven aircraft, Endurance-for propeller driven aircraft,Guiding Flight.

Laboratory Sessions/ Experimental learning:

Conduct the various experiments using the Aerodyanamics lab and its equations.

Applications:

Determine the endurance limit for propeller driven shaft.

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

1. NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2. NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

Stability & Control: Stability, Longitudinal, lateral, Dynamic stability, Aerodynamics control, Pitch control, lateral control, Autopilots, sensor, Controller, actuator, Airframe control, Inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot.

Laboratory Sessions/ Experimental learning:

Determine the longitudinal, lateral and dynamic stability using the Aerodynamics control.

Applications:

Various sensors used for the Autopilot system and control systems.

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

Propulsion Overview: Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine,Electric Motors, Sources of Electrical Power.

Structures: Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials Resin Materials, CoreMaterials& Construction Techniques.

Laboratory Sessions/ Experimental learning:

Determine the efficiency of the various types engines used in the Unmanned Aerial Vehicle

Applications:

Usage of various applications of the resin material and skin reinforcing materials for the aircraft constructions.

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

Mission Planning and Control, Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch, Recovery Trade-offs.

Laboratory Sessions/ Experimental learning:

Determine the various payloads used for the various operations of flight

Applications:

Usage of launch and recovery systems used in the Unmanned Aerial Vehicle

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

Course outcomes:

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

CO312.3.1	Apply the basic concepts of UAV systems
CO312.3.2	Utilise the knowledge of air vehicle basic aerodynamics and performance
CO312.3.3	Apply the knowledge of Stability and Control
CO312.3.4	Evaluate the Propulsion systems, Loads and Structures
CO312.3.5	Apply the mission, planning and control

Reference Books:

1.	Paul GerinFahlstrom , Thomas James Gleason, INTRODUCTION TO UAV SYSTEMS, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd
2.	Landen Rosen, Unmanned Aerial Vehicle, Publisher: Alpha Editions, ISBN 13 : 9789385505034.
3.	Unmanned Aerial Vehicles: DOD‟s Acquisition Efforts, Publisher : Alpha Editions, ISBN13 : 9781297017544

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

Course Title	**GUIDANCE NAVIGATION & CONTROL**	**Semester**	**VII**
Course Code	**MVJ21AE735/ MVJ21AS735**	**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 Guidance and Navigation.

2. Gain knowledge of the various types of guidance and control systems

3. Comprehend the control system for missiles

4.Acquire knowledge of the missile guidance performance

5. Understand the requirement for integrating flight and fire control system.

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

Guidance, Navigation and ControlIntroduction: Concepts of navigation, guidance and control. Introduction to basic principles. Air data information.

Radar Systems: Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector.Limitation of MTI performance. MTI from a moving platform (AMTI).

Laboratory Sessions/ Experimental learning:

1. Analyse the flight instruments of aircraft for given flight condition using MATLAB

Applications: Guidance system for aircraft, Target detection

Video link / Additional online information:

https://nptel.ac.in/courses/101/104/101104062/ - IIT Kanpur

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

Target Detection and Tracking with Radar: Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT). Detection avoidance techniques.

Other Guidance Systems: Gyros and stabilised platforms. Inertial guidance and Laser based guidance. Components of Inertial Navigation System. Imaging Infrared guidance. GPS, SATcom.

Laboratory Sessions/ Experimental learning:

1. Calculate the position and velocity of an target for given doppler shift using MATLAB.

Applications: Target detection and tracking

Video link / Additional online information:

https://nptel.ac.in/courses/101/104/101104062/ -IIT Kanpur

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

Transfer Functions: Input-output Transfer function. Basic altitude reference. Concepts of Open loop and Close Loop, Root Locus plot.

Missile Control System: Guided missile concept. Roll stabilisation. Control of aerodynamic missile. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus.

Laboratory Sessions/ Experimental learning:

1. Determine stability of a system using Root locus plot.

Applications: Stability of a system, Missile autopilot design

Video link / Additional online information:

https://nptel.ac.in/courses/101/104/101104062/ - IIT Kanpur

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

Missile Guidance: Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance.

Laboratory Sessions/ Experimental learning:

1. Draw a missile trajectory to hit a slow moving target using Proportional guidance

Applications: Guidance system for missiles

Video link / Additional online information:

https://nptel.ac.in/courses/101/104/101104062/- IIT Kanpur

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

Integrated Flight/Fire Control System: Principal of missile launch from aircraft, Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. Rate of change of Euler angle , Auto Pilot.

Laboratory Sessions/ Experimental learning:

1. Draw a missile trajectory to hit a combat aircraft using Command guidance.

Applications: Simulation of dynamic modes and performance parameters for Aircraft design

Video link / Additional online information:

https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2005/video-lectures/lecture-16/ - MIT

Course outcomes:

Upon completion of the course, students will be able to:	
CO404.3.1	Apply the concept of guidance and navigation to design guidance system for aircraft.
CO404.3.2	Apply knowledge of the various types of guidance and control systems
CO404.3.3	Evaluate control of missile
CO404.3.4	Analyse missile guidance performance
CO404.3.5	Analyse integrated flight and fire control system

Reference Books:	
1.	P.T. Kabamba and A.R. Girard, Fundamentals of Aerospace Navigation and Guidance, Cambridge Aerospace Series, 2014
2.	John H Blakelock,Automatic control of Aircraft & Missiles`, Wile –Inter Science Publication, 2nd edition, May 1990.
3.	Merrilh I. Skolnik,`Introduction to Radar Systems`, 3rd edition, Tata Mc Graw Hill, 2001.
4.	George M. Siouris**,** Missile Guidance and Control Systems, Springer, 2004

CIE Assessment:

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SEE Assessment:

xxxvii. 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.

xxxviii. 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.

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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

Semester: VII		
AIRCRAFT PROPULSION		
Course Code:	**MVJ21AE741**	**CIE Marks:100**
Credits: L:T:P:S: 3:1:0:0		**SEE Marks: 100**
Hours: 40 Hours		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand and apply the basic thermodynamic principles in aircraft propulsion.	
2	Understand and solve the problems on turboprop, turbojet and turbofan engines.	
3	Acquire knowledge on subsonic and supersonic inlets.	
4	Describe the working of combustion chambers and nozzles.	
5	Understand the fundamentals of rocket propulsion.	

UNIT-I	
Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two stroke and four stroke piston engines, Gas, turbine engines, Cycle analysis of reciprocating engines and jet engines, advantages and disadvantages, numerical problems Laboratory Sessions/ Experimental learning: 1. Identify and demonstrate the various components of Guiberson T-1020 (9-cylinder radial engine) and Tumansky R-25-300 R-26(Jet engine) **Applications**: Automobile industries, Gas turbine industries and Power plants **Web Link and Video Lectures:** • https://youtu.be/XKcRf2R5h4o • https://youtu.be/fTAUq6G9apg • https://ocw.mit.edu/courses/mechanical-engineering/2-61-internal-combustion-enginesspring-2017/lecture-notes/MIT2_61S17_lec1.pdf • https://nptel.ac.in/courses/101106033/	**8 Hrs**
UNIT-II	
Propeller Theories & Jet propulsion **Propeller Theories & Jet propulsion**: Types of propeller, Propeller thrust: momentum theory, Blade element theories, propeller blade design, and propeller selection.	**8 Hrs**

Jet Propulsion: Illustration of working of gas turbine engine, the thrust equation, Factors affectingthrust, Effect of pressure, velocity and temperature changes of air entering compressor Methods of thrust augmentation, Characteristics of turboprop, turbofan and turbojet, Performance characteristics. Ramjet and Scramjet Engines. **Laboratory Sessions/ Experimental learning:** 1. Analyze the performance of a 2 blade fixed pick propeller and plot the performance . **Applications**: Gas turbine and aircraft engine design industries **Web Link and Video Lectures:** **1.** https://youtu.be/0bP2MH3LqvI **2.** https://youtu.be/KjiUUJdPGX0 **3.** https://youtu.be/vq54Tn9djsY	
UNIT-III	
Inlets **Subsonic Inlets** Internal flow and Stall in Subsonic inlets, Boundary layer separation. Major features of external flow near a subsonic inlet. Relation between minimum area ratio and external deceleration ratio. **Diffuser performance.** Supersonic inlets: Supersonic inlets, starting problem in supersonic inlets, Shock swallowing by area variation, External deceleration. Modes of inlet operation. **Laboratory Sessions/ Experimental learning:** Visualize the external and internal deceleration (pre compression and diffusion) over inlet using wind tunnel Learn NASA's Engine Sim Applet Version 1.8a (latest edition) by using Beginner's Guide to Propulsionhttps://www.grc.nasa.gov/WWW/K-12/airplane/ngnsim.html Calculate and draw the performance curves using EngineSim Applet Version 1.8a **Applications**: gas turbine engine design industries **Web Link and Video Lectures:** https://youtu.be/ZoObIZfLa94 https://youtu.be/hFO_n44Uv_Y	**8 Hrs**
UNIT-IV	
Combustion chambers & Nozzles **Combustion chambers** Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance, Flame tube cooling, Flame stabilization , Use of flame holders **Nozzles:** Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions. Nozzle efficiency, Losses in nozzles. Over expanded and under, expanded nozzles, Ejector and variable area nozzles, Thrust reversal. **Laboratory Sessions/ Experimental learning:**	**8 Hrs**

Make a model and explain thrust reversal technique Learn NASA's Range Games Version 1.3 (latest edition) by using Beginner's Guide to Propulsionhttps://www.grc.nasa.gov/WWW/K-12/airplane/ngnsimr.html Calculate and understand the aircraft motion and performance using Range Games Version **Applications:** Gas turbine industries **Web Link and Video Lectures:** https://youtu.be/3u7d-IlvRqs https://youtu.be/LPXLFY-WR-4 https://youtu.be/E4wFJCHEwW4	
UNIT-V	
Rocket Propulsion Classification of rockets, Principle of rocket propulsion, Analysis of ideal chemical rocket, The chemical rocket, Solid propellant rockets, Liquid propellant rockets, Hybrid rockets, Cryogenic rockets nuclear propulsion, Electrodynamic propulsion, Photon propulsion, Propulsive efficiency. **Laboratory Sessions/ Experimental learning:** Make Sugar rocket by using potassium nitrate (small size) Find the specific impulse of the sugar rocket **Applications**: Rockets and missile manufacturing industries **Web Link and Video Lectures:** https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-50-introduction-to-propulsionsystems-spring-2012/lecture-notes/MIT16_50S12_lec9.pdf https://nptel.ac.in/courses/101106033/	**8 Hrs**

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the basic thermodynamic principles and theories in aircraft propulsion.
CO2	Understand the thrust generation and performance of turbojets, turbofans and turboprops.
CO3	Analyze the performance of inlet for subsonic and supersonic applications
CO4	Demonstrate the principle of combustion and distinguish between different types of combustion chambers
CO5	Explain the basic principles of rocket propulsion.

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

	Longman, 1989, ISBN 13: 9780582236325.
5.	

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):

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												
CO2												
CO3												
CO4												
CO5												

High-3, Medium-2, Low-1

Course Title	**AIRCRAFT TRANSPORT SYSTEMS**	**Semester**	**VI**
Course Code	**MVJ21AE742**	**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 air transport systems.
2. Acquire the knowledge of aircraft characteristics and manufacturers
3. Acquire the knowledge of airlines, airport, and infrastructure
4. Understand the navigation and environmental systems.
5. Acquire the knowledge of managerial aspects of airlines

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

Air Transport Systems –Introduction

Environment, transport, and mobility. Systematic description and current challenges. Development of aircraft design driver-speed and range. Development of Airport, Airlines, ICAO, Regulatory Framework and Market Aspects.

Laboratory Sessions/ Experimental learning:how control surfaces behave with change in Cg in lateral, longitudinal and transvers direction.

Applications: Development of aircraft design,Airport and Airlines

Video link / Additional online information

1. https://nptel.ac.in/courses/101/104/101104075/
2. https://www.youtube.com/watch?v=WUq3uN4MDms
3. https://nptel.ac.in/courses/101/104/101104071/

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

Aircraft Characteristics and Manufacturers

Classification of flight vehicles, cabin design, basics of flight physics- structures, mass, and balance. Flight performance and mission. Aircraft manufacturers, development process, production process, supply chain.

Laboratory Sessions/ Experimental learning:

Applications: Aircraft manufacture ring and development process

Video link / Additional online information

1. https://www.youtube.com/watch?v=bn2_NZkYQAo

2. https://nptel.ac.in/courses/101/104/101104075/

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

Airlines, Airport, and Infrastructure

Airline types, Network management. Flight strategy and aircraft selection, flight operations, MRO. Role of Airport, Regulatory Issues, Airport operation and services. Airport planning - infrastructure.

Laboratory Sessions/ Experimental learning: Basic simulation concepts for airport planning and design

Applications: Airport operation and planning

Video link / Additional online information:

1. https://youtu.be/BhvYofNQUQE?list=PL05C6EFB31D920568
2. https://youtu.be/dzlHwwmca4c?list=PL05C6EFB31D920568
3. https://www.nap.edu/read/25573/chapter/4

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

Air Navigation System & Environmental Systems

Principle of operation- Role of Air Navigation services. Air space structures, Airspace and Airport capacity, Aircraft separation. Flight guidance system. runway layout and runway lighting, Communication system. Integrated air traffic management and working system. Air traffic controlEnvironmental aspects-emission, noise, and sound.

Laboratory Sessions/ Experimental learning: Basic simulation on Flight guidance system.

Applications: Air Navigation servicesand Environmental considerations

Video link / Additional online information:

1. https://youtu.be/Th2N_rDfkDw
2. https://youtu.be/shHvE6yV4IM

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

Managerial Aspects of Airlines

Airline passenger marketing, forecasting methods, pricing, and demand. Air cargo-market for air freight. Principles of airline scheduling. Fleet planning.

Laboratory Sessions/ Experimental learning:

Applications: Airline passenger marketing and Air cargo-market

Video link / Additional online information:

1. https://nptel.ac.in/courses/101/104/101104075/
2. https://nptel.ac.in/courses/101/104/101104071/

Course outcomes:

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

CO314.2.1	Describe the air transport systems.

CO314.2.2	Discuss aircraft characteristics and manufacturers
CO314.2.3	Describe airlines, airport, and infrastructure
CO314.2.4	Summariesairnavigation and environmental systems
CO314.2.5	Apply the knowledge of managerial aspects of airlines

Reference Books:	
1.	Air Transport System, Dieter Schmitt, and ValkerGollnick, Springer, 2016
2.	Air Transportation-A Management Prospective, Jhon G Wensveen, Ashgate Publishing Ltd, 2011
3.	The Air Transportation System, Mike Hirst, Woodhead Publishing Ltd, England, 2008
4.	Transport Category Aircraft Systems, Thomas W. Wild, IAP, Inc, Year: 1990

CIE Assessment:

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

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

SEE Assessment:

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

CO, PO Mapping

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

CO5	3	2	2	1	1	2	1	1	1	2	1	2	1	1

High,3, Medium,2, Low,1

Semester: VII		
ROCKETS AND MISSILES		
Course Code:	**MVJ21AE743**	**CIE Marks:100**
Credits: 3 L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 40 Hours		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Basics of Rockets and Missiles is an elective course offered in 5th semester Aeronautical Engineering curriculum.	
2	This subject covers extensively regarding design and analysis of rockets and missiles.	
3	The different types of Airframe components, types of propulsion system, and types of guidance systems are also covered in this subject.	
4	This subject will make student to understand advanced problems facing in launch vehicles and missiles.	
5		

UNIT-I	
INTRODUCTION 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. **Applications**: **Web Link and Video Lectures:** https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-512-rocket-propulsion-fall-2005/ https://www.isro.gov.in/launchers	**8 Hrs**
UNIT-II	
SOLID AND LIQUID ROCKET MOTOR SYSTEMS **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,	**8 Hrs**

thermal protection. Igniters, types, construction. Description of modern solid boosters I) Space Shuttle SRB, II) the Arienne SRB **Applications**: **Web Link and Video Lectures:** https://www.esa.int/Our_Activities/Space_Transportation/Launch_vehicles/Ariane_5 https://www.nasa.gov/centers/glenn/about/history/lvpo.html	
UNIT-III	
MODULE 3: AERODYNAMICS OF ROCKETS AND MISSILES **Liquid Propellant Rocket Motor Systems:** Liquid propellants, types, composition, properties, performance. Propellant tanks, feed systems, pressurization, turbo-pumps, and 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 **Applications**: **Web Link and Video Lectures:** https://www.nasa.gov/connect/ebooks/aeronautics_ebooks_archive_1.html	**8 Hrs**
UNIT-IV	
LAUNCH VEHICLE DYNAMICS & ATTITUDE CONTROL OF ROCKETS **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.Λ **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 **Applications** **Web Link and Video Lectures:** http://nptel.ac.in/courses/101104019/	**8 Hrs**
UNIT-V	
ROCKET TESTING AND MATERIALS **Rocket Testing:** Ground Testing and Flight Testing, Types of Tests facilities and safeguards, monitoring and control of toxic materials, instrumentation and data	**8 Hrs**

management. Ground Testing, Flight Testing, Trajectory monitoring, post -accident procedures. Description of atypical space launch vehicle launch procedure. **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. **Applications**: **Web Link and Video Lectures:** http://nptel.ac.in/courses/101105030/33	

Course Outcomes: After completing the course, the students will be able to	
CO1	Identify the types of space launch vehicles and missiles.
CO2	Distinguish the solid and liquid propellant motors.
CO3	Classify different types of missiles, understand missile aerodynamics.
CO4	Acquire the knowledge on launch vehicle dynamics, Attitude control
CO5	Identify different types of materials used in rockets, missiles and acquire knowledge on rocket testing

Reference Books	
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.
3.	SS Chin, 'Missile *Configuration Design'*.
4.	Cornelisse, J.W., Schoyer H.F.R. and Wakker, K.F., *Rocket Propulsion and Space-Flight Dynamics*, Pitman, 1979,ISBN-13: 978-0273011415
5.	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):

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												
CO2												
CO3												
CO4												
CO5												

High-3, Medium-2, Low-1

Course Title	**AIRCRAFT SYSTEMS & INSTRUMENTATION**	**Semester**	**VII**
Course Code	**MVJ21AE744**	**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:		
6. Gain knowledge of the aircraft control systems. 7. Understand the applications of hydraulics and pneumatics in aircraft systems. 8. Acquire knowledge regarding aircraft engine systems. 9. Comprehend the aircraft auxiliary systems 10. Acquire the knowledge of aircraft instruments.		
Module 1	**L1,L2,L3**	10 Hrs.

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

LaboratorySessions/ Experimental learning:

How it works, flight controls PID controls.

Applications:

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

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

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

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

12. https://nptel.ac.in/courses/112/105/112105047/
13. https://nptel.ac.in/courses/112/103/112103249/
14. https://sciencing.com/make-simple-hydraulic-system-7380816.html

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

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

Laboratory Sessions/ Experimental learning:

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

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

Applications:

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

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

18. https://nptel.ac.in/courses/101/101/101101002/
19. https://spocathon.page/video/lecture-06-lubrication-system

Module 4	**L1,L2,L3**	10 Hrs.
Auxiliary System: Basic Air cycle systems, Vapour Cycle systems, Evaporative vapour cycle systems, Evaporative air cycle systems, Fire protection systems, Deicing and anti-icing systems. **Laboratory Sessions/ Experimental learning:** Response time and operations of firefighting systems in case of engine failure. **Applications:** Firefighting, precautions, how to fight different classes of fire. **Video link / Additional online information (related to module if any):** 15. https://nptel.ac.in/content/storage2/courses/101106035/001_Chapter%201_L1_(01-10-2013) 16. https://nptel.ac.in/courses/103/107/103107156/ 17. https://www.draeger.com/en_seeur/ Products/Aircraft-fire-training-systems.		
Module 5	**L1,L2**	10 Hrs.
Aircraft Instruments: Flight Instruments and Navigation Instruments, Gyroscope, Accelerometers, Air speed Indicators, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles. **Laboratory Sessions/ Experimental learning:** Gyroscope working and applications, Avionics lab instruments working. **Applications:** Understanding readings of the flight instruments, prediction of failure or trouble before actual encounter and taking necessary precautions. **Video link / Additional online information (related to module if any):** 17. https://nptel.ac.in/courses/101/108/101108056/ 18. https://onlinecourses.nptel.ac.in/noc20_ae01/preview 19. https://www.wingbug.com/wingbug-for-experimental-aircraft/		

Course outcomes:

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

CO314.1.1	Distinguish the conventional and modern control systems.
CO314.1.2	Analyse the aircraft systems.
CO314.1.3	Analyse the working of Aircraft engine systems.
CO314.1.4	Describe aircraft Auxiliary systems
CO314.1.5	Applydifferent aircraft instruments.

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

CIE Assessment:

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

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

SEE Assessment:

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

CO, PO Mapping

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

High,3, Medium,2, Low,1

Course Title	UNMANNED AERIAL VEHICLES	Semester	VII
Course Code	MVJ21AE745	**CIE**	50
Total No. of Contact Hours	40 L: T: P:: 3 :1 :0	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	3	**Exam. Duration**	3 Hrs.

The course objective is to:

6. Comprehend the basic aviation history and UAV systems
7. Understand the air vehicle basic aerodynamics and performance.
8. Acquire knowledge of Stability and Control
9. Understand concepts of Propulsion, Loads and Structures
10. Comprehend the various Mission Planning and Control

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

Introduction to Aviation, Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology UAVs, UAV fundamentals, MAVs, and Drones. Examples of UAV systems-very small, Small UAV, Medium UAV, Large UAV, UAV applications.

Laboratory Sessions/ Experimental learning:

Design and development of Unmanned Aerial vehicle for real world applications.

Applications:

Usage of UAV systems for Aerial monitoring, surveillance systems

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2. NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

Introduction: The Air Vehicle Basic Aerodynamics, Basic Aerodynamics equations, Aircraft polar, The real wing and Airplane, Induced drag, The boundary layer, Flapping wings, Total Air-Vehicle Drag, Performance: Overview,Climbing flight, Range for propeller driven aircraft,Range- a jet-driven aircraft, Endurance-for propeller driven aircraft,Guiding Flight.

Laboratory Sessions/ Experimental learning:

Conduct the various experiments using the Aerodyanamics lab and its equations.

Applications:

Determine the endurance limit for propeller driven shaft.

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

1. NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2. NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

Overview, Stability, Longitudinal, lateral, Dynamic stability, Aerodynamics control, Itch control, lateral control, Autopilots, sensor, Controller, actuator, Airframe control, Inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot.

Laboratory Sessions/ Experimental learning:

Determine the longitudinal, lateral and dynamic stability using the Aerodynamics control.

Applications:

Various sensors used for the Autopilot system and control systems.

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

Propulsion: Overview, Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine,Electric Motors, Sources of Electrical Power, Loads and Structures, Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials Resin Materials, CoreMaterials& Construction Techniques.

Laboratory Sessions/ Experimental learning:

Determine the efficiency of the various types engines used in the Unmanned Aerial Vehicle

Applications:

Usage of various applications of the resin material and skin reinforcing materials for the aircraft constructions.

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

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

Mission Planning and Control, Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch, Recovery Trade-offs.

Laboratory Sessions/ Experimental learning:

Determine the various payloads used for the various operations of flight

Applications:

Usage of launch and recovery systems used in the Unmanned Aerial Vehicle

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

Course outcomes:

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

CO401.1	Apply the basic concepts of UAV systems
CO401.2	Utilise the knowledge of air vehicle basic aerodynamics and performance
CO401.3	Apply the knowledge of Stability and Control
CO401.4	Evaluate the Propulsion systems, Loads and Structures
CO401.5	Apply the mission, planning and control

Reference Books:

1.	Paul Gerin Fahlstrom , Thomas James Gleason, INTRODUCTION TO UAV SYSTEMS, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd
2.	Landen Rosen, Unmanned Aerial Vehicle, Publisher: Alpha Editions, ISBN 13 : 9789385505034.
3.	Unmanned Aerial Vehicles: DOD‟s Acquisition Efforts, Publisher : Alpha Editions, ISBN13 : 9781297017544

CIE Assessment:

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

- 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

MVJ College of Engineering, Whitefield, Bangalore 560067

An Autonomous Institution, Affiliated to VTU, Belagavi

Scheme of Teaching and Examination

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

Effective from the academic year 2021-22

Department of Aeronautical Engineering

Semester VIII

Sl. No.	Course		Course Title	BoS	Teaching hrs./week				Examination				Credits
	Type	Code			Lecture L	Tutorial T	Practical P	Self-Study S	Duration Hrs.	CIE Marks	SEE Marks	Total Marks	
1	PRJ	MVJ21XXP81	Project Phase II	AE	-	-	-	-	3	50	50	100	10
2	INT	MVJ21XXINT82	Research / Industrial Internship	AE	-	-	-	-	3	50	50	100	05
3	Seminar	MVJ21XXS83	Seminar	AE	-	-	-	-	3	50	50	100	01
Total					-	-		-		150	150	300	16