Course Title	**Transforms and Statistical Methods**	**Semester**	III
Course Code	**MVJ22MAS31/MAE31**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 0: 0**	**SEE**	50
No. of Contact Hours/week	**4**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

• Comprehend and use of analytical and numerical methods in different engineering fields.

• Apprehend and apply Fourier Series.

• Realize and use of Fourier transforms.

• Realize and use of Z-Transforms.

• Use of statistical methods in curve fitting applications.

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

Laplace Transform:

Definition and Laplace transforms of elementary functions. Laplace transforms of Periodic functions and unit-step function and problems.

Inverse Laplace Transform:

Definition and problems, Convolution theorem to find the inverse Laplace transforms and problems.

Applications: Solution of linear differential equations using Laplace transforms.

Web Link and Video Lectures:

https://www.youtube.com/watch?v=8oE1shAX96U

https://www.intmath.com/laplace-transformation/7-inverse-laplace-transform.php

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

Fourier series:

Recapitulation of Series, Continuous and Discontinuous functions, Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period 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

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

Fourier transforms:

Infinite Fourier transform, Infinite Fourier sine and cosine transforms, Inverse Fourier transforms, Inverse Fourier sine and cosine transforms, Convolution theorem.

Web Link and Video Lectures:

https://www.youtube.com/watch?v=spUNpyF58BY

https://www.youtube.com/watch?v=6spPyJH6dkQ

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

Z-Transforms:

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

Applications: Application of Z- transforms to solve difference equations.

Web Link and Video Lectures:

http://www.eas.uccs.edu/~mwickert/ece2610/lecture_notes/ece2610_chap7.pdf

https://electricalbaba.com/final-value-theorem-and-its-application/

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

Curve Fitting:

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

Statistical Methods:

Introduction, Correlation and coefficient of correlation, Regression, lines of regression and problems.

Web Link and Video Lectures:

https://mathbits.com/MathBits/TISection/Statistics2/correlation.htm

https://www.youtube.com/watch?v=xTpHD5WLuoA

Course outcomes:

CO201.1	Use Laplace transform and inverse transforms techniques in solving differential equations.

CO201.2	Demonstrate Fourier Transform as a tool for solving Integral equations.
CO201.3	Demonstrate Fourier Transform as a tool for solving Integral equations.
CO201.4	Apply Z Transform to solve Difference Equation.Use Method of Least Square for appropriate Curves.
CO201.5	Fit a suitable curve by the method of least squares and determine the lines of regression for a set of statistical data.

Text Books:	
1	Prof G.B.Gururajachar "Engineering Mathematics-III , Academic Excellent series Publications, 2016-17
2	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013
Reference Books:	
1	Erwin Kreyszig, "Advanced Engineering Mathematics", Wiley-India publishers, 10thedition,2014.
2	Ramana B. V., "Higher Engineering Mathematics", Tata McGraw-Hill, 2006.
3	Bali N. P. & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition.

CIE Assessment:

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

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

SEE Assessment:

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

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

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

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

High-3, Medium-2, Low-1

Semester: III		
MECHANICS OF MATERIALS + MATERIAL TESTING LAB (Theory and Practice)		
Course Code:	**MVJ22AS32/AE32**	**CIE Marks:50+50**
Total No. of Contact Hours:	**50 L: T: P: 3: 0: 2**	**SEE Marks: 50 +50**
Hours:	**40 L+ 26 P**	**SEE Duration: 03+03 Hours**

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

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

UNIT-II	
Bending Moment and Shear Force in Beams: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams. **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. 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 Experiment 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	**10 Hrs**

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

Technology Madras	

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

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

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		
Course Code:	**MVJ22AS33/AE33**	**CIE Marks:50+50**
Credits:	**L: T: P: 3: 0: 2**	**SEE Marks: 50 +50**
Hours:	**40 L**	**SEE Duration: 03+03 Hours**

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

UNIT-I	
Basic Considerations: Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids. **Fluid Statics:** Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples. Laboratory Sessions/ Experimental learning: Use of piezometer and manometers Applications: For pressure measurements by using different types of manometers. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/103/101103004/	**10 Hrs**
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	**10 Hrs**

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/	
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. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/103/101103004/	**10 Hrs**
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.	**10 Hrs**

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/	
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**

Course Outcomes: After completing the course, the students will be able to	
CO203.1	Evaluate the effects of fluid properties
CO203.2	Estimate velocity, acceleration and stream function for an incompressible and invisid flow along with governing equations of fluid flow.
CO203.3	Perform dimensional analysis and apply Bernoulli's and Eulers equation for various flow situations involving venturimeter, orificemeter and pitot-tube
CO203.4	Calculate boundary layer thickness and drag co-efficient for laminar and turbulent flows.
CO203.5	Illustrate the basic concepts of compressible flows.

Reference Books

1.	Bansal, R.K, Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi 2015, ISBN-13: 978-8131808153
2.	Yunus A. Cengel& John M Cimbala, Fluid Mechanics and Applications, McGraw Hill Education; 3rd edition, 2013, ISBN-13: 978-0073380322.
3.	Rathakrishnan. E, Fluid Mechanics, Prentice-Hall of India Pvt.Ltd, 2010, ISBN 13: 9788120331839.
4.	Ramamritham. S, Hydraulic Fluid Mechanics and Fluid Machines, Dhanpat Rai& Sons, Delhi, 1988, ISBN 13: 9788187433804

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B Students have to answer five questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have a maximum of three sub divisions. Each unit will have internal choice in

which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Laboratory- 50 Marks

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

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

High-3, Medium-2, Low-1

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

Course objective is to:

1.Understand basic principles of Aircraft and the history of space vehicles.
2.Acquire the basic principles of flight.
3.Learn the basic principle of Aircraft & Rocket propulsion.
4.Understand the Aircraft Structures and Materials.
5.Acquire the basics of Aircraft Instruments & systems.

Module-1	**RBT Level**	**Hours**

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

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

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

Applications: Environmental conditions

Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101101079/

Module-2	**RBT Level**	**Hours**

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

and drag.

Laboratory Sessions/ Experimental learning: Aerodynamics lab Applications: Aircraft Flow dynamics
Video link / Additional online information (related to module if any):
https://nptel.ac.in/courses/101104061/https://nptel.ac.in/courses/101101079/

Module-3	**RBT Level**	**Hours**

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

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

Laboratory Sessions/ Experimental learning: Propulsion lab

Applications: Aircraft engines

Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101101079/

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

Aircraft and Spacecraft - Structures and Materials:

Introduction- General types of construction, Monocoque, Semi-Monocoque and Geodesic structures. Typical wing and fuselage structure; Metallic and non-metallic materials for aircraft application. Use of aluminum alloy, titanium, stainless steel and composite materials. Materials selection for spacecraft application.

Laboratory Sessions/ Experimental learning: Structures lab

Applications: Material & Structural Dynamics of Aircraft

Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101101079/

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

Instrument:

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

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

Laboratory Sessions/ Experimental learning: Instrumentation lab. Applications: Aircraft Instruments. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101101079/	
Course outcomes:	
CO204.1	Differentiate the different concepts of aircrafts and spacecraft's in flight.
CO204.2	Describe the Principle of aviation and space flight.
CO204.3	Explain the Fundamentals of Rocket Propulsion and Aircraft Propulsion.
CO204.4	Apply the concepts of aircraft materials and structures.
CO204.5	Appreciate the complexities involved during development of flight vehicles systems.

Reference Books:	
1	John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673.
2	Lalit Gupta and O P Sharma, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006, ISBN: 9788170020752
3	Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 3rd edition, 2011, ISBN: 9781119965206
4	Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 9th edition,2016, ISBN: 9781118753910

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**MACHINE SHOP**	**Semester**	III
Course Code	**MVJ19ASL35/AEL35**	**CIE**	50
Total No. of Contact Hours	**L: T: P: 3: 0: 0**	**SEE**	50
No. of Contact Hours/week	03	**Total**	100
Credits	02	**Exam. Duration**	3 Hours

Course objective is to:

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

Sl No	Experiment Name	RBT Level	Hours
	PART A		
1	Introduction to Machining operations & tools (i.e., Lath machine & shaper machine etc.)	L1, L2, L3	03
2	Machining and machining time estimation for plain turning taper turning & step turning	L1, L2, L3	03
3	Machining and machining time estimation for thread cutting	L1, L2, L3	03
4	Machining and machining time estimation for knurling	L1, L2, L3	03
5	Machining and machining time estimation for knurling operation	L1, L2, L3	03
6	Machining and machining time estimation for drilling operation	L1, L2, L3	03
7	Machining and machining time estimation for boring operation	L1, L2, L3	03
	PART B		
8	Machining and machining time estimation for internal thread cutting	L1, L2, L3	03
9	Machining and machining time estimation for external thread cutting	L1, L2, L3	03
10	Machining and machining time estimation for eccentric turning	L1, L2, L3	03
11	Machining of hexagon in shaping machine	L1, L2, L3	03
12	Machining of square in shaping machine	L1, L2, L3	03
13	Cutting of gear teeth using milling machine	L1, L2, L3	03
14	Grinding operations using grinding machine	L1, L2, L3	03

Course outcomes:

CO1	Demonstrate the operation of general-purpose machine tools and manufacturing process.

CO2	Identify the special purpose machine tools for specific requirements
CO3	Develop physical models using different mechanical processes.

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

High-3, Medium-2, Low-1

Course Title	**AEROSPCE MATERIALS**	**Semester**	**III**
Course Code	**MVJ22AS361/AE361**	**CIE**	**50**
Total No. of Contact Hours	**40 L: T: P: 3: 0: 0**	**SEE**	**50**
No. of Contact Hours/week	**4**	**Total**	**100**
Credits	**3**	**Exam. Duration**	**3 Hours**

Course objective is to:

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

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

Phase diagrams and Microstructures:

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

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

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

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

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

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

Non-ferrous materials in aircraft construction:

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

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

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

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

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

Ferrous materials in aircraft construction:

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

Maraging Steels: Properties and Applications.

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

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/

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

Composites:

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

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

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

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

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

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

Non-Metals in Aircraft construction:

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

Glass: Types, properties, and applications.

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

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

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

Course outcomes:

CO206.1.1	Apply the knowledge about the phase diagrams and microstructure of alloys.
CO206.1.2	Explain the applications of Non-ferrous alloys in Aircraft and Aerospace industry.
CO206.1.3	Gain knowledge about the application of Ferrous alloys in Aircraft construction

CO206.1.4	Explain the applications of Polymer, Metal matrix composites.
CO206.1.5	Get adequate understanding about the application of Non-metals in Aircraft construction

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

CIE Assessment:

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

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

SEE Assessment:

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

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

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

CO-PO Mapping

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

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

High-3, Medium-2, Low-1

Course Title	**MECHANISM & MACHINE THEORY**	**Semester**	3
Course Code	**MVJ22AS362/AE362**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 1: 0**	**SEE**	50
No. of Contact Hours/week	**4**	**Total**	100
Credits	**3**	**Exam. Duration**	3 Hours

Course objective is to:

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

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

Introduction to Mechanisms:

Types of constrained motion, Link and its types, joints and its types, kinematic pair and its types, degrees of freedom, Grubler's criterion, Types of kinematic chains and inversions: Inversions of Four bar chain: Beam engine, coupling rod of a locomotive, Watt's indicator mechanism. Inversions of Single Slider Crank Chain: Pendulum pump or Bull engine, oscillating cylinder engine, Rotary internal combustion engine, Crank and slotted lever quick return motion mechanism, Whitworth quick return motion mechanism. Inversions of Double Slider Crank Chain: Elliptical trammels, Scotch yoke mechanism, Oldham's coupling. Straight line motion mechanisms: Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism and Ratchet and Pawl mechanism, Ackerman steering gear mechanism.

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

Applications: Ackerman steering gear mechanism.

Video link / Additional online information:

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

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

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

Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons. Static force analysis: Introduction: Static equilibrium, Equilibrium

of two and three force members. Members with two forces and torque. Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction Video link / Additional online information: https://www.youtube.com/watch?v=CTcdQzH5e04		
Module-3	**L1, L2, L3**	**8Hours**
Spur Gears and Gear Trains Spur Gears: Gear terminology, law of gearing, Path of contact, Arc of contact, contact ratio of spur gear, Interference in involute gears, Methods of avoiding interference. Gear Trains: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains. Applications: Design Of spur Gear Video link / Additional online information: https://www.youtube.com/watch?v=N0hTFnvIE7A		
Module-4	**L1, L2, L3**	**8Hours**
Balancing of Rotating and Reciprocating Masses Balancing of Rotating Masses: Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes (only Graphical Methods). Balancing of Reciprocating Masses: Primary and Secondary Unbalanced Forces of Reciprocating Masses, Partial Balancing of Unbalanced Primary Force in a Reciprocating Engine, Balancing of Primary and secondary Forces of Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods) Video link / Additional online information: https://www.youtube.com/watch?v=N0hTFnvIE7A		
Module-5	**L1, L2, L3**	**8Hours**
Types of governors; force analysis of Porter and Hartnell governors, Controlling force, stability, sensitiveness, isochronism, effort, and power of Porter and Hartnell governors. Gyroscopes: Vectorial representation of angular motion, gyroscopic couple, effect of gyroscopic couple on plane disc and aeroplane Laboratory Sessions/ Experimental learning: Porter and Hartnell governors (Design lab) Applications:: Working Of Governors Links https://www.youtube.com/watch?v=FydJu1A1oeM		
Course outcomes:		

CO206.2.1	Apply the theory of velocity, acceleration, and static force analysis to design of mechanisms.
CO206.2.2	Analyze static and dynamic force analysis of mechanisms.
CO206.2.3	Design of spur gears & Gear train.
CO206.2.4	Evaluate spur gears, gear train, balancing of rotating and reciprocating masses.
CO206.2.5	Analyse governors and gyroscope

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

CIE Assessment:

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

- 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 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.

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

High-3, Medium-2, Low-1

Course Title	**Introduction to Drone Technologies**	**Semester**	3
Course Code	**MVJ22AS363**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 0: 0**	**SEE**	50
No. of Contact Hours/week	**4**	**Total**	100
Credits	**3**	**Exam. Duration**	3 Hours

Course objective is to:

- Comprehend the basic evolution of Drones / UAV systems.
- Acquire the knowledge of basic aerodynamics, performance, stability and control.
- Understand the propulsion, loads and structures.
- Understand Regulations and Certification aspects

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

Basics: Introduction, History, UV types: UGV, UAV, USV, UUWV, Drones in India, Future scope. Introduction to nano drones and Swarm Drones

Principles, Newton's Laws, Degrees of Freedom, Stick Movements, Flight Modes, Basic Manoeuvres, Take-off, Pitch, Roll, Yaw, Landing.

Video link / Additional online information:

https://onlinecourses.nptel.ac.in/noc22_ae15/preview

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

Components and Systems: Basic components, Micro controllers, microprocessors, Sensors, Pre-Flight Checks, Flight Planning, Transmitter, Receiver.

Introduction to Arduino Sensors, Program Structures, Flight Controllers, Telemetry, Mission Planning, Camera, Binding, etc.

Video link / Additional online information:

https://onlinecourses.nptel.ac.in/noc22_ae15/preview

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

Air Worthiness: DGCA Rules and Regulations, Pilot Licensing requirements, NPNT Compliance. Certifications.

Video link / Additional online information:

https://onlinecourses.nptel.ac.in/noc22_ae15/preview

Module-4	**L1, L2, L3**	**8Hours**
Basics of Structures: Configurations, Payload Configurations, Design Considerations. **Basics of Propulsion:** Batteries, Hybrid Propulsions, IC Engines, Mini Turbines, Solar, Video link / Additional online information: https://onlinecourses.nptel.ac.in/noc22_ae16/preview		
Module-5	**L1, L2, L3**	**8Hours**
Tuning, Testing, Manufacturing Constraints, Simulator Training, Applications CASE Studies: Construction and testing of a basic drone. Video link / Additional online information: https://onlinecourses.nptel.ac.in/noc22_ae15/preview		

Course outcomes:	
CO206.3.1	Apply the basic concepts of UAV systems.
CO206.3.2	Explain the basic aerodynamics, performance, stability and control required for UAV.
CO206.3.3	Select the propulsion system and materials for structures.
CO206.3.4	Understand Regulatory and Certification aspects
CO206.3.5	Understand basic flight with experimentation

Reference Books:	
1	Introduction to UAV Systems Paul Gerin, Fahlstrom, Thomas James Wiley Publication 4th Edition,2012
2	Unmanned Aerial Vehicles: DOD's Acquisition Efforts Alpha Editions.
3	Handbook of Unmanned Aerial Vehicles Valavanis, K., Vachtsevano S, George J Springer

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars, and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks)

- Mini Project / Case Studies (8 Marks)
- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

xiii. 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.

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**AIRCRAFT MATERIALS AND PROCESSES**	**Semester**	IV
Course Code	**MVJ22AS364/AE364**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 0: 0**	**SEE**	50
No. of Contact Hours/week	**4**	**Total**	100
Credits	**3**	**Exam. Duration**	3 Hours

Course Objectives: This course will enable students to

1. Acquire knowledge of different aerospace materials & their properties.
2. Understand the Heat Treatment processes of aircraft metals and alloys
3. Characteristics and Applications of Aluminium alloys, Ceramics, Composites and Material Testing

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

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

Video link:

https://www.youtube.com/watch?v=hnkFR5J_Ifw&list=PLfIFNJ1DPG4nwAQAY8aEi2-1JPwCRj9Gq

https://www.youtube.com/watch?v=2rxbxNem1iI&list=PLyqSpQzTE6M_ON8uXt-PP8uX6hMWJeYSJ

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

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

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

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

Video link:

https://www.youtube.com/watch?v=pz4w91xiZ6s

https://www.youtube.com/watch?v=PY1GtKQO_20

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

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

Maraging Steels: Properties and Applications.

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

Video link:

https://www.youtube.com/watch?v=LiIuU5MfUOg

https://www.youtube.com/watch?v=SN8-gZwNDCs

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

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

Video link:

https://www.youtube.com/watch?v=LGERbwD5S2g

https://www.youtube.com/watch?v=sCE780XZuaE

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

Material Testing:

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

Video link:

https://www.youtube.com/watch?v=4fcPga2wjSk

https://www.youtube.com/watch?v=5cNWF61Tmj0&list=PLyAZSyX8Qy5AePdV6vbGP4OJQOpbga-

0Q https://www.youtube.com/watch?v=2rxbxNem1iI&list=PLyqSpQzTE6M_ON8uXt-PP8uX6hMWJeYSJ

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

Reference Books:	
1	Titterton GF, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition, 1998, ISBN-13: 978-8175980136
2	H Buhl, Advanced Aerospace Materials, Springer, Berlinl992, ISBN-13: 978-3540558880.

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
SEE Assessment:
xvi. 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. xvii. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. xviii. One question must be set from each unit. The duration of examination is 3 hours.

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

High-3, Medium-2, Low-1

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

Course objective is to:

1) To enhance knowledge on Introduction to Big Bang Theory, Galaxies, Stars, Solar Systems, Electromagnetic Spectrum, Space Communication and Telescopes.
2) Make the learner to familiarize with the solar systems, origin, composition, surface and structure of planets.

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

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

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

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

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

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

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

COs	1) Understand the fundamentals of Astronomy 2) Adequate knowledge about our planetary system, orbits of the moon and earth and properties of planets.

Reference Books:

1.	Forest Ray Moulton, "An Introduction to Astronomy Hardcover", The Macmillan Company, New and Revised Edition, 2018.
2.	Sally R. Ball, "Astronomy for Beginners: The Introduction Guide to Space, Cosmos, Galaxies and Celestial Bodies", Blue source and Friends, 2020.
3	Johnson B. K "Optics and Optical Instruments", Dover Publications, Inc. New York. 2001.

4	Whitlock LA, Pulliam K. "Laboratory exercises for introductory radio astronomy with a small radio telescope". iUniverse. 2008.

Semester: III		
Diploma Mathematics-I		
Course Code:	**MVJ22MATDIP31**	**CIE Marks:100**
Credits:	**L: T: P: 1: 2: 0**	**SEE Marks: 100**
Hours:	**30L+26T**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To familiarize the important and basic concepts of Differential calculus and Differential Equation, ordinary/partial differential equations and Vector calculus and analyse the engineering problems.	

UNIT-I	
Differential calculus: Recapitulations of successive differentiations -n^{th} derivative -Leibnitz theorem and Problems, Mean value theorem -Rolle's theorem, Lagrange's Mean value theorem , Cauchy's theorem and Taylor's theorem for function of one variables. 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 https://nptel.ac.in/courses/111/105/111105122/	**8 Hrs**
UNIT-III	
Vector Calculus: Derivative of vector valued functions, Velocity, Acceleration and related problems, Scalar and Vector point functions, Gradient, Divergence, Curl, Solenoidal and Irrotational vector fields. Vector identities - div (φA), curl (φA), curl (grad φ), div (curl A). Video Link:	**8 Hrs**

https://www.whitman.edu/mathematics/calculus_online/chapter16.html https://www.math.ust.hk/~machas/vector-calculus-for-engineers.pdf	
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:	**MVJ22MAS41/MAE41/MME41**	**CIE Marks:100**
Credits: L: T: P: S	**3: 0: 0: 0**	**SEE Marks: 100**
Hours:	**40**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the concepts of Complex variables and transformation for solving Engineering Problems.	
2	Understand the concepts of complex integration, Poles and Residuals in the stability analysis of engineering problems.	
3	Apply the concept to find external of functional.	
4	Solve initial value problems using appropriate numerical methods.	
5	Students learn to obtain solution s of ordinary and partial differential equations numerically.	

UNIT-I	
Complex variables - 1: 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	
CO211.1	State and prove Cauchy - Riemann equation with its consequences and demonstrate Con-formal Transformation.
CO211.2	Illustrate Complex Integration using Cauchy's Integral theorem, Cauchy's Integral formula, and Cauchy's Residue theorem.
CO211.3	Identify appropriate numerical methods to solve ODE.
CO211.4	Determine the extremals of functionals and solve the simple problems of the calculus of variations.
CO211.5	Choose appropriate numerical methods to solve Partial Differential Equations.

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 + AERODYNAMICS LAB		
Course Code:	**MVJ22AS42/AE42**	**CIE Marks:100**
Credits: L: T: P: S	**3: 0: 2: 0**	**SEE Marks: 100**
Hours: 40L	**40L + 26P**	**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the basics of fluid mechanics as a prerequisite to Aerodynamics	
2	Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil	
3	Acquire knowledge of incompressible flows over airfoil	
4	Understand the fundamentals of incompressible flow over finite wings	
5	Assimilate the understanding of application of finite wing theory and high lift systems	

UNIT-I	
Review of Basic Fluid Mechanics 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	**10 Hrs**

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/	
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	
Incompressible Flow Over Finite Wings 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	**10 Hrs**

flow patterns Video link / Additional online information (related to module if any): http://web.iaa.ncku.edu.tw/~aeromems/Aerodynamics/Ch5.pdf	
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, 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/	**10 Hrs**

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

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

Course Title	AERODYNAMICS LAB	**Semester**	IV
Course Code	**MVJ22AE42/AS42**	**CIE**	50

Total No. of Contact Hours	**40L + 26P**	**SEE**	50
No. of Contact Hours/week	3	**Total**	100
Credits		**Exam. Duration**	3 Hours

Course objective is to:

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

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

11	Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.	L1, L2, L3	03
12	Calculation of aerodynamic forces and moments acting on a model aircraft at various Angle of Attack and speeds using wind tunnel balance With Yaw.	L1, L2, L3	03
13	Calculation of aerodynamic coefficients and forces acting on a model aircraft at various Angle of Attack and speeds using wind tunnel balance Without Yaw.	L1, L2, L3	03
14	Pressure measurements on aerofoil for a case of reverse flow.	L1, L2, L3	03

Course outcomes:

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Semester: IV			
THERMODYNAMICS + (ENERGY CONVERSION LAB+ FLUID MECHANICS LAB)			
Course Code	**MVJ22AS43/AE43**	**CIE**	50
Total No. of Contact Hours	50 L: T : P :: 3 : 2 : 0	**SEE**	50

No. of Contact Hours/week	5	**Total**	100
Credits	4	**Exam. Duration**	3 Hours

Course objective is to: This course will enable students to

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

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

Fundamental Concepts & Definitions:

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

Work and Heat:

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

Laboratory Sessions / Experimental learning:

To determine the unknown area of a given drawing using planimeter

Applications:

1.For temperature measurements

2.To obtain displacement work

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

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

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

First Law of Thermodynamics:

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

Laboratory Sessions/ Experimental learning:

https://www.youtube.com/watch?v=suuTC9uGLrIhttps://www.youtube.com/watch?v=7bJywbP7ZIU

Applications:

1. Conservation of energy principle to Heat and Thermodynamic processes
2. Compressors, Blowers, Steam or Gas Turbines, IC engines Video link / Additional online information (related to module if any):

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

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

Second Law of Thermodynamics:

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

Entropy:

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

Laboratory Sessions/ Experimental learning:

https://www.youtube.com/watch?v=7OJG-ZHrbD8https://www.youtube.com/watch?v=7bJywbP7ZIU

https://www.youtube.com/watch?v=2vHLJjlinjw

Applications:

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

https://nptel.ac.in/courses/101/104/101104067/		
Module-4	**L1, L2, L3**	**10Hours**
Pure Substances: Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point, and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour, and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and HS diagrams, representation of various processes on these diagrams. **Gas Cycles:** Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency, Numerical Laboratory Sessions/ Experimental learning: https://www.youtube.com/watch?v=Juz9pVVsmQQ https://www.youtube.com/watch?v=L1AHGHRvv9s Applications: Working fluids and its properties, in power plants for power generations. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/104/101104067/		
Module-5	**L1, L2, L3**	**10Hours**
Heat Transfer: Introduction to heat transfer, Modes of heat transfer, conduction, convection, radiation heat transfer, heat exchangers, types of heat exchangers(shell and tube heat exchanger, plate heat exchanger) Application of heat transfer in Aeronautical and Aerospace engineering. Applications: IC engines, Gas turbine engines etc.. Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101/104/101104067/		

Course outcomes:

CO203.1	Apply the concepts of thermodynamics in various engineering problems.
CO203.2	Differentiate thermodynamic work and heat and apply I law of thermodynamics to different process
CO203.3	Differentiate thermodynamic work and heat and apply II law of thermodynamics to different process

CO203.4	Apply the concepts of Pure Substances & of various gas cycles
CO203.5	Apply the principles heat transfer

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

CIE Assessment:

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

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

SEE Assessment:

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 Mapping

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

High-3, Medium-2, Low-1

Course Title	ENERGY CONVERSION & FLUID MECHANICS LAB	**Semester**	V
Course Code	MVJ22AS43/AE43	**CIE**	50
Total No. of Contact Hours	40	**SEE**	50
No. of Contact Hours/week	03	**Total**	100
Credits	02	**Exam. Duration**	3 Hours

Course objective is to:

- Familiarize with the flash point, fire point and viscosity of lubricating oils.
- Study IC engine parts, opening and closing of valves to draw the valve-timing diagram.
- Gain the knowledge of various flow meters and the concept of fluid mechanics.
- Understand the Bernoulli’s Theorem.

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

Course outcomes:

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

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

High-3, Medium-2, Low-1

Semester: IV			
COMPUTER AIDED AIRCRAFT DRAWING			
Course Code	MVJ22ASL44/AEL44	**CIE**	50
Total No. of Contact Hours	40	**SEE**	50
No. of Contact Hours/week	03	**Total**	100
Credits	02	**Exam. Duration**	3 Hours

Course objective is to:

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

Sl No	Experiment Name	L1, L2, L3, L4	20Hours
	PART A		
	Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections. 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	L1, L2, L3, L4	10Hours
	Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. **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. **Keys & Joints:** Parallel key, Taper key, Feather key, Gibhead key and Woodruff key. **Riveted Joints:** Single and double riveted lap joints, butt joints with single/double cover strap. **Couplings:** Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint) Laboratory Sessions/ Experimental learning: CAAD Lab Applications: For Manufacturing Aerospace Components. Video link / Additional online information (related to module if any): https://www.youtube.com/watch?v=70hESLwUhMEhttps://www.youtube.com/watch?v=Gdvtw0pTAOs		
	PART C	L1, L2, L3, L4	20Hours
1	Modelling of propeller and hub assembly		
2	Modelling of wing assembly		
3	Modelling of fuselage assembly		
4	Modelling of Engine Mounts		
5	Modelling of main rotor blade assembly of helicopter		
6	Modelling of UAV assembly		
7	Modelling of Landing Gear Assembly		

	Laboratory Sessions/ Experimental learning: CAAD Lab Applications: To Design an Aircraft Model. Video link / Additional online information (related to module if any): https://www.youtube.com/watch?v=rmlUXhvJHt0 https://www.autodesk.com/autodesk-university/class/Fusion-360-and-SketchBook-Teammates-2016#chapterhttps://www.autodesk.in/solutions/cad-cam
Course outcomes:	
CO1	Distinguish drawings of machine and aircraft components
CO2	Identify assembly drawings either manually or by using standard CAD packages.
CO3	Practice with standard components and their assembly of an aircraft.

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

CIE Assessment:

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

- 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 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.

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

High,3, Medium,2, Low,1

Semester: IV			
AIRCRAFT SYSTEMS & INSTRUMENTATION			
Course Code	MVJ20AS451	CIE	50
Total No. of Contact Hours	50 L: T : P :: 3 : 2: 0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hrs.

Course objective is to:

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

Module 1	L1,L2,L3	10 Hrs.

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

LaboratorySessions/ Experimental learning:

How it works, flight controls PID controls.

Applications:

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

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

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

Module 2	L1,L2,L3,	10 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

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

Module 3	L1,L2,L3	10 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

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

Applications:

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

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

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

Module 4	L1,L2,L3	10 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

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

Module 5	L1,L2	10 Hrs.

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

Laboratory Sessions/ Experimental learning:

Gyroscope working and applications, Avionics lab instruments working.

Applications:

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

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

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

Course outcomes:

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

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

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

Semester: V			
FINITE ELEMENT METHODS			
Course Code	**MVJ22AE452/AS452**	**CIE**	**50**
Total No. of Contact Hours	**50 L: T: P: 3: 2: 0**	**SEE**	**50**
No. of Contact Hours/week	**5**	**Total**	**100**
Credits	**4**	**Exam. Duration**	**3 Hrs.**

The course objective is to:

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

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

Introduction: Basic Concepts, Background Review: Introduction, Stresses and Equilibrium, Plane stress, Plane strain, Boundary Conditions, Strain-Displacement Relations, simple elements for the FEM, Potential Energy and Equilibrium, The Rayleigh-Ritz Method, Galerkin's Method, Saint Venant's Principle, Von Mises Stress,

Finite Element Modeling, node, element, Coordinates and Shape Functions, Element Stiffness Matrix and assembly, Properties of K, Use of local and natural coordinates, compatibility and convergence requirements of shape functions.

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

Applications:

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

Video link / Additional online information

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

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

Analysis of bars, truss, frames and beams:

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

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

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

Applications:

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

Video link / Additional online information

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

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

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

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

Applications:

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

Video link / Additional online information:

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

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

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

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

Applications:

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

Video link / Additional online information:

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

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

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

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

Applications:

1. Problem involving heat flow
2. Structural dynamics

Video link / Additional online information:

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

Course outcomes:

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

CO315.2.1	Apply discretization technique for domain using different finite elements

CO315.2.2	Evaluate the effects of different loading and boundary conditions
CO315.2.3	Analyze the governing equations of finite element analysis
CO315.2.4	Formulating mathematical model using higher order element type
CO315.2.5	Analyze heat flow problem by considering dynamic consideration

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

CIE Assessment:

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 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.

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

High,3, Medium,2, Low,1

Semester: IV
INTRODUCTION TO SPACE TECHNOLOGY

Course Code	MVJ22AS453/AE453	**CIE**	**50**
Total No. of Contact Hours	**3 L: T: P: 3: 0: 0**	**SEE**	**50**
No. of Contact Hours/week	**4**	**Total**	**100**
Credits	**3**	**Exam. Duration**	**3 Hrs.**

The course objective is to:

1. Understand the fundamentals of aerospace propulsion.
2. Understand the orbit mechanics and orbit maneuvers.
3. Acquire the knowledge of satellite attitude dynamics and space mission operations.

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

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

Two-dimensional trajectories of rockets and missiles, multi-stage rockets-Vehicle sizing, two stage Multi-stage Rockets, Trade-off Ratios-Single Stage to Orbit, Sounding Rocket, Aerospace Plane, Gravity Turn Trajectories, Impact point calculation, injection conditions-Flight dispersions, Burnout velocity.

Video link / Additional online information:

https://www.youtube.com/watch?v=Hlj2eVt1Vbk&list=PLbMVogVj5nJQt5nsksLn4qcsBrDL_JKkd

https://www.youtube.com/watch?v=Hlj2eVt1Vbk

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

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

Video link / Additional online information:

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

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

Video link / Additional online information:

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

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

Video link / Additional online information:

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

Space Mission Operations: Supporting Ground Systems Architecture and Team interfaces, Mission phases and Core operations, Team Responsibilities, Mission Diversity, Standard Operations Practices.

Video link / Additional online information:

Course outcomes:

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

CO315.3.1	Distinguish the types of aerospace propulsion.
CO315.3.2	Determine the attitude of the satellites.
CO315.3.3	Support the space mission operations

Reference Books:

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

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 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.

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

High,3, Medium,2, Low,1

Course Title	**TURBOMCHINES**	**Semester**	IV
Course Code	**MVJ20AE454/AS454**	**CIE**	50
Total No. of Contact Hours	**40 L: T : P :: 3 : 0 : 0**	**SEE**	50
No. of Contact Hours/week	**4**	**Total**	100
Credits	**3**	**Exam. Duration**	3 Hours

Course objective is to:

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

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

Introduction to turbomachines:

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

Energy transfer in turbomachines:

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

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

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

Video link / Additional online information:

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

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

General analysis of Turbomachines

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

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

on performance.

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

Applications: Compressors and Turbines in Aircraft engines.

Video link / Additional online information: https://nptel.ac.in/courses/101/101/101101058/ https://www.youtube.com/watch?v=oitC03G-QYE

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

Compression process:

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

Expansion process:

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

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

Applications: Turbojet, turbofan, turbo shaft engines.

Video link / Additional online information:

https://youtu.be/8y5KX4kzt0A

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

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

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

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

Applications: Turbojet, turbofan, turbo shaft engines.

Video link / Additional online information:

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

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

https://www.youtube.com/watch?v=b1dyUVA19kQ		
Module-5	**L1,L2**	**8Hours**

Design and performance analysis of axial flow turbines:

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

Designandperformanceanalysisofradialturbines:

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

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

Applications: Turbojet, turbofan, turbo shaft engines.

Video link / Additional online information:

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

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

Course outcomes:

CO315.4.1	Compute the energy transfer and energy transformation in turbomachines.
CO315.4.2	Analyse the design of turbomachine blades.
CO315.4.3	Apply hydraulic pumps and turbines for specific requirements
CO315.4.4	Apply dimensionless parameters for turbomachines
CO315.4.5	Analyse Compression and Expansion process

Reference Books:

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

CIE Assessment:

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

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

SEE Assessment:

xxxi. 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.

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
CO1	3	3	1	0	0	0	0	0	0	0	0	0
CO2	3	3	3	3	0	0	0	0	0	0	0	0
CO3	3	3	3	2	0	0	0	0	0	0	0	0
CO4	3	3	2	1	0	0	0	0	0	0	0	0
CO5	3	3	2	0	0	0	0	0	0	0	0	0

High-3, Medium-2, Low-1

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

Course objective is to:

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

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

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

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

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

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

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

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

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

Reference Books:

1.	Johnson B. K "Optics and Optical Instruments", Dover Publications, Inc. New York. 2001.
2.	Whitlock LA, Pulliam K. "Laboratory exercises for introductory radio astronomy with a small radio telescope". iUniverse. 2008.
3.	Forest Ray Moulton, "An Introduction to Astronomy Hardcover", The Macmillan Company, New and Revised Edition, 2018.
4.	Sally R. Ball, "Astronomy for Beginners: The Introduction Guide to Space, Cosmos, Galaxies and Celestial Bodies", Blue source and Friends, 2020.

Semester: IV			
Diploma Mathematics-II			
Course Code	MVJ22MATDIP-II	**CIE**	50
Total No. of Contact Hours	40	**SEE**	50
No. of Contact Hours/week	4	**Total**	100
Credits	-	**Exam. Duration**	3 Hours

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

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

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

Linear Algebra:

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

Video Link:

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

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

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

Differential calculus:

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

Beta and Gamma functions:

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

Video Link:

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

https://www.youtube.com/watch?v=s6F5yjY6jWk&list=PLMLsjhQWWlUqBoTCQDtYlloI-o-9hxp11 http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx		
Module-3	**L1, L2**	8Hrs.
Analytical solid geometry: Introduction –Directional cosine and Directional ratio of a line, Equation of line in space- different forms, Angle between two-line, shortest distance between two line, plane and equation of plane in different forms and problems. Video Link: https://www.toppr.com/guides/maths/three-dimensional-geometry/ https://www.toppr.com/guides/maths/three-dimensional-geometry/distance-between-skew-lines/		
Module-4	**L1, L2, L3**	8 Hrs.
Probability: Random variable, Discrete probability distribution, Mean and variance of Random Variable, Theoretical Distribution-Binomial distribution, Mean and variance Binomial distribution -Problems. Poisson distribution as a limiting case of Binomial distribution, Mean and variance of Poisson distribution. Normal Distribution-Basic properties of Normal distribution –standard form of normal distribution and Problems. Video Link: https://nptel.ac.in/courses/111/105/111105041/ https://www.mathsisfun.com/data/probability.html		
Module-5	**L1, L2, L3**	8 Hrs.
Partial differential equation: Formation of PDE's by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration. Homogeneous PDEs involving derivative with respect to one independent variable only. Video Link: http://tutorial.math.lamar.edu/Classes/DE/IntroPDE.aspx https://www.studyyaar.com/index.php/module-video/watch/233-cauchys-legendres-de-a-method-of- variation-of-parameters		

Course outcomes:	
CO1	Apply the knowledge of Matrices to solve the system of linear equations and to understand the concepts of Eigen value and Eigen vectors for engineering problems.
CO2	Demonstrate various physical models, find Maxima and Minima for a function of one variable., Point of inflections and Problems. Understand Beta and Gamma function
CO3	Understand the 3-Dimentional geometry basic, Equation of line in space- different forms, Angle between two line and studying the shortest distance.
CO4	Concepts OF Probability related to engineering applications.
CO5	Construct a variety of partial differential equations and solution by exact methods.

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

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (8 marks)
SEE Assessment:
xxxiv. 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. 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.