Semester: IV		
COMPLEX VARIABLES & NUMERICAL METHODS		
Course Code:	**MVJ21MAE41/MAS41/MME41**	**CIE Marks:100**
Credits: L:T:P:S: 2:2:0:0		**SEE Marks: 100**
Hours: 30L+26T		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the concepts of Complex variables and transformation for solving Engineering Problems.	
2	Understand the concepts of complex integration, Poles and Residuals in the stability analysis of engineering problems.	
3	Apply the concept to find external of functional.	
4	Solve initial value problems using appropriate numerical methods.	
5	Students learn to obtain solution s of ordinary and partial differential equations numerically.	

UNIT-I	
Complex variables - 1: Functions of complex variables, Analytic function, Cauchy-Riemann Equations in Cartesian and polar coordinates, Consequences of Cauchy-Riemann Equations, Construction of analytic functions (Using Milne-Thomson method). **Transformations:** Bilinear Transformation, Conformal transformation, Discussion of the transformations $w = z^2$, $w = e^z$ and $w = z + \frac{a}{z}, (z \neq 0)$. **Video Link:** https://www.youtube.com/watch?v=oiK4gTgncww https://www.youtube.com/watch?v=WJOf4PfoHow	**10 Hrs**
UNIT-II	
Complex variables-2: Complex integration - Cauchy theorem, Cauchy's Integral Theorem-Problems, Taylor & Laurent series- Problems, Singularities, Types of Singularities, Poles,	**10 Hrs**

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

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

Reference Books	
1.	Prof G.B.Gururajachar "Engineering Mathematics-III , Academic Excellent series Publications, 2016-17
2.	B.S. Grewal, "Higher Engineering Mathematics" Khanna Publishers, 43rd Edition, 2013.
3.	B.V.Ramana, "Higher Engineering Mathematics", Tata McGraw-Hill, 2006
4.	N.P. Bali & Manish Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 8th Edition.
5.	H K Dass: **"Advanced Engineering Mathematics"**- S Chand & Company Ltd.12th edition.

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

High-3, Medium-2, Low-1

Semester: IV		
INCOMPRESSIBLE AERODYNAMICS		
Course Code:	**MVJ21AE42/AS42**	**CIE Marks:100**
Credits: L:T:P:S: 3:0:0:0		**SEE Marks: 100**
Hours: 40L		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	Understand the basics of fluid mechanics as a prerequisite to Aerodynamics	

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

UNIT-I	
Review of Basic Fluid Mechanics Continuity, momentum and energy equation, Control volume approach to Continuity, momentum and energy equation, Types of flow, pathlines, streamlines, and streaklines, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes. Vorticity, Angular velocity, Stream function, velocity potential function, Circulation, Numericals, Mach cone and Mach angle, Speed of sound. Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds Applications: provides a proper understanding of the flow properties and their characteristics features which helps in the study of flow over airfoils Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101105059/	**10 Hrs**
UNIT-II	
Airfoil Characteristics Fundamental aerodynamic variables, Airfoil nomenclature, airfoil characteristics. wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, aerodynamic center, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. Types of drag-Definitions. Laboratory Sessions/ Experimental learning: Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds Applications: understand the characteristics and the distribution of pressure over the airfoil Video link / Additional online information (related to module if any): https://nptel.ac.in/courses/101105059/	**10 Hrs**
UNIT-III	

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

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

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

CO-PO Mapping												
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	0	1	1	0	1	1	0	11
CO2	3	3	2	3	0	1	1	0	1	1	0	1
CO3	3	3	3	3	1	1	1	0	1	1	0	1
CO4	3	3	3	3	1	1	1	0	1	1	0	1
CO5	3	3	3	2	1	1	1	0	1	1	0	1

High-3, Medium-2, Low-1

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

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

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

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

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

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of three quizzes are conducted along with tests. Test portion is evaluated for 50 marks and quiz is evaluated for 10 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The

number of quizzes may be more than three (conduct additional quizzes and take best three). The three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the assignments are 20 (2 assignments for 10 marks each). The marks obtained in test, quiz and assignment are added to get marks out of 100 and report CIE for 50 marks.

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

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

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

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

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

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

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

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

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Laboratory- 50 Marks

The laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of the marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The

students are encouraged to implement additional innovative experiments in the lab and are awarded 10 marks. Total marks for the laboratory is 50.

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

Laboratory- 50 Marks

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

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

High-3, Medium-2, Low-1

Semester: IV		
FUNDAMENTALS OF AIRCRAFT STRUCTURES + CAAD LAB (Theory and Practice)		
Course Code:	**MVJ21AS45**	**CIE Marks:50+50**
Credits: L:T:P: 3:0:2		**SEE Marks: 50 +50**
Hours:40 L+ 26 P		**SEE Duration: 03+03 Hours**
Course Learning Objectives: The students will be able to		
1	Comprehend the basic concepts of stress strain and understand the different failure theories and to learn the concept of static strength	
2	Illustrate the methods to design a structure against impact and fatigue loads.	
3	Acquire the knowledge of types of loads on aerospace vehicles.	
4	Understand the theory of elasticity.	
5	Apply different Energy methods in calculations related to structural components and to understand the different methods to analyse columns	

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

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

Theory of Elasticity: Theory of Elasticity: Concept of stress and strain, derivation of Equilibrium equations, strain displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity. Principle Stresses and Orientation of Principle Directions. **Columns**: Columns with various end conditions, Euler's Column curve, Rankine's formula, Column with initial curvature, Eccentric loading, southwell plot, Beam-column. Laboratory Sessions/ Experimental learning: 1. Determine the Spring Stiffness for the given spring. 2. Buckling load of slender Eccentric Columns and Construction of Southwell Plot Applications: Stress and Strain displacement, Columns Video link / Additional online information (related to module if any): http://www.digimat.in/nptel/courses/video/112101095/L02.htmlhttps://www.digimat.in/nptel/courses/video/105105177/L01.html	**10 Hrs**
UNIT-V	
Energy Methods: Strain Energy due to axial, bending and Torsional loads. Castigliano's theorem, Maxwell's Reciprocal theorem. **Introduction to Shear Flow:** Symmetrical and Unsymmetrical bendingConcept of shear flow – The shear centre and its determination – Shear flow distribution in symmetrical and unsymmetrical thin-walled sections. Laboratory Sessions/ Experimental learning: 1. Verify Maxwell's Reciprocal theorem 2. Determining of Shear centre location for open sections-unsymmetrical bending Applications: Maxwell's Theorem, Shear Flow and Shear Center Video link / Additional online information (related to module if any): https://www.youtube.com/watch?v=149j7Ys0F58http://www.nptelvideos.com/video.php?id=1637	**10 Hrs**
LABORATORY EXPERIMENTS	
Part A- Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.	

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.

Laboratory Sessions/ Experimental learning: CAAD Lab

Applications: Helps to understand Engineering Drawing.

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

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

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

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

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

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

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

Part C - Assembly Drawings

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

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

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

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

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

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

three tests are conducted for 50 marks each and the average of all the tests are calculated for 50. The marks for the self -study are 20 (2 presentations are be held for 10 marks each). The marks obtained in test, quiz and self -studies are added to get marks out of 100 and report CIE for 50 marks.

Laboratory- 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

Laboratory- 50 Marks

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

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

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

High-3, Medium-2, Low-1

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

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

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

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

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

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

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

Scheme of Evaluation:	
Details	**Marks**

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

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

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

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

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

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

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

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (40 marks each), the final IA marks to be awarded will be the average of three tests - Assignment (10 marks)

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

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

High-3, Medium-2, Low-1

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

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

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

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

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

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

High-3, Medium-2, Low-1

Semester: IV		
Diploma Mathematics-II		
Course Code:	**MVJ21MATDIP41**	**CIE Marks:100**
Credits: L:T:P:S: 1:2:0:0		**SEE Marks: 100**
Hours: 30L+26T		**SEE Duration: 3 Hrs**
Course Learning Objectives: The students will be able to		
1	To familiarize the important and basic concepts of Differential calculus and Differential	

	Equation, ordinary/partial differential equations and Vector calculus and analyse the engineering problems.

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

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

Course Outcomes: After completing the course, the students will be able to	
CO1	Apply the knowledge of Matrices to solve the system of linear equations and to understand the concepts of Eigen value and Eigen vectors for engineering problems.

CO2	Demonstrate various physical models, find Maxima and Minima for a function of one variable., Point of inflections and Problems. Understand Beta and Gamma function
CO3	Understand the 3-Dimentional geometry basic, Equation of line in space-different forms, Angle between two line and studying the shortest distance.
CO4	Concepts OF Probability related to engineering applications.
CO5	Construct a variety of partial differential equations and solution by exact methods.

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

Continuous Internal Evaluation (CIE):

Theory for 50 Marks

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

Semester End Examination (SEE):

Total marks: 50+50=100

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

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

High-3, Medium-2, Low-1