MVJ College of Engineering, Whitefield, Bangalore

An Autonomous Institution, Affiliated to VTU, Belagavi

Scheme of Teaching and Examination 2024

Effective from the academic year 2024-25

Department of Aeronautical Engineering - PG Program

I SEMESTER M.Tech -AE

S. No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
	Type	Code			Theory L	Practical / Seminar T	Tutorial /SDA T/SDA	Duration in Hours	CIE Marks	SEE Marks	Total marks	
1	BSC	MVJMAE11	Applied Mathematics	Mathematics	3	0	0	3	50	50	100	3
2	IPCC	MVJMAE12	Advanced Aerodynamics (+Aerodynamic Lab)	AE	3	2	0	3	50	50	100	4
3	PCC	MVJMAE13	Aerospace Propulsion	AE	3	0	1	3	50	50	100	3
4	PCC	MVJMAE14	Aircraft Performance Engineering	AE	3	0	0	3	50	50	100	3
5	PCC(PB)	MVJMAE15	Airframe Structural Analysis	AE	3	0	1	3	50	50	100	3
6	PCCL	MVJMAEL16	Propulsion Lab	AE	1	2	0	3	50	50	100	2
7	NCMC	MVJRMI17	Research Methodology and IPR(**Online**)	AE	Online courses (online.vtu.ac.in)							PP
Total					**16**	**4**	**2**	-	**300**	**300**	**600**	**18**

Note: **BSC**-Basic Science Courses, **PCC**: Professional core. **IPCC**-Integrated Professional Core Courses, **PCC(PB)**: Professional Core Courses (Project Based), **PCCL**-Professional Core Course lab ,**NCMC**- None Credit Mandatory Course, ,L-Lecture, P-Practical, **T/SDA**-Tutorial / Skill Development Activities(Hours are for Interaction between faculty and students) **MRMI19**- Research Methodology and IPR

(**Online**) for the students who have **not studied** this course in the Undergraduate level. This course is not counted for vertical progression, Students have to qualify for the award of the master's degree.

BSC: Basic Science Courses: Courses like Mathematics/ Science are the prerequisite courses that the concerned engineering stream board of Studies will decide. **PCC:** Professional Core Course: Courses related to the stream of engineering, which will have both CIE and SEE components, students have to qualify in the course for the award of the degree. **Integrated Professional Core Course (IPCC)**: Refers to a Professional Theory Core Course Integrated with practical's of the same course. The IPCC's theory part shall be evaluated by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper. **Project Based Learning Course (PCC(PB):** Project Based Learning course is a professional core Course. Only Students have to complete a project out of learning from the course and SEE will be viva voce on project work. **PCCL: Professional Core Course Laboratory**: Practical courses whose CIE will be evaluated by the class teacher and SEE will be evaluated by the two examiners.
Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in the modelling of systems and algorithms for transient and steady-state operations, thermal study, etc
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc. Students and the course instructor/s are to be involved either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities that will enhance their skills. The prepared report shall be evaluated for CIE marks.

MVJ24IPR16-Research Methodology and IPR- None Credit Mandatory Course (NCMC) if students have not studied this course in their undergraduate program then he /she has to take this course at **http://online.vtu.ac.in** and to qualify for this course is compulsory before completion of the minimum duration of the program (Two years), however, this course will not be considered for vertical progression.

Course Title	**Applied Mathematics**	Semester	I
Course Code	MVJMAE11	CIE	50
Total No. of Contact Hours	40 L: T: P: 3:0:0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

- Acquire Knowledge of Numerical Differentiation and Integration
- Understand Tensors and the Algebra of Tensors
- Gain Knowledge of Optimization Techniques
- Understand the Application of Variational Methods

Module 1	**L3, L4**	8 Hrs.

Numerical Differentiation & Integration

Numerical Differentiation – Formulae for derivatives, differentiation via interpolation, Richardson`s extrapolation.

Numerical Integration: Composite numerical integration, Romberg integration, Inherent errors in numerical integrations; Newton-Cotes quadrature formula; Euler-Maclaurin formula; Adaptive quadrature method, Gaussian quadrature, Multiple integrals.

Applications: Analysis techniques in Aeronautical field

Self-study topic: Method for undetermined coefficients

Module 2	**L3, L4**	8 Hrs.

Multilinear Algebra:

Review of linear algebra-vector spaces, linear transformation, Eigen bases. Multilinearity. Tensor as a generalized concept of a vector in a Euclidean space. Tensor ranks, properties of matrix ranks, properties of multilinear rank, algebraic computational complexity. Contravariant and covariant vectors and mixed tensors; symmetric and skew- symmetric tensors. Addition and scalar multiplication. Outer and Inner products of tensors; Quotient law.

Applications: Flow simulation, Structural analysis, Stability & Control of flight vehicles

Self-study topic: Application-Inertia tensor, stress tensor, contravariance of stress tensor.

Module 3	**L3, L4**	8 Hrs.

Optimization Techniques: Unconstrained optimization- Category of optimization methods. Optimality condition (univariate/multi-variate). Single variable optimization, maxima/minima of a function, Unimodel-Fibonacci method. Polynomial based method. Multivariable optimization. Steepest decent method, conjugate gradient method. Optimization algorithm (analytical, and numerical). Constrained optimization- Lagrange method, Augmented Lagrange technique. Applications: Aerodynamic optimization, Structural optimization, Multi-disciplinary optimization Self study topics: Quadratic programming		
Module 4	**L3, L4**	8 Hrs.
Variational Methods-I: Euler Lagrange necessary condition for an extremum and constraints. Euler Lagrange multiplier theorem for many constraints, and proof of the theorem. Application of Euler-Lagrange multiplier theorem in calculus of variations. Problems with fixed end points & variable end points. Application: Development and Solution of Differential equations Video		
Module 5	**L3, L4**	8 Hrs.
Variational Methods-II: Use of second variation in Extremum problems, necessary and sufficient conditions for extremum. Du Bois-Reymond`s theorem. Function of several variables, Dirichlet` principle. Application: Development and Solution of Differential equations. Self study topics: Eigenvalue problem formulation as a variational problem.		

Course outcomes:

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

CO1	Analyze flow field and aero-structures, aero systems related problems.
CO2	Perform Flow simulation, Structural analysis, Stability & Control of flight vehicles
CO3	Evaluate Multi-disciplinary optimal solutions
CO4	Develop and solve object orientated differential equations for several variables.

Text Books:	
1.	Ray M Bowen & C._C.Wang, `Introduction to Vectors and Tensors, Vol1: Linear & Multilinear Algebra,1976.
2.	Kevin W. Cassel,` Variational Methods with Applications in Science & Engineering, Cambridge University Press,2013.
Reference Books:	
3.	D James Benton, `Numerical Calculus: Differentiation & Integration`,2018, ISBN-13:978-1980680901
4.	Jorge Nocedal & Stephen J. Wright, ‘Numerical Optimization`, Springer,2006

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

High,3, Medium,2, Low,1

Course Title	AERODYNAMICS	Semester	1
Course Code	MVJMAE12	CIE	50
Total No. of Contact Hours	40 L: T: P: 3 : 0: 2	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hrs.

Course objective is to:

- Gain knowledge of incompressible flows over aerofoil
- Understand aerofoil and wing aerodynamic characteristics and theory of lift generation
- Learn about high speed flows over aerofoils
- Acquire knowledge of potential flow equations and its applications
- Acquire knowledge of Unsteady Flows

Module 1	L1,L2,L3	8 hrs

Basics of Aerodynamics: Properties of fluids, Characteristics of Atmosphere, Type of fluid flows, Generation of Lift, Drag and Moment, Incompressible flows over airfoils, calculation of lift and drag from measured pressure distribution, Streamlined and bluff-body, Reynolds number and Mach number, Conservation law of mass and momentum, Euler and Bernoulli's equations, pitot-tube measurement of airspeed. Pressure coefficient. Streamlines, path lines and streak lines. Angular velocity, vorticity, circulation Stream function, velocity potential and their relationship. Governing equation for irrotational and incompressible fluid flow.

Laboratory Sessions/ Experimental learning:

Flow over an aerofoil: Pressure distribution and Force at various angles of attack

Applications

Applicable in standardAirplane Design

Module 2	L1,L2,L3,	8 hrs

Aerodynamics of Airfoils and Wings: Airfoil nomenclature and classification, Low speed aerodynamic characteristics of symmetric and cambered airfoils, Centre of pressure, aerodynamic centre and aerodynamic moment, Concept of point vortex, line vortex and vortex sheet, Kutta condition, Kelvins circulation theorem and starting vortex, Classical thin airfoil theory and symmetric airfoil. Finite wing nomenclature. Incompressible flow over wing, vortex filament, bound vortex, horse shoe vortex, downwash, induce angle of attack and drag. Type of drag. Biot-Savart law and Helmholtzs vortex theorem. Prandtls lifting line theory and limitations. Elliptic lift distributions, expression for induced angle of attack and induce drag. Two dimensional and three dimensional wings lift curve slope and effect of aspect ratio. High lift devices.

Laboratory Sessions/ Experimental learning:

Flow over the various wing configurations **Applications**

Applicable in standardAirplane Design

Module 3	L1,L2,L3	8 hrs

High speed Aerodynamics: Fundamentals of thermodynamic concepts, conservation of energy. Speed of sound, Mach wave and Mach angle. Normal shock wave, Oblique shock wave, Expansion fan, Prandtl-Meyer expansion. Family of shocks. Flow through convergent divergent nozzle. Hodograph and pressure turning angle. Rankine- Hugoniot relation.

Laboratory Sessions/ Experimental learning:

Flow Visualisation at high speeds

Applications

Applicable in standardAirplane Design

Module 4	L1,L2,L3	8 hrs

Compressible flow over airfoil: Full velocity potential equation. Small perturbationtheory. Linearized velocity potential equation and boundary conditions. Pressure coefficient for small perturbation. Prandtl- Glauret compressibility correction. Critical Mach number, Drag Divergence Mach Number, Sound barrier. Transonic area rule, supercritical airfoil, swept wing and delta wing.

Laboratory Sessions/ Experimental learning:

Estimation Compressible flow pressure distribution and thereby estimate Drag Divergence Mach number for the given aerofoil

Applications

Applicable in standardAirplane Design

Module 5	L1,L2	8 hrs

Unsteady Aerodynamics-Aerofoils undergoing small amplitude heave & pitch motion. Effect of harmonically oscillating aerofoils on resulting forces & moments. Unsteady analysis of separated aerodynamic flow. Unsteady loads acting of aircraft.Transition to turbulent flow in aerodynamics.

Applications

Applicable in unsteady flow analysis

Course outcomes: Upon completion of the course, students will be able to:	
CO1	Solve aerodynamic problems related to pressure distribution
CO2	Estimate the lift coefficient of an arbitrary wing configuration
CO3	Evaluate compressible one dimensional flows through varying area ducts
CO4	Analyse problems related to normal and oblique shock wave
CO5	Analyse unsteady flows

Text books:	
1.	Fundamentals of Aerodynamics ,John D. Anderson, McGraw-Hill publication, 5th edition and 2010
2.	Modern compressible flow, John D. Anderson , McGraw-Hill publication, 3rd edition and 2002
3.	Rathakrishnan.E., Gas Dynamics, Prentice Hall of India, 5th edition, 2013

Reference Books:	
1.	Anderson J.D., Introduction to Flight, McGraw Hill, 1987
2.	McCormick B.W., Aerodynamics, Aeronautics and Flight Mechanics, John Wiley & Sons New York, 1979.
3.	Anderson J.D., Foundation of Aerodynamics, McGraw Hill Book Co, New York, 1985.

Aerodynamics Lab

Sl No	**Experiment Name**	**RBT Level**	**Hours**
1	Calibration of test section of subsonic wind tunnel	L1, L2, L3	03
2	Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at lowspeeds.	L1, L2, L3	03
3	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
4	Surface pressure distribution around building models in multiple model arrangement.	L1, L2, L3	03
5	Surface pressure distributions on a cambered wing airfoil at different angles of incidence and estimation of lift and pressure drag.	L1, L2, L3	03
6	Calculation of total drag of a two-dimensional wing of cambered airfoil at low incidence using pitot-static probe wake survey.	L1, L2, L3	03
7	Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of	L1, L2, L3	03

	boundary layer displacement and momentum thickness in the presence of a circular cylinder model.		
8	Study the effect of blockage ratio on drag & pressure distribution of a circular cylinder	L1, L2, L3	03
9	Study of pressure distribution on a hemispherical object.	L1, L2, L3	03
10	Measurement of turbulence level in low speed wind tunnel.	L1, L2, L3	03
11	Study of wake behind wing under reverse flow condition at various angels of attack and compare it with normal flow conditions.	L1, L2, L3	03
12	Conduct a series of test to obtain the stagnation pressure response of pitot probe in a wind tunnel for varied yaw angle and obtain the response curve in terms of error (percentage of velocity head to yaw angle).	L1, L2, L3	03
13	To determine longitudinal static stability derivative of an aircraft configuration model at various angles of attack and slip angles.	L1, L2, L3	03
14	To determine lateral and directional static stability derivative of an aircraft configuration model at various angles of attack and side slips.	L1, L2, L3	03

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

High 3, Medium 2, Low 1

Course Title	Aerospace Propulsion	Semester	III
Course Code	MVJMAE13	CIE	50
Total No. of Contact Hours	50 L : P : SDA : 3 : 00:01	SEE	50
No. of Contact Hours/week	04	Total	100
Credits	3	Exam. Duration	3 Hrs.

Course Learning Objectives:

- Identify the various types of gas turbine engines.
- To analyze the fuel and fuel systems for gas turbine engines.
- To study and analyze propeller aerodynamic theories and rocket propulsion.
- Distinguish between different types of rocket engines and aircraft engines.
- Carry out engine performance analysis and health monitoring.

Module 1	L1,L2	8 Hrs.

Introduction to Gas Turbine Engines: Atmospheric Properties. Turbojet, Turbofan, Turboprop, Turbo-shaft Engine Construction and Nomenclature, theory and performance, introduction to compressors, turbines, combustors, and after burners for aircraft engines.

Applications:

Module 2	L1,L2,	8 Hrs.

Fuel and Fuel Systems for Gas Turbine Engines: Fuel specification, fuel properties, liquid fuel handling and treatment, heavy fuels, fuel gas handling and treatment, equipment for removal of particulate and liquids from fuel gas systems, fuel heating, cleaning of turbine components, fuel economics, operating experience, heat tracing of piping systems. Types of heat tracing systems, storage of liquids.

Module 3	L1,L2	8 Hrs.

Engine Air Frame Integration: Engine Performance theory, Propeller theory – pusher and tractor mode. Thrust vectoring nozzles.

Introduction to Rocket Propulsion and Space Mission: Classification and fundamentals. Fuels and propellants. Rocket combustion processes. Introduction to Space mission. Fuel cells for space mission.

Module 4	L1,L2	8 Hrs.

Solid Propellant Rocket Description: Performance Estimation, Flame spread, and Ignition transient. Mechanical characterization of propellants. Grain design. Burn rate estimation. **Liquid Propellant Rocket Description:** Performance estimation. Injectors. Cooling systems. Combustion instabilities. **Hybrid Propellant Rocket Description**: Performance estimation, Mission requirements, and Power plant selection. Cryogenic engines. Ramjet and Scramjet engines, introduction to Electric propulsion.

Module 5	L1,L2	8 Hrs.
Engine Performance and Health Monitoring: Performance and Matching of modules of gas turbines turbomachine aerothermodynamics, aerothermal equations, efficiencies, dimensional analysis, compressor performance characteristics, turbine performance characteristics, and Engine health monitoring techniques.		

Course outcomes: Upon completion of the course, students will be able to:	
CO1	An ability to independently carry out research /investigation and development work to solve practical problems.
CO2	An ability to write and present a substantial technical report/document.
CO3	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor's program
CO4	Acquire technical competence, comprehensive knowledge, and understanding of the methodologies and technologies associated with Aerospace Engineering. Apply knowledge to identify, formulate, and analyze complex engineering problems.
CO5	Having the ability to apply knowledge of science, mathematics, engineering & technology for the development of Aerospace Propulsion technologies.

Text Books:	
1.	Aerospace Propulsion, Dennis G Shepherd, American Elsevier Publishing Co Inc NY.
2.	Rocket Propulsion Elements, George P Sutton and Donald M Ross, John Wiley & Sons NY

3.	Gas turbine by V Ganeshan, TMH Publication 2018
Reference Books:	
1.	Aircraft power plants, Michael J Kroes and Thomas W Wild, Macmillan/McGraw Hill NY.
2.	Aircraft Gas Turbine Engine Technology, E. Irwin Treager, 3rd Edition, 1995, 'ISBN-002018281
3.	Mechanics & Thermodynamics of Propulsion, Hill, P.G. , Peterson, C.R. Addison, Wesley Longman INC, 1999.

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

High,3, Medium,2, Low,1

Course Title	Aircraft Performance Engineering	Semester	I
Course Code	MVJMAE14	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to: • Understand the fundamentals of Engine Performance. • Acquire knowledge on Aero engine off design performance and analysis • Acquire knowledge on Aircraft Performance		
Module 1	L1, L2	08 Hrs.
Introduction to Aero Engine Performance Analysis: Fundamentals of Aero Engine Performance: Overview of thermodynamic cycles, efficiency, and performance metrics. Gas Turbine Engines: Analysis of various gas turbine cycles (Brayton cycle, turbojet, turbofan, etc.).Performance Parameters: Specific thrust, specific fuel consumption (SFC), thermal efficiency, and propulsive efficiency.		
Module 2	L3	08 Hrs.
Component-Level Performance Analysis: Compressor and Turbine Performance: Characteristics, efficiency, and matching of components. Combustion Chamber Analysis: Heat addition, pressure loss, and efficiency Engine Performance Modeling: Integration of component performance to predict overall engine performance.		
Module 3	L3,L4	08 Hrs.
Advanced Topics in Aero Engine Performance: Off-Design Performance: Analysis of engine performance at different operating conditions (altitude, speed, etc.). Transient Performance: Engine behavior during start-up, acceleration, and deceleration. Case Studies: Performance analysis of modern aero engines, including afterburning turbojets and high-bypass turbofans.		
Module 4	L3	08 Hrs.

Aircraft Performance: Fundamentals and Steady-Level Flight: Basics of Aircraft Performance: Forces acting on an aircraft, equations of motion, and energy methods. Steady-Level Flight: Lift-to-drag ratio, minimum drag, and maximum range and endurance. Power Required and Available: Thrust, power curves, and flight envelope.		
Module 5	L5	08 Hrs.
Aircraft Performance: Maneuvering and High-Speed Flight: Climb Performance: Rate of climb, ceiling, and climb optimization. Takeoff and Landing Performance: Factors affecting takeoff and landing distances, performance under different conditions. High-Speed Flight: Performance analysis in transonic, supersonic, and hypersonic regimes.		

Course outcomes:

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

CO1	Understand the aero engine performance
CO2	Understand the functions of various engine components performance
CO3	Apply the knowledge of engine performance in off design aero engines
CO4	Understand and apply the aircraft performance
CO5	Analyse the Component-Level Performance Analysis

Text books:

1.	"Mechanics and Thermodynamics of Propulsion" by Philip G. Hill and Carl R. Peterson, Pearson, ISBN: 978- 0201146592.
2.	"Aircraft Performance & Design" by John D. Anderson Jr., McGraw-Hill Education, ISBN: 978-0070019715.

Reference Books:

1	"Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamic Design and Performance of Jet Engines" by Nicholas Cumpsty, Cambridge University Press.

2	"Gas Turbine Theory" by H.I.H. Saravanamuttoo, G.F.C. Rogers, and H. Cohen, Pearson
3	“Flight Performance of Fixed and Rotary Wing Aircraft" by Antonio Filippone, Butterworth-Heinemann.

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

High,3, Medium,2, Low,1

Course Title	AIRFRAME STRUCTURAL ANALYSIS	Semester	I
Course Code	**MVJMAE15**	**CIE**	**50**
Total No. of Contact Hours	**50 L : T : P :: 3 : 1:0**	**SEE**	**50**
No. of Contact Hours/week	**4**	**Total**	**100**
Credits	**3**	**Exam. Duration**	**3 Hrs.**

The course objective is to:

- Comprehend the fundamentals knowledge of structural analysis of airframe parts.
- Acquire the knowledge of Airworthiness and Airframe loads.
- Understand the Bending of open and closed, thin-walled beams.
- Understand the Shear of beams and Structural idealization.
- Acquire the knowledge on Stress Analysis of Aircraft Components.

Module 1	**L1,L2,L3**	08 Hrs.

Fundamentals of Structural Analysis: Stress, Equations of equilibrium, Plane stress, Plane strain, Boundary conditions, Determination of stresses on inclined planes, statically determinate, indeterminate systems. Euler buckling of columns.

Module 2	**L2,L3,L4**	08 Hrs.

Structural components of aircraft: Loads on structural components, Function of structural components, Fabrication of structural components, Airworthiness: Factors of safety-flight envelope, Load factor determination.

Airframe loads, Aircraft inertia loads, Symmetric manoeuvre loads, Gust loads, Safe life and fail-safe structures, Designing against fatigue, Fatigue strength of components, Prediction of aircraft fatigue life.

Module 3	**L2,L3,L4**	08 Hrs.

Bending of open and closed, thin-walled beams: Symmetrical bending, Unsymmetrical bending, Deflections due to bending, Calculation of section properties, Applicability of bending theory, Temperature effects.

Module 4	L2,L3,L4	08 Hrs.
Shear of beams: General stress, strain and displacement relationships foropen and single cell closed section thin-walled beams, Shear of open section beams, Shear of closed section beams. **Structural idealization:** Idealization of a panel, Effect of idealization on the analysis of open and closed section beams, Deflection of open and closed section beams.		
Module 5	**L2,L3,L4**	08 Hrs.
Stress Analysis of Aircraft Components: Wing spars and box beams, Tapered wing spar, Open and closed section beams, Beams having variable stringer areas. Fuselages: Bending, Shear, Torsion, Cut-outs in fuselages. Wings: Three-boom shell, Bending, Shear, Cut-outs in wings, Fuselage frames and wing ribs: Fuselage frames, Wing ribs.		

Course outcomes: Upon completion of the course, students will be able to:	
CO1	Apply fundamental concepts of structural analysis to airframe parts
CO2	Demonstrate the knowledge of Airworthiness and Airframe loads.
CO3	Understand the Bending of open and closed, thin-walled beams.
CO4	Understand the Shear of beams and Structural idealization
CO5	Acquire the knowledge on Stress Analysis of Aircraft Components.

Text Book:	
1.	Megson, T.H.G., Aircraft Structures for Engineering Students, Sixth Edition, Elsevier - 2016
Reference Books:	
2.	Perry D J & Azar J J , Aircraft Structures, 2nd edition, McGraw Hill N.Y, 2016
3.	BruhnE.F., Analysis and Design of Flight Vehicles Structures, Tri-Stateoffset Co.USA,1985

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

High,3, Medium,2, Low,1

Course Title	Propulsion Laboratory	Semester	I
Course Code	MVJMAEL16	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3 : 1:0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hrs.

The course objective is to:

- Familiarization with various propulsion experimental facilities
- Familiarize with different propulsion experiments and measurement techniques
- Conduct the test, acquire the data and analyze and document

SL NO	Experiments
1	Cascade testing of a model of turbine blade row and study of wake survey
2	Estimation of propeller performance
3	Forced Convective heat transfer on a flat surface
4	Measurement of Burning Velocity of a Premixed Flame
5	Determination of heat of combustion of aviation fuels
6	Measurement of static overall pressure rise & rotor static pressure rise & fan overall efficiency through axial flow fan unit
7	Effect of inlet flow distortion on measurement of static overall pressure rise & rotor static pressure rise & fan overall efficiency through axial flow fan unit
8	Study of Jet Engine characteristics (thrust, static and total pressures, temperatures, exhaust velocity & fuel consumption)
	Demonstration Experiments (For CIE) if any
9	Performance studies on 2-dimensional diffuser (Stable flow and separated flow)
10	Free and wall jet experimental studies
11	Natural convective heat transfer over an aero foil wing model

12	Measurement of Nozzle flow setup

Course outcomes: Upon completion of the course, students will be able to:	
CO1	Demonstrate various experimental facilities
CO2	Apply the knowledge to use of different sensors and measurement techniques
CO3	Perform the test, acquire the data and analyze and document

Suggested Learning Resources:

- Propulsion lab Manual

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

High 3, Medium 2, Low 1

MVJ College of Engineering, Whitefield, Bangalore

An Autonomous Institution, Affiliated to VTU, Belagavi

Scheme of Teaching and Examination 2024

Effective from the academic year 2024-25

Department of Aeronautical Engineering - PG Program

II SEMESTER M.Tech -AE

Sl. No	**Course**	**Course Code**	**Course Title**	**Teaching Hours /Week**			**Examination**				**Credits**
				Theory	**Practical/ Seminar**	**Tutorial/ Skill Development Activities**	**Duration in hours**	**CIE Marks**	**SEE Marks**	**Total Marks**	
				L	P	T/SDA					
1	IPCC	MVJMAE21	Flight Mechanics (+Simulation Lab)	03	02	00	03	50	50	100	4
2	PCC	MVJMAE22	Applied Computational Fluid Dynamics	03	00	00	03	50	50	100	3
3	PCC	MVJMAE23	Artificial Intelligence and Robotics	03	00	00	03	50	50	100	3
4	PCC	MVJMAE24	Aircraft Design	03	00	00	03	50	50	100	3
5	PEC	MVJMAE25X	Professional Elective Courses-1	03	00	00	03	50	50	100	3
6	PEC	MVJMAE26X	Professional Elective Courses-2	03	00	00	03	50	50	100	3
7	PCCL	MVJMAEL27	Modelling and Analysis Lab	01	02	00	03	50	50	100	2
8	AEC/SEC	MVJMAE28X	Ability/Skill Enhancement Course (Offline/Online)	00 01	02 00	--- ----	02 01	50	50	100	1
TOTAL								**400**	**400**	**800**	**22**

Note: **PCC**: Professional core. **IPCC**-Integrated Professional Core Courses, **PCC(PB):** Professional Core Courses (Project Based), **PCCL**-Professional Core Course lab, **PEC-** Professional Elective Courses, **MDC-** Multi-Disciplinary Courses

, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities** (Hours are for Interaction between faculty and students)

L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities (Hours are for Interaction between faculty and students) **PBLC**: Project Based Learning Course,

Note: **xxx**means specialization code for example **MDE- Design** Engineering, **LDN-** Digital Communication and Networking, **SCE-** Computer Engineering, **CCT-** Construction Technology, **AUD-** Urban Design, **MBA-** Master of Business Administration, **MCA-**Master of Computer Application, etc

Professional Elective Courses-I				
Course Code	**Course title**	L	T/SDA	P
MVJMAE251	Fatigue and Fracture Mechanics	03	00	00
MVJMAE252	Flight Dynamics and Automatic Flight Control	03	00	00
MVJMAE253	Aero Engine Testing and Evaluation	03	00	00
MVJMAE254	Theory of Aeroelasticity	03	00	00

Professional Elective Courses-II				
Course Code	**Course title**	L	T/SDA	P
MVJMAE261	Composite Materials & Fabrication Techniques	03	00	00
MVJMAE262	Flight Testing	03	00	00
MVJMAE263	Rocket and Missiles	03	00	00
MVJMAE264	Hypersonic Aerodynamics	03	00	00

Ability/Skill Enhancement Courses				
Course Code	**Course title**	L	T/SDA	P
MVJMAE281	Avionics	01	00	00
MVJMAE282	Unmanned Aerial Vehicles	01	00	00
MVJMAE283	Aircraft Systems and Instrumentation	01	00	00
MVJMAE284	Theory of Combustion	01	00	00

Ability Enhancement Courses (AEC):.These courses are designed to help students enhance their skills in communication, language, and personality development.

They also promote a deeper understanding of subjects like social sciences and ethics, culture and human behaviour, human rights, and the law.

Skill Enhancement Course (SEC): Skill Enhancement Course means a course designed to provide value-based or skill-based knowledge and should contain both theory and lab/hands-on/training/fieldwork. The main purpose of these courses is to provide students with life skills in the hands-on mode to increase their employability.

AEC/SEC courses are ONLINE (MOOCs) courses These courses can also be conducted off-line

Course Title	Flight Mechanics	Semester	II
Course Code	MVJMAE21	CIE	50
Total No. of Contact Hours	40+26P L: T: P: 3: 2: 0	SEE	50
No. of Contact Hours/week	3	Total	100
Credits	4	Exam. Duration	3hrs

Course objective is to:

This course will enable students to

- Understand the steady performance of airplanes
- Understand the accelerated performance of airplane
- Acquire knowledge of static longitudinal stability of airplane
- Acquire knowledge of static directional and lateral stability of airplane
- Gain knowledge of dynamic longitudinal stability of airplanes

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

Aircraft Performance: Aviation history. Principles of Flight. Aircraft aerodynamics; Drag and Thrust. Steady and level Flight. Variation of Thrust, Drag, Power available, and Power required with speed and altitude. Minimum drag, minimum power, Maximum and minimum level flight speeds. Simple problems

Laboratory Sessions/Experimental Learning

Estimation of Drag and Lift at various speeds and thereby drag polar estimation applications applicable in standard Airplane design

Application:- Applicable in Standard Aircraft Design

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

Steady Performance: Airplane Steady Performance: General equation of motion, Steady level flight performance, Steady Climbing, Gliding Flights; Minimum rate of sink and range in a glide. Range and Endurance of jet and piston prop airplanes.

Accelerated Performance: Estimation of take-off and landing distances. Ground effect, Balanced Field Length. Turn performance; Bank angle, load factor, pull-up & pull-down maneuver; accelerated climbing, V-n diagram.

Laboratory Sessions/Experimental Learning

Estimation of Drag and Lift at various turn performances

Applications:

Applicable in Standard Aircraft Design

Module-3	L2 , L3 L4	**8 Hours**

Static Longitudinal Stability and Control : Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane. Trim condition. Static margin.stick fixed neutral points. Longitudinal control, Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range, Hinge moment parameters, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G

Laboratory Sessions/Experimental Learning

Estimation of Static Stability Derivatives at various Speeds

Applications:

Applicable in Standard Aircraft Design

Module-4	L2 , L3 L4	**8 Hours**

Static Directional Stability and Control: Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition, Weather cocking effect.

Static Lateral Stability And Control: Introduction, definition of Roll stability. Estimation of dihedral effect., Effect of wing sweep, flaps, and power, Lateral control, Estimation of lateral control power, Aileron control forces, Balancing the aileron.

Laboratory Sessions/Experimental Learning

Estimation of Static stability derivatives at various speeds applications

Applications:

Applicable in Standard Aircraft Design

Module-5	L2 , L3 L4	**8 Hours**

Dynamic Longitudinal Stability: Definition of Dynamic longitudinal stability: types of modes of motion: long or phugoid motion, short period motion. Airplane Equations of longitudinal motion, Derivation of rigid body equations of motion, Orientation and position of the airplane, gravitational and thrust forces, Small disturbance theory.

Dynamic Lateral and Directional Stability: Routh’s criteria. Factors affecting period and damping of oscillations. Effect of wind shear.

Laboratory Sessions/Experimental Learning

Estimation of Dynamics stability Derivatives

Applications:

Applicable in standard aircraft design

Course outcomes:	
CO1	Apply knowledge to calculate steady and accelerated performance
CO2	Apply knowledge to calculate steady and accelerated performance
CO3	Solve problems of longitudinal static stability for stick fix and stick free condition
CO4	Evaluate problems of lateral and traverse static stability for stick fix and stick free condition
CO5	Analyse dynamic stability for rigid airframe

Text Books:	
1	Anderson J.D., Introduction to Flight, McGraw Hill, 1987
2	Perkins, C.D., and Hage, R.E., Airplane Performance, stability and Control, John Wiley & Sons Inc, New York, 1988
Reference Books:	
1	McCormick B.W., Aerodynamics, Aeronautics and Flight Mechanics, John Wiley & Sons New York, 1979.
2	Anderson J.D., Foundation of Aerodynamics, McGraw Hill Book Co, New York, 1985.

CIE Assessment:

CIE is based on quizzes, tests, assignments/seminars, and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests. Quizzes/mini tests (10 marks). Assignment (10 marks).

SEE Assessment:

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

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

High-3, Medium-2, Low-1

LAB COMPONENT – SIMULATION LAB			
Sl. No	**Experiment Name**	**RBT Level**	**Hours**
1	Simulate aircraft Take-off and landing trajectory for a piston and for a Jet driven plane	L2,L3	02
2	Develop a straight and level flight simulation program using MATLAB and show the effect of head and tail wind shear on this motion	L2,L3	02
3	Simulate aircraft motion to show phugoid and short period motions	L2,L3	02
4	Simulate stall of aircraft under varied conditions of W/S for Jet driven aircraft	L2,L3	02
5	Simulate the effect of variation in static margin on stalling characteristics for jet aircraft	L2,L3	02
6	Simulate and demonstrate balanced field length concept for a jet driven aircraft	L2,L3	02
7	Simulate Dutch roll and Spiral motion of aircraft under varied directional Stability conditions for a Jet plane, keeping lateral stability unaltered.	L2,L3	02
8	Simulate turning flight of airplane under varied conditions of speed and load factor.	L2,L3	02
9	Simulate a spring mass system with damping for analysis of linear motion	L2,L3	02
10	Demonstrate the phenomenon of rudder lock under varied conditions of directional stability	L2,L3	02
11	Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a pulse input in pitch that is intended to bleed the airspeed.	L2,L3	02
12	Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a doublet input in pitch.	L2,L3	02

Course Title	**APPLIED COMPUTATIONAL FLUID DYNAMICS**	**Semester**	II
Course Code	**MVJMAE22**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 1: 0**	**SEE**	50
No. of Contact Hours/week	**3**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

- Understand CFD ideas and Mathematical behavior of PDEs
- Acquire the knowledge to solve CFD problems through finite difference discretization
- Gain knowledge for grid generation and optimize grids
- Acquire the knowledge to solve CFD problems through finite volume technique

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

Introduction: CFD ideas to understand, CFD Application, Models of flows, Substantial derivative, Divergence of velocity. Governing Equations (no derivation) of flow; continuity, momentum, energy. Physical Boundary conditions. Conservative & Non-conservative forms of equations, Integral vrs Differential Forms of Equations. Form of Equations particularly suitable for CFD work. Shock capturing, Shock fitting. Mathematical Behavior of Partial Differential Equations: Classification of partial differential equations - Cramer Rule, Eigenvalue method. Equations of mixed type. Classification Impact on Physical & Computational Fluid Dynamics:

Case studies. Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Choice of PDE vis a vis Flow behavior

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

Discretization: Essence of discretization- Finite difference quotient, solution process, Reflection Boundary condition. Difference equation-Explicit and Implicit approach. Errors and stability analysis. Stability regions of standard time -steeping techniques. Solution of finite difference equations; Time marching and Space marching. Upwind and Mid-point leap frog schemes. shock capturing, Numerical viscosity, artificial viscosity. Relaxation technique; successive over relaxation/ successive under relaxation. Alternating Direction Implicit (ADI) Method. Lax- Wendroff second order scheme (without and with artificial viscosity). Effect of conservative smoothing. Unsteady problem-Explicit versus Implicit Scheme.

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Flow analysis using Finite Difference Techniques

Module-3	L2 , L3 L4	**8 Hours**

Grid Generation: Structured Grid Generation:-Algebraic Methods, Numerical grid generation methods, Surface grid generation, Multi Block Structured grid generation. Unstructured Grid Generation:- Delaunay-Voronoi Method, advancing front methods (AFM) Modified for Quadrilaterals, iterative paving method, Quadtree& Octree method. Multi-grid methods (Cycling Strategies). PDE mapping methods, use of grid control functions, and Chimera grids. **Laboratory Sessions/ Experimental learning:** Ansys Lab **Applications**: Body fitting Grid generation		
Module-4	L2 , L3 L4	**8 Hours**
Adaptive Grid Methods: Adaptive Structured Grid Generation, Unstructured adaptive grid Methods. Mesh refinement methods, and Mesh enrichment method. Unstructured Finite Difference mesh refinement. Approximate Transformation & Computing Techniques: Matrices & Jacobian. Generic form of governing Flow Equations with strong conservative form in transformed space. Transformation of Equation from physical plane into computational Plane - examples. Control function methods. Variation Methods. Domain decomposition. Need for Parallel Computing in CFD algorithms. **Laboratory Sessions/ Experimental learning**: Ansys Lab **Applications:** Adaptive Grid formulation		
Module-5	L2 , L3 L4	**8 Hours**
Finite Volume Techniques: Spatial discretisation:-Cell Centered Formulation and Cell vertex Formulation. Temporal discretisation:- Explicit time-stepping and Implicit time- stepping, time step calculation, Boundary conditions Case studies- Laplace equation, Diffusion problem, Convection and diffusion, Unwinding scheme, and Unsteady flows. High Resolution schemes- Total variation diminishing scheme, Hybrid differencing scheme, weighted essentially non- oscillatory scheme, artificial dissipation, and flux limiters. CFD Application to Some Problems: Aspects of numerical dissipation & dispersion. Approximate factorization, Flux Vector splitting. Application to Turbulence-Models. Large eddy simulation, Direct Numeri Computational solution to turbulent and laminar boundary layers. Heat through c radiation. Post-processing and visualization, contour plots, vector plots etc. **Laboratory Sessions/ Experimental learning:** Ansys Lab **Applications:** Flow analysis through Finite Volume Technique		

Course outcomes:

CO1	Apply knowledge to CFD ideas and Flow Equations
CO2	Assimilate Mathematical behavior of PDEs Vis a Vis Nature of flow
CO3	Utilize finite difference techniques
CO4	Generate and utilize grids
CO5	Apply finite volume techniques

Text Books:	
1	John D. Anderson, Computational Fluid Dynamics – The Basics with Application, Indian Edition, McGraw Hill Education (India) Private Limited (1995).
2	S C Gupta, Applied Computational Fluid Dynamics, first edition, Wiley India Pvt. Ltd (2019)
Reference Books:	
1	F. Wendt (Editor), Computational Fluid Dynamics - An Introduction, Springer Verlag, Berlin; 1992.
2	Charles Hirsch, Numerical Computation of Internal and External Flows John Wiley & Sons, New York; 1988
3	Fletcher, C.A.J, Computational Techniques for Fluid Dynamics, Sprir edition, 2002,ISBN-13: 978-3540543046
4	Tapan K. Sengupta, Fundamentals of CFD, Universities Press, 2004
CIE Assessment:	
CIE is based on quizzes, tests, assignments/seminars, and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests Quizzes/mini tests (10 marks), Assignment (10 marks)	
SEE Assessment:	
. Question paper for the SEE consists of two parts i.e., Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. 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	0	1	1
CO2	3	2	1	0	0	0	0	0	0	0	0	0	1	1
CO3	3	2	1	0	0	1	1	0	0	0	0	0	1	1
CO4	3	2	1	0	0	1	1	0	0	0	0	0	1	1
CO5	3	2	1	0	0	0	0	0	0	0	0	0	1	1

High-3, Medium-2, Low-1

Course Title	**ARTIFICIAL INTELLIGENCE AND ROBOTICS**	**Semester**	II
Course Code	**MVJMAE23**	**CIE**	50
Total No. of Contact Hours	**40 L: T:P: 3:1:0**	**SEE**	50
No. of Contact Hours/week	**3**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to: This course will enable students to • Understand the basic techniques of artificial intelligence • Understand Non-monotonic reasoning and statistical reasoning • Introduce the electronics and software aspects in the design of robots • Introduce the latest state of the art robots • Understand the usage of AI in Robots		
Module-1 Introduction to AI	L1,L2,L3	**8 Hours**
Computerized reasoning - Artificial Intelligence (AI) - characteristics of an AI problem - Problem representation in AI - State space representation - problem reduction-Concept of small talk programming **Laboratory Sessions/ Experimental learning:** Compare the theoretical solution to the forward kinematics problem with a physical implementation on the robot. **Applications:** Design, Supply chain management, Prediction of in-service damages		
Module 2 Search Process Knowledge Representation	**L1, L2, L3,**	**8 Hrs.**
Search Process: AI and search process - Brute force search techniques - Depth first - Breadth first search techniques - Hill climbing - Best first search - AND/OR graphs - A* algorithm - Constraint satisfaction. **Knowledge Representation:** Logic, Propositional logic - Tautology - Contradiction - Normal forms - Predicate logic - Rules of inference - Resolution - Unification algorithm -Production rules - Semantic networks - Frames – Scripts - Conceptual dependency. **Laboratory Sessions/ Experimental learning:** Derive and implement a solution to the inverse kinematics problem for the robot **Applications:** Predictive Maintenance, Flight performance Optimization, Reverse Engineering		
Module-3 Introduction to Robotics	L1, L2, L3	**8 Hours**
Scope of Robots: The scope of industrial Robots - Definition of an industrial robot - Need for industrial robots. **Robot Components:** Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume- Precision of movement - End effectors - Sensors **Laboratory Sessions/ Experimental learning:** Controlling the robots using the programming language		

Applications: Quality control, Smart Factory Building, Repetitive work management		
Module-4 Future Trends in Robots	L1, L2, L3	**8 Hours**
Telepresence robot - Autonomous mobile robots - Walker Robots – Solar ball Robot – Under water bots – Aerobots - Advanced robotics in Space - Specific features of space robotics systems – long term technical developments - Next generation robots. **Laboratory Sessions/ Experimental learning:** Integrate computer vision and control of the robot Applications: Training, Smart Repairs Management		
Module-5 AI in Robotics	L1, L2	**8 Hours**
Robotic perception, localization – mapping- configuring space - planning uncertain movements - dynamics and control of movement, Ethics and risks of artificial intelligence in robotics. **Laboratory Sessions/ Experimental learning:** Integrate forward and inverse kinematics and computer vision to control the robot **Applications:** AI Autopilot in commercial flights, Knowledge-Based Engineering		

Course outcomes:	
CO1	Apply the basic techniques of artificial intelligence
CO2	Compare and contrast non-monotonic reasoning and statistical reasoning
CO3	Design and develop robotic based systems
CO4	Develop automatic solution for replacing humans in life threatening area
CO5	Interpret basic AI algorithms in Robotics

Text Books:	
1	Elaine Rich And Kevin Knight, Artificial Intelligence, Tata Mcgraw-Hill, 3rdedition,2008.
2	Barry Leatham - Jones, Elements of industrial Robotics, Pitman Publishing, 1987
Reference Books:	
1	J. M. Selig, Introductory Robotics, Prentice Hall, 1992
2	David Jefferis, Artificial Intelligence: Robotics and Machine Evolution, Crabtree Publishing Company, 1992
CIE Assessment:	
CIE is based on quizzes, tests, assignments/seminars, and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests Quizzes/mini tests (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.

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	AIRCRAFT DESIGN	Semester	II
Course Code	MVJMAE24	CIE	50
Total No. of Contact Hours	40 L: T:P: 3:1:0	SEE	50
No. of Contact Hours/week	3	Total	100
Credits	3	Exam. Duration	3hrs

The course objective is to: 1. Understand the overview of Aircraft design process 2. Acquire knowledge of configuration layout and design of structural components 3. Gain knowledge of engine selection. 4.Comprehend the stability and control and sizing of control surfaces. 5. Understand the design aspects of subsystems		
Module 1	**L1,L2**	8 Hrs.
Overview of Design Process Introduction, Requirements, Phases of design, Conceptual Design Process, Initial Sizing, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take- off weight calculation, Thrust to Weight Ratio & Wing Loading: Thrust to Weight Definitions, Statistical Estimate of T/W. Thrust matching, spread sheet in design, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance, Instantaneous Turn rate, Sustained Turn rate, Climb, & Glide, Maximum ceiling. **Laboratory Sessions/ Experimental learning:** Design and modelling of the aircraft components based on the requirements chosen in CAAd lab **Applications:** Apply the design requirements for an aircraft in response to requirements based on fundamental principles and statistical data in the initial phase of design.		
Module 2	**L1,L2,L3**	8 Hrs.
Configuration Layout & loft Conic Lofting, Conic Fuselage Development, Conic Shape Parameter, Wing-Tail Layout & Loft. Aerofoil Linear Interpolation. Aerofoil Flat-wrap Interpolation. Wing aerofoil layout-flap wrap. Wetted area determination. Special considerations in Configuration Layout: Aerodynamic, Structural, Delectability. Crew station, Passenger, and Payload arrangements. Design of Structural Components: Fuselage, Wing, Horizontal & Vertical Tail. Spreadsheet for fuselage design. Tail arrangements, Horizontal & Vertical Tail Sizing. Tail Placement. Loads on Structure. V-n Diagram, Gust Envelope. Loads distribution, Shear and Bending Moment analysis. **Laboratory Sessions/ Experimental learning:**Structural analysis and Aerodynamic analysis in Ansys lab **Applications:** Analyse the various constraints coming from specifications and choose key parameters (total weight, wing plan form, thrust/power required etc.)		
Module 3	**L2,L3**	8 Hrs.
Engine Selection & Flight Vehicle Performance Turbojet Engine Sizing, Installed Thrust Correction, Spread Sheet for Turbojet Engine Sizing. Propeller Propulsive		

System. Propeller design for cruise. Take-off, Landing & Enhanced Lift Devices: - Ground Roll, Rotation, Transition, Climb, Balanced Field Length, Landing Approach, Braking. Enhanced lift design -Passive & Active **Laboratory Sessions/ Experimental learning:** Modelling of engine selected in CAAD lab **Applications:** Compare different engine configurations and choose the design which meets the requirements.		
Module 4	**L2,L3**	8 Hrs.
Static Stability & Control: Longitudinal Static Stability, Pitch Trim Equation. Effect of Airframe components on Static Stability. Lateral stability- Contribution of Airframe components. Directional Static stability. Contribution of Airframe components. Aileron Sizing, Rudder Sizing. Flying qualities. Cooper Harper Scale. Environmental constraints, Aerodynamic requirements. **Laboratory Sessions/ Experimental learning:** Performance analysis in Matlab **Applications:** Calculate and compare performance and stability characteristics against design goals and generate a layout		
Module 5	**L2,L3,L4**	8 Hrs.
Design Aspects of Subsystems: Flight Control system, Landing Gear and subsystem, Propulsion and Fuel System Integration, Air Pressurization and Air Conditioning System, Electrical & Avionic Systems, Structural loads, Safety constraints, Material selection criteria. Applications: Calculate and compare performance and stability characteristics against design goals and generate a layout **Laboratory Sessions/ Experimental learning:** Assemble the CAD models of the components and verify performance using CFD tool in Ansys lab. **Applications:** Analyse design issues for aerodynamics, propulsion, structure, weights, stability, cost, and performance and generate a layout.		

Course outcomes: Upon completion of the course, students will be able to:	
CO1	Define a configuration for given specifications.
CO2	Evaluate configuration layout & airframe components sizing
CO3.	Determine Engine selection and flight performance
CO4	Evaluate the stability and control and sizing of control surfaces.
CO5	Analyse the design aspects of subsystems

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

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

High-3, Medium-2, Low-1

Course Title	**FATIGUE AND FRACTURE MECHANICS**	**Semester**	II
Course Code	**MVJMAE251**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 1: 0**	**SEE**	50
No. of Contact Hours/week	**3**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

- Understand the basics of fatigue of structures.
- Understand the Statistical Aspects of Fatigue Behavior
- Acquire knowledge of Physical Aspects of Fatigue
- Understand concepts of equations of Fracture Mechanics
- Comprehend the various Fatigue Design and Testing Procedures.

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

Fatigue of Structures: S.N. curves, Endurance limit, Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentrations, Neuber's stress concentration factors, plastic stress concentration factors – Notched S-N curves. Plane stress and plane strain concepts, Dugdale approach

Laboratory Sessions/ Experimental learning:

Effect of Stress concentration factors and SN curves plot in strength of materials lab

Applications:

Determine the Endurance limit and Stress concentration factors

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

Statistical Aspects of Fatigue Behaviour: Low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, Cyclic Strain hardening and softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory, Fatigue loading, Various stages of crack propagation

Laboratory Sessions/ Experimental learning:

Experimental verification of the components can be done for Low cycle and high cycle fatigue

Applications:

Determine the cumulative damage of the material

Module-3	L2 , L3 L4	**8 Hours**

Physical Aspects of Fatigue: Phase in fatigue life, Crack initiation, Crack growth, Final fracture, Dislocations, Fatigue fracture surfaces. Crack opening displacement, crack tip opening displacement.

Laboratory Sessions/ Experimental learning:

To determine the crack initiation and crack growth of the given material using equipment setup. **Applications:** To determine the COD and CTOD values of the given material		
Module-4	L2 , L3 L4	**8 Hours**
Fracture Mechanics: Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin – Orwin extension of Griffith's theory to ductile materials, Stress analysis of cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries, Linear elastic fracture mechanics. **Laboratory Sessions/ Experimental learning:** Estimate the effect of stress intensity factors and effect of thickness on fracture toughness. **Applications:** To find out the stress analysis of the cracked bodies		
Module-5	L2 , L3 L4	**8 Hours**
Fatigue Design and Testing: Safe life and fail safe design philosophies, Importance of Fracture Mechanics in aerospace structure, Application composite materials and structures. **Laboratory Sessions/ Experimental learning:** Determine short period and phugoid oscillations for a given Quadratic equation **Applications:** Determine the relative stability of an Aircraft		

Course outcomes:	
CO1	Apply the concept of Fatigue analysis of the structures
CO2	Compare the low cycle fatigue and high cycle fatigue and strain hardening and softening
CO3	Investigate the reasons for crack initiation, growth, and fracture and for COD and CTOD
CO4	Evaluate Fracture Toughness
CO5	Analyse Design for Fatigue

Text Books:	
1	D. Brock, Elementary Engineering Fracture Mechanics, Noordhoff International Publishing Co., London, 1994
2	J.F. Knott, Fundamentals of Fracture Mechanics, Butterworth & Co., Publishers Ltd., London,1983.
Reference Books:	
1	W. Barrois and L. Ripley, Fatigue of Aircraft Structures, Pergamon Press, Oxford, 1983
2	C.G.Sih, Mechanics of Fracture, Vol.1 Sijthoff and Noordhoff International Publishing Co., Netherland, 1989.
CIE Assessment:	

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

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

High-3, Medium-2, Low-1

Course Title	**FLIGHT DYNAMICS AND AUTOMATIC FLIGHT CONTROL**	**Semester**	**II**
Course Code	**MVJMAE252**	**CIE**	**50**
Total No. of Contact Hours	**40 L : T : P :: 3 : 1:0**	**SEE**	**50**
No. of Contact Hours/week	**3**	**Total**	**100**
Credits	**3**	**Exam. Duration**	**3 Hrs.**

The course objective is to:

- Understand the Concept of application of control and airframe parameters
- Acquire knowledge of vehicles equations of motion
- Understand the longitudinal dynamics.
- Understand the longitudinal and lateral feedback control
- Know the feedback systems and autopilot for pitch, roll, and yaw control

Module 1	**L2,L3**	8 Hrs.

Review of feedback system analysis and aerodynamic fundamentals: Mathematical models of linear open loop and closed loop systems, Transfer functions and Bode plot and root locus methods of analysis, analysis of multi-loop vehicular control systems; Definition of airframe parameters, coefficients and reference geometries, aerodynamic characteristics of plan forms and fuselage and effectiveness of control surfaces.

Laboratory Sessions/ Experimental learning: MAT Lab

Applications: Flight Control Stability

Module 2	**L2,L3**	8 Hrs.

Vehicle equations of motion and axis systems: Newton's Second Law and reference frames Expansion of inertial forces and moments, gravity forces and their linearization, Expansion of aerodynamic forces and moments and direct thrust forces, Complete linearized equations of motion, description of dimensional and non-dimensional stability axis derivatives.

Laboratory Sessions/ Experimental Learning: MAT Lab

Applications: Development of Equations of motion

Module 3	**L2,L3**	8 Hrs.

Longitudinal dynamics: Review of simplifying assumptions and derivation of simplified longitudinal equations of motion, longitudinal controls and control input transfer functions, two degrees of freedom short period approximations and typical example transfer functions of

conventional aircraft and their responses Lateral dynamics: Simplified lateral equations of motion, lateral controls and control input transfer functions, two degrees of freedom Dutch roll approximations, typical example transfer functions of conventional aircraft and their responses. **Laboratory Sessions/ Experimental learning:** MAT Lab **Applications:** Analysis of Longitudinal & Lateral motions of Aircraft		
Module 4	**L2 ,L3,L4**	8 Hrs.
Longitudinal and lateral feedback control: Longitudinal FeedbackControl: Feedback of pitch angle and pitch rate to the elevator, feedback of speed error to elevator, feedback of angle of attack and acceleration to elevator, feedback of altitude to the elevator. **Lateral Feedback Control**: Feedback of bank angle and rolling velocity to ailerons, feedback of other quantities to ailerons, feedback of heading angle to rudder, feedback of yawing velocity to rudder, feedback of sideslip to rudder, feedback of lateral acceleration to rudder. **Laboratory Sessions/ Experimental learning:** MAT Lab **Applications:** Development of feedback control System		
Module 5	**L2,L3, L4**	8 Hrs.
Longitudinal and lateral autopilots: Longitudinal Autopilots: Displacement autopilot, pitch orientational control system, acceleration control system, glide slope coupler and automatic flare control, flightpath stabilization, attitude reference systems, effect of nonlinearities. **Lateral Autopilots**: Damping of Dutch roll, discussion on coordination techniques and methods of obtaining coordination, yaw orientational control system and other lateral autopilot configurations, automatic lateral beam guidance. **Laboratory Sessions/ Experimental learning:** MAT Lab **Applications:** Augmentation of Aircraft Stability		

Course outcomes: Upon completion of the course, students will be able to:	
CO1	Define a configuration for given specifications.
CO2	Model equations of motion.
CO3	Analyse the longitudinal dynamics.
CO4	Evaluate feedback systems.
CO5	Apply autopilot mode.

Textbooks:	
1.	Thomas R Yechout: Introduction to Aircraft Flight Mechanics, AIAA Education Series
2.	D McRuer, I Ashkenas and D Graham: Aircraft Dynamics and Automatic Control, Princeton University Press, Princeton, New Jersey, 1973

Reference Books:	
1.	Blake lock J H: Automatic Control of Aircraft and Missiles, John Wiley & Sons, Inc, 1991
2.	Jan Roskam: Airplane flight dynamics and automatic flight controls, Part I & II, Published by Design Analysis and Research Corporation (DAR Corporation), 2003, USA.

CO,PO Mapping

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

High,3, Medium,2, Low,1

Course Title	AERO – ENGINE TESTING AND EVALUATION	Semester	II
Course Code	MVJMAE253	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 0 :1	SEE	50
No. of Contact Hours/week	3	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

1. Acquire the knowledge of compressor testing
2. Gain knowledge to test combustors
3. Learn engine performance requirements
4. Acquire knowledge of engine qualification criteria
5. Understand various tests cells

Module 1	L1,L2	8 Hrs.

Introduction: Need for Gas Turbine Engine Testing and Evaluation, Philosophy of Testing, Rationale of Testing. Types of tests, Proof of Concepts, Design Verification, Design Validation, and Formal Tests. Aero Thermodynamic Tests, Compressor: Compressor scaling parameter Groups, Compressor MAP. Inlet distortions. Surge margins stack up. Testing and Performance Evaluation, Test rig.

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

Module 2	L2,L3	8 Hrs.

Combustor: Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation.

Aero Thermodynamic Tests: Turbines: Turbine MAP. Turbine Testing and Performance Evaluation. Component model scaling. Inlet duct & nozzles: Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation.

Module 3	L2,L3	8 Hrs.

Engine performance: Design & off-design Performance. Transient performance. Qualitative characteristics quantités. Transient working lines. Starring process & Wind milling of Engines. Thrust engine start envelope. Calculations for design and off-design performance from given test data – (case study for a Jet Engine).

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

Module 4	L2,L3	8 Hrs.

Qualification Tests: Tests used to evaluate a design. Environment ingestion capability. Preliminary flight rating tests, Qualification testing, acceptance tests, Reliability figure of merit. Structural integrity tests: Design Verification Tests, Durability and Life Assessment Tests, Reliability Tests, Failure Simulation Tests, Functional and Operability Tests. Types of engine tests: Normally Aspirated Testing, Ram Air Testing, Altitude Testing, Flying Test Bed, Mission Oriented Tests, Open Air Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing.

Applications:

1. To understand the properties of fuels use in gas turbines
2. To understand the various fuel, oil and starting systems

Module 5	**L2,L3**	8 Hrs.

Test cell: Air breathing engine test facility. Direct connect altitude cell, propulsion wind tunnels. Types of test beds. Factors in designing engine test beds. Altitude test facility. Steps in test bed cross calibration. Engine testing with simulated inlet distortions. Surge test. Cell Calibration and Correction. Performance Reduction Methodology. Instrumentation: Data Acquisition, Measurement of Thrust, Pressure, Temperature, Vibration, etc.

Accuracy and Uncertainty in Measurements. Experimental Stress Analysis.

Applications: To understand the standard flight-testing procedures.

Course outcomes:

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

CO1	Solve problems related to aero thermodynamics of compressors
CO2	Evaluate combustor performance of engines
CO3	Specify engine performance requirements
CO4	Analyse engine qualification data
CO5	Select appropriate test cells

Text books:

1.	Gas Turbine Performance P.P Walshand P.Peletcher Black well Science 1998

Reference Books:

1.	Experimental methods for Engineers JP Holman Tata McGraw–Hill Publishing Co. Ltd., 2007
2.	Advance Aero-Engine Testing, AGARD-59 Publication

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 (30marks each),the final IA marks to be awarded will be the average of three tests

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

SEE Assessment:
- Question paper for the SEE consists of two parts i.e. Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each of 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. - Onequestionmustbesetfromeachunit.Thedurationofexaminationis3hours.

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

High,3,Medium,2,Low,1

Course Title	**THEORY OF AERO ELASTICITY**	**Semester**	II
Course Code	**MVJMAE254**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 1: 0**	**SEE**	50
No. of Contact Hours/week	**3**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to:

1. Understand the deformation of structure under static and dynamic loads
2. Acquire knowledge of static aerostatic phenomenon
3. Acquire the knowledge of dynamic aeroelasticity
4. Know technique of the similarities in test techniques
5. Gain Knowledge of wind tunnel model similarities and testing of models.

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

Aeroelastic phenomenon: flutter, buffeting, dynamic loads problems, load distribution, divergence, control effectiveness & reversal. Deformation of airplane structures under static loads: Forces acting on aeroplane, Influence coefficients. Properties of influence coefficients. Deformation under distributed forces. Simplified elastic airplane. Bending, torsional and shear stiffness curves.

Laboratory Session/Experimental Learning: Aerodynamic interaction between wing and truss in transonic flow using ANSYS

Applications:

1.Structural Strength, 2. Control Effectiveness, 3. Moment acting on body, 4. Unsteady flow flutter analysis

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

Static aeroelastic phenomena: Load distribution and divergence-wing torsional divergence (two-dimensional case, & finite wing case). Prevention of aeroelastic instabilities. Control effectiveness and reversal: Aileron effectiveness and reversal -2-dimensional case, and finite wing case. Strip theory. Aileron effectiveness in terms of wing -tip helix angle. Critical aileron reversal speed. Rate of change of local pitching moment coefficient with aileron angle.

Laboratory Session/Experimental Learning: Effect of wing sweep and thickness on drag divergence mach number.

Applications:

1. Mach divergence, .Flutter Analsys

Module-3	L2 L3	**8 Hours**

Deformation of airplane structures under dynamic loads: Differential and Integral forms of equations of motions of vibrations. Natural modes and frequencies of complex airplane structures - introduction. Dynamic response phenomenon. Dynamic problems of Aeroelasticity: Determination of critical flutter speed. Aeroelastic modes. Wing bending and torsion flutter. Coupling of bending and torsion oscillations and destabilizing effects of geometric incidences. Flutter prevention and control.

Laboratory Session/Experimental Learning: Comparison of flutter speed Between Theodorsen, Wagner and Quasi-steady approximation for 2D

Applications:

1.Selection of optimal approximation based on the condition

2. Analyze the airspeed at different location

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

Test model similarities: Dimensional concepts. Vibration model similarity laws. Dimensionless form of equation of motion. Mode shapes and natural frequencies in dimensionless forms. Model scale factors. Flutter model similarity law. Scale factors. Structural simulation: -shape, mass and stiffness.

Laboratory Session/Experimental Learning: Study of wingtip washout using flat wing varying stiffness

Applications:

1. load distribution
2. Position of Aerodynamic center
3. Design consideration to reduce wingtip stall

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

Testing techniques: Measurement of structural flexibility, natural frequencies and mode shapes. Polar plot of the damped response. Identification and measurement of normal modes. Steady state and dynamic Aeroelastic model testing.

Laboratory Session/Experimental Learning: Calculate first 7 flexible modes in Simple aeroelastic model of a Generic transport aircraft

Applications:

1. Flutter mechanism between different modes
2. First mode: Wing bending
3. Third mode: Aileron deflection

Course outcomes:

CO1	Estimate structural deformations under static loading conditions.
CO2	Analyse structural deformations under dynamic loading conditions.
CO3	Develop models for aeroelastic phenomenon.
CO4	Develop wind tunnel models for aeroelastic testing.
CO5	Perform different testing techniques for static and dynamic Aeroelastic model.

Text Books:	
1	Dowell, E. H., Crawley, E. F., Curtiss Jr., H. C., Peters, D. A., Scanlan, R. H., and Sisto, F., A Modern Course in Aeroelasticity, Kluwer Academic Publishers, 3rd Edition, 1995.
2	Bisplinghoff, R., Ashley, H., and Halfman, R. L., Aeroelasticity, Dover, 1955.
Reference Books:	
1	Fung, Y. C., An Introduction to the Theory of Aeroelasticity, Dover, 1969.
2	Megson THG, Aircraft structures for Engineering students, Edward Arnold.

CIE Assessment:

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

Quizzes/mini tests (10 marks)

Assignment (10 marks)

SEE Assessment:

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

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

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

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

High-3, Medium-2, Low-1

Course Title	**COMPOSITE MATERIALS AND FABRICATION TECHNIQUES**	**Semester**	II
Course Code	**MVJMAE261**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 1: 0**	**SEE**	50
No. of Contact Hours/week	**3**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

- Understand the basic characteristics of composite materials
- Understand the advanced processing and fabrication techniques
- Acquire the knowledge of micro-and macro-mechanical behavior of composite laminate
- Gain the knowledge of composite materials.
- Acquire the knowledge of MMCs and application of MMCs

Module-1	**L1,L2,L3**	8 Hrs.

Introduction to Composite Materials

Definition, classification and characteristics of composite materials - fibrous composites, laminated. Matrix materials

Fiber Reinforced Plastic Processing Layup and curing, fabricating process - open and closed mould process - hand layup techniques structural laminate bag molding, production procedures for bag molding

Metal Matrix Composites: Introduction, Reinforcement materials, role of metal matrix, types, characteristics and selection of base metals. Advantage, disadvantage and Application of MMCs.

Laboratory Sessions/ Experimental learning: Optional Applications: Composites recent application in Aeronautical and Aerospace

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

Advanced Processing Techniques and Application of Composites Filament winding, pultrusion, pulforming, thermo - forming, injection, injection moulding, liquid moulding, blow moulding, Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites.

Laboratory Sessions/ Experimental learning: Optional Applications: Manufacturing of aircraft structural components

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

Micro-Mechanical Behaviour of a Lamina

Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics-based analysis and experimental determination of material constants.

Ultimate Strengths of a Unidirectional Lamina **Macro-Mechanical Behaviour of a Laminate:** Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Global and local axis for angle lamina, Stress-Strain relations for lamina of arbitrary orientation, Numerical problems. **Laboratory Sessions/ Experimental learning:** Determination of Young's Modulus of a Composite beam **Applications:** Basics of macro level elastic properties, Scales of analysis of composites. Unidirectional and Woven fibres		
Module-4	L2, L3	**8 Hours**
Applications and Future of Composites Application developments – Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites. **Future of Composites:** -General introduction and theory of nanocomposites- History of nanocomposites; Size and shape dependent properties and their uniqueness. Flexible Composites, High Temperature materials. **Laboratory Sessions/ Experimental learning:** Evaluate the mechanical properties of a lamina and a laminate **Applications:** Specific Aircraft Structural components.		
Module-5	L2, L3	**8 Hours**
Composite Testing, Inspection & Quality Control: Determination of Mechanical properties of composite materials, Testing of composites – Interlaminar Shear testing, Fracture testing, Delamination, Raw material testing. Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan **Laboratory Sessions/ Experimental learning:** Determination of Defects in a composite by NDT Methods **Applications:** NDT- DT Methods, Composites in Aerospace sector		

Course outcomes:

CO1	Compare the properties and select material for the given application.
CO2	Fabricate composite parts
CO3	Apply constitutive equations of composite materials and understand mechanical behaviour
CO4	at micro and macro levels.
CO5	Apply the composite materials for a specific application

Text Books:

1	K.K Chawla, Composite Materials- Science and Engineering, IV edition, Springer

	International Publishing, 2019: ISBN: 978-3-030-28983-6
2	Autar Kaw, Mechanics of Composites, II edition, Taylor & Francis Group CRC Press. 2006, ISBN:978-0-8493-1343-1
Reference Books:	
1	R M Jones, Mechanics of Composite Materials, 2nd Edition, Taylor & Francis, 2015; ISBN:978-1560327127
2	Ajay Kapadia, Non-Destructive Testing of Composite Materials, National Composites Network, Best Practices Guide, TWI Publications, 2006.
CIE Assessment:	
CIE is based on quizzes, tests, assignments/seminars, and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests Quizzes/mini tests (10 marks) Assignment (10 marks)	
SEE Assessment:	
Question paper for the SEE consists of two parts i.e., Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. One question must be set from each unit. The duration of examination is 3 hours.	

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**FLIGHT TESTING**	**Semester**	II
Course Code	**MVJMAE262**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P:3: 1: 0**	**SEE**	50
No. of Contact Hours/week	**3**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

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

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

Introduction:

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

Flight test instrumentation:

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

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

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

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

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

Stability and control - longitudinal and maneuvering

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

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

Stability and control - lateral and directional

Lateral and directional static & dynamic stability: - Coupling between rolling and yawing moments. Steady

heading slide slip. Definition of Roll stability. Adverse yaw effects. Aileron reversal. Regulations, test techniques and method of data reduction.		
Module-5	L2, L3	**8 Hours**
Flying qualities: MIL and FAR regulations. Cooper-Harper scale. Pilot Rating. Flight test procedures. Hazardous flight testing: Stall and spin- regulations, test and recovery techniques. Test techniques for flutter, vibration and buffeting.		

Course outcomes:	
CO1	Measure the flight parameters.
CO2	Estimate the performance of flight.
CO3	Calculate the longitudinal stability and control parameters
CO4	Specify Test for the lateral and directional stability and control
CO5	Apply the FAR regulations.

Text Books:	
1	Ralph D Kimberlin, Flight Testing of Fixed Wing Aircraft, AIAA educational Series 2003.
2	Benson Hamlin, Flight Testing- Conventional and Jet-Propelled Airplanes, Mac Millan, 1946.
Reference Books:	
1	A. Filippone, Flight Performance of Fixed and Rotary Wing Aircraft, AIAA Series, 2006

CIE Assessment:

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

Quizzes/mini tests (10 marks)

Assignment (10 marks)

SEE Assessment:

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

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

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

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**ROCKET AND MISSILES**	**Semester**	II
Course Code	**MVJMAE263**	**CIE**	50
Total No. of Contact Hours	**40 L: T: P: 3: 1: 0**	**SEE**	50
No. of Contact Hours/week	**3**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

- Gain knowledge of aircraft and space launch vehicles and missiles
- Understand the applications of solid propellants
- Acquiring knowledge of liquid propellant applications
- Comprehend the trajectory of rockets and missiles
- Acquiring knowledge of rocket testing

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

Introduction: Space launch Vehicles and military missiles, function, types, role, mission, mission profile, thrust profile, propulsion system, payload, staging, control and guidance requirements, performance measures, design, construction, operation, similarities, and differences. Some famous space launch vehicles and strategic missiles.

Launch Vehicle Dynamics: Tsiolskovsky's rocket equation, range in the absence of gravity, vertical motion in the earth's gravitational field, inclined motion, flight path at constant pitch angle, motion in the atmosphere, the gravity turn – the culmination altitude, multi staging.

Laboratory Sessions/ Experimental learning: Calculate the ballistic missile trajectories.

Applications:

Designing missiles, rockets, spacecrafts, launching of satellites

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

Solid Propellant Rocket Motor Systems: Solid Propellant rocket motors, principal features, applications. Solid propellants, types, composition, properties, performance. Propellant grain, desirable properties, grain configuration, preparation, loading, structural design of grain. Liners, insulators and inhibitors, function, requirements, materials. Rocket motor casing – materials. Nozzles, types, design, construction, thermal protection. Igniters, types, construction. Description of modern solid boosters I) Space Shuttle SRB, II) the Arienne SRB

Laboratory Sessions/ Experimental learning: To calculate thrust profile for different solid grain structures

Applications:

Selection of solid propellant based on the mission requirement, grain configuration and resulting different thrust profile, design important systems of rockets and missiles.

Module-3	L2 , L3, L4	8 Hours
Liquid Propellant Rocket Engine Systems: Liquid propellants, types, composition, properties, performance. Propellant tanks, feed systems, pressurization, turbo-pumps, valves and feed lines, injectors, starting and ignition. Engine cooling, support structure. Control of engine starting and thrust build up, system calibration, integration, and optimization – safety and environmental concerns. Description of the space shuttle main engine. Propellant slosh, propellant hammer, geysering effect in cryogenic rocket engines. **Laboratory Sessions/ Experimental learning:** To study the burning velocity of premixed flames at various air/fuel ratio. **Applications:** Selection of liquid propellant based on the mission requirement, specific impulse resulting from different fuel and oxidizer combination, design of pump or pressure feed system for propellant transfer from tanks to combustion chamber.		
Module-4	L2 , L3, L4	**8 Hours**
Attitude Control of Rockets and Missiles: Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques. **Trajectory Monitoring and control:** Forces acting on a missile while passing through atmosphere, method of describing aerodynamic forces and moments, lateral aerodynamic moment, lateral damping moment, longitudinal moment of a rocket, Rocket Dispersion. Missile Autopilot, proportional navigation guidance, command guidance. **Laboratory Sessions/ Experimental learning**: Role of multi staging in performance of launch vehicles. **Applications**: Planning and designing of flight path and trajectories for rockets and missiles. Directional change control using thrust vectoring.		
Module-5	L2 , L3, L4	**8 Hours**
Rocket Testing: Ground Testing and Flight Testing, Types of Tests facilities and safeguards, monitoring and control of toxic materials, instrumentation, and data management. Ground Testing, Flight Testing, Trajectory monitoring, post -accident procedures. Descriptions of a typical space launch vehicle launch procedure. **Materials:** Criteria for selection of materials for rockets and missiles, requirements for choice of materials for propellant tanks, liners, insulators, inhibitors, at cryogenic temperatures, re-entry body design consideration, requirements of materials for thermal protection and for pressure vessels. **Laboratory Sessions/ Experimental learning:** Reentry vehicles: Sphere v/s Blunt bodies drag estimation. **Applications:**		

Selection of right materials depending on the mission requirement. Designing of a failsafe testing rocket system. Design of Rockets and Missiles, aerodynamic controls, reentry body design configurations.

Course outcomes:	
CO1	Analyse aircraft and space launch vehicles and missiles
CO2	Apply the various types of solid propellants
CO3	Apply various types of liquid propellant
CO4	Evaluate the trajectory of rockets and missiles
CO5	Perform the static rocket testing

Text Books:	
1	George P Sutton and Oscar Biblarz, Rocket Propulsion Element, John Wiley and Sons Inc, 7th edition, 2010.
2	Cornelisse, J.W., Schoyer, Rocket Propulsion and Space Flight Dynamics, H.F.R. and Wakker,. K.F, Pitman, 1979.
Reference Books:	
1	Ball, K.J., Osborne, G.F, Space Vehicle Dynamics, Oxford University Press, 1967
2	Parker, E.R, Materials for Missiles and Spacecraft, McGraw Hill, 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 (10 marks) Assignment (10 marks)
SEE Assessment:
Question paper for the SEE consists of two parts i.e., Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. 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

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

High-3, Medium-2, Low-1

Course Title	**HYPERSONIC AERODYNAMICS**	**Semester**	II
Course Code	**MVMAE264**	**CIE**	50
Total No. of Contact Hours	**40 L: T:P: 3:1:0**	**SEE**	50
No. of Contact Hours/week	**3**	**Total**	100
Credits	**3**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

- Understand general considerations of hypersonic flight
- Acquire knowledge of modelling of hypersonic flows
- Gain knowledge of Shock structure and Newtonian theory of hypersonic flows
- Understand the effect viscosity in hypersonic flows
- Understand hypersonic testing

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

General Considerations. Characteristics. General features of hypersonic flow field. Assumptions underlying inviscid hypersonic theory. Normal shock waves, oblique & curved shocks. Mach number independence principles. General strip theory.

Laboratory Sessions/ Experimental learning: Producing a normal shock wave using a shock tube and studying the pressure and temperature behind it.

Applications:

Hypersonic wind tunnel

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

Small Disturbance Theory. Slightly blunted slender bodies, large incidence & correlation of Similitude. Unsteady flow theory. Non equilibrium effects. Newtonian Theory. Two-dimensional axis symmetric bodies, simple shapes & free layers. Optimum shapes, shock layer structure.

Laboratory Sessions/ Experimental learning:

Experimental learnings to study two dimensional axi-symmetric bodies and simple shapes subjected to hypersonic flow in hypersonic wind tunnel.

Applications:

To determine the unsteady flow over two dimensional axi-symmetric bodies and simple shapes for a space vehicle re-entry.

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

Newtonian Theory. Shock layer structure with cross flow. Conical flow, bodies of revolution at small incidences. Theory of Thin Shock Layers. Basic concepts, successive approximation schemes. Constant stream tube-area approximation. Two-dimensional axis symmetric blunt faced bodies.

Laboratory Sessions/ Experimental learning:

Experiment to study the melting of models due to aerodynamic heating at hypersonic wind tunnel.

Applications:

1. Re-entry of space vehicles.
2. Most controlled objects enter at hypersonic speeds due to their sub-orbital (e.g., intercontinental ballistic missile re-entry vehicles), orbital (e.g., the Soyuz), or unbounded (e.g., meteors) trajectories. Various advanced technologies have been developed to enable atmospheric re-entry and flight at extreme velocities.
3. Study of objects entering an atmosphere from space at high velocities relative to the atmosphere will cause very high levels of heating.

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

Viscous Flows. Hypersonic Viscous effects, Boundary Layer equations. Similar laminar boundary layer solutions. Local similarity concept. Viscous interactions - flow models and interaction parameters. Weak pressure interaction. Strong pressure interaction. General features of rarified gas flows.

Laboratory Sessions/ Experimental learning:

Shock tunnel testing of materials subjected to unsteady with supersonic and hypersonic flows.

Applications:

Shock tunnels to study about weak and strong pressure interactions.

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

Hypersonic Testing. Hypersonic Scaling, high enthalpy & high speed, types of hypersonic facilities. Shock tunnels & expansion tubes. Features of Hypersonic wind tunnel design. Instrumentation to hypersonic vehicle testing. Test model similarity laws.

Laboratory Sessions/ Experimental learning:

Experiment to test materials at high enthalpy shock tunnel.

Applications:

Material testing during high-speed flows up to supersonic and hypersonic level in shock tunnel.

Course outcomes:

CO1	Select various considerations for hypersonic flight
CO2	Solve problems related to hypersonic flows
CO3	Analyse the viscous effects in hypersonic flows
CO4	Apply knowledge of Newtonian theory for hypersonic flow analysis
CO5	Perform hypersonic wind tunnel testing.

Text Books:

1	John D Anderson Jr. Hypersonic and High Temperature Gas Dynamics, AIAA, 2000.
2	Frank K.Lu and Dart E. Marran, Advanced Hypersonic Test Facilities, AIAA 2002.

Reference Books:	
1	Cherynl C.G., Introduction to Hypersonic Flow, Academic Press, 1961.
2	Utyuzhnikov, S. V., & Tirskiy, G. A. (2014). Hypersonic Aerodynamics and Heat Transfer. Begell House Publishers Inc.
CIE Assessment:	
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SEE Assessment:	
Question paper for the SEE consists of two parts i.e., Part A and Part B. Part A is compulsory and consists of objective type or short answer type questions of 1 or 2 marks each for total of 20 marks covering the whole syllabus. Part B also covers the entire syllabus consisting of five questions having choices and may contain sub-divisions, each carrying 16 marks. Students have to answer five full questions. One question must be set from each unit. The duration of examination is 3 hours.	

CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**AVIONICS**	**Semester**	II
Course Code	**MVJMAE281**	**CIE**	50
Total No. of Contact Hours	**15 L:T:P:1:1:0**	**SEE**	50
No. of Contact Hours/week	**1**	**Total**	100
Credits	**1**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

- Understand the aircraft electrical and avionics systems.
- Acquire knowledge of flight control and navigation systems
- Gain knowledge of display technologies, display units and communication systems
- Understand the digital flight control computer, Microprocessor and memory devices
- Apprehend the functioning of data buses and avionics architectures

Module-1 Introduction to Aircraft Electrical Systems and Avionics	**L2**	**3 Hours**

Basic electrical theory: Ohm's Law, Kirchhoff's Laws, AC & DC Generators, Integrated Drive Generator (IDG), Emergency power: Li-Ion & Ni-Cd batteries, Inverter, RAT, Busbars, Grounding, Bonding, Earthing, Avionic subsystems

Laboratory Sessions/ Experimental learning: Seminar presentations on modern avionic systems.

Applications: Civil and Military Aircraft electronics and power systems

Module-2 Communication and Navigation Systems	L3	**3 Hours**

Frequency bands: LF to UHF, RF basics, Radar, Antennae, Transmitters, Receivers, ATC and SATCOM systems, Magnetic compass, INS, GPS, VOR/DME, ADF, ILS, and MLS.

Laboratory Sessions/ Experimental learning: Seminar on Communication and Navigation equipment and their roles in achieving precision navigation and effective communication.

Applications: Guidance, Navigation and Control

Module-3 Electronic Flight Instrument & Display Systems	L3	**3 Hours**

Basic flight instruments and sensors, Air data and inertial sensors, Display technologies -CRT, LCD, LED, **Display units:** HUD, HDD, HMD, PFD, MFD

Laboratory Sessions/ Experimental learning: Seminar on Importance of Flight Instruments and their operation in all phases of flight.

Applications: Navigation, and Fault-tolerant control

Module-4 Digital Avionic Data Buses	L3	**3 Hours**

Digital Logic: Gates, Truth Tables, 8085A Microprocessor and memory types, Flight Control Computer, Data Buses: MIL-STD-1553B, ARINC 429, ARINC 629.

Laboratory Sessions/ Experimental learning: Seminar on centralized data processing and intra aircraft communication. **Applications:** Flight control computer		
Module-5 Autopilot and Flight Control	L3	**5 Hours**
Autopilot modes: longitudinal and lateral, Conventional control mechanisms, Stability enhancement and maneuvering. **Laboratory Sessions/ Experimental learning:** Seminar on Fault-tolerant flight control in the presence of external disturbances. **Applications:** Guidance, and Control		

Course outcomes:	
CO1	Apply the fundamental concepts of aircraft electrical systems and emergency power sources.
CO2	Apply the different techniques of aviation communication and navigation systems to civil and military aircrafts.
CO3	Identify and compare the technologies and functions of modern electronic flight instruments and display systems.
CO4	Demonstrate knowledge of digital avionic data buses and onboard computational architecture.
CO5	Create and explore the structure and functioning of autopilot and advanced flight control systems including FBW and FBL.

Text Books:	
1	R.P.G. Collinson, "Introduction to Avionics Systems", Springer.
2	Myron Kayton and Walter R. Fried, "Avionics Navigation Systems", Wiley.
Reference Books:	
1	Digital Avionics Systems: Principles and Practices 2nd Edition, Cary R. Spitzer, McGraw-Hill; 2nd Edition, 1993

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars, and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests Quizzes/mini tests (10 marks) Assignment (10 marks)
SEE Assessment:

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

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

High-3, Medium-2, Low-1

Course Title	**UNMANNED AERIAL VEHICLES**	**Semester**	II
Course Code	**MVJMAE282**	**CIE**	50
Total No. of Contact Hours	**15 L:T:P: 1:1:0**	**SEE**	50
No. of Contact Hours/week	**1**	**Total**	100
Credits	**1**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

- Understand UAV classifications, applications, and system-level architecture
- Acquire the knowledge of modern aerodynamic principles and performance metrics for UAV
- Learn concepts of flight dynamics, navigation systems, and sensors in autonomous UAVs.
- Understand UAV propulsion systems, materials, and structural configurations for airworthiness.
- Learn about Loads consideration and DGCA requirements

Module-1 UAV Systems and Applications	**L2,L3**	**3 Hrs.**

Basic elements and Taxonomy of UAVs-HALE, MALE, Tactical, Nano. Hybrid UAVs, Bio-inspired Designs, VLOS operations, Modular Subsystems- Avionics, Communications, GNC. Drone applications

Module-2 Aerodynamics and Performance Optimization	**L2,L3**	**3 Hrs.**

Modern Fixed-Wing, Rotary-Wing & Hybrid Configurations-Tiltrotor, HTOL, VTOL, Modeling and Optimization, Flight Path Reconstruction & Endurance Enhancements, Flapping Wing UAVs.

Module-3 Flight Dynamics, Control Systems & Navigation	**L2,L3**	**3 Hrs.**

Multirotor and Fixed-wing UAV Dynamics Modelling, Autopilot-PX4, ArduPilot, and ROS-based Integration, Sensor Fusion-GPS/INS/GNSS, SLAM, Visual Odometry, Navigation

Module-4 Propulsion, Structures and Smart Materials	**L2,L3**	**3 Hrs.**

Hybrid-Electric, Hydrogen Fuel Cells, UAV Battery Technologies, Solar Integration, Lightweight Structures-3D Printed UAVs, Vibration Isolation

Module-5 Mission Planning, Payloads, and Regulatory Framework	**L2,L3**	**3 Hrs.**

Autonomous Mission, Real-Time Payload Data Processing, Payload Integration-LiDAR, EO/IR, SAR, Hyperspectral Sensors, DGCA UAS Rules 2021, NPNT, RPL, UAOP

Course outcomes:

CO1	Select UAV classifications, applications, and system-level architecture.
CO2	Apply modern aerodynamic principles and performance metrics to UAV
CO3	Analyze flight dynamics, navigation systems, and sensor in autonomous UAVs.
CO4	Evaluate UAV propulsion systems, materials, and structural configurations for airworthiness.
CO5	Design mission plans and integrate payloads considering DGCA requirements

Text Books:	
1	Small Unmanned Aircraft: Theory and Practice, Randy Beard, Timothy McLain, Princeton University Press, 2021.
2	Unmanned Aircraft Systems: UAVS Design, Development and Deployment, Reg Austin, Wiley, 2nd Edition, 2020.
Reference Books:	
1	Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Kimon Valavanis, Springer, 2021.
2	UAV Communications for 5G and beyond, Yong Zeng, Rui Zhang, Cambridge University Press, 2022.
3	Design, Construction and Testing of UAV Systems – Paul G. Fahlstrom, CRC Press, 2021.

CIE Assessment:

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

Quizzes/mini tests (10 marks)

Assignment (10 marks)

SEE Assessment:

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

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

High-3, Medium-2, Low-1

Course Title	**AIRCRAFT SYSTEMS AND INSTRUMENTAION**	**Semester**	II
Course Code	**MVJMAE283**	**CIE**	50
Total No. of Contact Hours	**15 L: T: P: 1: 1: 0**	**SEE**	50
No. of Contact Hours/week	**1**	**Total**	100
Credits	**1**	**Exam. Duration**	3hrs

Course objective is to: This course will enable students to • Gain knowledge of aircraft control systems • Understand the applications of hydraulics and pneumatics in aircraft systems • Acquiring knowledge regarding aircraft engine systems • Comprehend the aircraft auxiliary systems • Acquiring the knowledge of aircraft instruments		
Module-1	L2 , L3	**3 Hours**
Airplane Control Systems: Conventional Systems, fully powered flight controls, powered actuated systems, Modern control systems. **Laboratory Sessions/Experimental Learning** How it works, flight controls PIDs controls **Applications:** Pilots training, UAV Controls and piloting. RC aircraft piloting		
Module-2	L2 , L3	**3 Hours**
Aircraft Systems: Hydraulic systems. Study of a typical working system, components, Pneumatic systems, Advantages, Working principles, Typical Air pressure system, Brake system, Typical Pneumatic power system, components. **Laboratory Sessions/Experimental Learning** Working principles of hydraulic system and pneumatic system in aircraft applications. **Applications:** Hydraulic lifts, pneumatic door opening and closing, landing gears, breaks		
Module-3	L2 , L3	**3 Hours**
Engine Systems Fuel systems for piston and jet engines, Components of Multiengine, Lubricating systems for piston and jet engines, starting and ignition systems. **Laboratory Sessions/Experimental Learning** Working knowledge of engine systems (Virtual Labs-IIT Kanpur) **Applications:** Handling of fuel systems		

Module-4	L2 , L3	3 Hours
Auxiliary System: Basic air cycle, vapor systems, evaporative vapor cycle system, evaporative air cycle systems, deicing and anti-icing systems **Laboratory Sessions/Experimental Learning** Working of auxiliary systems **Applications:** Handling of auxiliary systems		
Module-5	L2 , L3	**3 Hours**
Airplane Instruments: Flight instruments and Navigation instruments, gyroscope, accelerometers, air speed indicators, TAS, EAS, Mach meters, study of various types of engine instruments **Laboratory Sessions/Experimental Learning** Working knowledge of Instruments **Applications:** Handling of aircraft instruments		

Course outcomes:	
CO1	Analyze various aircraft control systems
CO2	Apply various hydraulics and pneumatics systems
CO3	Evaluate aircraft engine systems
CO4	Describe the aircraft auxiliary systems
CO5	Apply different aircraft instruments

Text Books:	
1	Ian Moir and Allan Seabridge,` Aircraft Systems: Mechanical, Electrical, and Avionics-Subsystem Integration`, Wiley India Pvt, Ltd, 3rd edition, 2012.
2	William A Neese, `Aircraft Hydraulic Systems`, Himalayan Books, 2007
Reference Books:	
1	Lalit Gupta and OP Sharma, ` Aircraft Systems (Fundamentals of Flight Vol IV), Himalayan Books, 2006
2	S R Majumdar, ` Pneumatics Systems`, Tata McGraw Hill Publishing Co., 1st edition, 2001.
CIE Assessment:	
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SEE Assessment:
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CO-PO Mapping

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

High-3, Medium-2, Low-1

Course Title	**THEORY OF COMBUSTION**	**Semester**	II
Course Code	**MVJMAE284**	**CIE**	50
Total No. of Contact Hours	**15 L: T: P: 1: 1: 0**	**SEE**	50
No. of Contact Hours/week	**1**	**Total**	100
Credits	**1**	**Exam. Duration**	3hrs

Course objective is to:

This course will enable students to

- Understand the Concept of Combustion
- Comprehend the combustion fundamentals and performance
- Understand the concept of combustion sustainability in gas turbines
- Gain fundamentals of combustion noise and stability
- Acquire knowledge of combustion emission

Module-1	L2 , L3	**3 Hours**

Combustion Fundamentals: Deflagration, detonation, classification of flames, flammability limits, weak mixtures, laminar premixed flames, laminar diffusion flames, turbulent premised flames, droplet and spray evaporation. Adiabatic flame temperature.

Laboratory Sessions/Experimental Learning

Aircraft Propulsion lab

Applications:

Rocket engines, Gas turbine engines

Module-2	L2 , L3	**3 Hours**

Combustion Performance: Combustion efficiency, combustion process, reaction-controlled systems, mixing-controlled systems, evaporation-controlled systems. Flame stabilization & fuel classification-definition of stable performance, measure of stable performance, bluff-body flame holders, stabilization

Laboratory Sessions/Experimental Learning

Aircraft Propulsion lab

Applications:

Rocket engines, Gas turbine engines

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

Basic Considerations in Combustor Performance: Introduction to Gas Turbine combustor, combustor performance parameter, combustor types, atomizers, liner wall-cooling techniques, combustor exit temperature, traverse quality (pattern factors), combustors for low emissions.

Laboratory Sessions/Experimental Learning

Aircraft Propulsion lab **Applications:** Rocket engines, Gas turbine engines		
Module-4	L2 , L3	**3 Hours**
Alternate Fuel and Combustion Noise: Introduction, Alternate fuel used in aero applications, direct combustion noise, combustion instabilities, influence of fuel types, combustion operating condition, ambient conditions, aerodynamic instabilities, control of combustion instabilities. **Laboratory Sessions/Experimental Learning** Aircraft Propulsion lab **Applications:** Handling of auxiliary systems		
Module-5	L2 , L3	**3 Hours**
Combustion Emission: Introduction, regulations, mechanisms of pollutant formation. Pollutants reduction in conventional combustors, pollutants reduction by control of flame temperature, dry low-oxide of nitrogen combustors. Lean pre-mix pre-vaporise combustion. **Laboratory Sessions/Experimental Learning** Aircraft Propulsion lab **Applications:** Rocket engines, Gas turbine engines		

Course outcomes:	
CO1	Apply the concept of combustion
CO2	Analyze the combustion performance
CO3	Evaluate the combustion instability in gas turbine engines
CO4	Estimate the combustion noise
CO5	Analyze the combustion emission

Text Books:	
1	Arthur H. Lefebvre & Dilip R Ballal,` Gas Turbine Combustion`, CRC Press, 3rd Edition, 2010
2	Minkoff, G. J. & C.F.H. Tipper, ‘Chemistry of combustion Reaction`, London Butterworth, 1962
Reference Books:	
1	Samir Sarkar,` Fuel & Combustion`, Orient Longman , 1996
2	Wilson, P.J. and J. H. Wells,` Coal, Coke and Coal Chemicals, McGraw-Hill,1960.
CIE Assessment:	

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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	1	1	1	0
CO4	3	2	1	0	0	1	1	0	0	0	0	1	1	0
CO5	3	2	1	0	0	0	0	0	0	0	0	1	1	0

High-3, Medium-2, Low-1

Course Title	**MODELING AND ANALYSIS LAB**	**Semester**	II
Course Code	MVJMAE27	**CIE**	50
Total No. of Contact Hours	26	**SEE**	50
No. of Contact Hours/week	02	**Total**	100
Credits	02	**Exam. Duration**	3 Hours

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

Sl No	Experiment Name	RBT Level	Hours
1	Modeling of Symmetrical/Cambered Aerofoil Geometry, and Generation of Body Fitting AdaptiveMesh.	L2,L3	02
2	Modeling of 2-D Incompressible and Inviscid Flow over Symmetrical/Cambered Aerofoil, and Plottingof Pressure distribution and Velocity vectors for Subsonic/Supersonic Mach numbers.	L2,L3	02
3	Modeling of 2-D Compressible and Viscid Flow over Symmetrical/Cambered Aerofoil and Plotting ofPressure distribution and Velocity vectors for Subsonic Mach numbers.	L2,L3	02
4	Isentropic Flow Analysis in a 2-D Subsonic Diffuser and a Subsonic Nozzle.	L2,L3	02
5	Isentropic Flow Analysis in a 2-D Supersonic Diffuser and a Supersonic Nozzle.	L2,L3	02
6	Geometric Modeling and Mesh Generation of a 2-D Convergent- Divergent Nozzle and Analyses of flow for Adiabatic Conditions (Fanno Flow).	L2,L3	02
7	Geometric Modeling and Mesh Generation of a 2-D Pipe and Modeling of Steady/Unsteady Heat Convection and Conduction (Rayleigh Flow).	L2,L3	02
8	Structural Modeling of Sandwich Beam of Rectangular Cross-section and Analyses for Stress for Unsymmetrical bending case	L2,L3	02
9	Structural Modeling and Stress Analysis of a Torsion Box of a Wing.	L2,L3	02
10	Structural Modeling and Stress Analysis of a Fuselage Frame.	L2,L3	02
11	Structural Modeling and Stress Analysis of a Tapered I-Section Spar.	L2,L3	02
12	Determine the Natural frequency and Mode shapes of a Cantilever beam under UDL.	L2,L3	02

Course outcomes:	
CO1	Draw the geometric models of symmetric, cambered aerofoil, nozzle, wing and other structures.
CO2	Apply different types of meshing.
CO3	Perform the flow and stress analysis.

CO-PO Mapping

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

High-3, Medium-2, Low-1

MVJ College of Engineering, Whitefield, Bangalore

An Autonomous Institution, Affiliated to VTU, Belagavi

Scheme of Teaching and Examination 2024

Effective from the academic year 2024-25

Department of Aeronautical Engineering - PG Program

III SEMESTER M.Tech AE (A)

For the students who are willing to take up a two-semester duration Industry/Research Internship Leading to Project work /start-up

S. No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory	Practical / Seminar	Tutorial / Skill Development Activity	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	PCC/MDC	MVJMAEA31	(Online Courses) 12 weeks duration	AE	-	-	-	-	-	-	100	3
2		MVJMAEA32	(Online Courses) 12 weeks duration	AE	-	-	-	-	-	-	100	3
3		MVJMAEA33	(Online Courses) 12 weeks duration	AE	-	-	-	-	-	-	100	3
4	INT	MVJINTA34	Research Internship /Industry-Internship leading to project work/ Startup		Two-semester duration, SEE in the IV semester which leads to project work /start-up			3	100	-	100	3
Total					-	-	-	-	**100**	-	**400**	**12**

Note:

PCC: Professional core courses, **MDC**- Multi-Disciplinary Courses, **INT**: Industry/ Research Internship leading to the project work /startup, IV SEMESTER M.Tech AE (A)

S. No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory	Practical / Field work	Tutorial / Skill Development Activity	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	P					
1	INT	MVJINTA41	Research Internship / Industry Internship Leading to Project Work/Start-up	AE	Two Semester Duration			3	100	100	200	12
2	PROJ	MVJPRJA42	Project	AE				3	100	100	200	16
Total					-	-	-	**6**	**200**	**200**	**400**	**28**

Note:
INT: Industry/ Research Internship leading to the project work /startup,
PROJ: Project work outcome of Internship (Project Phase-II is Viva voce SEE)

Taking up a two-semester Industry/Research Internship that leads to project work or a start-up can be a highly rewarding experience for students. It allows them to apply theoretical knowledge in practical settings, gain valuable industry or research experience, and potentially develop innovative solutions or business ideas. Here are some key steps and considerations for students pursuing such an internship:

Industry Internship: The main objective of the industry internship is to ensure that the intern is exposed to a real-world environment and gain practical experience. Often, it may be a practical exposure to the theory that has been learned during the academic period. The industry internship helps students understand of analytical concepts and tools, hone their skills in real-life situations, and build confidence in applying the skills learned.

Research Internship: A research internship is an opportunity for students or early career professionals to gain hands-on experience in conducting research under the guidance of a mentor or within a research team. These internships can take place in academic institutions, research organizations, government agencies, or private companies

Research /Industry Internship: In the third-semester Students have to be in touch with a guide/mentor/coordinator and regularly submit the report referred to the progress internship. Based on the progress report the Guide/Mentor/coordinator has to enter the CIE marks at the end of the 3rd semester. At the beginning of the 4th semester, students have to define the project topic out of the learning due to the Internship, upon completion of the project work he/she has to attend the SEE at the parent Institute.

Internship Leading to Start-up: An internship that leads to a startup is an exciting pathway, blending real-world experience with entrepreneurial ambition. Here's a comprehensive guide to transitioning an internship experience into launching your startup: 1) Maximize your internship experience, 2) Identifying Viable Business Ideas, 3) Research and Validation 4) Building a Business Plan 5) Networking and Mentorship 6) Securing Funding 7) Establishing Startup 8) Launching and Marketing. By following these steps, you can effectively transition from an internship to launching a successful startup. This journey requires dedication, resilience, and a willingness to learn and adapt.

III SEMESTER M.Tech AE (B)

For the students who are willing to take an Industry Internship for one-semester duration and independent project work next semester

<table>
<tr><th rowspan="3">S. No</th><th colspan="2" rowspan="2">Course</th><th rowspan="3">Course Title</th><th rowspan="3">Teaching Department</th><th colspan="3">Teaching hours/week</th><th colspan="4">Examination</th><th rowspan="3">Credits</th></tr>
<tr><th>Theory</th><th>Practical / Seminar</th><th>Tutorial / Skill Development Activity</th><th rowspan="2">Duration in Hours</th><th rowspan="2">CIE Marks</th><th rowspan="2">SEE Marks</th><th rowspan="2">Total marks</th></tr>
<tr><th>Type</th><th>Code</th><th>L</th><th>T</th><th>SDA</th></tr>
<tr><td>1</td><td rowspan="3">MDC/PEC</td><td>MVJMAEB31</td><td>(Online Courses) 12 weeks duration</td><td>AE</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>100</td><td>3</td></tr>
<tr><td>2</td><td>MVJMAEB32</td><td>(Online Courses) 12 weeks duration</td><td>AE</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>100</td><td>3</td></tr>
<tr><td>3</td><td>MVJMAEB33</td><td>(Online Courses) 12 weeks duration</td><td>AE</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>100</td><td>3</td></tr>
<tr><td>4</td><td>INT</td><td>MVJINTB34</td><td>Industry-Internship</td><td></td><td colspan="3">One Semester Duration</td><td>3</td><td>100</td><td>100</td><td>200</td><td>11</td></tr>
<tr><td colspan="5">Total</td><td>-</td><td>-</td><td>-</td><td>-</td><td>100</td><td>100</td><td>500</td><td>20</td></tr>
</table>

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project with Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab, L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities (Hours are for Interaction between faculty and students) PP/NP-Passed / Not Passed (Only for non-Credit Course)

IV SEMESTER M.Tech AE (B)

S. No	Course		Course Title	Teaching Department	Teaching hours/week		Examination				Credits
					Theory	Tutorial / Skill Development Activity	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	P					
1	PROJ	MVJPRJB41	Project	AE	-	8	3	100	100	200	20
Total					-	**8**	**3**	**100**	**100**	**200**	**20**

Note:
INT: Industry/ Research Internship leading to the project work /startup,
PROJ : Project work outcome of Internship (Project Phase-II is Viva voce SEE)

Industry Internship: The main objective of the industry internship is to ensure that the intern is exposed to a real-world environment and gains practical experience. Often, it may be a practical exposure to the theory that has been learned during the academic period. The industry internship helps students understand of analytical concepts and tools, hone their skills in real-life situations, and build confidence in applying the skills learned. The students who take up a one-semester Internship in the Industry have to appear SEE at the institute at the end of the semester as per the examination calendar.

Project Work: Students in consultation with the guide shall carry out literature survey/ visit industries to finalize the topic of the Project.
Subsequently, the students shall collect the material required for the selected project, prepare a synopsis, and narrate the methodology to carry out the project work. Each student, under the guidance of a Faculty, is required to

- Present the seminar on the selected project orally and/or through Power Point slides.
- Answer the queries and be involved in debate/discussion.
- Submit two copies of the typed report with a list of references.
- The participants shall take part in discussions to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident

CIE marks for the project report (20 marks), seminar (20 marks) and question and answer (10 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session by the student) by the committee constituted for the purpose by the Principal. The committee shall consist of an internal guide and a faculty from the department with the senior most acting as the Chairperson.

Semester End Examination SEE marks for the project report (30 marks), seminar (10 marks) and question and answer session (10 marks) shall be awarded (based on the quality of the report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

III SEMESTER M.Tech AE (C)

For the students who are willing to take a research-leading paper publication in Q1/Q2/Q3 Journals and to a PhD Registration

S. No	Course		Course Title	Teaching Department	Teaching hours/week			Examination				Credits
					Theory	Practical / Seminar	Tutorial / Skill Development Activity	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	T	SDA					
1	PCC/IPCC/MDC/PEC	MVJMAEC31	(Online Courses) 12 weeks duration	AE	-	-	-	-	-	-	100	3
2		MVJMAEC32	(Online Courses) 12 weeks duration	AE	-	-	-	-	-	-	100	3
3		MVJMAEC33	(Online Courses) 12 weeks duration	AE	-	-	-	-	-	-	100	3
4		MVJMAEC34	(Online Courses) 12 weeks duration	AE	-	-	-	-	-	-	100	3
4	PROJ	MVJPRJC35	Project-Phase-I		One Semester Duration			3	100	--	100	6
			Total		-	-	-	-	**100**	-	**500**	**18**

IV SEMESTER M.Tech AE (C)

S. No	Course		Course Title	Teaching Department	Teaching hours/week		Examination				Credits
					Theory	Tutorial / Skill Development Activity	Duration in Hours	CIE Marks	SEE Marks	Total marks	
	Type	Code			L	P					
1	PROJ	MVJPRJC41	Project work	AE	-	8	3	100	100	200	22
			Total		-	**8**	**3**	**100**	**100**	**200**	**22**

Note:

The research section of the university has to announce the number of seats for M.Tech. students who are seeking PhD (research study) admission through a project leading to the publication of the paper in Q1/Q2/Q3 journals. Only full-time research work will be permitted in the university department or approved research centers of the affiliated colleges of the university (guidelines need to be set up). Based on seat availability, the students are permitted to register for project work leading to the publication of papers in Q1/Q2/Q3 journals and admission to research (PhD) in their 3rd semester of the M.Tech., program

Project Phase-1 Project Phase-I, typically the initial phase in any project, is crucial as it lays the foundation for the entire project. This phase involves defining the project's scope, objectives, and initial planning. Here's a structured approach to effectively carry out Project Phase-I: • **Project Charter**: Outlines the project's purpose, objectives, and stakeholders. • **Scope Statement**: Defines the project boundaries and deliverables. • **Requirements Document**: Captures all project requirements. • **Project Plan**: Details the approach, timeline, and resource allocation. • **Risk Management Plan**: Identifies and plans for potential risks. • **Feasibility Study Report**: Assesses technical, economic, and operational feasibility. Students in consultation with the guide shall carry out literature survey/visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis, and narrate the methodology to carryout the project work. Each student, under the guidance of a faculty, is required to • Present the seminar on the selected project orally and/or through power point slides. • Answer the queries and be involved in debate/discussion. • Submit two copies of the typed report with a list of references. • The participants shall take part in discussions to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident. **Continuous Internal Evaluation (100 Marks).** CIE marks for the project report (60 marks), seminar (20 marks) and question and answer(20marks) shall be awarded (based on the quality of report and presentation skill, participation in the question-and-answer session by the student) by the committee constituted for the purpose by the Principal. The committee shall consist of an internal guide and a faculty from the department with the senior most acting as the Chairperson.
Project Work Phase-II: Each student shall be involved in carrying out the project work jointly in constant consultation with internal guide and external guide and prepare the project report as per the norms of the university to avoid plagiarism. Phase II of a project typically involves the detailed execution of the planned activities, continuous monitoring and control of the project's progress, and making necessary adjustments to ensure the project stays on track. Keep detailed records of all project activities, decisions, and changes. Ensure all project documentation is organized and accessible. Conduct a final project review to evaluate overall performance, achievements, and lessons learned. Document best practices and areas for improvement for future projects. **Paper Publication Process**: Publishing a research paper based on your project in a Q1/Q2/Q3 journal involves several key steps, from writing the manuscript to navigating the peer review process. Here's a comprehensive guide: **Writing the Manuscript**: Choose a clear and concise title that accurately reflects the content. Write an abstract summarizing the research question, methods, results, and conclusions. **Literature Review**: Review relevant existing research to establish the foundation of your study. Identify gaps that your research aims to fill. **Methodology**: Describe the research design, methods, and procedures in detail. Include information on data collection, analysis, and any tools or software used. Results: Present the findings of your research clearly and logically. Use tables, figures, and charts to illustrate key results. **Discussion**: Interpret the results and explain their implications. Compare your findings with existing research and discuss any discrepancies or new insights. **Conclusion**: Summarize the main findings and their significance. Suggest potential future research directions. **References**: Cite all sources used in your research following the journal's citation style. **Journal Selection:** Choose a journal that aligns with the scope and focus of your research. Consider the journal's impact factor (Q1, Q2, Q3) and audience. **Review Journal Guidelines**: Carefully read the journal's submission guidelines and ensure your manuscript adheres to them. **Prepare Your Manuscript**: Format your manuscript according to the journal's guidelines. Include all required sections and supplementary materials. **Cover Letter**: Write a cover letter to the journal editor highlighting the significance of your research and why it fits the journal. **Submit the Manuscript**: Use the journal's online submission system to submit your manuscript. Ensure all required information and documents are included. **Semester End Examination** SEE marks for the project report (60 marks), seminar (20marks) and question and answer session (20 marks) shall be awarded (based on the quality of report and presentation skill ,participation in the question and answer session) by the examiners appointed by the University.