Course Title	AIRCRAFT STABILITY AND CONTROL	Semester	VII
Course Code	MVJ19AE71	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3 :2: 0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam Duration	3 Hrs.

The courseobjective is to:

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

Module 1	L1,L2	10 Hrs.

Static Longitudinal Stability and Control-Stick Fixed

Definition, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution,

Fuselage contribution, Power effects- Propeller airplane and Jet airplane Introduction, Trim condition. Static

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

Laboratory Sessions/ Experimental learning:

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

Applications:

Determine the Longitudinal stability of Aircraft with Stick fixed

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

27. NPTEL- Aircraft Stability & Control

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

2. MIT open course ware- Aircraft Stability & Control

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

Module 2	L1,L2,L3,	10 Hrs.

Static Longitudinal Stability and Control-Stick free

Introduction, Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G.

Laboratory Sessions/ Experimental learning:

Calculate the variation of Trim Tabs during Stick free Neutral point condition

Applications:

Determine the Longitudinal stability of Aircraft with controls free

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

1. NPTEL- Aircraft Stability & Control

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

2. MIT open course ware- Aircraft Stability & Control

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

Module 3	L1,L2	10 Hrs.

Static Directional and Lateral Stability and Control

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

Static Lateral stability. Estimation of dihedral effect. Effect of wing sweep, flaps, and power. Lateral control, Estimation of lateral control power, Aileron control forces, Balancing the aileron. Coupling between rolling and yawing moments. Adverse yaw effects. Aileron reversal.

Laboratory Sessions/ Experimental learning:

Effect of aileron input in lateral and directional motion of Aircraft

Applications:

Effect of Directional and Lateral stability on Aircraft

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

1. NPTEL- Aircraft Stability & Control

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

2. MIT open course ware- Aircraft Stability & Control

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

Module 4	L1,L2,L3	10 Hrs.

Equations of Motions

Derivation of rigid body equations of motion, Orientation and position of the airplane, gravitational and thrust Forces, Small disturbance theory. Aerodynamic force and moment representation,

Derivatives due to change in forward speed, Derivatives due to the pitching velocity, Derivatives due to the time rate of change of angle of attack, Derivatives due to rolling rate, Derivatives due to yawing rate.

Laboratory Sessions/ Experimental learning:

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

Applications:

Stability derivative estimation for a stable aircraft

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

1. NPTEL- Aircraft Stability & Control

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

2. MIT open course ware- Aircraft Stability & Control

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

Module 5	L1,L2,L3	10 Hrs.

Dynamic Stability

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

Laboratory Sessions/ Experimental learning:

Determine short period and phugoid oscillations for a given Quartic equation

Applications:

Determine relative stability of an Aircraft

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

1. NPTEL- Aircraft Stability & Control

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

2. MIT open course ware- Aircraft Stability & Control

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

Course outcomes:

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

CO401.1	Analyse Longitudinal stability for Stick fixed conditions.

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

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

CIE Assessment:

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

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

SEE Assessment:

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

xlviii. 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.

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

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

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

High 3, Medium 2, Low 1

Course Title	AIRCRAFT PERFORMANCE	Semester	VII
Course Code	MVJ19AE72	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3 :2: 0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hrs.

The course objective is to:

1. Understand Steady Unaccelerated Flight
2. Comprehend Steady Performance – Level Flight, Climb & Glide
3. Gain knowledge of Airplane Performance Parameters like Range and Endurance etc.
4. UnderstandAircraft Performance in Accelerated Flight
5. Acquire knowledge of Maneuver Performance of an Aircraft

Module 1	L1,L2	10 Hrs.

The Equations of Motion in Steady Unaccelerated Flight

Introduction and four forces of flight, General equations of motion, Power available and power required curves, Thrust available and thrust required curves, Conditions for power required and Thrust required minimum, Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required, Thrust available and Thrust required

Laboratory Sessions/ Experimental learning:

Estimation of Thrust and Power of an engine – Aircraft Propulsion Lab

Applications: Introduction to Steady Unaccelerated Flight

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

https://www.youtube.com/watch?v=tEWuP1NVdgE&list=PLtUPB3SCffXP43al7ILIR5qaZF_5fEDXm

Module 2	L1,L2	10 Hrs.

Steady Performance – Level Flight, Climb & Glide

Performance: Equations of motion for Rate of climb- graphical and analytical approach, Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach, Climb performance graph (hodograph diagram), Maximum climb angle and rate of climb, Gliding flight, Range during glide, Minimum rate of sink and shallowest angle of glide

Laboratory Sessions/ Experimental learning:

Calculation of Absolute ceiling and Service ceiling and their importance

Applications: To understand Steady Performance of an Aircraft – Level Flight, Climb & Glide **Video link / Additional online information (related to module if any):** https://www.youtube.com/watch?v=QXpO3WIxJx8		
Module 3	L1,L2	10 Hrs.
Fundamental Airplane Performance Parameters **The fundamental parameters**: Thrust-to-Weight ratio, Wing loading, Drag polar and Lift-to-Drag ratio, Minimum velocity, Aerodynamic relations associated with lift-to-drag ratio **Range and Endurance**: **Propellerdriven Airplane**: Physical considerations, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance **Jet Airplane**: Physical considerations, Quantitative formulation, Equations for Range and Endurance, Conditions for maximum range and endurance, Effect of Head wind and Tail wind **Laboratory Sessions/ Experimental learning:** Determination of Range and Endurance for Propeller driven and Jet airplane **Applications**:Calculation of Range and Endurance of an Aircraft **Video link / Additional online information (related to module if any):** https://www.youtube.com/watch?v=YOTdaEeA8tM		
Module 4	L1,L2,L3	10 Hrs.
Aircraft Performance in Accelerated Flight **Take-off Performance**: Calculation of Ground roll, Calculation of distance while airborne to clear an obstacle, Balanced field length **Landing Performance and Accelerated Climb**: Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, Ground effects, Acceleration in climb **Laboratory Sessions/ Experimental learning:** Assessment of Ground roll and Distance while airborne to estimate Total Take-off distance **Applications**: Understanding Take-off Performance, Landing Performance and Accelerated Climb **Video link / Additional online information (related to module if any):** https://www.youtube.com/watch?v=lzbg9t-6-gA		
Module 5	L1,L2,L3	10 Hrs.
Maneuver Performance **Turning performance**: Level turn, Load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate **Pull-up and Pull-down maneuvers**: Turning rate, turn radius, Limiting case for large load factor, V-n diagram, Limitations of pull up and push over		

Laboratory Sessions/ Experimental learning: Study of Velocity-Load factor (V-n) Diagram for an aircraft **Applications**: To understand Maneuver Performance of an Aircraft **Video link / Additional online information (related to module if any):** https://www.youtube.com/watch?v=KNPxD7bbMP8	
Course Outcomes: Upon completion of the course, students will be able to:	
CO402.1	Analyse Steady Unaccelerated Flight
CO402.2	Evaluate Steady Performance of an Aircraft – Level Flight, Climb & Glide
CO402.3	Analyze Range and Endurance of an Aircraft
CO402.4	Illustrate Take-off Performance, Landing Performance and Accelerated Climb
CO402.5	Compute Maneuver Performance of an Aircraft

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

CIE Assessment:

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

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

SEE Assessment:

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

li. 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.

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

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

High:3, Medium:2, Low:1

Course Title	COMPUTATIONAL FLUID DYNAMICS	Semester	VI
Course Code	MVJ19AE731	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3hrs

The Course objective is to:

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

Module-1	L2,L3	08 Hrs.

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

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications:Flow Analysis

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Module-2	L3,L4	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Flow analysis

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Module-3	L3,L4	08 Hrs.

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

Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Finite Difference Techniques for flow analysis

Video link / Additional online information (related to module if any):
Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Module-4	L3,L4	08 Hrs.

Grid generation &Adaptive Grid Methods: Need for grid generation and Body-fitted coordinate system. Structured grids-essential feature. Structured grids generation techniques-algebraic and numerical methods. Unstructured grid generation Techniques-Delaunay-Voronoi diagram, advancing front method, multi-block grid generation, Grid quality, adaptive grids.
Adaptive Structured Grid Generation, Unstructured adaptive grid Methods.
Transformation: Matrices &Jacobian of transformation. Transformation of Equation from physical plane into computational Plane-examples.
Laboratory Sessions/ Experimental learning: Ansys Lab

Applications: Grid formulation and transformation of planes

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

Nptel Video: CFD by Prof. S Chakraborty IIT Kharagpur

Module-5	L3,L4	08 Hrs.

Finite Volume Techniques and some Applications: **Spatial**discretisation:-Cell Centred Formulation and Cell vertex Formulation (overlapping control volume, duel control volume). Temporal discretisation: - Explicit time-stepping and Implicit time- stepping, time step calculation
Applications: Aspects of numerical dissipation & dispersion. Approximate factorization, Flux Vector splitting. Diffusion problem. Heat through conduction and radiation. Up winding technique. Post-processing and visualization, contour plots, vector plots etc.

Laboratory Sessions/ Experimental learning: Ansys Lab **Applications**: Flow analysis through Finite Volume Technique **Video link / Additional online information (related to module if any)**: **Nptel Video**: CFD by Prof. S Chakraborty IIT Kharagpur

Course outcomes:	
CO403.1.1	Apply knowledge of CFD ideas, and Flow Equations
CO403.1.2	Assimilate Mathematical behaviour of PDEs vis a vis nature of flow
CO403.1.3	Utilisefinite difference techniques.
CO403.1.4	Generate &Utilise grids
CO403.1.5	Apply finite volume techniques

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

CIE Assessment:

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

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

SEE Assessment:

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

liv. 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.

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

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

High-3, Medium-2, Low-1

Course Title	FATIGUE AND FRACTURE MECHANICS	Semester	VI
Course Code	MVJ19AE732	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

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

Module 1	L1,L2	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

Effect of Stress concentration factors and SNcurves plot in strength of materials lab

Applications:

Determine the Endurance limit and Stress concentration factors

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

NPTEL-

1. https://nptel.ac.in/courses/112/106/112106065/
2. https://www.youtube.com/watch?v=o-6V_JoRX1g

Module 2	L1, L2	08 Hrs.

Statistical Aspects of Fatigue Behaviour:Low cycle and high cycle fatigue, Coffin-Manson's relation, Transition life, Cyclic Strain hardening and softening, Analysis of load histories, Cycle counting techniques, Cumulative damage, Miner's theory,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 **Video link / Additional online information (related to module if any):** 1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/		
Module 3	**L1, L2**	08 Hrs.
Physical Aspects of Fatigue:Phase in fatigue life, Crack initiation, Crack growth, Final fracture, Dislocations, Fatigue fracture surfaces.Crack opening displacement,crack tip opening displacement. **Laboratory Sessions/ Experimental learning:** To determine the crack initiation and crack growth of the given material using equipment setup. **Applications:** To determine the COD and CTOD values of the given material **Video link / Additional online information (related to module if any):** 1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/		
Module 4	**L1, L2**	08 Hrs.
Fracture Mechanics: Strength of cracked bodies, potential energy and surface energy, Griffith's theory, Irwin – Orwin extension of Griffith'stheory to ductile materials, Stress analysis of cracked bodies, Effect of thickness on fracture toughness, Stress intensity factors for typical geometries, Linear elastic fracture mechanics. **Laboratory Sessions/ Experimental learning:** Estimate the effect of stress intensity factors and effect of thickness on fracture toughness. **Applications:** To find out the stress analysis of the cracked bodies **Video link / Additional online information (related to module if any):** 1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/		
Module 5	**L1, L2**	08 Hrs.
Fatigue Design and Testing: Safe life and fail safe design philosophies,Importance of Fracture Mechanics in aerospace structure, Application composite materials and structures. **Laboratory Sessions/ Experimental learning:** Determine short period and phugoid oscillations for a given Quadratic equation **Applications:** Determinethe relative stability of an Aircraft **Video link / Additional online information (related to module if any):** 1.NPTEL- https://nptel.ac.in/courses/112/106/112106065/		
Course outcomes: Upon completion of the course, students will be able to:		

CO403.2.1	Apply the concept of Fatigue analysis of the structures
CO403.2.2	Compare the low cycle fatigue and high cycle fatigue and strain hardening and softening
CO403.2.3	Investigate the reasons for crack initiation, growth, and fracture and for COD and CTOD
CO403.2.4	Evaluate Fracture Toughness
CO403.2.5	Analyse Design for Fatigue

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

CIE Assessment:

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

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

SEE Assessment:

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

lvii. 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.

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

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

High,3, Medium,2, Low,

Course Title	CONTROL ENGINEERING	Semester	7
Course Code	MVJ19AE733/AS733	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

1. Understand the basic concepts of control systems and mathematical models.
2. Acquire knowledgeof block diagrams and signal flow graphs.
3. Gain knowledge of stability analysis in Laplace domain through various techniques
4. Apprehend the frequency response specifications and polar plots
5. Understand the requirement for controller and compensation gain.

Module 1	L1,L2,L3	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

1. Aircraft Controls

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

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

Module 2	L1,L2,L3,	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

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

Module 3	L1,L2,L3	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

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

Module 4	L1,L2,L3	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

1. Determine stability of an aircraft

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

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

Module 5	L1,L2	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

1. Design PID controller for non linear system

Applications:

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

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

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

Course outcomes:

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

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

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

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

CIE Assessment:

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

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

SEE Assessment:

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

lx. 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.

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

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

High,3, Medium,2, Low,1

Course Title	AVIONICS	Semester	VII
Course Code	MVJ19AE741	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

Course objective is to:

This course will enable students to

1. Understand the need for avionics in civil, military and space systems.
2. Acquire the knowledge of control and navigation systems
3. Acquire the knowledge of display technologies and avionics system architectures
4. Appreciate the use of microprocessors
5. Understand the functioning of data buses

Module 1Power Distribution System	L1,L2	08 Hrs.

Power Distribution System: Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilization-typical application to avionics. Need for Avionics in civil and military aircraft.

Laboratory Sessions/ Experimental learning: Programming using microprocessor

Applications: Data Transfer, Communication

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

1. https://www.coursera.org/lecture/aeronautics/basics-X8Mvf

Module 2Inertial Navigation & Electronic Flight Control System	L1,L2,L3,	08 Hrs.

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

Electronic Flight Control System: Fly-by-wire system: basic concept and features. Pitch and Roll rate: command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis.

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

Applications: Communication, Tracking

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

1. https://www.coursera.org/lecture/aeronautics/basics-X8Mvf

Module 3Electronic Flight Instrument & Avionics Sub Systems	L1,L2,L3	08 Hrs.

Electronic Flight Instrument Systems: Display-units, presentation, failure, and annunciation. Display of air data.

Introduction to Avionics Sub Systems and Electronic Circuits: Typical avionics sub systems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna. **Laboratory Sessions/ Experimental learning**:Construct 7 segment display circuit using IC timer **Applications**: Attitude Estimation, Navigation, Control **Video link / Additional online information (related to module if any)**: 1. https://nptel.ac.in/courses/101/106/101106042/		
Module 4Digital Systems & Flight Deck and Cockpits	**L1,L2,L3**	08 Hrs.
Principles of Digital Systems: Digital Computers, Microprocessors, Memories. **Flight Deck and Cockpits**: Control and display technologies CRT, LED, LCD, EL and plasma panel, Touch screen, Direct voice input (DVI)-Civil cockpit and military cockpit : MFDS, HUD, MFK, and HOTAS. **Laboratory Sessions/ Experimental learning**:Data transfer using ARINC420 data bus **Applications**: Position Estimation, Guidance, Control **Video link / Additional online information (related to module if any)**: 1. https://nptel.ac.in/courses/101/108/101108056/ 2. https://nptel.ac.in/courses/101/108/101108056/		
Module 5Avionics Systems Integration	**L1,L2,L3**	08 Hrs.
Avionics Systems Integration: Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Flight control systems, Radar, Electronic Warfare, and fire control system. Avionics system architecture, Data buses, MIL–STD1553B **Laboratory Sessions/ Experimental learning**:Data transfer using MIL-STD 1553B Data bus **Applications**: Navigation, Guidance, Control **Video link / Additional online information (related to module if any)**: 1. https://nptel.ac.in/courses/101/106/101106042/		

Course outcomes:

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

CO404.1.1	Understand the necessity of avionics in civil, military and space systems
CO404.1.2	Understand the various aircraft navigation and control schemes
CO404.1.3	Appreciate the use of electronics packages in avionics
CO404.1.4	Understand the principles of various man machine interface devices such as data entry and displays.
CO404.1.5	Get introduced with the avionics systems and work with the various existing aircraft data buses.

Reference Books:

1.	R.P.G. Collinson, Introduction to Avionics Systems, 3rd Edition, 2011, Springer.

2.	Ian Moir, Allan Seabridge and Malcolm Jukes, Civil Avionics Systems, 2nd Edition, 2003, Wiley.
3.	R. Cundy Dale, Introduction to Avionics, 2010, Pearson Education.

CIE Assessment:

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

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

SEE Assessment:

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

lxiii. 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.

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

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

High,3, Medium,2, Low,1

Course Title	FLIGHT VEHICLE DESIGN	Semester	VII
Course Code	MVJ19AE742	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

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	08 Hrs.

Overview of Design Process

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

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

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

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

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

Module 2	L1,L2,	08 Hrs.

Configuration Layout & loft

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

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

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

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

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

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

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

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

Module 3	L1,L2	08 Hrs.

Engine Selection & Flight Vehicle Performance

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

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

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

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

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

Module 4	L1,L2	08 Hrs.

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

Laboratory Sessions/ Experimental learning:Performance analysis in Matlab

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

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

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

Module 5	L1,L2	08 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.

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

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

Course outcomes:

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

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

Reference Books:

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

CIE Assessment:

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

- Quizzes/mini tests (4 marks)
- Mini Project / Case Studies (8 Marks)

- Activities/Experimentations related to courses (8 Marks)

SEE Assessment:

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

lxvi. 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.

lxvii. 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	GUIDANCE NAVIGATION & CONTROL	Semester	VII
Course Code	MVJ19AE743	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

1.Understand the basics of Guidance and Navigation.

2. Gain knowledge of the various types of guidance and control systems

3. Comprehend the control system for missiles

4.Acquire knowledge of the missile guidance performance

5. Understand the requirement for integrating flight and fire control system.

Module 1	L1,L2,L3	08 Hrs.

Guidance, Navigation and ControlIntroduction:Concepts of navigation, guidance and control. Introduction to basic principles. Air data information.

Radar Systems:Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector.Limitation of MTI performance. MTI from a moving platform (AMTI).

Laboratory Sessions/ Experimental learning:

1. Analyse the flight instruments of aircraft for given flight condition using MATLAB

Applications: Guidance system for aircraft, Target detection

Video link / Additional online information:

https://nptel.ac.in/courses/101/104/101104062/ - IIT Kanpur

Module 2	L1,L2,L3,	08 Hrs.

Target Detection and Tracking with Radar: Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT). Detection avoidance techniques.

Other Guidance Systems: Gyros and stabilised platforms. Inertial guidance and Laser based guidance.

Components of Inertial Navigation System. Imaging Infrared guidance. GPS, SATcom.

Laboratory Sessions/ Experimental learning:

1. Calculate the position and velocity of an target for given doppler shift using MATLAB.

Applications: Target detection and tracking

Video link / Additional online information:

https://nptel.ac.in/courses/101/104/101104062/ -IIT Kanpur		
Module 3	**L1,L2,L3**	08 Hrs.
Transfer Functions: Input-output Transfer function. Basic altitude reference. Concepts of Open loop and Close Loop, Root Locus plot. **Missile Control System:** Guided missile concept. Roll stabilisation. Control of aerodynamic missile. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus. **Laboratory Sessions/ Experimental learning:** 1. Determine stability of a system using Root locus plot. **Applications:** Stability of a system, Missile autopilot design **Video link / Additional online information:** https://nptel.ac.in/courses/101/104/101104062/ - IIT Kanpur		
Module 4	**L1,L2,L3**	08 Hrs.
Missile Guidance: Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance. **Laboratory Sessions/ Experimental learning:** 1. Draw a missile trajectory to hit a slow moving target using Proportional guidance **Applications:** Guidance system for missiles **Video link / Additional online information:** https://nptel.ac.in/courses/101/104/101104062/- IIT Kanpur		
Module 5	**L1,L2**	08 Hrs.
Integrated Flight/Fire Control System: Principal of missile launch from aircraft, Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. Rate of change of Euler angle , Auto Pilot. **Laboratory Sessions/ Experimental learning:** 1. Draw a missile trajectory to hit a combat aircraft using Command guidance. **Applications:** Simulation of dynamic modes and performance parameters for Aircraft design **Video link / Additional online information:** https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2005/video-lectures/lecture-16/ - MIT		
Course outcomes: Upon completion of the course, students will be able to:		

CO404.3.1	Apply the concept of guidance and navigation to design guidance system for aircraft.
CO404.3.2	Apply knowledge of the various types of guidance and control systems
CO404.3.3	Evaluate control of missile
CO404.3.4	Analyse missile guidance performance
CO404.3.5	Analyse integrated flight and fire control system

Reference Books:	
1.	P.T. Kabamba and A.R. Girard, Fundamentals of Aerospace Navigation and Guidance, Cambridge Aerospace Series, 2014
2.	John H Blakelock,Automatic control of Aircraft & Missiles`, Wile –Inter Science Publication, 2nd edition, May 1990.
3.	Merrilh I. Skolnik,`Introduction to Radar Systems`, 3rd edition, Tata Mc Graw Hill, 2001.
4.	George M. Siouris, Missile Guidance and Control Systems, Springer, 2004

CIE Assessment:

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

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

SEE Assessment:

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

lxix. 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.

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

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

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

High,3, Medium,2, Low,1

Course Title	AIRCRAFT COMMUNICATION & NAVIGATION AIDS	Semester	VII
Course Code	MVJ19AE751	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

This course will enable students to

6. Acquire knowledge of aircraft radio communications
7. Understand the principles of primary and secondary radars
8. Understand the radio-based navigation methods
9. Gain knowledge of the inertial navigation systems
10. Comprehend the satellite navigation systems

Module 1Radio Communication	L1,L2,L3	08 Hrs.

Transmitters and Receivers: Propagation of Radio Waves – AM & FM Transmitters - Tuned Radio Frequency Receivers – Superheat Receivers – Selectivity – Image Channel Rejection – Automatic Gain Control – Digital Frequency Synthesis.

VHF and HF Communications: VHF Range and Propagation - DSB Modulation - Channel Spacing - Depth of Modulation – Compression – Squelch - Data Modes - VHF Radio Equipment - Aircraft Communications Addressing and Reporting System - HF Range and Propagation - SSB Modulation – SELCAL - HF Data Link - HF Radio Equipment - HF Antennas and Coupling Units – Satellite Communications.

Laboratory Sessions/ Experimental learning:To study Pulse Amplitude Modulationusing switching method&by sample and hold circuit

Applications:Air to Air Communications, Air to Ground Communications, Aircraft Communications Addressing and Reporting System

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

31. https://nptel.ac.in/courses/108/104/108104098/
32. https://nptel.ac.in/courses/117/105/117105132/

Module 2Primary and Secondary Radar	L1,L2,L3,	08 Hrs.

Primary Radar – Ground radar – Airborne Weather Radar – Secondary Surveillance Radar – Interrogation and Reply Pulses: Mode A, Mode C and Modes S - TCAS Principle – TCAS Equipment - Air Traffic Control System Equipment - ATC Transponder Modes – Modes of Operation **Laboratory Sessions/ Experimental learning**:To study sampling and reconstruction of Pulse Amplitude modulation system. To study amplitude demodulation by linear diode detector. **Applications**:Traffic Collision Avoidance System, Air Traffic Control, Weather Radar **Video link / Additional online information (related to module if any)**: 15. https://nptel.ac.in/courses/101/108/101108056/ 16. https://nptel.ac.in/courses/108/105/108105154/		
Module 3Radio Navigation	**L1,L2,L3**	08 Hrs.
Short Range Radio Navigation Devices: Automatic Direction Finder (ADF) - VHF Omnidirectional Range (VOR) - Distance Measuring Equipment (DME) – Area Navigation **Landing Aids**: Instrument Landing System (ILS) - Microwave Landing System (MLS) **Hyperbolic Navigation Systems**:Principle of Hyperbolic Navigation - LORAN A – LORAN C – Omega – Decca **Laboratory Sessions/ Experimental learning**:To study DSB/ SSB amplitude modulation & determine its modulation factor & power in side bands. To study frequency modulation and determine its modulation factor. **Applications**: Position Estimation, Guidance, Control **Video link / Additional online information (related to module if any)**: 21. https://nptel.ac.in/courses/101/108/101108056/		
Module 4Inertial Navigation	**L1,L2,L3**	08 Hrs.
Inertial Navigation: Principle of DR Navigation for Position Estimation – Principle of Inertial Navigation and Schuler Tuning –Stable Platform and Strap down INS – Attitude Heading reference System (AHRS). **Doppler Navigation**: Doppler Effect – Doppler Navigation Principles – Doppler Navigation Equipment **Laboratory Sessions/ Experimental learning**:To study PLL 565 as frequency demodulator. To study Pulse Width Modulation and Pulse Position Modulation. **Applications**: Position Estimation, Guidance, Control **Video link / Additional online information (related to module if any)**: 21. https://nptel.ac.in/courses/101/108/101108056/		
Module 5Satellite Navigation	**L1,L2**	08 Hrs.
Satellite Navigation: Segments of Satellite Navigation System - Basic Principles –Sources of Errors –Geometric Dilution of Position - Differential GPS – Local Area Augmentation System (LAAS) –		

Wide Area Augmentation System (WAAS) – Aircraft Based Augmentation System (ABAS) – Receiver Autonomous Integrity Monitoring (RAIM) - Terrain Reference Navigation.

Laboratory Sessions/ Experimental learning:To study sensitivity, selectivity, and fidelity characteristics of super heterodyne receiver.

Applications: Position Estimation, Guidance, Control, Communication

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

21. https://nptel.ac.in/courses/105/107/105107194/
22. https://nptel.ac.in/courses/105/107/105107062/

Course outcomes:

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

CO405.1.1	Analyse the principles and devices used in aircraft radio communications
CO405.1.2	Compute the radars and its associated modes of communication
CO405.1.3	Determine the various radio navigation devices
CO405.1.4	Analyse the inertial navigation systems
CO405.1.5	Evaluate satellite communication systems

Reference Books:

1.	R.P.G. Collinson, Introduction toAvionics Systems, 3rd Edition, 2011, Springer.
2.	Mike Tooley and David Wyatt, Aircraft Communications andNavigation Systems:Principles, Operation and Maintenance, 1st Edition, 2007, Elsevier.
3.	Chris Binns, Aircraft Systems: Instruments, Communications, Navigation and Control, 1st Edition, 2019, John Wiley & Sons, Inc.

CIE Assessment:

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

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

SEE Assessment:

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

lxxii. 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.

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

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

High,3, Medium,2, Low,1

Course Title	AIRCRAFT ARMAMENT STORES AND ESCAPE AID SYSTEMS	Semester	VII
Course Code	MVJ19AE752	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3hrs

Course objective:

- Gain knowledge of Guns, Bombs, and Rockets
- Learn the Air Launched missiles classification and its systems
- Learn the Fire Control Systems
- UnderstandEscape Aid Systems
- Acquire the knowledge oftesting of airborne stores

Module-1	L2,L3	08 Hrs.

Guns, Bombs, and Rockets.

Guns-specific design requirements, energy requirements of aircraft guns Gatling gun, barrel design considerations. Aircraft ammunition-classification and type of ammunition, gun ammunition propellant characteristics. Aerial Bombs and Rockets-Introductory, propulsive charges, aerodynamic considerations for carriage and release. Carriage considerations and pylons. Aerodynamic decelerators. Types of war heads. Penetration bombs, Cluster and HE bombs. Fuses and arming devices. Guided bombs.

Ballistics of Stores: precision, accuracy and CEP. Internal and external ballistics of guns, bombs and rockets-launch dynamics, trajectory, dispersion and stability.

Applications: Aircraft stores carriage

Module-2	L2,L3	08 Hrs.

Missiles.

Guided and unguided missiles, types of air launched missile. Launchers and adaptors for carriage of missiles. War head systems of guided and unguided missiles. General requirements of missile-structures, and propulsion systems. Guided missile systems: classification, interrelationship between various missile subsystems. Choice of subsystem, selection and preliminary design considerations. Guidance systems-classification and phases. Missiles servo systems and Missile instrumentation.
Applications: Airborne Missiles

Module-3	L3	08 Hrs.

Fire Control System.

Introduction to FCS-Classification and brief description. Fundamental elements of FCS-Acquisition & tracking system, weapon pointing system, command, control and communication element. Fire control testing. Design for reliability, maintainability, ease of operation and safety. Fire control radar.
Applications: Armament stores integration

Module-4	L3	08 Hrs..

Escape –Aid Systems

Aircrew ejection seat, working of ejection seat. Pyro techniques for seat firing. Pilot's personal clothing, main parachutes, and drogue parachute. Parachute deployment methods, parachute stability, trajectory and motion of deployed parachute, and parachute material. Canopy jettisoning system. Vertical acceleration `g` vrs time during ejection, Ejection sequence in case of multi crew ejections. Zero-zero ejection. Encapsulated seat egress systems. Ergonomics of pilot`s seat.
Applications: Crew safety related

Module-5	L3,L4	08 Hrs.

Testing and Certification of Air Armament Stores.

Ground testing: Guns ammunition, rockets, bombs, fuses, parachutes, and missiles- Procedure and Instrumentation set ups for testing and proof of air armament stores. Environmental testing of air armament stores. Airworthiness certification and failure investigation procedure of air armaments. Carriage and release-effect of external carriage and advance carriage concepts.
Applications: Stores testing related

Course outcomes:

CO405.2.1	Apply knowledge of Guns, Bombs, and Rockets
CO405.2.2	Assimilate the Air Launched missiles classification and its systems
CO405.2.3	IntegrateFire Control Systems

CO405.2.4	Utilise Escape Aid Systems
CO405.2.5	Apply the knowledge for testing of airborne stores

Reference Books:	
1.	Joint Services guide on environmental testing of armament stores & missiles, JSG-0102
2.	Design Development and Procedure of Military Aircraft and Airborne Stores, DDPMAS2002, CEMILAC
3.	MIL-STD-7743 Testing, store suspension and release equipment, general specifications
4.	Reference: Martin J Dougherty, ` Modern Air Launched Weapons`, Amber Books, Ltd,2019.

CIE Assessment:

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

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

SEE Assessment:

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

lxxv. 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.

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

CO-PO Mapping														
CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO 1	PSO 2
CO1	2	2	2	1	0	0	0	0	0	0	1	0	1	1

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

High-3, Medium-2, Low-1

Course Title	COMPOSITE MATERIALS AND APPLICATIONS	Semester	VII
Course Code	MVJ19AE753	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 : 1: 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

1.Understand theproperties and advantages of composite materials compared to conventional materials.

2.Comprehend the properties of polymer matrix composites with fibre reinforcements and to learn the fabrication methods used in composites

3. Gain knowledge about the Micro and macro mechanical properties of composite lamina and laminates

4. Understand the applications of composites

5. Learn the NDT and DT methods of Composites with Composite applications

Module 1	L1,L2,L3	08 Hrs.

Introduction to Composite Materials

Definition, classification of composite materials, classification of reinforcement - particulate, short fibers, whiskers, long fibers composites. matrix materials – metals, ceramics, polymers (including thermoplastics and thermosets), Carbon-Carbon Composites

Metal Matrix Composites:

MMC with particulate and short fiber reinforcement, liquid and solid state processing of MMC – stir casting, squeeze casting. Properties of MMCs, Applications of Al, Mg, Ti based MMC

Laboratory Sessions/ Experimental learning:

Determination of various composite materials by different types of fibers with application **Applications**: Aircraft structural Parts, Automobile Sector and Many Engineering fields **Video link / Additional online information (related to module if any):** 33. https://youtu.be/0kB0G6WKhKE?list=PLSGws_74K01-bdEEUElQ9-obrujIKGEhg – IIT Kanpur		
Module 2	**L1,L2,L3,**	08 Hrs.
Processing of Polymer Matrix Composites: Thermoset Polymers, Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding,**Resin Transfer Moulding**, Pultrusion, Pulforming, Autoclave Process **Processing of Polymer Matrix Composites**: Thermoplastic Polymers, Extrusion process, Injection Moulding Process, Thermo-forming process. **Post Processing of Composites** – Adhesive bonding, drilling, cutting processes. **Laboratory Sessions/ Experimental learning:** Preparation of Composite laminates by Hand layup method **Applications**: Thermosets and Thermoplastics are used in Aircraft Construction, corrosive environment, Common applications include fans, grating, tanks, ducts, hoods, pumps and cabinets. **Video link / Additional online information (related to module if any):** https://youtu.be/tP8JCX87DzI - IIT Roorkee		
Module 3	**L1,L2,L3**	08 Hrs.
Micro-Mechanical Behavior of a Lamina Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants. **Ultimate Strengths of a Unidirectional Lamina** **Macro-Mechanical Behaviour of a Lamina**: Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Global and local axis for angle lamina, Stress-Strain relations for lamina of arbitrary orientation, Numerical problems. **Laboratory Sessions/ Experimental learning**: Determination of Young's Modulus of a Composite beam **Applications**:Basics of macro level elastic properties, Scales of analysis of composites. Unidirectional and Woven fibers **Video link / Additional online information (related to module if any):** https://youtu.be/loyeZN5UQT8 - IIT Madras		
Module 4	**L1,L2,L3**	08 Hrs.

Applications and Future of Composites

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

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

Laboratory Sessions/ Experimental learning:

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

Applications: Specific Aircraft Structural components.

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

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

Module 5	L1,L2	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

1. Determination of Defects in a composite by NDT Methods

Applications: NDT- DT Methods, Composites in Aerospace sector

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

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

Course outcomes:

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

CO405.3.1	Compare the properties and select material for the given application.
CO405.3.2	Analyse the properties of polymer matrix composites and Fabrication of Composite materials
CO405.3.3	Apply constitutive equations of *composite* materials and understand mechanical behaviour at *micro and macro* levels.
CO405.3.4	Apply the composite materials for a specific application

CO405.3.5	Carry out various inspections in accordance with the established procedures and differentiate various defect types and select the appropriate **NDT** methods for better evaluation

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

CIE Assessment:

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

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

SEE Assessment:

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

lxxviii. 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.

lxxix. 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 SIMULATION LAB	Semester	VII
Course Code	MVJ19AEL76	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	02	Exam. Duration	3 Hours

Course objective is to:

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

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

9	Simulate stall of aircraft and show the effect of variation in static margin on stalling characteristics	L1,L2,L3	03
10	Design of proportional navigation trajectory for missile	L1,L2,L3	03
11	Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a pulseinput in pitch that is intended to bleed the airspeed.	L1,L2,L3	03
12	Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a doubletinput in pitch.	L1,L2,L3	03
13	Given a Quadratic characteristic equation, determine two quadratics that shall result in poles of short- period oscillations and poles of Phugoid. Vary the coefficients of polynomial to study the movement of poles.	L1,L2,L3	03
14	Given a Quartic characteristics equitation, determine Poles and Time constants for Roll mode, Spiral motion, and Dutch roll. Vary the coefficients of polynomial to study the movement of poles.	L1,L2,L3	03

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

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

High-3, Medium-2, Low-1

Course Title	MODELING AND ANALYSIS LAB	Semester	VII
Course Code	MVJ19AEL77	CIE	50
Total No. of Contact Hours	40	SEE	50
No. of Contact Hours/week	03	Total	100
Credits	02	Exam. Duration	3 Hours

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

Sl No	Experiment Name	RBT Level	Hours
1	Modeling of Symmetrical/Cambered Aerofoil Geometry , and Generation of Body Fitting AdaptiveMesh.	L1,L2,L3	03
2	Modeling of 2-D Incompressible and Invisicd Flow over Symmetrical/Cambered Aerofoil, and Plottingof Pressure distribution and Velocity vectors for Subsonic/Supersonic Mach numbers.	L1,L2,L3	03
3	Modeling of 2-D Compressible and Viscid Flow over Symmetrical/Cambered Aerofoil, and Plotting ofPressure distribution and Velocity vectors for Subsonic Mach numbers.	L1,L2,L3	03
4	Isentropic Flow Analysis in a 2-D Subsonic Diffuser and a Subsonic Nozzle.	L1,L2,L3	03
5	Isentropic Flow Analysis in a 2-D Supersonic Diffuser and a	L1,L2,L3	03

	Supersonic Nozzle.		
6	Geometric Modeling and Mesh Generation of a 2-D Convergent-Divergent Nozzle and Analyses of flow for Adiabatic Conditions (Fanno Flow).	L1,L2,L3	03
7	Geometric Modeling and Mesh Generation of a 2-D Pipe and Modeling of Steady/Unsteady Heat Convection and Conduction (Rayleigh Flow).	L1,L2,L3	03
8	Structural Modeling of Sandwich Beam of Rectangular Cross-section and Analyses for Stress for Unsymmetrical bending case	L1,L2,L3	03
9	Structural Modeling and Stress Analysis of a Torsion Box of a Wing.	L1,L2,L3	03
10	Structural Modeling and Stress Analysis of a Fuselage Frame.	L1,L2,L3	03
11	Structural Modeling and Stress Analysis of a Tapered I-Section Spar.	L1,L2,L3	03
12	Determine the Natural frequency and Mode shapes of a Cantilever beam under UDL.	L1,L2,L3	03
13	A Plate fixed at one end has a hole in centre and has varying thickness, Determine stresses developeddue to applied static loads in vertical direction.	L1,L2,L3	03
14	A Tapered Plate fixed at one end has a hole in centre and has varying thickness, determine stressesdeveloped due to applied static loads in vertical direction.	L1,L2,L3	03

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

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

High-3, Medium-2, Low-1