Course Title	COMPRESSIBLE AERODYNAMICS	Semester	VI
Course Code	MVJ19AE61	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3:2: 0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hrs.

The course objective is to:

1. Understand the concepts of compressible flow.
2. Acquire knowledge of normal shock waves
3. Comprehend the phenomenon of oblique shocks and expansion waves
4. Understand the concepts of Differential Equations of Motion for Steady Compressible Flows
5. Gain knowledge of flow measurement techniques

Module 1	L1,L2	10 Hrs.

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

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

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

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

9. https://www.youtube.com/watch?v=mS3ZVuOn_lU&list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0&index=2
10. https://youtu.be/mS3ZVuOn_lU?list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0
11. https://youtu.be/HfZ5gfybJK4?list=PLwdnzlV3ogoWb_iTQza6Z8dYHR-_1qhh0

Module 2	L1,L2,L3	10 Hrs.

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

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

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

Video link / Additional online information (related to module if any): 1. https://nptel.ac.in/courses/112/106/112106166/ 2. https://nptel.ac.in/courses/101/108/101108086/#		
Module 3	**L1,L2,L3**	10 Hrs.
Oblique shocks and Expansion waves: Prandtl equation and Rankine – Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, flow past wedges and concave corners, strong, weak and detached shocks, Flow past convex corners, Prandtl –Meyer expansion function, Reflection and interaction of shocks and expansion waves. **Laboratory Sessions/ Experimental learning**: Visualization of airfoil cross-section in Aerodynamics Lab **Applications**: Analyzing the supersonic flow problems involving oblique shock waves to design and analyze aircraft systems like nozzles, diffusers, intakes, shock tubes, wind tunnels, pipe flows **Video link / Additional online information (related to module if any):** 6. https://nptel.ac.in/courses/112/106/112106056/ 7. https://nptel.ac.in/courses/112/106/112106056/ 8. https://nptel.ac.in/courses/112/106/112106056/		
Module 4	**L1,L2,L3**	10 Hrs.
Differential Equations of Motion for Steady Compressible Flows: Basic potential equations for compressible flow. Linearisation of potential equation-small perturbation theory. Methods for solution of nonlinear potential equation –Introduction, Method of characteristics, Boundary conditions, Pressure coefficient expression, small perturbation equation for compressible flow - Prandtl, Glauret and Geothert's rules - Ackert's supersonic airfoil theory, Von-Karman rule for transonic flow, Lift, drag pitching moment and center of pressure of supersonic profiles **Laboratory Sessions/ Experimental learning**:Flow Problems using Ansys Lab **Applications**: Analyze and interpret the flow behavior **Video link / Additional online information (related to module if any):** 1. https://nptel.ac.in/courses/101/106/101106044/ 2. https://nptel.ac.in/courses/112/106/112106056/		
Module 5	**L1,L2**	10Hrs.
Measurements in High-speed Flow: Types of subsonic wind tunnels Balances and measurements - Interference effects transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance – Shock tubes and shock tunnels - Free flight testing -		

Measurements of pressure, velocity and Mach number -Flow visualization methods of subsonic and supersonic flows.

Laboratory Sessions/ Experimental learning:Wind Tunnel model force measurements

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

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

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

Course outcomes:

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

CO310.1	Apply the basic concepts of compressible flow
CO310.2	Evaluate the concepts of normal shock phenomenon
CO310.3	Apply the concepts of oblique shock and expansion wave formation.
CO310.4	Utilize the concepts of Differential Equations of Motion for Steady Compressible Flows
CO310.5	Investigate the parameters of high-speed flow.

Reference Books:

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

CIE Assessment:

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

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

SEE Assessment:

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

CO,PO Mapping

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

High,3, Medium,2, Low,1

Course Title	AIRCRAFT STRUCTURAL ANALYSIS	Semester	VI
Course Code	MVJ19AE62	CIE	50
Total No. of Contact Hours	50 L : T : P :: 3:2: 0	SEE	50
No. of Contact Hours/week	5	Total	100
Credits	4	Exam. Duration	3 Hrs.

The courseobjective is to:

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

Module 1	L1,L2,L3	10 Hrs.

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

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

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

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

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

Module 2	L1,L2,L3,	10Hrs.

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

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

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

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

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

Module 3	L1,L2,L3	10Hrs.

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

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

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

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

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

Module 4	L1,L2,L3	10 Hrs.

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

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

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

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

8. https://www.youtube.com/watch?v=3HE3A_vUZnw
9. https://www.youtube.com/watch?v=aivDhiLwu8E
10. https://www.youtube.com/results?search_query=unsw+aerospace+structures

Module 5	L1,L2	10Hrs.

Stress Analysis in Wing Spars and Box beams:

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

Stress Analysis in Fuselage Frames:

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

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

Applications:Helps to analyze the stress in Aircraft components. **Video link / Additional online information (related to module if any)**: 8. https://youtu.be/bQQMIy7Dlt0 9. https://nptel.ac.in/courses/101/101/101101079/

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

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

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

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

High,3, Medium,2, Low,1

`Course Title	HELICOPTER DYNAMICS	Semester	VI
Course Code	MVJ19AE631	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. Comprehend the basic concepts of helicopter dynamics.
2. Acquire knowledge of helicopter performance and rotor bearing system.
3. Understand the Aerodynamics of Rotor Airfoil and rotor wake phenomenon
4. Gain knowledge on the stability and control of Helicopter and its flight test requirements
5. Comprehend the design of Helicopter and its standards and specifications

Module 1	L1, L2	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

Study of Performance of Propeller

Applications:

Understand the fundamentals of Helicopters dynamics

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

15. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

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

Module 2	L1, L2	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

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

Module 3	L1, L2	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

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

Tuft Flow visualization studies on 2-D airfoil

Applications:

Learn the aerodynamics of helicopter rotor

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

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

Module 4	L1,L2	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

https://nptel.ac.in/courses/101/104/101104017/		
Module 5	**L1, L2**	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

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

Applications:

Learn the design requirements of helicopter and its standards & specifications

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

1. NPTEL- Introduction to Helicopter Aerodynamics & Dynamics

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

Course outcomes:

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

CO312.1.1	Apply the basic concepts of helicopter dynamics.
CO312.1.2	Evaluate the helicopter performance.
CO312.1.3	Outline the Aerodynamics of rotor Airfoil and rotor wake
CO312.1.4	Generalize the helicopter stability and control and its test requirements
CO312.1.5	Illustrate the design of a helicopter and its standards and specifications

Reference Books:

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

	Butterworth-Heinemann Publication, 2001.

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

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

High,3, Medium,2, Low,1

Course Title	EXPERIMENTAL STRESS ANALYSIS	Semester	VI
Course Code	MVJ19AS632/AE632	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 electrical strain gauges and their characteristics

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

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

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

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

Module 1	L1,L2	08 Hrs.

Introduction: Definition of terms, Calibration, Standards, Dimension and units generalized measurement system. Basic concepts in dynamic measurements, system response, distortion, impedance matching, Analysis of experimental data, cause and types of experimental errors. General consideration in data analysis.

Electrical Resistance: Strain Gages: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance' Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone's bridges, Constant current circuits.

Laboratory Sessions/ Experimental learning:

Strain sensitivity in metallic alloys, Wheatstone's bridges

Applications:

Usage of Strain gage, Identifying Errors during calibration

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

16. https://www.youtube.com/watch?v=tkOGqG1Wj8g

Module 2	L1,L2,L3,	08 Hrs.

Strain Analysis Methods: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage.

Force, Torque and strain measurements: Mass balance measurement, Elastic element for force measurements, torque measurement. **Laboratory Sessions/ Experimental learning**: Force measurements, torque measurement. **Applications**: Methods to find measuring parameters **Video link / Additional online information (related to module if any)**: 5. https://www.youtube.com/watch?v=ydyVsVk96z8		
Module 3	**L1,L2,L3**	08 Hrs.
Two Dimensional Photoelasticity: Nature of light, Wave theory of light - optical interference, Stress optic law –effect of stressed model in plane and circular polariscopes, Isoclinics&Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photo elastic model materials Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Materials for 2D photoelasticity. **Three Dimensional Photo elasticity**: Stress freezing method, Scattered light photoelasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses. **Digital Photoelasticity**: Introduction, Full field Displacement, Strain displacement data, Advanced Video Extensometer, Dic application and advantages. **Laboratory Sessions/ Experimental learning**: optical interference **Applications**: **Understanding** stress variation under loading **Video link / Additional online information (related to module if any)**: 12. https://www.youtube.com/watch?v=5tKPLfZ9JVQ		
Module 4	**L1,L2,L3**	08 Hrs.
Photo elastic (Birefringent) Coatings: **Birefringence** coating stresses, Effects of coating thickness: Reinforcing effects, Poission's, Stress separation techniques: Oblique incidence, Strip coatings **Laboratory Sessions/ Experimental learning**: Scattered light polariscope and stress data Analyses. **Applications**: Identifying Stress **Video link / Additional online information (related to module if any)**: 11. https://www.youtube.com/watch?v=bkYqqJa5P8w		
Module 5	**L1,L2**	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

Moire fringe analysis

Applications: Understanding holographic technique

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

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

Course outcomes:

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

CO312.2.1	Analyse electrical strain gaugesand their characteristics.
CO312.2.2	Evaluate stress strain of mechanical systems using electrical resistance strain gauges.
CO312.2.3	Analyse the elastic behavior of solid bodies using photo elastic methods
CO312.2.4	Illustrate tress strain measurements using method of coatings.
CO312.2.5	Analyse moire methods and their applications

Reference Books:

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

CIE Assessment:

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

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

SEE Assessment:

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

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

High,3, Medium,2, Low,1

Course Title	UNMANNED AERIAL VEHICLES	Semester	6
Course Code	MVJ19AE633	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. Comprehend the basic aviation history and UAV systems
2. Understand the air vehicle basic aerodynamics and performance
3. Acquire knowledge ofStability and Control
4. Understand concepts of Propulsion, Loads and Structures
5. Comprehend the various Mission Planning and Control

Module 1	L1,L2,L3	08 Hrs.

Introduction to Aviation, Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology UAVs, UAV fundamentals, Examples of UAV systems-very small, Small UAV, Medium UAV, Large UAV, UAV applications.

Laboratory Sessions/ Experimental learning:

Design and development of Unmanned Aerial vehicle for real world applications.

Applications:

Usage of UAV systems for Aerial monitoring, surveillance systems

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2. NPTEL- https://nptel.ac.in/courses/101/104/101104083/

Module 2	L1,L2,L3,	08 Hrs.

Introduction: The Air Vehicle Basic Aerodynamics, Basic Aerodynamics equations, Aircraft polar, The real wing and Airplane, Induced drag, The boundary layer, Flapping wings, Total Air-Vehicle Drag, Performance: Overview,Climbing flight, Range for propeller driven aircraft,Range- a jet-driven aircraft, Endurance-for propeller driven aircraft,Guiding Flight.

Laboratory Sessions/ Experimental learning:

Conduct the various experiments using the Aerodyanamics lab and its equations.

Applications:

Determine the endurance limit for propeller driven shaft.

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

1. NPTEL- https://nptel.ac.in/courses/101/104/101104073/
2. NPTEL- https://nptel.ac.in/courses/101/104/101104083/

Module 3	L1,L2,L3	08 Hrs.

Stability & Control: Stability, Longitudinal, lateral, Dynamic stability, Aerodynamics control, Pitch control, lateral control, Autopilots, sensor, Controller, actuator, Airframe control, Inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot.

Laboratory Sessions/ Experimental learning:

Determine the longitudinal, lateral and dynamic stability using the Aerodynamics control.

Applications:

Various sensors used for the Autopilot system and control systems.

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/
2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

Module 4	L1,L2,L3	08 Hrs.

Propulsion Overview: Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine,Electric Motors, Sources of Electrical Power.

Structures: Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials Resin Materials, CoreMaterials& Construction Techniques.

Laboratory Sessions/ Experimental learning:

Determine the efficiency of the various types engines used in the Unmanned Aerial Vehicle

Applications:

Usage of various applications of the resin material and skin reinforcing materials for the aircraft constructions.

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/
2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

Module 5	L1,L2	08 Hrs.

Mission Planning and Control, Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch, Recovery Trade-offs.

Laboratory Sessions/ Experimental learning:

Determine the various payloads used for the various operations of flight

Applications:

Usage of launch and recovery systems used in the Unmanned Aerial Vehicle

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

1.NPTEL- https://nptel.ac.in/courses/101/104/101104073/

2.NPTEL- https://nptel.ac.in/courses/101/104/101104083/

Course outcomes:

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

CO312.3.1	Apply the basic concepts of UAV systems
CO312.3.2	Utilise the knowledge of air vehicle basic aerodynamics and performance
CO312.3.3	Apply the knowledge of Stability and Control
CO312.3.4	Evaluate the Propulsion systems, Loads and Structures
CO312.3.5	Apply the mission, planning and control

Reference Books:

1.	Paul Gerin Fahlstrom , Thomas James Gleason, INTRODUCTION TO UAV SYSTEMS, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd
2.	Landen Rosen, Unmanned Aerial Vehicle, Publisher: Alpha Editions, ISBN 13 : 9789385505034.
3.	Unmanned Aerial Vehicles: DOD"s Acquisition Efforts, Publisher : Alpha Editions, ISBN13 : 9781297017544

CIE Assessment:

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

- Quizzes/mini tests (4 marks)

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

SEE Assessment:

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

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

High,3, Medium,2, Low

Course Title	MAINTENANCE REPAIR AND OVERHAUL	Semester	VI
Course Code	MVJ19AE641	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. Comprehend the fundamentals of maintenance and certification.
2. Acquire knowledge of documentation for maintenance.
3. Understand the AircraftManagement Maintenance.
4. Gain knowledge of Hanger maintenance on Aircraft and material support.
5. Acquire knowledge of maintenance safety and trouble shooting in Airlines.

Module 1	L1,L2	08 Hrs.

Fundamentals of Maintenance & Certification:

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

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

Applications: Apply the certification process in Aircraft industry.

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

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

Module 2	L1,L2	08 Hrs.

Documentation for Maintenance

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

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

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

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

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

Module 3	L1,L2	08 Hrs.

Aircraft Management Maintenance

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

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

Applications:Implement the aviation management in airlines.

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

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

Module 4	L1,L2	08 Hrs.

Hanger Maintenance on Aircraft & Material Support

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

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

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

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

12. https://www.youtube.com/watch?v=-zCTFfn-Fyk – Inside an Aircraft Maintenance hanger
13. https://www.youtube.com/watch?v=TCThd0Vr0cQ –Aircraft Maintenance work

14. https://www.youtube.com/watch?v=U44RQAzf4NI – Introduction to Inventory and materials management

Module 5	L1,L2	08 Hrs.

Maintenance Safety & Trouble shooting

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

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

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

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

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

Course outcomes:

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

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

Reference Books:

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

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

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO1 0	PO1 1	PO1 2	PSO 1	PSO 2
CO1	3	2	2	2	1	1	-	-	1	1	1	1	1	2
CO 2	3	2	2	1	1	1	-	-	1	1	1	1	-	-
CO3	3	2	2	2	1	1	-	-	1	1	1	1	1	1
CO 4	3	2	2	2	1	1	-	-	1	1	2	1	-	-
CO 5	3	2	2	2	1	1	-	-	1	1	1	1	1	1

High,3, Medium,2, Low,1

Course Title	ARTIFICIAL INTELLIGENCE AND ROBOTICS	Semester	VI
Course Code	MVJ19AE642	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 techniques of artificial intelligence
2. Understand Non-monotonic reasoning and statistical reasoning
3. Introduce the electronics and software aspects in the design of robots
4. Introduce the latest state of the art robots
5. Understand the usage of AI in Robots

Module 1Introduction to AI	L1,L2,L3	08 Hrs.

Computerized reasoning - Artificial Intelligence (AI) - characteristics of an AI problem - Problemrepresentation in AI - State space representation - problem reduction-Concept of small talkprogramming

Laboratory Sessions/ Experimental learning:Compare the theoretical solution to the forward kinematics problem with a physical implementation on the robot.

Applications: Design, Supply chain management, Prediction of in-service damages

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

20. https://nptel.ac.in/courses/106/102/106102220/

Module 2Search Process&Knowledge Representation	L1, L2, L3,	08 Hrs.

Search Process:AI and search process - Brute force search techniques - Depth first - Breadth first searchtechniques - Hill climbing - Best first search - AND/OR graphs - A* algorithm - Constraint satisfaction.

Knowledge Representation: Logic, Propositional logic - Tautology - Contradiction - Normal forms - Predicate logic - Rules of inference - Resolution - Unification algorithm -Production rules - Semantic networks - Frames – Scripts - Conceptual dependency.

Laboratory Sessions/ Experimental learning:Derive and implement a solution to the inversekinematics problem for the robot

Applications: Predictive Maintenance, Flight performanceOptimization, Reverse Engineering

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

9. https://nptel.ac.in/courses/106/102/106102220/

Module 3 Introduction to Robotics	L1, L2, L3	08 Hrs.
Scope of Robots: The scope of industrial Robots - Definition of an industrial robot - Need for industrial robots. **Robot Components**:Fundamentals of Robot Technology - Automation and Robotics - Robot anatomy - Work volume- Precision of movement - End effectors - Sensors **Laboratory Sessions/ Experimental learning**:Controlling the robots using the programming language **Applications**: Quality control, Smart Factory Building, Repetitive work management **Video link / Additional online information (related to module if any)**: 15. https://nptel.ac.in/courses/112/105/112105249/		
Module 4Future Trends in Robots	**L1, L2, L3**	08 Hrs.
Telepresence robot - Autonomous mobile robots - Walker Robots – Solarball Robot – Underwaterbots – Aerobots - Advanced robotics in Space - Specific features of space robotics systems – longterm technical developments - Next generation robots. **Laboratory Sessions/ Experimental learning**:Integrate computer vision and control of the robot **Applications**: Training, Smart Repairs Management **Video link / Additional online information (related to module if any)**: 15. https://nptel.ac.in/courses/112/105/112105249/		
Module 5AI in Robotics	**L1, L2**	08 Hrs.
Robotic perception, localization – mapping- configuring space - planning uncertain movements - dynamics and control of movement, Ethics and risks of artificial intelligence in robotics. **Laboratory Sessions/ Experimental learning**:Integrate forward and inverse kinematics and computer vision to control the robot **Applications**: AI Autopilot in commercial flights, Knowledge-Based Engineering **Video link / Additional online information (related to module if any)**: 15. https://nptel.ac.in/courses/106/102/106102220/		

Course outcomes:

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

CO313.2.1	Apply the basic techniques of artificial intelligence
CO313.2.2	Compare and contrast Non-monotonic reasoning and statistical reasoning
CO313.2.3	Design and develop robotic based systems
CO313.2.4	Develop automatic solution for replacing humans in life threatening area

CO313.2.5	Interpret basic AI algorithms in Robotics

Reference Books:	
1.	Elaine Rich And Kevin Knight,Artificial Intelligence, Tata Mcgraw-Hill, 3rd edition,2008.
2.	Barry Leatham - Jones, Elements of industrial Robotics, Pitman Publishing, 1987
3.	J. M. Selig, Introductory Robotics, Prentice Hall, 1992
4.	David Jefferis, Artificial Intelligence: Robotics and Machine Evolution, Crabtree Publishing Company, 1992

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

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

High,3, Medium,2, Low,1

Course Title	GAS TURBINE TECHNOLOGY	Semester	VI
Course Code	MVJ19AE643	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. Comprehend the types of engines and its applications.
2. Acquire the knowledge of engine parts.
3. Acquire the knowledge of engine performance.
4. Acquire the knowledge of fuels and various systems.
5. Gainknowledge of engine Testing.

Module 1	L1,L2	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

Demo in Propulsion laboratory

21. Comprehend the cascade testing of axial compressor and axial turbine blade row.
22. Study the performance of propeller and jet engines.
23. Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles.

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

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

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

https://youtu.be/30-FdRgygI0

https://youtu.be/iKLRgAgfjKE

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

https://youtu.be/7WFBBE2sKHE

Module 2	L1,L2,L3,	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

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

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

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

https://youtu.be/AOmo98peh6I

Module 3	L1,L2,L3	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

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

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

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

https://youtu.be/AOmo98peh6I

Module 4	L1,L2,L3	08 Hrs.

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

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

Laboratory Sessions/ Experimental learning:

Demo in Propulsion laboratory

1. Study of Fuel injection characteristics

Applications:

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

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

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

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

https://youtu.be/v7UJBqmsNWw

Module 5	L1,L2	08 Hrs.

Engine Testing: Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine - operating limits. Methods of displacing equilibrium lines.

Types of engine testing's: Normally Aspirated Testing, Open Air Test Bed, Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in flight. Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress,

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

Laboratory Sessions/ Experimental learning:

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

Applications: To understand the standardflight testing procedures.

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

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

https://youtu.be/BT9oq73VxC4

Course outcomes:

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

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

Reference Books:

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

CIE Assessment:
CIE is based on quizzes, tests, assignments/seminars and any other form of evaluation. Generally, there will be: Three Internal Assessment (IA) tests during the semester (30 marks each), the final IA marks to be awarded will be the average of three tests - Quizzes/mini tests (4 marks) - Mini Project / Case Studies (8 Marks) - Activities/Experimentations related to courses (8 Marks)
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CO,PO Mapping														
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CO3	3	2	2	1	1	1	1	-	-	-	1	1	1	1
CO4	3	2	2	1	1	1	1	-	-	-	1	1	1	1
CO5	3	2	2	1	1	1	1	-	-	-	1	1	1	1

High,3, Medium,2, Low,1

Course Title	GENERAL INTRODUCTION TO AERONAUTICS	Semester	VI
Course Code	19MVJAE651	CIE	50
Total No. of Contact Hours	40 L : T : P :: 3 :1 : 0	SEE	50
No. of Contact Hours/week	4	Total	100
Credits	3	Exam. Duration	3 Hrs.

The course objective is to:

6. Gain knowledge of the History of Aviation
7. Understand the basic Aircraft configurations
8. Understand the aircraft structures and materials.
9. Acquire knowledge of aircraft and rocket power units
10. Learn aircraft stability aspects

Module 1	L1,L2	08 Hrs.

Introduction

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

Laboratory Sessions/ Experimental learning:

Demo in Aerodynamics laboratory

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

Applications:

1. Understanding the basics concepts of flying

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

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

https://youtu.be/ohmyMEwfp5g

Module 2	L1,L2	08 Hrs.

Aircraft Configurations:

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

Laboratory Sessions/ Experimental learning:

Demo in Propulsion laboratory

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

Applications:

1. Understand the aircraft structures and materials.

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

General Introduction: Airplane Performance Characteristics (NPTEL)

https://youtu.be/tEWuP1NVdgE

Module 3	L1,L2	08 Hrs.

Airplane Structures and Materials:

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

Laboratory Sessions/ Experimental learning:

Demo in Aircraft Structures Lab

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

Applications:

1. Understand the aircraft structures and materials.

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

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

https://youtu.be/AOmo98peh6I

Module 4	L1,L2	08 Hrs.

Power Plants:

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

Laboratory Sessions/ Experimental learning:

Demo in Propulsion laboratory

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

Applications:

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

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

Jet Aircraft Propulsion by Prof. Bhaskar Roy and Prof. A. M. Pradeep, Department of Aerospace Engineering, IIT Bombay. For more details on NPTEL visit http://nptel.iitm.ac.in https://youtu.be/69Lyna4jcc8

Module 5	L1,L2	08 Hrs.

Aircraft Stability:

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

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

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

Course outcomes:

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

CO314.1.1	Review the historical aspects of Aviation
CO314.1.2	Outline the basic Aircraft configuration and details

CO314.1.3	Summarize the aircraft structures and materials.
CO314.1.4	Illustrate the power units in Aircrafts and Rockets.
CO314.1.5	Explain stability aspects of aeroplanes

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

CIE Assessment:

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

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

SEE Assessment:

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

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

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

High,3, Medium,2, Low,1

Course Title	AIRCRAFT TRANSPORT SYSTEMS	Semester	VI
Course Code	MVJ19AE652	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:

1. Understand the air transport systems.
2. Acquire the knowledge of aircraft characteristics and manufacturers
3. Acquire the knowledge of airlines, airport, and infrastructure
4. Understand the navigation and environmental systems.
5. Acquire the knowledge of managerial aspects of airlines

Module 1	L1, L2, L3	08 Hrs.

Air Transport Systems –Introduction

Environment, transport, and mobility. Systematic description and current challenges. Development of aircraft design driver-speed and range. Development of Airport, Airlines, ICAO, Regulatory Framework and Market Aspects.

Laboratory Sessions/ Experimental learning:how control surfaces behave with change in Cg in lateral, longitudinal and transvers direction.

Applications: Development of aircraft design,Airport and Airlines

Video link / Additional online information

1. https://nptel.ac.in/courses/101/104/101104075/
2. https://www.youtube.com/watch?v=WUq3uN4MDms
3. https://nptel.ac.in/courses/101/104/101104071/

Module 2	L1, L2, L3,	08 Hrs.

Aircraft Characteristics and Manufacturers

Classification of flight vehicles, cabin design, basics of flight physics- structures, mass, and balance. Flight performance and mission. Aircraft manufacturers, development process, production process, supply chain.

Laboratory Sessions/ Experimental learning:

Applications: Aircraft manufacture ring and development process

Video link / Additional online information

1. https://www.youtube.com/watch?v=bn2_NZkYQAo
2. https://nptel.ac.in/courses/101/104/101104075/

Module 3	L1, L2, L3	08 Hrs.

Airlines, Airport, and Infrastructure

Airline types, Network management. Flight strategy and aircraft selection, flight operations, MRO. Role of Airport, Regulatory Issues, Airport operation and services. Airport planning - infrastructure.

Laboratory Sessions/ Experimental learning: Basic simulation concepts for airport planning and design

Applications: Airport operation and planning

Video link / Additional online information:

1. https://youtu.be/BhvYofNQUQE?list=PL05C6EFB31D920568
2. https://youtu.be/dzlHwwmca4c?list=PL05C6EFB31D920568
3. https://www.nap.edu/read/25573/chapter/4

Module 4	L1, L2, L3	08 Hrs.

Air Navigation System & Environmental Systems

Principle of operation- Role of Air Navigation services. Air space structures, Airspace and Airport capacity, Aircraft separation. Flight guidance system. runway layout and runway lighting, Communication system. Integrated air traffic management and working system. Air traffic controlEnvironmental aspects-emission, noise, and sound.

Laboratory Sessions/ Experimental learning: Basic simulation on Flight guidance system.

Applications: Air Navigation servicesand Environmental considerations

Video link / Additional online information:

1. https://youtu.be/Th2N_rDfkDw
2. https://youtu.be/shHvE6yV4IM

Module 5	L1, L2, L3	08 Hrs.

Managerial Aspects of Airlines

Airline passenger marketing, forecasting methods, pricing, and demand. Air cargo-market for air freight. Principles of airline scheduling. Fleet planning.

Laboratory Sessions/ Experimental learning:

Applications: Airline passenger marketing and Air cargo-market

Video link / Additional online information:

1. https://nptel.ac.in/courses/101/104/101104075/
2. https://nptel.ac.in/courses/101/104/101104071/

Course outcomes:

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

CO314.2.1	Describe the air transport systems.
CO314.2.2	Discuss aircraft characteristics and manufacturers
CO314.2.3	Describe airlines, airport, and infrastructure
CO314.2.4	Summariesair navigation and environmental systems
CO314.2.5	Apply the knowledge of managerial aspects of airlines

Reference Books:	
1.	Air Transport System, Dieter Schmitt, and ValkerGollnick, Springer, 2016
2.	Air Transportation-A Management Prospective, Jhon G Wensveen, Ashgate Publishing Ltd, 2011
3.	The Air Transportation System, Mike Hirst, Woodhead Publishing Ltd, England, 2008
4.	Transport Category Aircraft Systems, Thomas W. Wild, IAP, Inc, Year: 1990

CIE Assessment:

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

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

SEE Assessment:

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

CO, PO Mapping

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

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

High,3, Medium,2, Low,1

Course Title	AIRCRAFT SYSTEMS & INSTRUMENTATION	Semester	V
Course Code	MVJ19AE653	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:

6. Gain knowledge of the aircraft control systems.
7. Understand the applications of hydraulics and pneumatics in aircraft systems.
8. Acquire knowledge regarding aircraft engine systems.
9. Comprehend the aircraft auxiliary systems
10. Acquire the knowledge of aircraft instruments.

Module 1	L1,L2,L3	08 Hrs.

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

LaboratorySessions/ Experimental learning:

How it works, flight controls PID controls.

Applications:

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

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

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

Module 2	L1,L2,L3,	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

10. https://nptel.ac.in/courses/112/105/112105047/
11. https://nptel.ac.in/courses/112/103/112103249/
12. https://sciencing.com/make-simple-hydraulic-system-7380816.html

Module 3	L1,L2,L3	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

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

Applications:

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

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

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

Module 4	L1,L2,L3	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

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

Applications:

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

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

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

Module 5	L1,L2	08 Hrs.

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

Laboratory Sessions/ Experimental learning:

Gyroscope working and applications, Avionics lab instruments working.

Applications:

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

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

16. https://nptel.ac.in/courses/101/108/101108056/
17. https://onlinecourses.nptel.ac.in/noc20_ae01/preview
18. https://www.wingbug.com/wingbug-for-experimental-aircraft/

Course outcomes:

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

CO314.1.1	Distinguish the conventional and modern control systems.
CO314.1.2	Analyse the aircraft systems.
CO314.1.3	Analyse the working of Aircraft engine systems.
CO314.1.4	Describe aircraft Auxiliary systems
CO314.1.5	Applydifferent aircraft instruments.

Reference Books:

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

CIE Assessment:

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CO, PO Mapping

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

High,3, Medium,2, Low,1

Course Title	AIRCRAFT PROPULSION LAB	Semester	VI
Course Code	MVJ19AEL66	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 how to do the heat transfer
- Comprehend the cascade testing of axial compressor and axial turbine blade row.
- Learn Pressure measurements using Axial Flow Fan setup

Sl No	Experiment Name	RBT Level	Hours
1	Study of an Aircraft Piston Engine.(Includes Study of Assembly of Sub Systems, Various Components, their Functions and Operating Principles)	L1,L2,L3	03
2	Study of an Aircraft Jet Engine (Includes Study of Assembly of Sub Systems, Various Components, their Functions and Operating Principles)	L1,L2,L3	03
3	Study of Forced Convective Heat Transfer Over a Flat Plate	L1,L2,L3	03
4	Cascade Testing of a Model of Axial Compressor Blade Row	L1,L2,L3	03
5	Cascade Testing of a Model of Axial Turbine Blade Row	L1,L2,L3	03
6	Study of Performance of a Propeller	L1,L2,L3	03
7	Determination of Heat of Combustion of Aviation Fuel	L1,L2,L3	03
8	Study of Free and Wall Jet	L1,L2,L3	03
9	Measurement of Burning Velocity of a Premixed Flame.	L1,L2,L3	03
10	Study of the Flame Lift Up and Fall Back Phenomenon for Varied Air/Fuel Ratio	L1,L2,L3	03
11	Measurement of Nozzle Flow	L1,L2,L3	03
12	Pressure Measurements Using Axial Flow Fan Setup	L1,L2,L3	03
13	Investigation of Pressure Distribution and Relationship Between	L1,L2,L3	03

	Inlet Pressure/Outlet Pressure and Mass Flow Rate in a Convergent-Divergent Nozzle When Working Over a Variety of Overall Pressure Ratios Including Under-Expanding and Over-Expanding Conditions		
14	Investigation of Pressure Distribution and Relationship Between Inlet Pressure/Outlet Pressure and Mass Flow Rate in a Convergent-Divergent Nozzle under Choked Conditions	L1,L2,L3	03

Course outcomes:	
CO1	Analyse heat transfer
CO2	Evaluate testing of axial compressor and axial turbine blade row.
CO3	Estimate Pressure measurements using Axial Flow Fan setup

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

High-3, Medium-2, Low-1

Course Title	AIRCRAFT STRUCTURES LAB	Semester	VI
Course Code	MVJ19AEL67	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:

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

Sl No	Experiment Name	RBT Level	Hours
1	Deflection of a Simply Supported Beam	L1,L2,L3	03
2	Deflection of a Cantilever Beam	L1,L2,L3	03
3	Beam with Combined Loading by using Superposition Theorem	L1,L2,L3	03
4	Verification of Maxwell's Reciprocal Theorem for Beam with a) Constant cross section b) Varying Cross section	L1,L2,L3	03
5	Determination of Young's Modulus and Poisson Ratio using Strain Gages.	L1,L2,L3	03
6	Buckling Load of Slender Eccentric Columns and Construction of South Well Plot	L1,L2,L3	03
7	Shear Failure of Bolted and Riveted Joint	L1,L2,L3	03
8	Bending Modulus of Sandwich Beam	L1,L2,L3	03
9	Determine the Index Factor `K` in a Tensile Field of Wagner Beam	L1,L2,L3	03
10	Tensile, Compressive and Flexural Testing of a Composite Material Plate	L1,L2,L3	03
11	Determination of Natural Frequency and Mode Shapes of a Cantilever Beam for the FollowingCases a) Constant cross section	L1,L2,L3	03

	b) Varying cross section		
12	Determination of Shear Centre for Following Cases Through Deflection a) Close section–Symmetrical bending b) Open section–Unsymmetrical bending	L1,L2,L3	03
13	Determination of Shear flow for Following Cases a) Close section–Symmetrical bending b) Open section–Unsymmetrical bending	L1,L2,L3	03
14	Determining of Shear Centre Through Shear Flow Measurement for Following Cases a) Close section–Symmetrical bending b) Open section–Unsymmetrical bending	L1,L2,L3	03

Course outcomes:

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

CO-PO Mapping

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

High-3, Medium-2, Low-1