

SEMESTER 3

AERONAUTICAL ENGINEERING

SEMESTER 3
MATHEMATICS FOR PHYSICAL SCIENCE – 3
(Common to B & C Groups)

Course Code	GYMAT301	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs .30 Min.
Prerequisites (if any)	Basic knowledge in complex numbers.	Course Type	Theory

Course Objectives:

1. To introduce the concept and applications of Fourier transforms in various engineering fields.
2. To introduce the basic theory of functions of a complex variable, including residue integration and conformal transformation, and their applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fourier Integral, From Fourier series to Fourier Integral, Fourier Cosine and Sine integrals, Fourier Cosine and Sine Transform, Linearity, Transforms of Derivatives, Fourier Transform and its inverse, Linearity, Transforms of Derivative. (Text 1: Relevant topics from sections 11.7, 11.8, 11.9)	9
2	Complex Function, Limit, Continuity, Derivative, Analytic functions, Cauchy-Riemann Equations (without proof), Laplace's Equations, Harmonic functions, Finding harmonic conjugate, Conformal mapping, Mappings of $w = z^2$, $w = e^z$, $w = \frac{1}{z}$, $w = \sin z$. (Text 1: Relevant topics from sections 13.3, 13.4, 17.1, 17.2, 17.4)	9
3	Complex Integration: Line integrals in the complex plane (Definition & Basic properties), First evaluation method, Second evaluation method, Cauchy's integral theorem (without proof) on simply connected domain, Independence of path, Cauchy integral theorem on multiply connected	9

	domain (without proof), Cauchy Integral formula (without proof). (Text 1: Relevant topics from sections 14.1, 14.2, 14.3)	
4	Taylor series and Maclaurin series, Laurent series (without proof), Singularities and Zeros – Isolated Singularity, Poles, Essential Singularities, Removable singularities, Zeros of Analytic functions – Poles and Zeros, Formulas for Residues, Residue theorem (without proof), Residue Integration- Integral of Rational Functions of $\cos\theta$ and $\sin\theta$. (Text 1: Relevant topics from sections 15.4, 16.1, 16.2, 16.3, 16.4)	9

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the Fourier transforms of functions and apply them to solve problems arising in engineering.	K3
CO2	Understand the analyticity of complex functions and apply it in conformal mapping.	K3
CO3	Compute complex integrals using Cauchy's integral theorem and Cauchy's integral formula.	K3
CO4	Understand the series expansion of complex function about a singularity and apply residue theorem to compute real integrals.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	2	-	-	-	-	-	-	-	2
CO2	3	3	-	2	-	-	-	-	-	-	-	2
CO3	3	3	-	2	-	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Engineering Mathematics	Erwin Kreyszig	John Wiley & Sons	10 th edition, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Complex Analysis	Dennis G. Zill, Patrick D. Shanahan	Jones & Bartlett	3 rd edition, 2015
2	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill Education	39 th edition, 2023
3	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	44 th edition, 2018
4	Fast Fourier Transform - Algorithms and Applications	K.R. Rao, Do Nyeon Kim, Jae Jeong Hwang	Springer	1 st edition, 2011

SEMESTER 3

ENGINEERING THERMODYNAMICS

Course Code	PCAOT302	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs .30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To understand the concepts of Engineering Thermodynamics.
2. To discuss various thermodynamic cycles and processes.
3. To understand laws of thermodynamics that quantify energy and its interactions with surroundings.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic Concepts: Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic system and Control Volume, Thermodynamic Equilibrium, State, Properties, Specific heat, Path function and point Function, Process-types, Cycle, Zeroth Law of Thermodynamics, First law of Thermodynamics, Internal Energy, Enthalpy, PMM I - Joule's Experiment, First law applied to Non-flow process and Flow processes- Steady Flow Energy Equation. (Numerical on work done and heat transformation)	9
2	Heat Engine Concepts: Limitations of the First Law, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements, PMM II, Heat Engine, Heat pump, Carnot's principle, Clausius Inequality, Entropy, Availability and Irreversibility, Thermodynamic Potentials- Gibbs and Helmholtz Functions, Third Law of Thermodynamics. (Numerical)	10
3	Thermodynamic cycles: Power cycles, Otto cycle, Diesel cycle, Dual Combustion cycle, Brayton cycle P-V and T-S diagram, Thermal Efficiency, Comparison of Cycles, Reheat and Regeneration cycle (Numerical).	14

	Refrigeration cycles- reverse Carnot cycle, reverse Brayton cycle, Air refrigeration cycles(T-S diagram and Description only) Psychrometric Properties-Dry & Wet Bulb Temperature, Specific Humidity, Relative Humidity, Degree of saturation – Adiabatic Saturation – Psychrometric chart.	
4	General thermodynamic relations: Combined First and Second law equations Maxwell relations, T-ds equations, Clapeyron Equations equation, equation for internal energy, enthalpy and entropy, specific heat, Throttling and Free Expansion Processes Joule Thomson coefficient and inversion curve. Perfect Gas Laws – Equation of State, Deviations from perfect Gas Model – Vander Waals Equation of State.	11

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic concepts of conversion of heat into work.	K2
CO2	Apply the thermodynamics laws for efficiency and COP calculations of heat engines and heat pumps.	K3
CO3	Apply the relations of various thermodynamics cycles for obtaining thermal efficiency.	K3
CO4	Understand the thermodynamic relations.	K2
CO5	Understand the basic concepts of conversion of heat into work.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Thermodynamics	Nag.P.K	Tata McGraw-Hill, New Delhi	2013
2	Thermodynamics: An Engineering Approach	Yunus A. Cengel and Michael A. Boles	McGraw-Hill book Co	7 th edition, 2010
3	Engineering Thermodynamics through examples	YVC Rao	Universities Press	2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Thermodynamics	Arora C.P	Tata McGraw-Hil	2003
2	Thermodynamics	Holman.J.P	McGraw-Hill	3 rd edition, 2007
3	Thermodynamics for Engineers	Merala C, Pother, Craig W, Somerton	Schaum Outline Series,Tata McGraw-Hill	2004
4	Fundamentals of Engineering Thermodynamics	Rathakrishnan E	Prentice-Hall India	2005

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/106/112106310/
2	https://archive.nptel.ac.in/courses/112/106/112106310
3	https://archive.nptel.ac.in/courses/112/106/112106310
4	https://archive.nptel.ac.in/courses/112/106/112106310

SEMESTER 3

MECHANICS OF AIRCRAFT MATERIALS

Course Code	PCAOT303	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs .30 Min.
Prerequisites (if any)	ENGINEERING MECHANICS	Course Type	Theory

Course Objectives:

1. To understand the concepts of stress, strain, and deformation under the influence of various loads.
2. To assess the stresses and deformation in simple structural members like beams, bars and shafts.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Stress & Strain, Poisson's ratio. Stress – strain curves for mild steel in tension, aluminium alloy, hard and soft rubber, brittle material and copper in compression. Hooke's law for linearly elastic isotropic material under axial and shear deformation, Bulk modulus, biaxial and triaxial deformations. Relationship between material constant (Derivations). Stress and strain tensors and its components, Factor of safety, Margin of safety.	11
2	Deformation in axially loaded bars: Principle of superposition. Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change Deformation of prismatic and conical bar under its self-weight. Strain energy, resilience and toughness – for pure axial loading, prismatic and conical bar under self-weight.	11
3	Beams: Types of Loads, types of Support, types of Beams, bending couple and twisting couple (Concept Only). Determination of support reaction, Shear force and bending moments, Relationships between loads-shear force-bending moments (Derivation for all the cases). Bending moment and shear force diagrams of beams (cantilever and simply supported) subjected to	11

	concentrated load, uniformly distributed loads, uniformly varying loads, couples and their combinations, Point of contra flexure, point and magnitude of maximum bending point and maximum shear force.	
4	Flexural stresses: Theory of simple bending, Assumptions, derivation of equation of bending, neutral axis, determination of bending stresses (rectangular, square, triangular, solid circular and hollow circular sections only). Torsion - Derivation of equation of torsion, Assumptions, application of torsional equation to solid and hollow circular shaft, torsional rigidity. Stresses on inclined planes – Principal Stresses and Principal Planes – Maximum shear stress – Mohr’s circle method.	11

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles of stress and strain, deformations, and their relationship.	K2
CO2	Discuss the effects of axial loads on stresses, strains, and elongations in axially loaded bars and columns under different boundary conditions.	K3
CO3	Construct the shear force and bending moment diagrams for various members under varying loading conditions and to identify critical points in a structure.	K3
CO4	Apply the bending and torsional concepts to find out the flexural stress on various cross sections.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Materials	James Gere & Barry Goodno.	Thomson-Engineering	9 th Edition, 2022.
2	Strength of Materials	S. Ramamrutham & R. Narayanan	Dhanpat Rai Publishing Company	20 th Edition, 2020
3	A Textbook of Strength of Materials - Mechanics of Solids	Bansal R. K.	Laxmi Publications	6 th Edition, 2022
4	Mechanics of Materials	James Gere & Barry Goodno.	Thomson-Engineering	9 th Edition, 2022.

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Strength of Materials	S. S. Rattan	2e McGraw Hill Education India	2011
2	Aircraft Materials and Processes	Titterton.G	Pitman Publishing Company	5 th Edition, 1995
3	Strength of Materials	R. Subramanian	Oxford University	3 rd Edition, 2016.

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/jyLIqUvwdtY https://youtu.be/Q1ON3aYVgPc
2	https://youtu.be/HP3N7IVjfz0
3	https://youtu.be/mgQU04-ilCA
4	https://youtu.be/5gRCClIP2IA

SEMESTER 3

FLUID MECHANICS

Course Code	PBAOT304	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0: 0: 1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs .30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To understand the concepts of fluid mechanics.
2. To analyse the effects of pressure, velocity, and density of fluids on various bodies.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Fluids and continuum, Properties of fluids, Newton's law of viscosity. Ideal and real fluids, Newtonian and non-Newtonian fluids, Fluid Statics- Pressure-density-height relationship, manometers, pressure on plane and curved surfaces, Centre of pressure, buoyancy, stability of immersed and floating bodies, measurement of pressure. (Problems)	10
2	Kinematics & Dynamics of fluid flow: Eulerian and Lagrangian approaches, Types of fluid flow. Equation of streamline, Velocity and acceleration in fluid flow, Euler's equation, Bernoulli's equation, Venturimeter and Orifice meters, Notches and Weirs (No derivations), Hydraulic Coefficients, Navier-Stokes equations. Dimensional analysis, Buckingham's theorem, non-dimensional numbers, Modal Analysis, Types of similarities (Problems)	11
3	Viscous flow & Head loss: Viscous flow through circular duct, parallel plates, Loss of head due to friction in viscous flow. Reynolds experiment, Frictional loss in pipe flow, Shear stress in turbulent flow a pipe, Velocity distribution in turbulent pipe flow, Major and Minor losses in pipe flow Hydraulic gradient and total energy line, Cavitation. (Problems)	12

4	Boundary Layer & Impact of jets: Growth of boundary layer over a flat plate and definition of boundary layer thickness, displacement thickness, momentum thickness and energy thickness, laminar and turbulent boundary layers, laminar sub layer, velocity profile, Von- Karman momentum integral equations for the boundary layers, calculation of drag, separation of boundary and methods of control. Impact of Jets-Force exerted by jet on moving plates.	11
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Suggestion on Project Topics

- Using flow visualisation techniques, study the fluid flow patterns.
- With the help of pneumatic/hydraulic cylinders (Eg: - syringe) study the Hydrostatic law
- Demonstrate the relationship between pressure, velocity, and elevation in a fluid, using simple models (Bernoulli's principle).
- Create a model to demonstrate different types of flow.

Course Assessment Method (CIE: 60 marks , ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment /Micro project	Internal Ex-1	Internal Ex-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 1 Questions from each module. • Total of 4 Questions, each carrying 2 marks (4x2 =8marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. (8x4 = 32 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles of fluid mechanics, fluid properties and their relationships.	K2
CO2	Understand the basic concepts of Flow measuring devices and dimensional analysis.	K2
CO3	Apply the principles of kinematics and dynamics using conservation of mass and momentum to solve problems in pressure distribution, buoyancy, and stability.	K3
CO4	Analyse viscous flow through pipes and channels and estimate the major and minor losses.	K4
CO5	Create a physical model to analyse the effects of fluid flow parameters on various flow regimes.	K6

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

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

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics & Hydraulic Machines	R K Bansal	McGraw Hill	6th Edition
2	Fluid Mechanics, Fundamental and application	Yunus A. Cengal	McGraw Hill	7th edition
3	Fluid Mechanics	Pijush K. Kundu	McGraw Hill	2th edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics	Frank M. White	McGraw Hill	8th edition
2	Hydraulic and Fluid Mechanics	Dr. Modi & S M Seth	Amit Publishers and distributors	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Fluid Statics - https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfY1O&index=4 Buoyancy, Metacentre, and stability - https://www.youtube.com/watch?v=gMuucNxc7eI&list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw&index=7&pp=iAQB
2	Fluid kinematics - https://www.youtube.com/watch?v=rY7bvZn75Do&list=PLwdnzlV3ogoWrAmpEcsPXayfsXnFfY1O&index=4
3	Internal viscous flow - https://www.youtube.com/watch?v=qLx7ip0eBps&list=PLCoE5wxWtHFYiVGswvsWRaHjv18vxZzE2&index=17

SEMESTER 3

INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND DATA SCIENCE

Course Code	GNEST305	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs .30 Mins.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Demonstrate a solid understanding of advanced linear algebra concepts, machine learning algorithms and statistical analysis techniques relevant to engineering applications, principles and algorithms.
2. Apply theoretical concepts to solve practical engineering problems, analyze data to extract meaningful insights, and implement appropriate mathematical and computational techniques for AI and data science applications.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to AI and Machine Learning: Basics of Machine Learning - types of Machine Learning systems-challenges in ML- Supervised learning model example- regression models- Classification model example- Logistic regression-unsupervised model example- K-means clustering. Artificial Neural Network- Perceptron- Universal Approximation Theorem (statement only)- Multi-Layer Perceptron- Deep Neural Network- demonstration of regression and classification problems using MLP.(Text-2)	11
2	Mathematical Foundations of AI and Data science: Role of linear algebra in Data representation and analysis – Matrix decomposition- Singular Value Decomposition (SVD)- Spectral decomposition- Dimensionality reduction technique-Principal Component Analysis (PCA). (Text-1)	11
3	Applied Probability and Statistics for AI and Data Science: Basics of probability-random variables and statistical measures - rules in probability-	11

	Bayes theorem and its applications- statistical estimation-Maximum Likelihood Estimator (MLE) - statistical summaries- Correlation analysis- linear correlation (direct problems only)- regression analysis- linear regression (using least square method) (Text book 4)	
4	Basics of Data Science: Benefits of data science-use of statistics and Machine Learning in Data Science- data science process - applications of Machine Learning in Data Science- modelling process- demonstration of ML applications in data science- Big Data and Data Science. (For visualization the software tools like Tableau, PowerBI, R or Python can be used. For Machine Learning implementation, Python, MATLAB or R can be used.)(Text book-5)	11

Course Assessment Method
(CIE: 40 marks , ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the concept of machine learning algorithms including neural networks and supervised/unsupervised learning techniques for engineering applications.	K3
CO2	Apply advanced mathematical concepts such as matrix operations, singular values, and principal component analysis to analyze and solve engineering problems.	K3
CO3	Analyze and interpret data using statistical methods including descriptive statistics, correlation, and regression analysis to derive meaningful insights and make informed decisions.	K3
CO4	Integrate statistical approaches and machine learning techniques to ensure practically feasible solutions in engineering contexts.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3								
CO2	3	3	3	3								
CO3	3	3	3	3								
CO4	3	3	3	3								
CO5	3	3	3	3								

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Linear Algebra	Gilbert Strang	Wellesley-Cambridge Press	6 th edition, 2023
2	Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow	Aurélien Géron	O'Reilly Media, Inc.	2 nd edition, 2022
3	Mathematics for machine learning	Deisenroth, Marc Peter, A. Aldo Faisal, and Cheng Soon Ong	Cambridge University Press	1 st edition. 2020
4	Fundamentals of mathematical statistics	Gupta, S. C., and V. K. Kapoor	Sultan Chand & Sons	9 th edition, 2020
5	Introducing data science: big data, machine learning, and more, using Python tools	Cielen, Davy, and Arno Meysman	Simon and Schuster	1 st edition, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data science: concepts and practice	Kotu, Vijay, and Bala Deshpande	Morgan Kaufmann	2 nd edition, 2018
2	Probability and Statistics for Data Science	Carlos Fernandez-Granda	Center for Data Science in NYU	1 st edition, 2017
3	Foundations of Data Science	Avrim Blum, John Hopcroft, and Ravi Kannan	Cambridge University Press	1 st edition, 2020
4	Statistics For Data Science	James D. Miller	Packt Publishing	1 st edition, 2019
5	Probability and Statistics -The Science of Uncertainty	Michael J. Evans and Jeffrey S. Rosenthal	University of Toronto	1 st edition, 2009
6	An Introduction to the Science of Statistics: From Theory to Implementation	Joseph C. Watkins	chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.math.arizona	Preliminary Edition.

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/106/106/106106198/
2	https://archive.nptel.ac.in/courses/106/106/106106198/ https://ocw.mit.edu/courses/18-06-linear-algebra-spring-2010/resources/lecture-29-singular-value-decomposition/
3	https://ocw.mit.edu/courses/18-650-statistics-for-applications-fall-2016/resources/lecture-19-video/
4	https://archive.nptel.ac.in/courses/106/106/106106198/

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

Course Code	UCHUT346	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with an understanding of fundamental economic principles essential for effective decision-making in engineering contexts.
2. To enable students to apply economic analysis to production decisions, cost management, and market strategies in engineering practice.
3. To equip students with the ability to evaluate macroeconomic scenarios, financial methods, and investment decisions relevant to engineering projects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility –Demand: Factors determining demand – Law of Demand – Demand curve- Price elasticity of demand- measurement of price elasticity and its applications – Supply: factors determining supply - Law of supply – Supply curve- Equilibrium price determination- Changes in demand and supply and its effects on equilibrium price and quantity Production: Production function - Law of variable proportion –Returns to scale- Cobb-Douglas Production Function	6
2	Cost: Cost concepts – Private cost and social cost – Sunk cost – Opportunity cost -Explicit and implicit cost –Short run cost curves –Long run average cost curve -Revenue concepts – Break-even point Market: Perfect Competition – Monopoly - Monopolistic Competition (features and equilibrium of a firm) - Oligopoly – Features – Kinked demand model	6

3	National income: Concepts (GDP, GNP and NNP)– Final goods and Intermediate goods - Methods of Estimation –output method – expenditure method-- Difficulties in the measurement of national income. Inflation: Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Repo and reverse repo rate	6
4	Value Analysis and value Engineering: Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure Capital Budgeting: Time value of money - Net Present Value Method - Benefit Cost Ratio – Internal Rate of Return – Payback – Accounting Rate of Return.	6

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/Case Study/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	15	12.5	12.5	50

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks (6x3 =18 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. (4x8 = 32 marks)	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	K2
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	K3
CO3	Outline the macroeconomic principles of monetary and fiscal systems and national income.	K2
CO4	Make use of the possibilities of value analysis and engineering, and take investment decisions through capital budgeting techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012
4	Financial Management	I M Pandey	Vikas Publishing House	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7 TH Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001
5	Financial Management: Theory and Practice	Prasanna Chandra	Mc Graw Hill	2007

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	UCHUT347	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of ethics - Personal vs. professional ethics, Civic Virtue, Respect for others, Profession and Professionalism, Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, Technology and digital revolution-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, High technologies: connecting people and places-accessibility and social impacts, Managing conflict, Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Codes of Ethics. Basic concepts in Gender Studies - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, Gender disparity and discrimination in education, employment and everyday life, History of women in Science & Technology,	6

	Gendered technologies & innovations, Ethical values and practices in connection with gender - equity, diversity & gender justice, Gender policy and women/transgender empowerment initiatives.	
2	Introduction to Environmental Ethics: Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). Sustainable Engineering Principles: Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. Ecosystems and Biodiversity: Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. Landscape and Urban Ecology: Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	6
3	Hydrology and Water Management: Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. Zero Waste Concepts and Practices: Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. Circular Economy and Degrowth: Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. Mobility and Sustainable Transportation: Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	6
4	Renewable Energy and Sustainable Technologies: Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. Climate Change and Engineering Solutions: Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. Environmental Policies and Regulations: Overview of key environmental policies and	6

	regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental policy-making. Case Studies and Future Directions: Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	
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Course Assessment Method
(CIE: 50 marks , ESE: 50)

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/ Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12

3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
Total Marks			50	

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis:** Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts:** Ability to apply course concepts to real-world problems and local contexts.
- **Creativity:** Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills:** Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	K3
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	K4
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	K5
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	K4
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

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

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessment	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and suggest sustainable management and restoration practices.
- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?

- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER 3

FLUID MECHANICS LAB

Course Code	PCAOL307	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Practical

Course Objectives:

1. To familiarise the applications of Fluid mechanics and dynamics.
2. Perform experiments to illustrate the viscous flow in open and closed channel.
3. To gain practical experience in handling flow measuring devices.

Details of Experiment

Expt. No	Experiment
1	Study of pipe fittings, valves, gauges, tools, and instruments.
2	Determination of coefficient of discharge and calibration of Venturimeter.
3	Determination of coefficient of discharge and calibration of Orifice meter.
4	Determination of coefficient of discharge and calibration of V-notch.
5	Determination of coefficient of discharge and calibration of Rectangular notch.
6	Determination of coefficient of discharge of Mouthpiece using constant head and varying head method.
7	Determine Chezy's constant and Darcy's coefficient of pipe friction.
8	Determination of Hydraulic Coefficients of orifices.
9	Determination of Minor losses in various pipe fittings.
10	Determine the metacentric height of a floating body.
11	Impact of jet on flat and curved surface.
12	Verification of Bernoulli's theorem.
13	Determination of velocity profile using Pitot-static tube.
14	Measurement of Fluid Viscosity.
15	Reynolds experiment.
16	Measurement of drag on a circular cylinder in high Reynolds number flow.

Note: A minimum of 10 experiments are mandatory.

Course Assessment Method (CIE: 50 Marks, ESE 50 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record. (Continuous Assessment)	Internal Exam	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

Mandatory requirements for ESE:

- Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- Endorsement by External Examiner: The external examiner shall endorse the record.

Course Outcomes (COs)

At the end of the course the student will be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Calibrate flow measuring devices such as Venturimeter, orifice meter and notches.	K3
CO2	Compute hydraulic coefficients associated with pipe flow.	K3
CO3	Compute the losses in pipes due to friction.	K3
CO4	Compute velocity profiles for any given fluid flow.	K3
CO5	Calculate the metacentric height for stability of the floating body.	K3

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table

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

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), : No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics: An Introduction	E Rathakrishnan	Prentice Hall	3 rd Edition, 2012
2	Fluid Mechanics: Fundamentals and Applications	John. M. Cimbala and Yunus A. Cengel,	McGraw Hill	3 rd Edition, 2019

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fluid Mechanics- Fundamentals and Applications	Yunus A. Cengel, John M. Cimbala	McGraw Hill,	2019
2	Engineering Fluid Mechanics	Graebel. W. P	Taylor & Francis, Indian Reprint,	2011
3	Fluid Mechanics and Machinery	Robert W. Fox, Alan T. McDonald, Philip J. Pritchard,	John Wiley and sons.	2015

Video Links (NPTEL, SWAYAM...)	
Sl. No.	Link ID
1	https://archive.nptel.ac.in/courses/112/106/112106311/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 3

MATERIAL TESTING LAB

Course Code	PCAOL308	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Practical

Course Objectives:

1. To introduce various material testing techniques and equipments used for it.
2. To evaluate the tensile strength, compressive strength, hardness, toughness, ductility, and impact resistance of various materials.

Details of Experiment

Expt. No	Experiment
1	Tension test on mild steel/ tor-steel/ high strength steel and cast iron using Universal Testing Machine
2	Compression test on spring
3	Torsion pendulum (mild steel, aluminium, and brass wires)
4	Hardness test (Brinell, Vickers and Rockwell)
5	Impact test (Izod and Charpy)
6	Torsion test on mild steel rods.
7	Shear test on mild steel rods
8	Bending test on wooden beams.
9	Verification of Clerk Maxwell's law of reciprocal deflection and determination of Young's modulus of steel.
10	Measurement using strain gauges
11	Deflection Test on steel and timber beam
12	Determination of moment of inertia of rotating bodies
13	Photo elastic methods for stress measurements.
14	Fatigue test – Study of testing machine.
15	Strut test (Column buckling experiment)

Note: A minimum of 10 experiments are mandatory.

Course Assessment Method
(CIE: 50 Marks, ESE 50 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record. (Continuous Assessment)	Internal Exam	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

Mandatory requirements for ESE:

- Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- Endorsement by External Examiner: The external examiner shall endorse the record.

Course Outcomes (COs)

At the end of the course the student will be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Evaluate the mechanical properties of materials such as tensile strength, compressive strength, hardness, ductility, toughness, and impact resistance.	K3
CO2	Perform bending and deflection tests.	K3
CO3	Evaluate the elastic constants, do torsion and flexural tests.	K3

K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1					2			
CO2	3	3	2	1					2			
CO3	3	3	2	1					2			

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), : No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Materials	Russell C Hibbeler	Pearson	9 th edition, 2013
2	Mechanical Metallurgy	G E Dieter	McGraw Hill	2013
3	Experimental Stress analysis	Dally J W, Railey W P	McGraw Hill	1991

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Materials	Timoshenko and Gere	CBS Publishers	1996
2	Theory of Elasticity	Jay sankar V P	Vedalekshmi publications	2016
3	Practical Non destructive testing	Baldev Raj, Jayakumar T, Thavasimuthu M	Narosa Book Distributors,	2015

Video Links (NPTEL, SWAYAM...)	
Sl. No.	Link ID
1	https://archive.nptel.ac.in/courses/105/106/105106172/

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

6. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

7. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

8. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

9. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

10. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 4

AERONAUTICAL ENGINEERING

SEMESTER 4

MATHEMATICS FOR PHYSICAL SCIENCE – 4

Course Code	GCMAT401	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Mins.
Prerequisites (if any)	Basic calculus.	Course Type	Theory

Course Objectives:

1. To familiarize students with the foundations of probabilistic and statistical analysis mostly used in varied applications in engineering and science.
2. To provide the students with the basics of various numerical methods to develop problem solving skills used in various engineering disciplines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Random variables, Discrete random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Binomial distribution, Poisson distribution, Poisson distribution as a limit of the binomial distribution, Joint pmf of two discrete random variables, Marginal pmf, Independent random variables, Expected value of a function of two discrete variables. [Text 1: Relevant topics from sections 3.1 to 3.4, 3.6, 5.1, 5.2]	9
2	Continuous random variables and their probability distributions, Cumulative distribution function, Expectation, Mean and variance, Uniform, Normal and Exponential distributions, Joint pdf of two Continuous random variables, Marginal pdf, Independent random variables, Expectation value of a function of two continuous variables. [Text 1: Relevant topics from sections 3.1, 4.1, 4.2, 4.3, 4.4, 5.1, 5.2]	9

3	Confidence Intervals, Confidence Level, Confidence Intervals and One-side confidence intervals for a Population Mean for large and small samples (normal distribution and t -distribution), Hypotheses and Test Procedures, Type I and Type II error, z Tests for Hypotheses about a Population Mean (for large sample), t Test for Hypotheses about a Population Mean (for small sample), Tests concerning a population proportion for large and small samples. [Text 1: Relevant topics from 7.1, 7.2, 7.3, 8.1, 8.2, 8.3, 8.4]	9
4	Newton-Raphson Method, Gauss Elimination Method, Gauss - Jordan Method, Numerical solution of ordinary differential equations-Euler's method, Modified Euler's method, Runge - Kutta method of 2 nd Order, Numerical solution of Laplace equation –Jacobi's Method, Curve Fitting by Method of Least Squares - Straight lines, Parabola. (Text 2: Relevant topics from sections 2.5, 4.2, 7.5, 8.4, 8.5, 9.4)	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept, properties and important models of discrete random variables and to apply in suitable random phenomena.	K3
CO2	Understand the concept, properties and important models of continuous random variables and to apply in suitable random phenomena.	K3
CO3	Estimate population parameters, assess their certainty with confidence intervals, and test hypotheses about population means and proportions using z -tests and the one-sample t -test.	K3
CO4	Apply numerical methods to find solutions of linear system of equations, ordinary differential equations and Laplace equations.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2
CO4	3	3	2	2	-	-	-	-	-	-	-	2

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probability and Statistics for Engineering and the Sciences	Devore J. L	Cengage Learning	9 th edition, 2016
2	Introductory Methods of Numerical Analysis	S S Sastry	PHI Learning Pvt Limited	5 th edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Probability, Random Variables and Stochastic Processes,	Papoulis, A. & Pillai, S.U.,	McGraw Hill.	4 th edition, 2002
2	Introduction to Probability and Statistics for Engineers and Scientists	Ross, S. M.	Academic Press	6 th edition, 2020
3	Numerical methods for Engineers	Steven C. Chapra, Raymond P. Canale	McGraw Hill Education	8 th edition, 2021

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/117/105/117105085/
2	https://archive.nptel.ac.in/courses/117/105/117105085/
3	https://archive.nptel.ac.in/courses/117/105/117105085/
4	https://archive.nptel.ac.in/courses/111/107/111107105/

SEMESTER 4
FLIGHT MECHANICS

Course Code	PCAOT402	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understanding the performance of airplanes under different operating conditions.
2. Examine the aircraft's response to intentional and unintentional changes in flying circumstances statically and dynamically.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Steady level performance: True, indicated and equivalent airspeed. Mach number, Drag polar equation and curves. Straight and level flight, thrust required and available. Power required and available, Effect of altitude on thrust and power. Conditions for minimum drag and minimum power required.	9
2	Accelerated Performance: Range and Endurance. Gliding and Climbing flight. Take-off and landing performance, Turning performance, horizontal and vertical turn. Pull up and pull down, maximum turn rate, V-n diagram.	11
3	Static Stability: Degree of freedom, Static and dynamic stability, static longitudinal stability conditions. Static longitudinal stability - Stick fixed and Stick free (Contribution of individual components, neutral point, static margin, Hinge moment, Elevator control effectiveness). Directional Stability- Weather cock stability, dorsal fin, directional control. Lateral Stability- Dihedral effect ,side slip	13

4	Dynamics: Aircraft equations of motion - Routh's criterion, Stability derivatives. Longitudinal Dynamics-Equation of Longitudinal motion., Phugoid motion: long period and short period. Lateral Dynamics-Spiral and directional divergence, Dutch roll, Autorotation and spin.	11
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the aircraft performance in steady level flight.	K2
CO2	Summarize the performance of aircraft under accelerated flight conditions.	K2
CO3	Apply the basic principle of motions to derive the static stability requirements of an aircraft .	K3
CO4	Utilize the equation of motions of an aircraft to assess the different maneuvers of an aircraft.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Performance and design	John D Anderson Jr.	McGraw-Hill Education	2017
2	Airplane Performance Stability and Control	Courtland D Perkins, Robert E Hage	John Wiley & Sons	
3	Flight stability and automatic control	Nelson R C	McGraw-Hill book Co	2004
4	Advanced Aircraft Flight performance	Filippone, Antonio	Cambridge university	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Steady Aircraft flight and performance	N.Harris, McClamroch	Princeton University	2011
2	Theory and Practice of aircraft performance	Ajoy Kumar Kundu, Mark A Price, David Riordan	Wiley	2016
3	Dynamics of flight stability and control	Bernard Etkin, Lloyd Duff Reid	Wiley	3rd Edition, 1996
4	Aircraft performance: An Engineering Approach	Mohammed H Sadraey	CRC Press	2023
5	Introduction to Flight	John D Anderson Jr	McGraw-Hill Education	Eighth Edition, 2016

SEMESTER 4

AIRCRAFT STRUCTURES -1

Course Code	PCAOT403	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Mechanics, Mechanics of Aircraft Materials	Course Type	Theory

Course Objectives:

1. To perform stress and deformation analysis on common structural member in aircraft.
2. To practice various method for analysis of stresses in structural members.
3. To describe the theories of failure employed in the analysis of structural elements.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Statically Determinate and Indeterminate structures: Types of Structures, Structural components of Aircraft. General loads on aircraft. Basic concept of determinate and indeterminate structure, Plane Truss Analysis- Method of joints, Method of section and Method of shear. Clapeyron's 3 moment equation and moment distribution method for indeterminate beams.	11

2	Energy Methods: Principle of Virtual work, Principal of superposition, St. Venant's principle, Maxwell's Reciprocal Theorem, Strain Energy in axial, bending, torsion and shear loadings. Castigliano's theorems and their applications, Energy methods applied to statically determinate and indeterminate beams- dummy load & unit load methods, frames, rings & trusses.	11
3	Column: Euler's column curve – inelastic buckling – effect of initial curvature – Southwell plot – columns with eccentricity – use of energy methods – Rankine formula. theory of beam columns – beam columns with different end conditions – stresses in beam columns.	11
4	Theories of failures- Maximum principal stress theory, Maximum shear stress theory, Maximum shear strain theory, Maximum strain energy theory, Maximum shear strain energy theory. Thermal stresses – impact loading – Fatigue – Creep - Stress Relaxation	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Calculate loads distributed along the connected structural members of truss and frame.	K3
CO2	Solve deflection of beams under various loading conditions through various analytical methods.	K3
CO3	Calculate the buckling load in columns and struts under various boundary conditions.	K3
CO4	Understand the theory of failures and induced stresses acting on structural member.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Analysis and Design of Flight Vehicles Structures	Bruhn. E.H	Tri- state off-set Company	1985
2	Aircraft Structures for Engineering Students	Megson T M G	Elsevier Ltd,2012	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Structures",	Peery, D.J., and Azar, J.J.,	2e McGraw Hill	1999
2	Airframe structural Design	Michael Chun-Yung Niu,	Conmilit Press Ltd	1998
3	Fundamentals of Aircraft Structural Analysis	Howard D Curtis	WCB- McGraw Hill	1997
4	Theory and Analysis of Flight Structures	Rivello, R.M.,	McGraw Hill	1993

SEMESTER 4

LOW SPEED AERODYNAMICS

Course Code	PBAOT404	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Student should be able to explain and use basic theorems in fluid mechanics, Sketch the stream line and equipotential lines of effective body under the different elementary flow combinations.
2. Student should be able to transform the flow past a body of definite shape , flow past the other related bodies by using complex variables and able to apply theory to predict air foil performance characteristics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation (Conservation and Non-Conservation forms). Path line, Streamline, Streakline, Irrotational flows, Barotropic flow, Stream function, Potential function, Equipotential line, Circulation and Vorticity, Green's lemma, Elementary flows and their combinations, Stoke's theorem, (Problems)	11
2	Ideal Flow over a circular cylinder, D'Alembert's paradox, Magnus effect, Real flow over smooth and rough cylinders, Kutta Joukowski's theorem, Kutta condition, Kelvin's theorem, Cauchy-Riemann relations, Complex potential, Methodology of conformal transformation, Kutta Joukowski's transformation and its applications, Blasius theorem. (Problems)	11

3	Starting vortex, Thin airfoil theory and its applications. Vortex filament, Biot and Savart law, Bound vortex and Trailing vortex, Horse shoe vortex, Lifting line theory and its limitations. (Problems)	11
4	Panel methods-Source and Vortex Panel, Turbulence on spheres, Shape parameter, Boundary layer growth over a flat plate, Propeller Theories- Ideal Momentum and Blade element theory Numerical problems on the performance of propellers using propeller charts.	11

Suggestion for Project topics

- Identify shapes which are more aerodynamic by observing the flow patterns in wind tunnel -Need of streamline body.
- Drag force estimation for different Shapes-Dependency of frontal area on drag force.
- Demonstrate flow over a cricket ball, Golf ball, Tennis ball in rotating and non-rotating conditions- Magnus effect
- Test propeller with and without twist- importance of blade twist.

Course Assessment Method **(CIE: 40 marks, ESE: 60 marks)**

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x2 =16 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand governing equations of incompressible fluid.	K2
CO2	Apply transformation techniques to convert physical problem to mathematical models.	K3
CO3	Understand the theories to quantify lift produced in airfoil, wing and propeller.	K2
CO4	Evaluate the relation of parameters that govern the aerodynamic forces produced on arbitrary bodies due to flow over it.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-					2	2		2
CO2	3	3	-	-					2	2		2
CO3	2	2	-	-					2	2		2
CO4	3	3	3	3					2	2		2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Aerodynamics	John D Anderson,	McGraw Hill	5th Edition
2	Aerodynamics for Engineering students, 2016	E.L. Houghton P.W. Carpenter & Steven H. Collicott, ,	McGraw Hill	6th Edition
3	Fluid Mechanics,	Frank M. White	McGraw Hill	8th edition
4	Fluid Mechanics,	Frank M. White	McGraw Hill	8th edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Flight, 2011	A C Kermode,	Pearson India,	11th edition
2	Aerodynamics for Engineers,	J Bertin,	Pearson Education	7th edition

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation / Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

Project Assessment and Evaluation criteria (30 Marks)

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. Execution and Implementation (10 Marks)

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. Final Presentation (5 Marks)

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER 4

NON-DESTRUCTIVE TESTING

Course Code	PEAOT411	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To comprehend the fundamental ideas, methodologies, tools, applications and constraints of NDT approaches.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Visual Inspection : tools, applications and limitations - Fundamentals of visual testing: vision, lighting, material attributes, environmental factors. visual perception, direct and indirect methods mirrors, magnifiers, boroscopes, fibroscopes, closed circuit television, light sources special lighting, a systems, computer enhanced system. Liquid penetrant Testing : Properties required for a good penetrant and developers - Types of penetrants and developers. LPI technique/ test procedure interpretation and evaluation of penetrant test indications, false indication and safety precaution required in LPI.	9

2	Magnetic Particle Testing: Methods of magnetization, magnetization techniques such as head shot technique, cold shot technique, central conductor testing, magnetization using products using yokes ,direct and indirect method of magnetization, continuous testing of MPI, residual technique of MPI, system sensitivity, checking devices in MPI. Eddy Current Testing: Physics aspects of ECT .Field factor and lift of effect, edge effect, end effect, impedance plane diagram in brief, depth of penetration of ECT, relation between frequency and depth of penetration in ECT equipments and accessories, Various application of ECT such as conductivity measurement, hardness measurement, defect detection coating thickness measurement.	9
3	Ultrasonic Testing: UT testing methods ,contact testing and immersion testing, normal beam and straight beam testing, angle beam testing, dual crystal probe, ultrasonic testing techniques, resonance testing, through transmission technique, pulse echo testing technique, instruments used UT. accessories such as transducers, types, frequencies, and sizes commonly used. Reference blocks with artificially created defects, calibration of equipments. Radiography Testing (RT): Electromagnetic radiation sources.Inspection techniques like SWSI, DWSI, DWDI, panoramic exposure, realtime radiography, films used in industrial radiography, types of film, speed of films, qualities of film screens used in radiography, quality of a good radiograph, film processing, interpretation, evaluation of test results, safety aspects required in radiography.	9
4	Advanced NDI Techniques: Principle and Procedure of Digital Signal and image Processing & Digital Image correlation Acoustic emission Inspection ,Thermography, Computed Tomography	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Identification of NDT Techniques which enable you to carry out various inspections in accordance with the established procedures.	K2
CO2	Familiarize with basic principles of electromagnetic NDT methods	K2
CO3	summarizing the principles of signal processing of ultrasonic signals and image processing of radiographic images.	K2
CO4	Analyzing the advanced techniques in NDT	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Practical Non- destructive testing	Baldev Raj	Alpha Science International	2008
2	Non - destructive testing	Hull V and V John	Micmillan	2012
3	Non Destructive testing Techniques	Ravi Prakash	New Academic Science	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Recent developments in the field of non destructive testing, safety and material science	Elena Lysenko, Alexander Rogachev, Oldrich Stary	Springer	2022
2	New Technologies in electromagnetic non-destructive Testing	Songling Huang & Shen Wang	Springer	2016
3	Recent Advances in Non - Destructive Inspection	Carosena Meola	Nova Science publishers	2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/113/106/113106070/

SEMESTER 4

VISCOUS FLOW THEORY

Course Code	PEAOT412	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. The objective of this course is to provide a comprehensive understanding of viscous flow phenomena and their impact on aircraft design, performance, and operation. The course aims to equip students with the theoretical knowledge and practical skills necessary to analyze, model, and optimize viscous flow effects in various aerodynamic applications

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals Of Viscous Flow Introduction to Viscous Flow: Definition and significance of viscosity. Newtonian and non-Newtonian fluids. Governing Equations: Continuity equation. Navier-Stokes equations: derivation and physical interpretation. Boundary conditions.: Reynolds number, Froude number, and others. Flow similarity and modelling. Exact Solutions of Navier-Stokes Equations: Couette flow. Poiseuille flow. Stokes' first and second problems	9

2	Laminar Flow Laminar Flow in Pipes and Channels: Fully developed flow. Hagen-Poiseuille law. Laminar flow in circular and non-circular ducts. Boundary Layer Theory: Concept of boundary layer. Derivation of boundary layer equations. Blasius solution for flat plate. Heat Transfer in Laminar Flow: Energy equation for viscous flows. Thermal boundary layers. Laminar flow heat transfer in tubes.	9
3	Turbulent Flow Characteristics of Turbulent Flow: Nature and characteristics of turbulence. Reynolds decomposition and averaging. Turbulent Boundary Layers: Turbulent boundary layer equations. Law of the wall. Empirical correlations for turbulent flow. Turbulent Flow in Pipes and Channels: Fully developed turbulent flow. Moody chart and friction factor. Turbulent flow in non-circular ducts. Mixing and Heat Transfer in Turbulent Flow: Turbulent mixing and diffusion. Heat transfer in turbulent flows. Empirical correlations for heat transfer	9
4	Advanced In Viscous Flow In For Aircraft Applications Computational Fluid Dynamics (CFD) for Viscous Flow: Introduction to CFD. Discretization methods: finite difference, finite volume. CFD applications for viscous flows. High Reynolds Number Flows: Characteristics of high Reynolds number flows in aerodynamics. Challenges in modelling and simulation. Practical implications for aircraft design. Heat Transfer in Viscous Flows: Energy equation in viscous flow. Convective heat transfer in boundary layers. Thermal management in aircraft systems. Flow-Induced Vibrations and Aeroelasticity: Interaction of viscous flows with flexible structures. Aero elastic phenomena: flutter, divergence. Mitigation and control strategies.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand Viscous Flow Fundamentals	K2
CO2	Analyze Boundary Layer Behavior: and Evaluate Viscous Effects on Aerodynamic Performance	K3
CO3	Apply Flow Control Techniques:	K3
CO4	Integrate Knowledge in Real-World Applications	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Boundary-Layer Theory"	Hermann Schlichting and Klaus Gersten	Hermann Schlichting and Klaus Gersten	-
2	Aircraft Aerodynamic Design:	András Sóbester and Alexander I.J. Forrester	-	-

SEMESTER 4

INDUSTRIAL AERODYNAMICS

Course Code	PEAOT413	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	PCAOT205 PCAOT402	Course Type	Theory

Course Objectives:

1. To familiarize non-aeronautical uses of aerodynamics in road vehicles, buildings and problems of flow induced vibrations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Atmosphere Introduction and Role of Atmosphere in the Aerodynamics, Types of wind, causes of variation of wind- Effect of terrain on gradient height- Atmospheric boundary layer, -Atmospheric disasters- clones, tornado. Classification of Wind Tunnels -Dimensional Analysis (Concept of Flow Similarity, Geometric Similarity, Kinematic Similarity, Dynamic Similarity),	9
2	Introduction to Wind Engineering Wind energy collectors -Pressure and velocity variations of wind turbines - Vertical and horizontal axis machines - Power coefficient, Betz coefficient by momentum theory Aerodynamic design of blades	9

3	Vehicle and Building Aerodynamics Power requirements and drag coefficients of automobiles, Effects of cut back angle, aerodynamics of trains and Hovercraft. Pressure distribution on low rise buildings, wind forces on buildings, Environmental winds in city blocks, special problems of tall buildings and bridges	9
4	Atmospheric Turbulence ,Flow Induced Vibrations & Sports Aerodynamics & Hydrodynamics Atmospheric turbulence and the causes - Structure of turbulence flow- Boundary layers and separation. Vortex shedding - Effects of Reynolds number on wake formation of bluff bodies across wind galloping - wake galloping-along wind galloping of circular cables - stall flutter- Wind loads on launch vehicles speed sports(Ski jumping and cycling), ball sports(Football) ,projectile sports and, Sports garments (Outfits)	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Familiarize with atmosphere and its effects, and wind tunnels	K2
CO2	To analyze the aerodynamics of automobiles, trains, hovercraft, buildings and bridges.	K4
CO3	Explain the concept of vortex induced vibrations.	K2
CO4	To determine the effect of wind on different structures and sports aerodynamics.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	wind turbines theory and practice book	Colin Anderson.		2020
2	“Aerodynamics and drag mechanisms of bluff bodies and road vehicles”	M.Sovran (Ed	Plenum press, New York,	1978
3	“The aerodynamics of heavy vehicle- Trucks, buses and trains”	Rose Mccallen, Fred Browand, James Rose	Springer	2004
4	Building Aerodynamics	T. Lawson,	Imperial College Press	(2001)
5	Wind power principles	N.G Calvent,	Charles Griffin, & Co..	1979

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	" Wind forces in engineering",	P. Sachs	Pergamon Press,	
2	" Flow induced vibrations",	R.D Belvins,	Van Nostrand,	
3	A review on aerodynamics and hydrodynamics in sports	Firoz Alam,Harun Chowdhury	2nd International Conference on Energy and Power, ICEP2018, 13–15 December 2018	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/8-30-oIeUuM?si=DSArHrukcmXNA40m
2	https://youtu.be/QmQ12gSz5CY?si=vYSgD15-fVBRs71_
3	https://youtu.be/PuDtLbPokSE?si=r9sTbZE6UKWUR-sf

SEMESTER 4

INSTRUMENTATION AND MEASUREMENTS

Course Code	PEAOT414	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. Introduce the basics of indicating and storage instruments.
2. Enable the students to measure electrical quantities like power, resistance, inductance, and capacitance.
3. Provide the basic principles of force, and torque measurement.
4. Enable the students to do linear and angular measurement..

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Indicating Instruments: Principle, types of control and damping; Moving coil Instruments: Types(permanent magnet, dynamometer type meters); Moving Iron Instruments: Attraction and repulsion type, Principles and torque equation; Wattmeters: Dynamometer type wattmeter ,Principles and torque equation; Measurement of single phase and three phase power; true RMS meter; Errors and Compensation.	9

2	Transformers Current transformers and Potential transformers; use of instrument transformers with wattmeter.	9
	Bridges and Potentiometers Measurement of resistance: Ohmmeter, Megger, Wheatstone bridge; Kelvin's double bridge; Phasor diagram; AC bridges: Measurements of inductance using Maxwell and Anderson bridges; Measurements of capacitance using Schering Bridge; Potentiometer: General principle; Modern form of dc potentiometers; Vernier dial principle; Standardization	
3	Oscilloscope: Simple CRO, CRT, Control of CRO; Dual beam CRO; Dual Trace CRO; Storage oscilloscope; Digital storage oscilloscope; Sampling Oscilloscope; measurement with CRO; Digital methods of frequency, phase, time and period measurements, Digital voltmeter and q –meter.	9
4	Measurement of force, and torque Principle of Dynamometers; mechanical and hydraulic Dynamometers. Linear and Angular Measurement Linear and angular measurement; slip gauges stack of slip gauge; method of selecting slip gauges; adjustable slip gauge; Measurement of angles; sine bar checking unknown angles; sine center; sources of error; angle gauges.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the principle and operation of moving coil instruments.	K2
CO2	Determine power, resistance, inductance, and capacitance.	K2
CO3	Explain the principle and operation of storage & display devices.	K2
CO4	Explain the principles and operation of measuring systems used for force, torque and moving coil instruments.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	3
CO3	2	-	-	-	-	-	-	-	-	-	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	“Electrical Measurements and Measuring Instruments”	E.W. Golding and F.C. Widdis,	Reem Publications Pvt. Ltd.,	3/e.
2	“A course in Electrical and Electronics Measurements and Instrumentation”	A.K. Sawhney	Dhanpat Rai & Co. (P) Limited.	
3	“Elements of electronic Instrumentation and Measurement”	Joseph J Carr	Pearson	3/e.
4	Mechanical Measurements”,	Thomas G. Beckwith and N. Lewis Buck	Pearson	6/e.

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	“Electronic Instrumentation and Measurement Techniques”,	William David Cooper	Prentice Hall,	3/e.
2	“Electronic Measurements and Instrumentation”,	K.B. Klaassan	Cambridge University Press	
3	Principles of Measurements Systems”	John Bentley	Pearson education	6/e.
4	“Measurement Systems, Application and Design”,	Ernest O. Doebelin	McGraw Hill Education,	6/e.

SEMESTER 4

AIRCRAFT GENERAL MAINTENANCE AND PRACTICES

Course Code	PEAOT416	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To comprehend the fundamentals of general engineering and maintenance procedures for airplanes.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Aircraft Weight and Balance- Purpose, Theory of Weight and Balance; Terminology - The Datum, C.G, Maximum Weight, Empty Weight, Useful load, Zero fuel weight; Aircraft weighing procedure - Control Surface Balancing - Rigging checks, Structural Alignment, Cable tension, Control surface travel - Aircraft Station Numbers.	9
2	Aircraft Hardware- Aircraft Bolts and Nuts, Washers, Aircraft Screws, Control cables, Turn Buckles, Rivets, Fluid lines and Fittings- Flexible Hose, Rubber Hose, Rigid tubes, Identification of Fluid Lines, Plumbing Connectors. Hand Tools, Lay out and Measuring tools, Precision Instruments	9
3	Inspection Fundamentals- Special Inspections-Hard Landing Inspection, Severe turbulence inspection. Aircraft log books- journey log books, Technical log books, Technical publications, Bulletins, Various Manuals, Type Certificate data sheet-ATA Specifications. American and British Systems for Identification	9

4	Inspection Procedures -Engine Starting Procedures, Aircraft Fuelling Procedures, Aircraft Tie down, Towing and Taxing of Aircraft, Jacking of Aircraft. Predictive Maintenance Techniques, Overview of aviation regulations - FAA, EASA	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To apply the basic concepts of aircraft weight and balance theory for structural balance and alignment	K2
CO2	To understand and identify basic hardware and plumbing technologies in an aircraft	K2
CO3	To familiarize the inspection fundamentals and aircraft logs	K2
CO4	To analyze the basic ground operations and maintenance operations.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft General Engineering Practices	Lalit Gupta	Himalayan Book house, New Delhi	2010
2	Aircraft Maintenance and Repair	Kroes Watkins Delp	McGraw Hill, New York	2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aviation Maintenance Technician : Airframe, Vol I	Dale Crane	Aviation Supplies and Academics Inc	2008
2	Aviation Maintenance Technician Handbook-Airframe Vol I & II	FAA	FAA, Shroff Publishers & Distributors ,New Delhi	2012

SEMESTER 4

AEROSPACE ENGINEERING AND NAVIGATION INSTRUMENTATION

Course Code	PEAOT417	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	GCPHT121 PCAOT205	Course Type	Theory

Course Objectives:

1. Understand basic principles of aviation and the history of space vehicles
2. Acquire the basics of space propulsion, space crafts and their orbits .
3. Comprehend the navigation concepts and navigation systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Space Flight: History of aviation, International Standard atmosphere, Atmosphere and its properties, Temperature, pressure and altitude relationships, Classification of aircrafts, Modern developments in Aviation like UAV. History of Space Flight & spacecraft technologies Difference between space and atmosphere, upper atmosphere, Introduction to basic orbital mechanics, types of Orbits (LEO, MEO, Geosynchronous and Geostationary, Polar orbits), Kepler's Laws of planetary motion.	9

2	Aircraft & Rocket Propulsion: Introduction, Classification, Piston Engine & its application, Principle of operation of Turboprop, turbojet and turbofan engines, Introduction to ramjets and scramjets; performance characteristics, Principles of operation of rocket, Classification of Rockets, Types of rockets and typical applications, Introduction to Space Exploration.	9
3	Navigation Concepts: Introduction. Radio navigational aids. Radio navigation systems. VHF-Omni directional range system. Distance Measuring Equipment. Instrument landing system. Area navigation. Global positioning system. Automatic Flight Control Systems – Aircraft Autopilot. Aircraft controls in modern aircrafts. Intelligent Flight Control Systems- Aircraft flight simulation instrumentation.	9
4	In-flight Navigation: Use of visual observations and application to in-flight navigation, Navigation in climb descent, average airspeed, average wind velocity, ground speed/distance covered during climb or descent, Navigation in cruising flight, use of fixes to revise navigation data, ground speed revision, off-track corrections. Principle, construction and applications of inertial sensors. Gyroscope and accelerometer, Radar- continuous wave and frequency modulated radar- MTI and pulse Doppler radar. Airborne Surveillance Radars.	9

Course Assessment Method
(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic knowledge & principles of aviation & spaceflight.	K2
CO2	Discuss the concepts of fundamentals of aircraft & rocket propulsion.	K2
CO3	Inferring the navigation basics, concepts and controls.	K2
CO4	Evaluate the inflight navigation principles, controls and measurements.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration	Ian Moir, Allan Seabridge	John Wiley & Sons	3rd edition, 2011
2	Flight without formulae	A.C. Kermode	Pearson Education India	5 th edition, 1989
3	Flight stability and automatic control	Nelson R.C	McGraw-Hill	2nd edition, 1998
4	Aircraft Instruments- Principles and Applications	Pallet. E.H.J	Pitman	1981

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Airplane Flight Mechanics	David.G.Hull	Springer	2007
2	Avionics Navigation Systems	Keyton.M and Walker.R. Fried	John Wiley	2nd edition, 1996
3	Space Flight: History, Technology, and Operations	Lance K. Erickson	The Scarecrow press	2010

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/101/101/101101079/
2	https://nptel.ac.in/courses/101104019
3	https://archive.nptel.ac.in/courses/101/108/101108056/
4	https://archive.nptel.ac.in/courses/101/108/101108056/

SEMESTER 4

AUTOMATION AND FEEDBACK CONTROLS IN AEROSPACE

Course Code	PEAOT418	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Mins
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To understand the principles of automation and feedback control systems, apply theoretical concepts to analyze and design control systems, and demonstrate proficiency in implementing feedback control techniques to achieve desired system performance.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction To Automation: Automation, Types and Strategies of Automation, Open Loop and Closed Loop (Feed Back) control systems. Types of feedback control systems. Laplace's transform.	9
2	Feedback Control Systems: Transfer function of linear systems. Impulse response of linear systems, Block diagrams of feedback control systems, Multivariable systems. Block diagram algebra.	9
3	Analysis Of Feedback Control Systems: Typical test input signals, Time domain performance characteristics of feedback control systems. Effects of derivative and integral control. Steady State response of feedback control system-steady State error, Frequency response.	9

4	System Stability: Routh-Hurwitz Criterion, the Root Locus Method Auto-Pilots: Longitudinal Auto Pilots: Brief description through Block diagrams and Root Locus of Displacement Auto Pilot. Pitch Orientational Control System. Acceleration control system.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the application of Laplace transforms and their role in solving ODEs and obtaining transfer functions	K2
CO2	Understand block diagrams and be able to transform them.	K2
CO3	Understand the differences between controlling the transient response and the steady-state response of a system	K2
CO4	Know how to apply Routh-Hurwitz stability criteria to determine absolute and parametric stability of linear systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	“Automatic Control of aircraft and Missiles”	John H. Blackelock	John Wiley and Sons	2011
2	Performance, stability, Dynamics and control of Airplanes	Bandu N Pamadi	American Institute of Aeronautics and Astronautics	2003

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flight Stability and Automatic Control	Robert C. Nelson	McGraw Hill Co	1997
2	Automatic Flight Control	Pallet H.J	B.S. Professionals Books	1993
3	Automatic Control Systems	S.Hasan Saeed	Arihant	2013

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/107/106/107106081/
2	https://onlinecourses.nptel.ac.in/noc24_ae05/preview

SEMESTER 4

DRONE TECHNOLOGY

Course Code	PEAOT415	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. Understand the history, evolution, classification, applications of different types of. Unmanned aircraft systems.
2. Understand the regulatory requirements and safety protocols of the drone operations.
3. To explore various sensors, payloads and communication technologies used in drone missions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Unmanned Aircraft Vehicles. Introduction to Drone Technology- History of Drone-Classification- Introduction to Unmanned aircraft systems-system compositions-application -Types of Drones -Fixed-wing, Rotary-wing, multi rotor, Fixed Wing VTOL (Vertical Take off and Landing)-Basic Components-arms-motors-propellers- battery-flight controllers-sensors-camera/gimble-electronic speed controllers(esc)-. Architecture-Hardware-Software-Applications of Drones- Surveillance-Mapping& Survey-Agriculture-Disaster Management- Structural Inspection-Wind turbine inspection-Thermography-LiDAR analysis-	9

2	Design and construction. Aerodynamics and Flight Mechanics of Drones-Lift induced drag-parasitic drag-rotary wing aerodynamics-response to air turbulence-Propeller-Types-Propeller theories-momentum theory-Blade element theory-combined blade element and momentum theory-Materials and Structural Design-types of materials-composite materials-classification and application-Propulsion Systems and Power Sources-electric propulsion system-internal combustion engines-hybrid propulsion turboprop-turbojet propulsion. Batteries -fuel cells-solar -hybrid power system- Supercapacitors-	9
3	Drone Assembly and Testing Procedures static and dynamic balancing of rotor blade-Payload and controls: Electro Optical-Laser-Infrared -Telemetry-tracking-Aerial photography-PID controls-Overview of radio frequency-control frequency-flight controllers and sensors-Launch and Recovery. Drone control systems and autonomy: Basic Principles of Drone Control-Flight Control Systems (GPS, IMUs, Gyros, etc.)-Autonomous Navigation and Path Planning-Sensor Integration (Cameras, LiDAR, RADAR)-Software Platforms and Programming for Drones (ROS, PX4, ArduPilot)	9
4	Drone communication Radio Frequency Communication Basics Data Links and Telemetry-Real-time Video Transmission-Communication Protocols and Standards-Challenges and Solutions in Drone Communication-Advanced Applications (AI in Drones, Swarm Drones)-Drone Data Processing and Analytics-Legal and Ethical Considerations-Future Trends in Drone Technology-Capstone Projects and Real-world Case Studies Regulatory aspects - Local and international drone regulations India -UK - USA-EU. Role of DGCA - Safety protocols and risk management, Ethical considerations in drone operations	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	Each question carries 9 marks. Two questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Demonstrate the fundamental aerodynamic principles to optimize flight conditions for efficient and safe drone operations.	K3
CO2	Understand the types and functionalities of sensors used in drones and to integrate and operate various payloads for specific drone missions.	K4
CO3	Describe the different communication technologies for secure and reliable communication between drones and ground control systems.	K3
CO4	Evaluate static response of drones for both voluntary and involuntary changes in flight condition.	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	-	-	-	-	-	-	-	2
CO2	3	3	3	2	-	-	-	-	-	-	-	2
CO3	3	3	3	3	-	-	-	-	-	-	-	2
CO4	3	3	3	3	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Small Unmanned Aircraft: Theory and Practice	Randal W. Beard and Timothy W. McLain	Princeton University Press	2012
2	Unmanned Aircraft Design: A Review of Fundamentals	Mohammad H. Sadraey	Momentum Press	First Edition, 2017
3	Principles of Modern Avionics	S. Nagabhushana & N Prabhu	I K International Publishing House	First Edition, 2018
4	UAV Communications for 5G and Beyond	Yong Zeng, Ismail Guvenc, Rui Zhang, Giovanni Geraci, & David W. Matolak	John Wiley & Sons Ltd	First Edition, 2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to UAV Systems	Paul Gerin Fahlstrom, Thomas James Gleason, Mohammed H Sadraey	Wiley	5 th Edition, 2022
2	Drones: The Ultimate Guide	Robert J. Chapman	CreateSpace Independent Publishing Platform	First Edition,2015
3	Make: Drones: Teach an Arduino to Fly	David Mc Griffy	Make Community, LLC	First Edition,2015

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://youtu.be/9c769xiEXn0?list=PLFW6lRTa1g83B1HdU2mece6QLeBrtsPL7
2	https://www.youtube.com/playlist?list=PLFW6lRTa1g82hgmTU6Z8rZ22uqiUpOMIm
3	https://www.youtube.com/watch?v=TO7qa8oCACI&list=PLgiealSjeVyx3t4N9GroE29SbVwhYrOtL

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

Course Code	UCHUT346	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with an understanding of fundamental economic principles essential for effective decision-making in engineering contexts.
2. To enable students to apply economic analysis to production decisions, cost management, and market strategies in engineering practice.
3. To equip students with the ability to evaluate macroeconomic scenarios, financial methods, and investment decisions relevant to engineering projects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility –Demand: Factors determining demand – Law of Demand – Demand curve- Price elasticity of demand- measurement of price elasticity and its applications – Supply: factors determining supply - Law of supply – Supply curve- Equilibrium price determination- Changes in demand and supply and its effects on equilibrium price and quantity Production: Production function - Law of variable proportion –Returns to scale- Cobb-Douglas Production Function	6
2	Cost: Cost concepts – Private cost and social cost – Sunk cost – Opportunity cost -Explicit and implicit cost –Short run cost curves –Long run average cost curve -Revenue concepts – Break-even point Market: Perfect Competition – Monopoly - Monopolistic Competition (features and equilibrium of a firm) - Oligopoly – Features – Kinked demand model	6

3	National income: Concepts (GDP, GNP and NNP)– Final goods and Intermediate goods - Methods of Estimation –output method – expenditure method-- Difficulties in the measurement of national income. Inflation: Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Repo and reverse repo rate	6
4	Value Analysis and value Engineering: Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure Capital Budgeting: Time value of money - Net Present Value Method - Benefit Cost Ratio – Internal Rate of Return – Payback – Accounting Rate of Return.	6

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/Case Study/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	15	12.5	12.5	50

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks (6x3 =18 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. (4x8 = 32 marks)	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	K2
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	K3
CO3	Outline the macroeconomic principles of monetary and fiscal systems and national income.	K2
CO4	Make use of the possibilities of value analysis and engineering, and take investment decisions through capital budgeting techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012
4	Financial Management	I M Pandey	Vikas Publishing House	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7 TH Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001
5	Financial Management: Theory and Practice	Prasanna Chandra	Mc Graw Hill	2007

SEMESTER S3/S4

ENGINEERING ETHICS AND SUSTAINABLE DEVELOPMENT

Course Code	UCHUT347	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Equip with the knowledge and skills to make ethical decisions and implement gender-sensitive practices in their professional lives.
2. Develop a holistic and comprehensive interdisciplinary approach to understanding engineering ethics principles from a perspective of environment protection and sustainable development.
3. Develop the ability to find strategies for implementing sustainable engineering solutions.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of ethics - Personal vs. professional ethics, Civic Virtue, Respect for others, Profession and Professionalism, Ingenuity, diligence and responsibility, Integrity in design, development, and research domains, Plagiarism, a balanced outlook on law - challenges - case studies, Technology and digital revolution-Data, information, and knowledge, Cybertrust and cybersecurity, Data collection & management, High technologies: connecting people and places-accessibility and social impacts, Managing conflict, Collective bargaining, Confidentiality, Role of confidentiality in moral integrity, Codes of Ethics. Basic concepts in Gender Studies - sex, gender, sexuality, gender spectrum: beyond the binary, gender identity, gender expression, gender stereotypes, Gender disparity and discrimination in education, employment and everyday life, History of women in Science & Technology, Gendered technologies & innovations, Ethical values and practices in	6

	connection with gender - equity, diversity & gender justice, Gender policy and women/transgender empowerment initiatives.	
2	Introduction to Environmental Ethics: Definition, importance and historical development of environmental ethics, key philosophical theories (anthropocentrism, biocentrism, ecocentrism). Sustainable Engineering Principles: Definition and scope, triple bottom line (economic, social and environmental sustainability), life cycle analysis and sustainability metrics. Ecosystems and Biodiversity: Basics of ecosystems and their functions, Importance of biodiversity and its conservation, Human impact on ecosystems and biodiversity loss, An overview of various ecosystems in Kerala/India, and its significance. Landscape and Urban Ecology: Principles of landscape ecology, Urbanization and its environmental impact, Sustainable urban planning and green infrastructure.	6
3	Hydrology and Water Management: Basics of hydrology and water cycle, Water scarcity and pollution issues, Sustainable water management practices, Environmental flow, disruptions and disasters. Zero Waste Concepts and Practices: Definition of zero waste and its principles, Strategies for waste reduction, reuse, reduce and recycling, Case studies of successful zero waste initiatives. Circular Economy and Degrowth: Introduction to the circular economy model, Differences between linear and circular economies, degrowth principles, Strategies for implementing circular economy practices and degrowth principles in engineering. Mobility and Sustainable Transportation: Impacts of transportation on the environment and climate, Basic tenets of a Sustainable Transportation design, Sustainable urban mobility solutions, Integrated mobility systems, E-Mobility, Existing and upcoming models of sustainable mobility solutions.	6
4	Renewable Energy and Sustainable Technologies: Overview of renewable energy sources (solar, wind, hydro, biomass), Sustainable technologies in energy production and consumption, Challenges and opportunities in renewable energy adoption. Climate Change and Engineering Solutions: Basics of climate change science, Impact of climate change on natural and human systems, Kerala/India and the Climate crisis, Engineering solutions to mitigate, adapt and build resilience to climate change. Environmental Policies and Regulations: Overview of key environmental policies and regulations (national and international), Role of engineers in policy implementation and compliance, Ethical considerations in environmental	6

	policy-making. Case Studies and Future Directions: Analysis of real-world case studies, Emerging trends and future directions in environmental ethics and sustainability, Discussion on the role of engineers in promoting a sustainable future.	
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**Course Assessment Method
(CIE: 50 marks , ESE: 50)**

Continuous Internal Evaluation Marks (CIE):

Continuous internal evaluation will be based on individual and group activities undertaken throughout the course and the portfolio created documenting their work and learning. The portfolio will include reflections, project reports, case studies, and all other relevant materials.

- The students should be grouped into groups of size 4 to 6 at the beginning of the semester. These groups can be the same ones they have formed in the previous semester.
- Activities are to be distributed between 2 class hours and 3 Self-study hours.
- The portfolio and reflective journal should be carried forward and displayed during the 7th Semester Seminar course as a part of the experience sharing regarding the skills developed through various courses.

Sl. No.	Item	Particulars	Group/Individual (G/I)	Marks
1	Reflective Journal	Weekly entries reflecting on what was learned, personal insights, and how it can be applied to local contexts.	I	5
2	Micro project (Detailed documentation of the project, including methodologies, findings, and reflections)	1 a) Perform an Engineering Ethics Case Study analysis and prepare a report 1 b) Conduct a literature survey on 'Code of Ethics for Engineers' and prepare a sample code of ethics	G	8
		2. Listen to a TED talk on a Gender-related topic, do a literature survey on that topic and make a report citing the relevant papers with a specific analysis of the Kerala context	G	5
		3. Undertake a project study based on the concepts of sustainable development* - Module II, Module III & Module IV	G	12
3	Activities	2. One activity* each from Module II, Module III & Module IV	G	15
4	Final Presentation	A comprehensive presentation summarising the key takeaways from the course, personal reflections, and proposed future actions based on the learnings.	G	5
Total Marks				50

*Can be taken from the given sample activities/projects

Evaluation Criteria:

- **Depth of Analysis:** Quality and depth of reflections and analysis in project reports and case studies.
- **Application of Concepts:** Ability to apply course concepts to real-world problems and local contexts.
- **Creativity:** Innovative approaches and creative solutions proposed in projects and reflections.
- **Presentation Skills:** Clarity, coherence, and professionalism in the final presentation.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Develop the ability to apply the principles of engineering ethics in their professional life.	K3
CO2	Develop the ability to exercise gender-sensitive practices in their professional lives	K4
CO3	Develop the ability to explore contemporary environmental issues and sustainable practices.	K5
CO4	Develop the ability to analyse the role of engineers in promoting sustainability and climate resilience.	K4
CO5	Develop interest and skills in addressing pertinent environmental and climate-related challenges through a sustainable engineering approach.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

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

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Ethics in Engineering Practice and Research	Caroline Whitbeck	Cambridge University Press & Assessment	2nd edition & August 2011
2	Virtue Ethics and Professional Roles	Justin Oakley	Cambridge University Press & Assessment	November 2006
3	Sustainability Science	Bert J. M. de Vries	Cambridge University Press & Assessment	2nd edition & December 2023
4	Sustainable Engineering Principles and Practice	Bhavik R. Bakshi,	Cambridge University Press & Assessment	2019
5	Engineering Ethics	M Govindarajan, S Natarajan and V S Senthil Kumar	PHI Learning Private Ltd, New Delhi	2012
6	Professional ethics and human values	RS Naagarazan	New age international (P) limited New Delhi	2006.
7	Ethics in Engineering	Mike W Martin and Roland Schinzinger,	Tata McGraw Hill Publishing Company Pvt Ltd, New Delhi	4" edition, 2014

Suggested Activities/Projects:

Module-II

- Write a reflection on a local environmental issue (e.g., plastic waste in Kerala backwaters or oceans) from different ethical perspectives (anthropocentric, biocentric, ecocentric).
- Write a life cycle analysis report of a common product used in Kerala (e.g., a coconut, bamboo or rubber-based product) and present findings on its sustainability.
- Create a sustainability report for a local business, assessing its environmental, social, and economic impacts
- Presentation on biodiversity in a nearby area (e.g., a local park, a wetland, mangroves, college campus etc) and propose conservation strategies to protect it.
- Develop a conservation plan for an endangered species found in Kerala.
- Analyze the green spaces in a local urban area and propose a plan to enhance urban ecology using native plants and sustainable design.
- Create a model of a sustainable urban landscape for a chosen locality in Kerala.

Module-III

- Study a local water body (e.g., a river or lake) for signs of pollution or natural flow disruption and

suggest sustainable management and restoration practices.

- Analyse the effectiveness of water management in the college campus and propose improvements - calculate the water footprint, how to reduce the footprint, how to increase supply through rainwater harvesting, and how to decrease the supply-demand ratio
- Implement a zero waste initiative on the college campus for one week and document the challenges and outcomes.
- Develop a waste audit report for the campus. Suggest a plan for a zero-waste approach.
- Create a circular economy model for a common product used in Kerala (e.g., coconut oil, cloth etc).
- Design a product or service based on circular economy and degrowth principles and present a business plan.
- Develop a plan to improve pedestrian and cycling infrastructure in a chosen locality in Kerala

Module-IV

- Evaluate the potential for installing solar panels on the college campus including cost-benefit analysis and feasibility study.
- Analyse the energy consumption patterns of the college campus and propose sustainable alternatives to reduce consumption - What gadgets are being used? How can we reduce demand using energy-saving gadgets?
- Analyse a local infrastructure project for its climate resilience and suggest improvements.
- Analyse a specific environmental regulation in India (e.g., Coastal Regulation Zone) and its impact on local communities and ecosystems.
- Research and present a case study of a successful sustainable engineering project in Kerala/India (e.g., sustainable building design, water management project, infrastructure project).
- Research and present a case study of an unsustainable engineering project in Kerala/India highlighting design and implementation faults and possible corrections/alternatives (e.g., a housing complex with water logging, a water management project causing frequent floods, infrastructure project that affects surrounding landscapes or ecosystems).

SEMESTER 4

COMPUTER AIDED DRAFTING LABORATORY

Course Code	PCAOL407	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. Understand the various tools for designing, modelling and drafting of components of aircraft in CAD software.
2. Develop skills to model and draft using CAD software.

Expt. No.	Experiments
1	Layout of Aircraft (Three view)
2	Layout of landing gear
3	Modelling and drafting of control component – Bell Crank
4	Modelling and drafting of control component – Spur Gear
5	Modelling and drafting of control component – Cam
6	Modelling and drafting of Tapered Wing
7	Modelling and drafting of Tapered wing with twist using NACA series.
8	Modelling of tapered swept wing with geometric and aerodynamic twist using NACA series
9	Modelling and drafting of turbine blades.
10	Modelling and drafting of compressor blades.
11	Modelling and drafting of Fuselage (with Bulkhead, stringers and spars)

12	Modelling and drafting of control component - Connecting Rod (Assembly)
13	Modelling and drafting of Riveted Lap joints. (Assembly)
14	Modelling and drafting of Riveted butt joints. (Assembly)
15	Modelling and drafting of welded joints. (Assembly)

*Minimum 10 Experiments

Course Assessment Method

(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Draw simple joints in modelling software	K3
CO2	Draw 3D models of critical aircraft components	K3
CO3	Obtaining practical skills in modelling and assembling control components.	K3
CO4	Optimize wing designs for better aerodynamics using NACA series.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

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

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Shigley's Mechanical Engineering Design	Richard Budynas, Keith Nisbett	McGraw-Hill Science/Engineering/Math	11 th edition, 2021

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	CATIA V5 Workbook Release 19	Richard Cozzens	SDC Publications	1 st edition, 2019

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Reports and Lab Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER: 4

AERODYNAMICS AND FLIGHT MECHANICS LABORATORY

Course Code	PCAOL408	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Lab

Course Objectives:

1. To provide practical knowledge in fundamental aerodynamic and geometrical properties and to visualize the flow and pressure distribution

Expt. No.	Experiments
1	Study of three and six component balance
2	Calibration of a Subsonic Wind tunnel.
3	Aerodynamic forces and moments measurement of symmetrical aerofoil
4	Aerodynamic forces and moments measurement of cambered aerofoil
5	Pressure distribution over a symmetrical aerofoil
6	Pressure distribution over a cambered aerofoil
7	Pressure distribution over a smooth cylinder
8	Pressure distribution over a rough cylinder
9	Flow visualization studies in Aerofoil
10	Flow visualization studies in various models (Cars, Aircraft)
11	Determination of the effect of speed on attitude for level flight & stall
12	Measurement of the lift curve for the wing up to & beyond stall.
13	Determination of neutral stability & plot trim curves
14	Determination of phugoid motion in terms of altitude.

Minimum 10 experiments have to be conducted.

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Examination	Total
5	25	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- *Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.*
- *Endorsement by External Examiner: The external examiner shall endorse the record*

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Determine the aerodynamic forces and moments experienced by airfoils	K3
CO2	Determine the pressure distribution over 2D and 3D bodies	K3
CO3	Visualize the flow over 2D and 3D bodies	K3
CO4	Evaluate various lateral and longitudinal stability derivatives and demonstrate dynamic stability	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO- PO Mapping (Mapping of Course Outcomes with Program Outcomes)

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

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamental of Aerodynamics	John D Anderson	McGraw Hill	5 th Edition, 2016
2	Mechanics of Flight	A C Kermode	Pearson India	2011

Continuous Assessment (25 Marks)

1. Preparation and Pre-Lab Work (7 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (7 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (6 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

Final Marks Averaging: The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

- Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 5

AERONAUTICAL ENGINEERING

SEMESTER 5

HIGH SPEED AERODYNAMICS

Course Code	PCAOT501	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fluid Mechanics, Low Speed Aerodynamics	Course Type	Theory

Course Objectives:

1. To introduce the concept of compressible flow.
2. To make the student understand the theory behind the formation of shocks and expansion fans in supersonic flows.
3. To introduce the methodology of measurements in supersonic flows and the effect of heat transfer and friction through constant area duct.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION TO COMPRESSIBLE FLOW AND NORMAL SHOCK: Continuity, Momentum and energy equations for steady one dimensional flow, Concepts of stagnation condition, Velocity of sound, Adiabatic steady state flow equations, Flow through convergent- divergent passage, Performance under various back pressures (Numerical problem) , Mach cone, Mach angle, Normal shock relations(Numerical problem), Prandtl's relation, Hugoniot equation ,Rayleigh Supersonic Pitot tube equation, Moving normal shock waves. (Simple numerical examples)	13
2	OBLIQUE SHOCK AND EXPANSIONS WAVES: Oblique shock relation (Numerical problem), Shock Polar, Reflection and intersection of oblique shocks, Introduction to slip line compression corner effect, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle (Numerical problem). Fanno flow and Rayleigh flow, Mass addition to the flow. (Numerical problem).	11
3	DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOWS: Small perturbation potential theory, Method of characteristics, solutions for supersonic flows, Prandtl-Glauert rule - affine transformation relations for subsonic flows, Linearised two-	10

	dimensional supersonic flow theory - Lift, drag, pitching moment and centre of pressure of supersonic profiles. (Numerical problem)	
4	TRANSONIC FLOW OVER WING AND BOUNDARY LAYER EFFECTS IN SUPERSONIC FLOW: Critical Mach number, drag divergence, Mach number, Shock Stall, Supersonic aerofoil and wings, Effect of thickness, camber and aspect ratio of wings, Supercritical Aerofoil Sections, Transonic area rule, Swept wing, Aerodynamic heating, Design considerations of supersonic airplane. Introduction to hypersonic aerodynamics.	10

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic theorems in compressible fluid dynamics.	K2
CO2	Apply the concepts of shock waves and compressible flow through variable area passages.	K3
CO3	Apply the concepts of Oblique shock and expansion waves and simple flows and able to solve complex problems	K3
CO4	Apply the airfoil wing and cone section presence in supersonic flow.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Aerodynamics	John D Anderson	Mc Graw Hill Education	6 th edition & 2016
2	Gas Dynamics	Ethirajan Rathakrishnan	PHI Learning Private limited	6 th edition and 2018
3	Gas Tables	Rathakrishnan E	Orient Blackswan Private Limited - New Delhi	2013
4	Gas Tables for Compressible Flow Calculations	S M Yahya	New Age International Publishing	2001

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Compressible Flow	Anderson, J. D	Mc Graw Hill Education	4 th edition & 2003
2	Compressible Fluid Flow	Oosthuizen,P.H., & Carscallen,W.E	McGraw- Hill & Co	1997
3	Dynamics and Thermodynamics of Compressible Fluid Flow	Shapiro, A. H	Shapiro, A. H	1982

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
Module – I to III	https://youtube.com/playlist?list=PLbMVogVj5nJRm6ODNAemYPS7E62_hPiqH&si=hd3SiAIEnFpcOl A
Module IV	https://youtu.be/7VzLwVi5lW0?si=meQRQII1ElCdV9VI

SEMESTER 5**AIRCRAFT STRUCTURES –II**

Course Code	PCAOT502	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	ENGINEERING MECHANICS, AIRCRAFT STRUCTURES-I	Course Type	Theory

Course Objectives:

1. To analyse the stress and strain in major aircraft structural components such as aircraft wings and fuselage

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	BENDING OF THICK & THIN-WALLED BEAMS: Symmetrical and unsymmetrical bending in symmetrical (skew load) and unsymmetrical cross-section - Bending stresses in thick & thin-walled beams using generalized k- method - Principal axis and Neutral axis methods.	11
2	SHEAR FLOW IN OPEN SECTION: Thin-walled beams- Concept of shear flow. Shear flow distribution in symmetrical and unsymmetrical thin-walled sections. Shear center and its determination– structural idealization – shear flow variation in idealized sections, with wall effective and ineffective in bending - Applications of shear flow calculations	11
3	SHEAR FLOW IN CLOSED SECTION: Bredt - Batho theory – shear center of closed section (Thin-walled, idealized sections) – single cell and multi cell tubes subject to torsion – shear flow distribution in thin walled single & multi cell structures subject to combined bending and torsion with walls effective and ineffective in bending.	11
4	THIN PLATES: Introduction to buckling of plates. Rectangular sheets under compression. Buckling stress of thin-walled section. Crippling stresses by Needham's and Gerard's methods, sheet stiffener panels- Effective skin width. STRESS ANALYSIS OF AIRCRAFT COMPONENTS: Loads on an aircraft-classification - V-n diagram. shear force and bending moment distribution over the aircraft wing and fuselage. Tension field web beams (Wagner's). Shear resistant web beams.	11

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze bending stress in symmetrical & Unsymmetrical sections	K4
CO2	Analyze the shear flow in open section beams and Torsion of non-circular prismatic beams	K4
CO3	Analyze the shear flow in closed section beams.	K4
CO4	Analyze the buckling behavior of plates, columns under various loads and also analyse aircraft wing and fuselage.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	"Aircraft Structures",	Peery, D.J., and Azar, J.J.,	McGraw – Hill, N.Y.,	2013
2	“Airframe structural Design”	Michael Chun-Yung Niu,	Conmilit Press Ltd,	1998
3	"Theory and Analysis of Flight Structures".	Rivello, R.M.	McGraw Hill,	1993.
4	"Fundamentals of Aircraft Structural Analysis".	Howard D Curtis,	WCB- McGraw Hill,	1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	"Analysis and Design of Flight Vehicles Structures",	Bruhn. E.H.,	Tri- state off-set Company, USA,	1985.
2	"Aircraft Structures for Engineering Students",	Megson T M G ,	Elsevier Ltd,	2012

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/101/112101004/

SEMESTER 5**AIR BREATHING PROPULSION**

Course Code	PCAOT503	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3-0-0-0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fluid Mechanics, Engineering Thermodynamics	Course Type	Theory

Course Objectives:

1. To understand the basic working principles of different types of air breathing engines.
2. To understand different components of a gas turbine.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Aircraft Engines: Classification of propulsion, Description of piston engines, turbojet engines—derivatives and hypersonic air-breathing engines. Types of propellers, thrust generation in propeller driven aircraft. General Thrust equation for jet engine, Engine performance parameters-altitude, density. Effect of parameters on aircraft range and endurance. Engine thrust, take-off thrust, installed thrust, operational envelopes for jet engines and propeller engines, Engine cycle analysis and performance analysis for turbojet, turbojet with afterburner, turbofan engine, turboprop engine, ramjets. (Numerical)	10
2	Aircraft Engine Inlets, Exhaust Nozzles, Combustors: Subsonic inlets: Function, design variables, operating conditions, inlet performance, performance parameters; Starting of Supersonic inlets: Compression process, types, construction, losses, performance characteristics; Exhaust nozzles: primary nozzle, fan nozzle, converging nozzle, variable nozzle, and performance maps, thrust reversers and thrust vectoring, Combustors and Afterburners: Types, flame stability, ignition and engine starting, pressure losses, performance maps, fuel types and properties.	8
3	Axial and Centrifugal Flow Compressors: Axial flow Compressors: Geometry, Velocity diagram, Work done and pressure rise, degree of reaction, compressor performance maps, compressor instability, stall and surge. efficiency calculations. Centrifugal Compressor: Principle of operation of centrifugal compressor	9

	Work done and pressure rise, Blade types, Performance characteristics of centrifugal compressors efficiency calculations.	
4	Axial Flow and Radial Flow Turbines: Principle of operation of axial flow turbines and radial flow turbines - Work done and pressure rise - Velocity diagrams – Degree of reaction – Free vortex and constant nozzle angle designs - Stage efficiency calculations – Basic blade profile design considerations – Matching of compressor and turbine - Performance characteristics of axial flow turbine– Turbine blade cooling methods. Cascades and cascade testing - Design of blades. (Numerical problems). Engines component matching and sizing.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Describe the various types, working and performance of air-breathing engines.	K2
CO2	Understand the design consideration required for inlets and combustion chamber performance parameters affecting it.	K2
CO3	Calculate the performance parameters- pressure ratio, efficiency of compressors used for aircraft propulsion.	K3
CO4	Solve problems related to performance parameters of turbines used for aircraft propulsion.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Jet Propulsion with Applications	Ronald D. Flack,	Cambridge University Press, 3rd Edition,	2011
2	Gas Turbine Theory	H Cohen. G F C Rogers HIH Saravanamuthoo	Pearson	2008
3	Turbines, Compressors and Fans	S M Yahya	McGraw- Hill & Co.	1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Elements of Propulsion: Gas Turbines and Rockets	Jack D. Mattingly	AIAA Education Series, 3rd Edition,	2006
2	Aircraft Propulsion	Saeed Farokhi	Wiley, 2nd Edition	2014

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/101/112101004/

SEMESTER 5

HEAT TRANSFER

Course Code	PBAOT504	CIE Marks	60
Teaching Hours/Week (L: T:P: R)	3:0:0:1	ESE Marks	40
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics	Course Type	Theory

Course Objectives:

1. The fundamentals of heat transfer as they relate to the design of engineering systems and devices that involve the transport of thermal energy or heat will be covered in this course.
2. The subject covers the mathematical formulations and real-world applications of the heat transport mechanisms by conduction, convection, and radiation. Heating issues that arise in high-speed, high-temperature flows are also addressed.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to heat transfer and its relation to thermodynamics. Basic modes of heat transfer and the laws governing them. Fourier's law and derivation of general three-dimensional heat conduction equation and the boundary conditions. One dimensional steady state heat conduction in composite mediums and with variable thermal properties and heat generation. Idea of electrical analogy and use of thermal resistance and capacitance concepts. Idea of critical thickness of insulation. Heat transfer in extended surfaces and design of fins. One dimensional transient heat conduction analysis and the idea of lumped mass analysis and its validity. Use of similarity solutions for heat transfer problems in semi-infinite and infinite solids. Application of non- dimensional parameters Fourier number and Biot number and the use of transient temperature (Heisler's)charts	9
2	Free and forced convection and non-dimensional parameters. Nusselt, Prandtl and Eckert and Grashof numbers. Free convection in atmosphere. Free convection on a vertical flat plate. Empirical relation	9

	for heat transfer. Concept of Laminar and turbulent convective heat transfer analysis using the boundary layer concepts in flows between parallel plates. over a flat plate and in a circular pipe. Need and application of numerical techniques in solving heat transfer problems.	
3	Radiation Heat Transfer: Introduction to physical mechanism of radiation heat transfer. Radiation properties of materials and their wave length dependence. Planck's radiation Law. Wein's displacement law and Kirchoff's law. Formulation of radiation shape factors for different geometries Concept of radiosity. Stefan-Boltzmann law Heat exchange between non-black bodies. Design of radiation shields. Heat exchangers and their classifications and applications. Design of heat exchangers using LMTD and e-NTU methods.	10
4	Introduction Spacecraft Thermal Control: need of spacecraft thermal control –energy balance in a spacecraft – modes of heat transfer – principles of spacecraft thermal control. Devices and Hardware for Spacecraft TCS (Principles & Operation): passive thermal control - mechanical joints – heat sinks and doublers –thermal louvers and switches – heat pipes – thermal coating materials – thermal insulation – ablative heat transfer – active thermal control techniques: electrical heaters, HPR fluid systems, space borne cooling systems.	10

Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Project	Internal Exam-1	Internal Exam-2	Total
5	30	12.5	12.5	60

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 2 marks (8x2 =16 marks)	2 questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 2 sub divisions. - Each question carries 6 marks. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply heat conduction problems with temperature dependent thermal properties, heat generation and across multi-layer materials.	K3
CO2	Solve forced and free convection problems using boundary layer concepts and empirical solutions. Use of important non-dimensional parameters	K3
CO3	Solve radiation problems using basic radiation laws like Planck's law, Wein's displacement law and Kirchoff's law	K3
CO4	Summarize the unique issues that arise in high-speed aircraft and the design of cooling systems and ablative heat shields.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Heat Transfer – A Practical Approach	Yunus A. Cengel	Tata McGraw-Hill, New Delhi	2003
2	Heat and Mass Transfer	P.K. Nag	McGraw-Hill publications	3 rd edition, 2011
3	Fundamentals of Engineering Heat & Mass Transfer	S.C. Sachdeva	Wiley Eastern Ltd., New Delhi	1981

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Heat Transfer	J.P. Holman	McGraw-Hil-New York	1991	Heat Transfer
A Heat Transfer Text Book	John H. Lienhard	Prentice Hall Inc.	1981	A Heat Transfer Text Book
Heat Transfer, A Basic Approach	M. NecatiOzisik	McGraw-Hil-New York	2005	Heat Transfer, A Basic Approach

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
Module - I	Heat Transfer, Chris Long & Naser Sayma, www.bookboon.com
Module - II	NPTEL Heat Transfer course for Mechanical Engineering, http://nptel.ac.in/courses/112101097/
Module - III	NPTEL Heat Transfer course for Mechanical Engineering, http://nptel.ac.in/courses/112101097/
Module - IV	NPTEL Heat Transfer course for Mechanical Engineering, http://nptel.ac.in/courses/112101097/

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/ Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
Total		30

1. Project Planning and Proposal (5 Marks)

- Clarity and feasibility of the project plan
- Research and background understanding
- Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

- Active participation and individual contribution
- Teamwork and collaboration

4. **Execution and Implementation (10 Marks)**

- Adherence to the project timeline and milestones
- Application of theoretical knowledge and problem-solving
- Final Result

5. **Final Presentation (5 Marks)**

- Quality and clarity of the overall presentation
- Individual contribution to the presentation
- Effectiveness in answering questions

6. **Project Quality, Innovation, and Creativity (3 Marks)**

- Overall quality and technical excellence of the project
- Innovation and originality in the project
- Creativity in solutions and approaches

SEMESTER 5

WIND TUNNEL TECHNIQUES

Course Code	PEAOT521	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To understand the basic principles, the design, operation, and application procedures of subsonic and supersonic tunnels.
2. To emphasize the working principle associated with the various measuring instruments.
3. To understand the flow visualization methods for low-speed and high-speed flows

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Wind Tunnels & Principles of Model Testing: Wind Tunnels and its functional parts, non-dimensional numbers, Scale effect, Geometric, Kinematic and Dynamic similarities. Problems of Testing in subsonic, transonic, supersonic, and hypersonic speed regions - Layouts - Sizing and Design Parameters.	9
2	Calibration of Wind Tunnels: Test section speed, Horizontal buoyancy, Flow angularities, Flow uniformity & turbulence measurements, Associated instrumentation – Calibration of subsonic & supersonic tunnels	9
3	Conventional measurement techniques: Force measurements and measuring systems, Multi component internal and external balances, Pressure measurement system - Steady and Unsteady Pressure single and multiple measurements – Velocity measurements, Intrusive and Non-intrusive methods, Particle image velocimetry	9
4	Flow Visualization Techniques: Flow visualization: necessity, streamlines, streak lines, path lines, time lines, tufts, oil film, smoke, hydrogen bubble. Optical methods: density and refractive index, schlieren system, shadowgraph, Digital Particle Image Velocimetry, Laser Doppler techniques,	9

	interferometry, working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits, and applications.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the importance of non-dimensional numbers, model testing and Basics of wind tunnels and their functions.	K2
CO2	Understand the calibrations and its functions used in wind tunnels.	K2
CO3	Understand the different approaches of measurements	K2
CO4	Understand the different types Flow Visualization Techniques	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3				-	-	-	-	-	-	-	2
CO2	3	2			-	-	-	-	-	-	-	2
CO3	3	2		2	-	-	-	-	-	-	-	2
CO4	3				-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Instrumentation, measurements, and experiments in fluids,	E. Rathakrishnan	CRC press,	2007.
2	Low Speed Wind Tunnel Testing	Rae, W.H. and Pope A	John Wiley Publication	1984.

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	High Speed Wind Tunnel Testing,	Pope, A., and Goin, L.,	John Wiley Publication	1985.
2	Transonic Wind Tunnel Testing,	Goethert B H	Pergaman Press	

Video Links (NPTEL, SWAYAM)	
Module No.	Link ID
1	Online Resources: Lecture by: Prof. Prof. Job Kurian, IIT Madras https://nptel.ac.in/courses/101106040/
2	Online Resources: Lecture by: Prof. Prof. Job Kurian, IIT Madras https://nptel.ac.in/courses/101106040/
3	Online Resources: Lecture by: Prof. Prof. Job Kurian, IIT Madras https://nptel.ac.in/courses/101106040/
4	Online Resources: Lecture by: Prof. Prof. Job Kurian, IIT Madras https://nptel.ac.in/courses/101106040/

SEMESTER 5**AERO ENGINE DESIGN**

Course Code	PEAOT522	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	THERMODYNAMICS	Course Type	Theory

Course Objectives:

1. To understand the basic concepts of Aircraft Engine Design.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Thermodynamic Cycles, Aircraft Propulsion Engines: Introduction, Components and Working of Propeller engines, Turbojet engines, Turboprop and Turboshaft engines, Turbofan engines, Ramjet engines, Pulsejet engines, Scramjet engines, Comparison of Propulsion systems.	7
2	Jet Engine Compressors and Turbines: Principle and operation of centrifugal compressor and axial flow compressor– Work done and pressure rise – velocity diagrams – degree of reaction – free vortex and constant reaction designs of axial flow compressor – performance parameters axial flow compressors– stage efficiency. Principle of operation of axial flow turbines– limitations of radial flow turbines- Work done and pressure rise turbine blade cooling methods – stage efficiency calculations, Problems. Propulsion Performance Parameters	11
3	Combustion Chamber Design Types of Combustors: Can, Annular, and Can-Annular Combustion Efficiency and Flame Stabilization Heat Transfer and Cooling Techniques. Turbine Design: Turbine Types and Configurations: Axial and Radial, Turbomachinery Performance: Blade Design, Cooling, and Efficiency Stress Analysis and Structural Integrity Nozzle and Exhaust Design Nozzle, Thrust Augmentation and Performance Optimization, Exhaust Systems and Noise Reduction Techniques.	11
4	Performance Metrics and Testing Key Performance Indicators: Thrust, Power Output, and Efficiency Engine Testing Procedures: Bench Testing, Flight Testing, and Simulation Data Analysis and Interpretation Performance Prediction and Optimization Analytical Models for Performance Prediction	7

	Optimization Techniques: Design of Experiments (DoE), Balancing of engines, Compressor turbine matching, Future Trends and Innovations in Engine Performance	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the performance characteristics of different propulsion systems, including their efficiency, thrust capabilities, and ideal use cases.	K3
CO2	Solve complex problems associated with propulsion performance parameters.	K3
CO3	Understand the principles and design considerations involved in combustion chamber, turbine systems and nozzle.	K2
CO4	Understand the key concepts and procedures involved in assessing and optimizing engine performance	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Engine Design	Jack D. Mattingly, William H. Heiser, David T. Pratt	AIAA Education Series	2 nd Edition
2	Gas Turbine Theory	H.I.H. Saravanamuttoo, G.F.C. Rogers, and H. Cohen	Pearson	5 th Edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamic Design and Performance of Jet Engines	Nicholas Cumpsty	Cambridge University Press	
2	The Jet Engine		Rolls Royce Technical Publications	2005

SEMESTER 5

AIR TRANSPORTATION AND AIRLINE MANAGEMENT

Course Code	PEAOT523	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. Prepare students for advanced roles in the air transportation industry by providing them with the necessary knowledge and skills effectively manage and navigate the complexities of the field.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
I	INTRODUCTION TO AIR TRANSPORTATION History and Evolution of Air Transportation. The Air Transportation System Components of the Air Transportation System. Major Stakeholders: Airlines, Airports, Air Traffic Control, Regulatory Bodies Economic Impact of Air Transportation. International Air Law and Regulations Chicago Convention. ICAO and IATA Bilateral and Multilateral Agreements	9
2	AIRLINE OPERATIONS AND MANAGEMENT Airline Organizational Structure, Airline Business Models, Full-Service Carriers vs. Low-Cost Carriers, Regional Airlines Fleet Planning and Management, Route Planning and Network Development. Airline Scheduling and Timetable, Planning Airline Alliances and Partnerships.	7
3	AIRPORT MANAGEMENT Airport Planning and Development, Airport Operations Management, Airport Economics and Finance Revenue Sources, Cost Management Airport Security and Safety Management. Environmental Issues in Airport Management, Future Trends in Airport Management	9

4	MARKETING, FINANCE, AND STRATEGIC MANAGEMENT IN AIRLINES Airline Marketing Strategies, Market Segmentation, Pricing Strategies Promotion and Distribution Channels, Financial Management in Airlines, Revenue Management, Cost Control and Management Financial Performance. Analysis Strategic Management in Airlines, Competitive Strategies Mergers, Acquisitions Crisis Management, Recovery Customer Service, Experience Management Loyalty Programs, Customer Satisfaction and Feedback	11
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the Historical Evolution: Students will gain a comprehensive understanding of the history and evolution of air transportation, including major milestones that have shaped the industry.	K2
CO2	Understand the benefits and drawbacks of airline alliances and partnerships, including the workings of code-sharing agreements.	K2
CO3	Students will be able to discuss emerging trends in airport management and how technology is transforming operations.	K2
CO4	Apply principles of airline and airport management to real-world scenarios.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	-	-	-	2	1	1	-	2	-	-
CO2	1	-	-	-	-	2	1	1	-	2	2	-
CO3	1	-	-	-	-	1	1	1	-	2	2	-
CO4	1	-	1	-	-	2	1	1	-	2	2	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Airline Finance	Peter S. Morrell and Thomas Klein	Publisher: Routledge	4th Edition (2018)
2	Air Transportation: A Management	Perspective" by John G. Wensveen	Publisher: Routledge	Edition: 9th Edition (2019)
3	Airline Operations and Scheduling	Massoud Bazargan	Routledge	Edition: 2nd Edition 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Airport Planning and Management	Seth B. Young and Alexander T. Wells	Publisher: McGraw-Hill Education	7th Edition (2019)
2	Airline Marketing and Management	Stephen Shaw	Publisher: Routledge	Edition: 7th Edition (2011) ISBN: 978-1409401494
3	Strategic Management in the Aviation Industry	Herbert Baum and Stefan Auerbach	Publisher: Routledge	Edition: 1st Edition (2017)ISBN: 978-1472457393

SEMESTER 5

AIR TRAFFIC CONTROL AND MANAGEMENT

Course Code	PEAOT524	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs.30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To study the procedure of the formation of an aerodrome and its design and air traffic control. Future Trends and Challenges in Air Traffic management.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	BASIC CONCEPTS Objectives of air traffic control systems - Parts of ATC services – Scope and Provision of ATCs – VFR & IFR operations – Classification of ATS air spaces – Various kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control	9
2	AIR TRAFFIC SYSTEMS Area control service, assignment of cruising levels - minimum flight altitude - ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time /distance – ATC clearances – Flight plans – position report	7
3	FLIGHT INFORMATION SYSTEMS & AERODROME DATA Radar service, Basic radar terminology – Identification procedures using primary / secondary radar – performance checks – use of radar in area and approach control services – assurance control and coordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Coordination and emergency procedures – Rules of the air. Aerodrome data - Basic terminology – Aerodrome reference code – Aerodrome reference point	11

	– Aerodrome elevation – Aerodrome reference temperature – Instrument runway, physical Characteristics	
4	SAFETY AND RISK MANAGEMENT IN ATC & FUTURE TRENDS AND CHALLENGES IN ATM Safety Management Systems (SMS) in ATC Human Factors in Air Traffic Control Human Error and Error Management Controller Workload and Fatigue Risk Assessment and Mitigation Strategies Incident and Accident Investigation Crisis Management and Emergency Procedures Integration of Unmanned Aircraft Systems (UAS) into ATM Urban Air Mobility (UAM) and Airspace Management Environmental Impact and Sustainable Practices, Cybersecurity in Air Traffic Management Global Harmonization of ATM Practices	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understanding The Requirement of Air Traffic Control Systems and Types Of Air Traffic Control System.	K2
CO2	Describe the Knowledge in Flight Information Systems And Rules Of Air Traffic Systems.	K2
CO3	Explain the Knowledge In direction Indicator Systems For Air Navigation.	K2
CO4	Understanding The future trends and challenges in Air Traffic Control managements	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	"AIP (India) Vol. I & II, "The English Book Store	AIP (India) Vol. I & II, "The English Book	, "The English Book Store",	17-1, Connaught Place, New Delhi

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Manual (India) Volume I”, latest Edition – The English Book Store, latest Edition – The English Book Store, 17-1	, Connaught Place, New Delhi.	Aircraft Manual (India) Volume I”, latest Edition – The English Book Store, latest Edition – The English Book Store, 17	1, Connaught Place, New Delhi.
2	PANS – RAC – ICAO DOC 4444”,	Latest Edition, The English Book Store, 17	1, Connaught Place, New Delhi. 17	1, Connaught Place, New Delhi.
3	Safety Management Systems in Aviation Stolzer	A. J.	Halford	(2011)

SEMESTER 5

MICROPROCESSOR AND ITS APPLICATION

Course Code	PEAOT 526	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To equip students with a comprehensive understanding of microprocessors and microcontrollers, their programming and interfacing techniques, and their applications in advanced systems, particularly in the aerospace sector.
2. Foundational knowledge prepares students for more specialized roles in embedded systems and aerospace engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION TO MICROPROCESSORS History and Evolution of Microprocessors, Basic Concepts of Microprocessors, Definition and Functions of Microprocessor vs. Microcontroller, Microprocessor Architecture, ALU, Registers, Control Unit Data, Address, and Control Buses. Overview of Microprocessor Families Intel, ARM, AMD, Introduction to Assembly Language Programming.	9
2	MICROPROCESSOR PROGRAMMING AND INTERFACING Assembly, Language, Programming, Instruction Set Architecture (ISA), Addressing Modes Writing and Debugging Programs, Interfacing Concepts Memory Interfacing I/O Interfacing Interrupts and Interrupt Handling, Direct Memory Access (DMA, Peripheral Devices and Their Interfacing Keyboards, Displays, ADC/DAC	9
3	ADVANCED MICROPROCESSOR ARCHITECTURES Introduction to Advanced Microprocessors, Architecture of 32-bit and 64- bit Microprocessors, Pipelining and Superscalar, Architecture, Cache Memory and Memory Hierarchy, Introduction to Multicore Processors.	9

4	EMBEDDED SYSTEMS AND MICROCONTROLLERS IN AEROSPACE Overview of Embedded Systems in Aerospace Microcontrollers vs. Microprocessors in Aerospace Applications, Microcontroller Architecture Example: 8051, PIC, ARM Cortex, Real-Time Operating Systems (RTOS) in Aerospace, Programming Microcontrollers for Aerospace Applications	7
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Students should be able to describe Microprocessor Evolution and its Architecture	K2
CO2	Students should be apply in Assembly Language Programming and Interfacing	K3
CO3	Understanding Advanced Microprocessor Architectures	K2
CO4	Students should be apply Embedded Systems and Microcontrollers in Aerospace	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	1
CO2	3	-	-	-	-	-	-	-	-	-	-	1
CO3	3	-	-	-	-	-	-	-	-	-	-	1
CO4	3	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Microprocessors and Peripherals:	Bhurchandi, K. M., & Ray, A. K.	With ARM and an Introduction to Microcontrollers and Interfacing. McGraw-Hill Education.	2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Processor Design: Fundamentals of Superscalar Processors"	John Paul Shen and Mikko H. Lipasti	-	-
2	Embedded Systems: Real-Time Interfacing to Arm Cortex-M Microcontrollers. Platform	Valvano, J. W.	CreateSpace Independent Publishing	(2015).
3	The 8051 Microcontroller and Embedded Systems: Using Assembly and C	Muhammad Ali Mazidi, Janice Gillispie Mazidi, and Rolin McKinlay	-	-

SEMESTER 5**AIRFRAME MAINTENANCE AND REPAIR**

Course Code	PEAOT527	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To understand the inspection and maintenance practices of airframe and aircraft systems, aircraft safety practices.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Aircraft Structural Component Maintenance Welding – Equipment used in welding shops and their maintenance, ensuring quality welds, welding jigs and fixtures, Soldering and brazing. Sheet metal inspection – Selection of materials, Repair schemes, Fabrication of replacement patches, Non- Destructive Inspection, Riveted repair design, Damage investigation – Reverse technology.	9
2	Plastics and Composites in Aircraft Plastics – Types of plastics used in aircraft, Maintenance and repair of plastic components - Repair of cracks, holes etc., various repairs schemes. Composites –Maintenance and repair of composite components, Vacuum bag process. Autoclave – Operation, Safety equipment, Special precautions.	9
3	Auxiliary systems – Inspection and maintenance of Fire protection system, Ice protection system, Rain removal system, Position & warning system and Auxiliary Power Unit. Aircraft Systems - Inspection and maintenance of Hydraulic system, Pneumatic power system, Air-conditioning system, Pressurization system, Landing gear system, Aircraft brake system.	10
4	Aircraft Safety Procedures Aircraft Instruments – Installation, Maintenance, Handling, Testing and	

	Inspection. Hazardous materials – types, storage and handling, Aircraft furnishing practices - Equipment. Troubleshooting – with and without chart, Format and Intermittent discrepancies.	8
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understanding the maintenance practices of aircraft structural components.	K2
CO2	Understand the maintenance practices of plastics and composite materials	K2
CO3	Understand the maintenance practices of aircraft systems and auxiliary systems	K2
CO4	Understand the aircraft safety procedures.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	1
CO2	2	-	-	-	-	-	-	-	-	-	-	1
CO3	2	-	-	-	-	-	-	-	-	-	-	1
CO4	2	-	-	-	-	1	1	2	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Maintenance and Repair	Michael J. Kroes, Ronald Sterkenburg	McGraw Hill, New York	7th edition, 2013
2	Aviation Maintenance Technician Handbook-Airframe	Federal Aviation Administration	The English Book Store, New Delhi.	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Maintenance	Brimm D J Bogges H E	Pitman Publishing Corp, New York	
2	Aircraft Maintenance Repair	Delp, Bent and Mckinely	McGraw Hill, New York.	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/101104075
2	https://nptel.ac.in/courses/101104075
3	https://nptel.ac.in/courses/101104075
4	https://nptel.ac.in/courses/101104075

SEMESTER 5

SPACE SCIENCE & SPACE ENVIRONMENT

Course Code	PEAOT528	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:1:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. Demonstrate a comprehensive understanding of the fundamental principles of space science, including astronomy, astrophysics, and planetary science.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Astronomy: Introduction —Coordinate Systems – Time - Observable quantities - Stellar Parameters –Brightness, Luminosity - Magnitude Scale - Colour - Black Body Temperature -Size.- Distances - Spectrum - Spectral Lines - Formation of Spectral Lines - Saha's Equation—Spectral Classification—H R Diagram— Binary stars and Stellar Masses and Sizes, Solar radiation and its safety precaution for astronauts as well as electronic components.	8
2	Solar System Objects and their Exploration : Planets ,satellites of the planets and their orbits - Structure and topography of planets and their satellites - Physical and chemical characteristics- Space imagery of planets and their environment - Comets, asteroids and other minor bodied in the solar system - Their orbits, surface and composition - Comet and asteroid collisions	8
3	Introduction to earth: Elements of earth's magnetic field, difference between geographic and geomagnetic coordinates, barometric altitude formula. The terrestrial upper atmosphere: Diffusion, molecular diffusion, eddy diffusion, diffusive equilibrium, maximum diffusion velocities, thermal structure, thermosphere, exosphere. Ionosphere; solar radiation	9

	and production of ionization, Ionization profile, Ion composition and chemistry.	
4	Space weather : Interaction of the solar wind with the terrestrial magnetic field, the bow shock and the magnetopause, The magnetospheric cavity, magnetospheric current systems, The ring current, field-aligned currents, Plasma convection in the magnetosphere-models, Magnetic diffusion and magnetic reconnection, Convection electric field and high-latitude electrodynamics, Ionospheric convection velocities, aurorae, space weather, magnetic activity and substorms, magnetic storms, geomagnetic activity indices, importance and applications of space weather.	10

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic physics of astronomy.	K2
CO2	Discuss the concepts of solar systems and satellites	K2
CO3	Interpret the earth's atmospheric basics.	K2
CO4	Summarize the weather conditions and its applications	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Physics of the Space Environment	Gombosi, T. I.	Cambridge University Press	1998
2	Space Weather: Physics and Effects	Ioannis A. Daglis and Volker Bothmer	Springer	2007
3	Understanding Space Weather and the Physics Behind It	Delores J. Knipp	McGraw-Hill	2004

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Space Physics, An Introduction to Plasmas and Particles in the Heliosphere and Magnetospheres	Kellenrode, M-B	Springer	2000
2	Space Mission Engineering: The New SMAD	James R. Wertz, David F. Everett, Jeffery J. Puschell	Microcosm Press	2015

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/101/101/101101079/
2	https://nptel.ac.in/courses/115107121
3	https://nptel.ac.in/courses/115107121
4	https://nptel.ac.in/courses/115107121

SEMESTER 5
CIVIL AVIATION REGULATION

Course Code	PEAOT525	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3/5	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. To teach the civil air rules and regulations to be followed by an aircraft maintenance

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	REGULATORY FRAME WORK Role of International Civil Aviation Organization; The Aircraft Act and Rules made there under; Role of the DGCA; Relationship between CAR-21, CAR- M,CAR-145,CAR-66,CAR147;TheAircraft Rules(Applicable to Aircraft Maintenance and Release).Aeronautical Information Circulars(Applicable to Aircraft Maintenance and Release).	9
2	CARSECTION1–GENERAL: SERIES A Series A: General Policy and Procedures Adopted by DGCA: Part I-Issuance of the Civil Aviation Requirements and revisions thereof etc. - Requirements to be complied with. Part II-Definitions; Part III-Procedure for holding examinations, proficiency checks etc. for Defense personnel to fulfill the requirements for grant of civil licenses. Part IV-Regulatory Document Management System Part V-Procedure for an appeal on orders issued under Rule 3B of the Aircraft Rules, 1937.	7
3	CARSECTION2-AIRWORTHINESS: SERIES B & C Series B: Approval of Cockpit Checklist, MEL, CDL. Part I-Minimum Equipment List (MEL) Series D: Part II-Preparation and use of Cockpit and emergency checklist (Refer Section 8, Series D, Part II); Series C: Defect Recording, Monitoring, Investigation and Reporting: Part I-Defect recording, reporting, investigation, rectification and analysis.	11

4	CARSECTION2-AIRWORTHINESS: SERIES E Series E-Approval of Organizations: Part I-Approval of organization, Part VI-Approval of organization - Cat. E - Aviation Fuel, Aviation Lubricants and special products, Part VIII-Acceptance of Foreign Approved Organization (FAO) - Aircraft Type Rating, Part XI-Acceptance of Foreign Approved Maintenance Organization (FAMO); Part XII-CAR 147-Approved Maintenance Training Organization (Type Training).	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the regulatory Framework	K2
CO2	Remember Knowledge About car Section 1 – General: Series A	K1
CO3	Understand the techniques About the Car Section 1 – General: Series B & Series C	K2
CO4	Understand the techniques About the Car Section 2 - Airworthiness: Series B, C & E	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	1	-	1	-	-	-	-
CO2	2	-	-	-	-	1	-	1	-	-	-	-
CO3	2	-	-	-	-	1	-	1	-	-	-	-
CO4	2	-	-	-	-	1	-	1	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aviation Legislation",	Aircraft Tech Book Co.	EASA,"Module-10	EASA,"Module-10
2	DGCA,CARSection1: General			
3	CAR145,CARM			

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
Module-I&II	http://dgca.nic.in/rules/rule-ind.htm

SEMESTER 5**PROPULSION LAB**

Course Code	PCAOL 507	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics, Fluid Mechanics	Course Type	Practical

Course objectives:

- 1 To explore practically components of aircraft piston and gas turbine engines and their working principles.
2. To impart practical knowledge of flow through different parts of a gas turbine engine.

Experiment No.	Experiment
1.	Study of aircraft piston and its components.
2.	Study of gas turbine engines and its components.
3.	Port timing of a 2-stroke engine.
4.	Valve timing of a 4 – stroke engine
5.	Determination of Propeller Thrust and Performance
6.	Performance test on a 4-stroke engine
7.	Wall pressure measurements of subsonic diffusers.
8.	Determine Velocity profiles of wall jets.
9.	Wall pressure measurements of supersonic diffusers.
10.	Cascade testing of axial compressor blade row.
11.	Flame stabilization studies using conical and hemispherical flame holders.

12.	Cascade testing of axial Turbine blade row.
13.	Determine the velocity profiles of free jets.
14.	Wall Pressure measurements of nozzle.
15.	Determination of calorific value of a fuel.

Course Assessment Method
Course Assessment Method (CIE: -50 Marks, ESE: 50 Marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)</i>	<i>Internal Exam</i>	<i>Total</i>	<i>Attendance</i>
10	20	20	50	10

End Semester Examination Marks (ESE)

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record:*** Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- ***Endorsement by External Examiner:*** The external examiner shall endorse the record.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the practical working of components of piston and gas turbine engines employed for airplane propulsion.	K2
CO2	Analyse the performance of Inlets diffusers, Combustion Chamber and Nozzle	K4
CO3	Calculate the performance of piston engines.	K3
CO4	Analyse the flow through compressor and turbine cascades.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Gas Turbine Theory	H Cohen. G F C Rogers HIH Saravanamuthoo	Pearson	2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Elements of Propulsion: Gas Turbines and Rockets	Jack D. Mattingly	AIAA Education Series, 3rd Edition,	2006

Continuous Assessment (20 Marks)

1. Preparation and Pre-Lab Work (5 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (5 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (5 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging:** The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.*

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.

- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

Completeness, clarity, and accuracy of the lab record submitted.

SEMESTER 5**AIRCRAFT STRUCTURES LAB**

Course Code	PCAOL 508	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Practical

Course objectives:

- 1 Apply theoretical knowledge to effectively provide practical knowledge on static and dynamic analysis of aircraft structural components under different loading conditions.
To impart practical knowledge of flow through different parts of a gas turbine engine.

Experiment No.	Experiment
1	Constant Strength Beams
2	Buckling of Columns
3	Unsymmetrical Bending of Beams
4	Flexibility Matrix for Cantilever Beam
5	Combined Loading
6	Wagner Beam
7	Shear Centre Location for Open Section
8	Shear Centre Location for Closed Section
9	Vibration Damping Test- Longitudinal
10	Vibration Damping Test- Torsional
11	Stress-Strain measurement on Pressurized thin-walled tubes of various materials using strain gauges
12	Stress-Strain measurement on flat plate and cylindrical rod with axial loads using strain gauges

13	Stress-Strain measurement on hollow cylindrical rod with torsional load using strain gauges
14	Stress-Strain measurement using strain rosette – Star and Delta connected
15	Verification of stress optic law using photoelasticity.

Course Assessment Method

Course Assessment Method (CIE: -50 Marks, ESE: 50 Marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)</i>	<i>Internal Exam</i>	<i>Total</i>	<i>Attendance</i>
10	20	20	50	10

End Semester Examination Marks (ESE)

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- ***Submission of Record:*** Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- ***Endorsement by External Examiner:*** The external examiner shall endorse the record.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Evaluate the buckling and bending strength of different structural members.	K4
CO2	Analyse the shear centre position for open and closed section of beams	K4
CO3	Evaluate the natural frequency for longitudinal and torsional vibration of different structural components.	K4
CO4	Evaluate the stress-strain values for different structural components	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Structures for Engineering students	Megson T M G	Elsevier	2007
2	Mechanics of Materials	Timoshenko and Gere	Tata McGraw Hill	1993
3	Mechanical Vibrations	Grover. G.K	Nem Chand Brothers, Roorkee,	2003
4	Experimental Stress Analysis	Sadhu Singh	Khanna Publishers, New Delhi,	2009

Continuous Assessment (20 Marks)

1. Preparation and Pre-Lab Work (5 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (5 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (5 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging:** The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.*

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.

- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 6

AERONAUTICAL ENGINEERING

SEMESTER S6

ROCKETRY AND ROCKET PROPULSION

Course Code	PCAOT601	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. Understand the working of different types of rocket engines used for space transportation.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Principles of operation of rocket motor – Thrust equation, one dimensional and two-dimensional rocket motion in free space and homogeneous gravitational field, description of vertical, inclined and gravity turn trajectories determinations of range and altitude, simple approximation to burnout velocity, need for multi staging of rocket vehicle, multistage vehicle optimization (Numerical problems)	11
2	Stage separation dynamics and separation techniques, aerodynamic jet control methods of rocket vehicles, description of various loads experienced by a rocket passing through atmosphere, drag estimation- wave drag, skin friction drag, form drag and base pressure drag, boat tailing in missiles- performance at various altitudes, rocket dispersion-launching problems	11
3	Solid propellant rocket motor-General features, solid propellants and its chemical compositions desirable properties and its demerits, combustion of solid propellant, erosive burning, combustion instability. Liquid propellant rocket engines, liquid propellants, selection of liquid propellants, pressure and turbo pump feed system, ignition of propellants, cooling system, injectors for liquid propellant rockets Combustion instability in liquid propellant rockets.	11

4	Hybrid rocket engines, inverse hybrid rocket engines, comparisons, and its limitations. Other non-air breath propulsion systems: - Nuclear rockets, electric rocket engines, electro thermal propulsion, electrostatic propulsion, solar thermal rocket, solar sail,	11
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the principles of rocket motion under gravitational field	K3
CO2	Apply the principles of system of rocket motion under gravitational field	K3
CO3	Describe the salient features of Solid propellant and liquid propellants rockets, propellants, and combustion characteristics.	K2
CO4	Understand the working of different types of non-conventional type of propulsion systems such as Hybrid propellant rockets, nuclear propulsion, electric propulsion and solar sail	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Rocket Propulsion and Spaceflight Dynamics	J. W. Cornelisse, H. F. R. Schöyer, K. F. Wakker	Cambridge University Press	04 July 2016
2	Rocket Propulsion Elements	George P Sutton	WILEY	NINTH
3	Mechanics and Thermodynamics of Propulsion	Philip Hill and Carl Peterson	PEARSON	SIXTH

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Compressible Flow	Anderson, J. D	Mc Graw Hill Education	4th edition & 2003

SEMESTER S6

COMPUTATIONAL AERODYNAMICS

Course Code	PCAOT602	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	AERODYNAMICS HGH SPEED AERODYNAMICS	Course Type	Theory

Course objectives:

1. To develop the engineering skills required for the students to become intelligent users of aerodynamic simulation codes.
2. To familiarise the students with the key numerical methods utilised for solving the governing equations of fluid dynamics for aerodynamic design.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Governing equations and boundary conditions: Basics of computational fluid dynamics, Governing equations of fluid dynamics (Conservation and Non-Conservation forms), Continuity, Momentum and Energy equations, Physical boundary conditions, Different CFD Methods: Numerical source, panel method of non-lifting flows over arbitrary bodies, Vortex panel method of lifting flows over arbitrary bodies, Mathematical behaviour of PDEs on CFD, Elliptic, Parabolic and Hyperbolic equations. Introduction to Numerical Methods – Properties of Numerical Solutions: Errors, Consistency, Accuracy, Stability, Convergence.	11
2	Stability properties of computational techniques, finite difference scheme for parabolic and hyperbolic differential equation: Concepts of numerical dissipation, numerical dispersion, Stability property of different CFD methods, Lax equivalence theorem, Von Neumann Stability Analysis, CFL Criterion for Stability. Finite difference scheme for heat conduction equation: FTCS scheme, Crank Nicholson Implicit scheme and convergence and stability property of above scheme, Dissipative and dispersive error stability of crank Nicholson scheme. Euler equation of inviscid and	11

	incompressible flow. Lax Wendroff technique, its limitations, McCormack's technique. Dissipative and dispersive error stability property Pressure correction technique application to incompressible viscous flow incompressible Navier stokes equation – central differencing of above equations – transformation and Grid co-ordinate transformation - Jacobian transformation - need for a staggered grid.	
3	Finite difference scheme for elliptical differential equation and finite volume techniques: Laplace's equation in two dimensions, Numerical difference method. Iterative method for solution of linear algebraic system, Jacobi, and the Gauss- Seidel. Scheme convergence of above method. Condition for stability. Introduction to Finite volume techniques Two dimensional problems – Node centred control volume, cell centred control volume approaches. Three dimensional problems -3-D geometry of data structure, cell centred average scheme, three dimensional FVM equations Lax Vendroff time stepping, Runge kutta time stepping, Multistage time stepping.	13
4	Turbulence models and mesh generation: Introduction to turbulence and its mathematical models. Numerical software for flow simulation and their applications. Steps involved in solving aerodynamic problems. Grid generation and types of grids and their relative merits/ Verification and validation of flow simulation softwares.	7

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply fundamental conservation equations of fluid mechanics.	K3
CO2	Apply Finite difference scheme to discretize the fundamental governing equations.	K3
CO3	Apply the finite volume methods for Navier-Stokes equations on different type of grids and time integration methods for solution of flow equations	K3
CO4	Become conversant with different steps involved in getting numerical solutions of flow problems. Use of commercially available software and their verification and validation for practical problems.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computational Fluid Dynamics	John D Anderson	Mc Graw Hill Education	1995
2	Computational Fluid Dynamics	John F Wendt	Mc Graw Hill Education	5 th edition and 2008
3	Computational Fluid Dynamics (Vol. I & II)	– Hoffmann, K.A. and Chiang, S.T.	Engineering education system	4 th edition and 2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Computational Methods for Fluid Dynamics	J.H.Feriger,M.Peric	Springer	3 rd edition & 2002
2	An introduction to Computational Fluid Dynamics	H K Versteeg & W Malalasekera	Pearson Private limited	2 nd edition & 2002

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1 – 4	https://youtube.com/playlist?list=PLaDq_DX7U7V91gf-LrGdx0Yg68KW1Xljq&si=7_JtlryeCEZcv0Vg

SEMESTER 6

ACTUATORS AND CONTROLS IN AIRCRAFT

Course Code	PEAOT631	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. To impart knowledge of the hydraulic and pneumatic systems components and types.
2. Describe various types of air cycle systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fluid Power Systems: Introduction to oil hydraulics and pneumatics, their structure, advantages, and limitations. Properties of fluids, Fluids for hydraulic systems, governing laws. Distribution of fluid power, ISO symbols, energy losses in hydraulic systems. Applications, Basic types and constructions of Hydraulic pumps and motors. Pump and motor analysis.	9
2	HYDRAULIC ACTUATORS. Types and constructional details, lever systems, control elements. Direction, pressure and flow control valves. Proportional control valves and servo valves. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities).	9
3	DESIGN AND ANALYSIS OF TYPICAL HYDRAULIC CIRCUITS. Regenerative circuits, high low circuits, Synchronization circuits, and accumulator sizing. Intensifier circuits Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits, accessories used in fluid power systems. Filtration systems and maintenance of systems. Valve configurations. General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve Analysis and Design.	9
4	AIR CYCLE SYSTEMS – vapour cycle systems, boot-strap air cycle systems, Evaporative vapour cycle systems – evaporation air cycle systems Oxygen systems – fire protection systems, Deicing and anti-icing systems.	9

	Flight instruments and navigation instruments - Accelerometers, air speed indicators – Mach meters – altimeters - gyroscopic instruments– principles and operation. Study of various types of engine instruments – tachometers – temperature gauges – pressure gauge – operation and principles.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept of hydraulic and pneumatic systems	K2
CO2	Describe the principle and working of hydraulic actuators.	K2
CO3	Understand the concept of typical hydraulic circuits	K2
CO4	Understand the concept of air cycle systems and engine instruments	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	1
CO2	3	-	-	-	-	-	-	-	-	-	-	1
CO3	3	-	-	-	-	-	-	-	-	-	-	1
CO4	3	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Power Plants.	Mckinley, J.L. and R.D. Bent,	McGraw Hill 1993.	McGraw Hill 1993.
2	Aircraft Instruments & Principles	Pallet	E.H.J	Pitman & Co 1993.

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Handbooks of Airframe and Power plant Mechanics,	US dept. of Transportation, Federal Aviation Administration,	The English Book Store,	New Delhi, 1995
2	Gas Turbine Technology	Treager, S.,	McGraw Hill 1997.	1997
3	Aircraft Maintenance & Repair.	Mckinley, J.L. and Bent R.D.	McGraw Hill,	1993.

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1 – 2	https://onlinecourses.nptel.ac.in/noc24_ae05/preview

SEMESTER 6

ADVANCED DYNAMICS AND CONTROL

Course Code	PEAOT632	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Mins.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. Understand the state space representation of linear continuous time systems and state transition matrices.
2. Analyze electrical circuits and servo motors using state space methods.
3. Analyze stability of nonlinear systems and discrete-time control systems

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to State Space and State Model Concepts State Equation of Linear Continuous Time Systems, Matrix Representation and Features, Examples: Electrical Circuits and DC Servomotors, Phase Variable Forms of State Representation, Diagonal Canonical Forms and Similarity Transformations	9
2	State Transition Matrix and Transfer Functions Properties and Computation of State Transition Matrix-Using Laplace Transform, Cayley Hamilton Method, Derivation of Transfer Functions from State Equations, Solution of Time Invariant Systems, Time Response of Autonomous Systems, Time Response of Forced Systems	9
3	Discrete-Time Control Systems State Space Analysis of Discrete-Time Control Systems, Phase Variable Form and Diagonal Canonical Form Representations, Pulse Transfer Function from State Matrix, Computation of State Transition Matrix (for 2nd Order Systems), Controllability and Observability, Kalman's, Gilbert's, and PBH Tests, Duality Principle	9
4	Advanced Control Systems and Nonlinear Dynamics State Feedback Controller Design, Pole Placement Technique, State Observers for LTI Systems, Types and Design of Full Order Observer, Nonlinear Systems: Types and Characteristics, Jump Resonance, Limit Cycles,	9

	Frequency Entrainment, Describing Function Method, Harmonic Linearization, Stability Analysis of Autonomous Systems (Relay, Dead Zone, Saturation), Phase Plots and Stability, Concepts, Singular Points, Classification, Lyapunov Stability Analysis, Lyapunov Function, Application to Nonlinear Systems and LTI Continuous Time Systems	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the state space representation of linear continuous time systems.	K2
CO2	Understand state transition matrices using different methods.	K2
CO3	Explain discrete-time control systems using state space methods	K2
CO4	Understand the stability of nonlinear systems using describing functions and Lyapunov methods.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2
CO4	3	-	-	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Modern Control Engineering	Katsuhiko Ogata	Pearson	5 th Edition, 22 nd October 2009
2	Nonlinear Systems	Hassan K. Khalil	Pearson	3 rd Edition, 11 th January 2002

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Feedback Systems: An Introduction for Scientists and Engineers	Karl Johan Åström, Richard M. Murray	Princeton University Pr	01 st April 2008
2	Feedback Control of Dynamic Systems	Gene Franklin, J. Da Powell, Abbas Emami-Naeini	Pearson	6 th Edition

SEMESTER 6

FATIGUE AND FRACTURE MECHANICS

Course Code	PEAOT633	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Mechanics of Materials	Course Type	Theory

Course objectives:

1. Understand about the fundamental source of failure of mechanical components.
2. Understand the fatigue design curve approaches and limitations.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	FATIGUE OF STRUCTURES: S.N. curves - Endurance limits - 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 – Fatigue of composite materials.	9
2	PHYSICAL AND STATISTICAL ASPECTS OF FATIGUE: Phases in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces. 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 -. Life Estimation	9
3	FRACTURE MECHANICS: Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - stress analysis of cracked bodies - Effect of thickness on fracture toughness - stress intensity factors for typical Geometries. Importance of Fracture Mechanics in aerospace structures Application to composite materials and structures.	10
4	FATIGUE DESIGN AND TESTING: Safe life and Fail-safe design philosophies, Crack Arrest / Repair Methodologies, Fracture Toughness Testing, Failure Assessment Diagram	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the causes for the fatigue failure of the materials.	K2
CO2	Apply the causes of the crack initiation & its growth.	K3
CO3	Apply the mathematical knowledge to define fatigue behaviours of the materials	K3
CO4	Understand the fracture due to fatigue	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Elements of Fracture Mechanics	Prasanth Kumar	Wheeter publication	1999
2	Fracture Mechanics – Fundamentals & Applications	Barrois W, Ripely, E. L	CRC press	Third edition, 2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Advanced Fracture Mechanics	M.F.Kanninen and C.H.Popelar	Oxford press	1985
2	Elementary Engineering Fracture Mechanics	D.Broek	Martinus Nijhoff publishers	1982

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc22_mm42
2	https://onlinecourses.nptel.ac.in/noc22_mm42
3	https://onlinecourses.nptel.ac.in/noc22_mm42
4	https://onlinecourses.nptel.ac.in/noc22_mm42

SEMESTER 6

HIGH TEMPERATURE MATERIALS

Course Code	PEAOT634	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. Understand the Heat Treatment processes of aircraft metals and alloys
2. Characteristics and Applications of Aluminium alloys, Ceramics, Composites and High Temperature Materials

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Thermal Behaviour of Engineering Materials Creep: Factors influencing functional life of components at elevated temperatures. Definition of creep curve. Various stages of creep, metallurgical factors influencing various stages. Effect of stress, temperatures, and strain rate. Design for Creep resistance: Design of transient creep time, hardening, strain hardening. Expressions of rupture life of creep. Ductile and brittle materials. Monkman-Grant relationship.	9
2	Fracture: Various types of fracture, brittle to ductile from low temperature to high temperature. Cleavage fracture due to micro void coalescence. Diffusion controlled void growth; fracture maps for different alloys and oxides	9
3	Oxidation and Hot corrosion: Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation. Defect structure and control of Oxidation by alloy additions, hot gas corrosion deposit. Modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep. Methods of combat hot corrosion.	9
4	Temperature driven Materials Characterization: Classification, production and characteristics, Methods and testing, Determination of mechanical and thermal properties of materials at elevated temperatures, Application of these materials in Thermal protection systems of Aerospace vehicles, High temperature material characterization	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concept of creep and design of creep resistance at elevated temperature.	K2
CO2	Understand the fracture of mechanism at elevated temperature.	K2
CO3	Understand the oxidation and hot corrosion.	K2
CO4	Understand the characterization of materials driven by temperature	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	-	-	-	-	-	-	-	-	-	-	2
CO3	3	-	-	-	-	-	-	-	-	-	-	2
CO4	3	-	-	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flow and Fracture at Elevated Temperature	Raf. R	American Society for Metals, USA	1985
2	Deformation and Fracture Mechanics of Engineering materials	Hertzberg R.W	John Wiley, USA	4 th edition, 1996
3	Mechanical Behaviour of Materials	Courtney T .H	McGraw-Hill	1990

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Directionally Solidified Materials for High Temperature Service	McLean D	The Metals Society, USA	1985
2	Stress Analysis for Creep	Boyle J.T, Spencer J	Butterworths, UK	1983
3	Creep and Fatigue in High Temperature Alloys	Bressers.J	Applied Science	1981

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/113105081
2	https://nptel.ac.in/courses/113105081
3	https://nptel.ac.in/courses/113105081
4	https://nptel.ac.in/courses/113105081

SEMESTER 6

EXPERIMENTAL AERODYNAMICS

Course Code	PEAOT636	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Aerodynamics, High speed Aerodynamics	Course Type	Theory

Course objectives:

1. Estimate energy ratios and power requirements in low-speed wind tunnels evaluation of Aerodynamic Forces.
2. Measure and estimation of Flow Characteristics
3. Analyze boundary layer effects, determine velocity profiles, calculate drag coefficients
4. Understand and apply various flow visualization techniques

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Subsonic and supersonic wind tunnel: - Low speed wind tunnels - Estimation of energy ratio and power required supersonic wind tunnels - Calculation of running time and storage tank requirements- Shock tunnel. Pressure and velocity distributions: - Calculation of CL and CD on aerofoils from pressure distribution - CD from wake survey - Span wise load distribution for different taper ratios of wing.	9
2	Pressure, velocity and temperature measurements: - Mach number estimation in test section by pressure measurement and using a wedge - Hot wire anemometer and laser Doppler anemometer for turbulence and velocity measurements - Use of thermocouples and pyrometers for measurement of static and total temperatures - Use of pressure transducers, Rotameters, and ultrasonic flow meters.	9
3	Boundary layer effects and heating problems: - Pitot-static tube correction for subsonic and supersonic Mach numbers - Boundary layer effects -Velocity profile on a flat plate by momentum integral method - Calculation of CD from wall shear stress - Heating requirements in hypersonic wind tunnels - Re-entry problems	9

4	Flow Visualization and its advancements Principles of Flow Visualization – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph. Theories of -Digital particle image velocimetry (DPIV), Tomographic particle image velocimetry (TOMO-PIV), advanced computational flow visualization, 3d flow visualization using holography, volumetric velocimetry, flow visualization in multiphase flows	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the behaviour of subsonic and supersonic wind tunnels. Understand the lift and drag coefficient calculation for pressure and velocity distributions	K2
CO2	Understand the various velocity, pressure, and temperature measurement techniques.	K2
CO3	Understand the boundary layer effects and heating problems	K2
CO4	Understand the various flow visualization techniques and its advancement.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	High speed wind tunnel testing	Pope. A and Goin. L	John Wiley	1985
2	Low speed wind tunnel testing"	Rae W.H and Pope. A	John Wiley Publication	1984
3	Instrumentation, Measurement and Experiments in Fluids	Rathakrishnan. E	CRC Press, London,	2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Experimental Fluid Mechanics	Bradsaw	Oxford	1977
2	Supersonic Aerodynamics	Edward R. C. Miles	Dover, New York	1957
3	Lecture course on Advanced Flow Diagnostic Techniques 17	NAL, Bangalore.		19 September 2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/101/105/101105088/
2	https://archive.nptel.ac.in/courses/101/105/101105088/
3	https://archive.nptel.ac.in/courses/101/105/101105088/
4	https://archive.nptel.ac.in/courses/101/105/101105088/

SEMESTER 6

PRECISION ENGINEERING

Course Code	PEAOT637	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. Understand the BIS code fits and tolerances for geometrical dimensioning and tolerance.
2. Describe the primary applications for various instruments for measurement.
3. Summarize the application of latest manufacturing techniques (nano).

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Accuracy and Alignment Tests: General concept of accuracy, spindle rotation accuracy, test methods, displacement accuracy, dimensional wear of cutting tools, accuracy of NC systems, clamping errors, setting errors, location of rectangular prism, cylinder, basic type of tests, measuring instruments used for testing machine tools, alignment tests, straightness, flatness, parallelism, squareness, circularity, cylindricity.	9
2	Lithography: Photolithography, electron beam lithography, Ion Beam lithography, Deep UV lithography, Optical lithography, LIGA process, dip pen lithography. MEMS – Principle – Elements – Characteristics – Applications.	9
3	Precision machining: Concepts and Significance, Classification – Top down, bottom-up approaches, Precision, and micromachining: – Machining of micro-sized components, Ultra precision grinding, mirror grinding of ceramics.	9
4	Nano Measuring Systems: In-process measurement of position of processing point, post process and online measurement of dimensional features, mechanical measuring systems, optical measuring systems, electron beam measuring systems, pattern recognition and inspection systems.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the principles and methods used to assess accuracy and alignment in machine tools.	K2
CO2	Describe various lithography techniques.	K2
CO3	Explain the concepts and significance of precision machining.	K2
CO4	Understand nano measuring systems utilized in manufacturing, including their applications	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	1
CO4	3	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Precision Engineering in Manufacturing	Murthy R. L	New Age International, New Delhi	2005
2	Precision Manufacturing	David A. Dornfeld, Dae-Eun Lee	Springer-Verlag New York Inc.	2010
3	Micro Sensors, MEMS, and Smart Devices	Julir W. Gardner, Vijay K. Varadan	John Wiley and Sons	2001

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	MEMS Handbook		CRC Press	2001
2	The Science and Engineering of Microelectronic Fabrication	Stephen A. Campbell	Oxford University Press	1996
3				

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
3	https://nptel.ac.in/courses/112105231

SEMESTER 6

AIRCRAFT PRODUCTION TECHNOLOGY

Course Code	PEAOT638	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. Gain knowledge pertaining to different casting, welding and machining processes involved in manufacturing.
2. Acquire knowledge regarding different types of material processing and heat treatments.
3. Understand the different types of tools, equipment and inspection techniques used in the aircraft industry.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Casting and Welding Techniques Various moulding processes employed in aircraft industry, Types of patterns, Casting Process involved in Sand casting, die-casting, centrifugal casting, investment casting and shell moulding. Working Principles and equipment used in arc welding, gas welding, resistance welding, Laser welding, Soldering and brazing techniques.	9
2	Conventional Machining, Unconventional Machining General Principles (with schematic diagram only) of working and types-lathe, shaper, milling machines, grinding, drilling m/c, CNC machining. Principles of working and applications of abrasive jet machining, ultrasonic machining, electric discharge machining, electro chemical machining, laser beam, electron beam and plasma arc machining. Sheet metal operations - shearing, punching, super plastic forming and diffusion bonding. Bending, Automation in bend forming and different operations in bending like stretch forming, spinning, drawing etc.	11

3	Heat Treatment and Surface Finishing Heat treatment of Aluminium alloys, titanium alloys, steels, case hardening. Corrosion prevention, protective treatment for aluminium alloys, steels, anodizing of titanium alloys, organic coating, and thermal spray coatings.	8
4	Jigs & Fixtures Jigs, fixtures, stages of assembly, types and equipment for riveted joints, bolted joints (only). Aircraft Tooling Concepts. - Types of tools used in A/C industry. NDT and Other Inspection Techniques Comparison of NDT & DT, process involved in Dye Penetrate Test, X-ray, and magnetic particle and ultrasonic testing, thermography and infra-red testing, acoustic emission testing.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
● 2 Questions from each module. ● Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	● Each question carries 9 marks. ● Two questions will be given from each module, out of which 1 question should be answered. ● Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the different casting and welding processes involved in manufacturing.	K2
CO2	Understand the principles of conventional and unconventional machining processes along with the forming techniques in manufacturing industry	K2
CO3	Explain about various heat treatment techniques and corrosion prevention methods in various alloys.	K2
CO4	Discuss aircraft tooling concepts and also the importance of NDT in the Aircraft Industry.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Manufacturing Engineering and Technology	Kalpakjianserope	Pearson Education	5th edition, 2011
2	Production technology	R.K. Jain	Khanna Publishers	2002

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft production techniques	Keshu S.C, Ganapathy K.K.	Interline Publishing House	1993
2	Production technology	O.P.Khanna and Lal.	M.Dhanpatrai publications	1997

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/104/112104304/

SEMESTER 6

VIBRATION AND AEROELASTICITY

Course Code	PEAOT 635	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Mechanics, Mechanics of Aircraft Materials, Aircraft Structures I & Aircraft Structures II	Course Type	Theory

Course objectives:

- Understand the principles governing vibration and aeroelasticity in Aerospace structures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Single Degree of Freedom Systems: Vibration Terminologies – Simple Harmonic Motion, Newton’s Law – D’Alembert’s Principle – Spring Combination – Energy Method – Rayleigh’s Method – Simple and Compound Pendulum – Longitudinal, Transverse and Torsional Vibrations, Damped Vibrations – Types – Differential Equations – Logarithmic Decrement, Forced Vibrations – With and Without Damping – Support Excitation – Vibration Isolation – Transmissibility – Vibration Measuring Instrument.	11
2	Several Degrees of Freedom Systems: Two Degrees of Freedom Systems – Coordinate Coupling – Principal Coordinates – Principal Modes – Vibration Absorber, Multi Degrees of Freedom Systems – Orthogonality Principle – Hamilton’s Principle. Vibrations of Plates: Vibrations of Rectangular Plates, Vibrations of Circular Plates	9
3	Approximate Methods: Rayleigh’s Method – Dunkley’s Method – Holzer’s Method – Stodola Method – Matrix Method – Matrix Iteration Method. Continuous Systems: Vibration of Strings – Longitudinal Vibration of Bars – Lateral Vibration of Beams – Torsional Vibration of Shafts	9
4	Aeroelasticity: Static Aeroelasticity, Dynamic Aeroelasticity Concepts – Coupling – Collar’s Triangle – Aero Elastic Instabilities and their	7

	Prevention – Wing Divergence – Loss and Reversal of Aileron Control – Flutter and its Prevention, Flutter of a Cantilever Wing.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Solve equations of motion for undamped one-dimensional vibrations.	K3
CO2	Apply principles associated with vibrations of systems having more than one Degree of Freedom(s).	K3
CO3	Apply different methods to solve continuous systems to minimize vibration.	K3
CO4	Understand the aeroelastic instabilities and the methods of prevention	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanical Vibrations	V. P Singh	Dhanpat Rai & Co (P) Ltd	2014
2	Principles of Aeroelasticity	Rama B Bhat	CRC Press	2016
3	Mechanical Vibrations	G.K. Grover	Nem Chand & Bros	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Principles of Vibration	Tongue. B. H.	Oxford University Press	2000
2	An Introduction to the Theory of Aeroelasticity	Fung Y.C.	John Wiley & Sons, New York	2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://onlinecourses.nptel.ac.in/noc24_me85/preview
2	https://onlinecourses.nptel.ac.in/noc21_me42/preview , https://www.youtube.com/watch?v=bCWidtRmPQ8
3	https://onlinecourses.nptel.ac.in/noc21_me42/preview
4	https://nptel.ac.in/courses/101104005

SEMESTER S6**FINITE ELEMENT METHOD**

Course Code	PBAOT604	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:1:0:0	ESE Marks	60
Credits	4	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Aircraft Structures I & II	Course Type	Theory

Course objectives:

1. To understand the basic steps of finite element methods, types of elements, its characteristics, and applications in commercial softwares.
2. To apply the finite element techniques in One dimensional, Two dimensional and three dimensional static and dynamic structural and heat conduction problems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Finite Element Methods-Areas of Application-General steps in Finite Element Methods- Geometric modelling techniques. Derivation of the stiffness matrix using displacement technique- Spring, Bar, and truss elements – Assembly of global stiffness matrix, boundary conditions. Development of Euler beam equations- Finite element formulations.	11
2	Coordinate transformation- Global and local coordinate system, Interpolation functions for general element formulation. Stiffness Matrix of Isoparametric Elements. Patch test, Mesh convergence – Basic concept only. Different type of refinements (h, p and r). Rayleigh's- Ritz Method (Variational method) and weighted residual method. Numerical integration using Gaussian quadrature.	11
3	Development of the Plane Stress and Plane Strain Stiffness Equations: - Development of the CST, Linear-Strain Triangle (Shape functions and equations only), Galerkin weighted residual Techniques, Types of Boundary conditions (Neumann, Dirichlet and Robin)	11
4	Introduction to plate bending– finite element analysis of thin plate – finite element analysis of thick plate –	11

	Structural Dynamics, Mass matrix computation, Evaluation of eigen values and eigen vectors, Transient analysis: Euler's method, Central difference technique, Critical time step, Rigid body modes.	
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Course Assessment Method
(CIE: 60 marks, ESE: 40 marks)

Continuous Internal Evaluation Marks (CIE):

<i>Attendance</i>	<i>Project</i>	<i>Internal Ex-1</i>	<i>Internal Ex-2</i>	<i>Total</i>
5	30	12.5	12.5	60

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x2 =16 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x6 = 24 marks)	40

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the basic principles, concepts, applications of Finite Element Methods	K2
CO2	Apply the mathematical formulations of finite element techniques, to derive and implement shape functions for One dimensional and two-dimensional problems.	K3
CO3	Analyze structural mechanics problems using Finite elements techniques for trusses, beams, frames, and Plate elements.	K4
CO4	Perform dynamic analysis of structures, including time-dependent problems, vibration analysis, and Transient analysis using finite element techniques.	K4
CO5	Develop solution techniques for beam, truss, plate elements using commercial softwares/MATLAB	K5

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Finite Element Method Its Basis and Fundamentals	Olek C Zienkiewicz, Robert L. Taylor, Sanjay Govindjee	Elsevier Science	2024
2	Textbook of finite element analysis	P. Seshu	PHI Learning	2004
3	Finite Element Method with Applications in Engineering	Y. M. Desai	Dorling Kindersley	2011
4	Introduction to Finite Elements in Engineering	Tirupathi R. Chandrupatla, Ashok D. Belegundu	Pearson Education	5 th edition 2021
5	A First Course in the Finite Element Method	Daryl L. Logan	Cengage Learning	2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	The Finite Element Method Using MATLAB	Young W. Kwon, Hyochoong Bang	CRC Press	2018
2	Introduction to Finite Element Analysis Using MATLAB® and Abaqus	Amar Khennane	Taylor & Francis	2013
3	An introduction to the finite element method	J N Reddy	McGraw-Hill Education	2006

4	Fundamental and Advanced Finite Element Analysis and Applications: with Mathematica and MATLAB Computations	M. Asghar Bhatti	Wiley	2005
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Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1 – 4	https://archive.nptel.ac.in/courses/112/105/112105308/

PBL Course Elements

L: Lecture (3 Hrs.)	R: Project (1 Hr.), 2 Faculty Members		
	Tutorial	Practical	Presentation
Lecture delivery	Project identification	Simulation/ Laboratory Work/ Workshops	Presentation (Progress and Final Presentations)
Group discussion	Project Analysis	Data Collection	Evaluation
Question answer Sessions/Brainstorming Sessions	Analytical thinking and self-learning	Testing	Project Milestone Reviews, Feedback, Project reformation (If required)
Guest Speakers (Industry Experts)	Case Study/ Field Survey Report	Prototyping	Poster Presentation/ Video Presentation: Students present their results in a 2 to 5 minutes video

Assessment and Evaluation for Project Activity

Sl. No	Evaluation for	Allotted Marks
1	Project Planning and Proposal	5
2	Contribution in Progress Presentations and Question Answer Sessions	4
3	Involvement in the project work and Team Work	3
4	Execution and Implementation	10
5	Final Presentations	5
6	Project Quality, Innovation and Creativity	3
	Total	30

1. Project Planning and Proposal (5 Marks)

1. Clarity and feasibility of the project plan
2. Research and background understanding
3. Defined objectives and methodology

2. Contribution in Progress Presentation and Question Answer Sessions (4 Marks)

- Individual contribution to the presentation
- Effectiveness in answering questions and handling feedback

3. Involvement in the Project Work and Team Work (3 Marks)

1. Active participation and individual contribution
2. Teamwork and collaboration

4. Execution and Implementation (10 Marks)

1. Adherence to the project timeline and milestones
2. Application of theoretical knowledge and problem-solving
3. Final Result

5. Final Presentation (5 Marks)

1. Quality and clarity of the overall presentation
2. Individual contribution to the presentation
3. Effectiveness in answering questions

6. Project Quality, Innovation, and Creativity (3 Marks)

1. Overall quality and technical excellence of the project
2. Innovation and originality in the project
3. Creativity in solutions and approaches

SEMESTER 6

DESIGN THINKING AND PRODUCT DEVELOPMENT

(Common to Group C & Group D)

Course Code	GZEST605	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	60
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To guide students through the iterative stages of design thinking, including empathizing with users, defining problems, ideating solutions and developing Proof of Concepts (PoC) and technical feasibility studies.
2. To promote the development of critical thinking skills by engaging students in integrative inquiry, where they ask meaningful questions that connect classroom knowledge with real-world applications.
3. To equip students with the ability to involve in product design considering the sustainability, inclusivity, diversity and equity aspects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of design thinking and product development: Overview of stages of product development lifecycle; Design thinking -Definition-Design thinking for product innovation; Bringing social impact in ideation-Identifying societal needs-understanding multi-faceted issues-community engagement and empathetic design- technological innovation meeting societal needs; Understanding and Bridging the divide using Human Centered Design (HCD); Designing for inclusivity in product development-embracing user diversity - Long term impact - sustainability encompassing environmental,economic and social dimensions; Technology Readiness Level in the Innovation Life-cycle; Performing a self-check on innovative ideas - Originality of idea-understanding innovation landscape - patentability - understanding the economic landscape - Unique Selling Proposition (USP) - Repeatability and	6

	Manufacturability - Sustainability - Leveraging business models for comprehensive analysis	
2	Empathize: Design thinking phases; Role of empathy in design thinking; Methods of empathize phase - Ask 5 Why/ 5 W+H questions; Empathy maps - Things to be done prior to empathy mapping - Activities during and after the session; Understanding empathy tools - Customer Journey Map - Personas. Define: Methods of Define Phase: Storytelling, Critical items diagrams, Define success.	6
3	Ideation : Stages of ideation; Techniques and tools - Divergent thinking tools - Convergent thinking tools - Idea capturing tools; Cross-industry inspiration; Role of research in ideation - Market research - consumer research - leveraging research for informed ideation; Technological trends - navigating the technological landscape - Integrating emerging technologies; Feasibility studies - technical, economic, market, operational, legal, and ethical feasibility; Ideation session- techniques and tips. Proof of Concept (PoC) : Setting objectives; Risk assessment; Technology scouting; Document and process management; Change management; Knowledge Capture; Validating PoC; Story telling in PoC presentation	6
4	Design: Navigating from PoC to detailed design; Developing Specification Requirement Document (SRD); Design for manufacturability; Design to cost; Pre-compliance; Design Failure Mode and Effects Analysis (DFMEA); Forecasting future design changes. Prototyping: Alpha prototypes; Beta prototypes; Transition from design to prototype; Goals and expectations for Alpha and Beta prototypes; Effective strategies for maintaining timeline in prototyping; Testing and refining Alpha prototypes; Transitioning to Beta prototypes. Pilot build: Definition and purpose of a pilot build; setting objectives; Identification and selection of manufacturing partner for pilot build; Testing procedures in pilot build; Scaling from pilot build to full-scale production / implementation.	6

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Empathize to capture the user needs and define the objectives with due consideration of various aspects including inclusivity, diversity and equity	K5
CO2	Ideate using divergent and convergent thinking to arrive at innovative ideas keeping in mind the sustainability, inclusivity, diversity and equity aspects.	K6
CO3	Engage in Human Centric Design of innovative products meeting the specifications	K5
CO4	Develop Proof of Concepts (PoC), prototypes & pilot build of products and test their performance with respect to the Specification Requirement Document.	K4
CO5	Reflect on professional and personal growth through the learnings in the course, identifying areas for further development	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Product Sense: Engineering your ideas into reality	Dr. K R Suresh Nair	NotionPress.com	2024
2	Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation	Tim Brown	HarperCollins Publishers Ltd.	2009
3	Design Thinking for Strategic Innovation	Idris Mootee	John Wiley & Sons Inc.	2013

Sample Assignments:

1. Evaluate and prepare a report on how the aspects including inclusivity, diversity and equity are taken into consideration during the empathize and define phases of the Miniproject course.
2. Evaluate and prepare a report on how the aspects including sustainability, inclusivity, diversity and equity are taken into consideration during the ideate phase of the Miniproject course.
3. Evaluate and prepare a report on how User-Centric Design (UCD) is used in the design and development of PoC of the product being developed in the Miniproject course.
4. Prepare a plan for the prototype building of the product being developed in the Miniproject course.
5. Report on the activities during the empathize phase including the maps & other materials created during the sessions.
6. Report on the activities during the define phase including the maps & other materials created during the sessions.

SEMESTER 6

INTRODUCTION TO AERODYNAMICS

Course Code	OEAOT611	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics	Course Type	Theory

Course objectives:

1. To study about the basic flows, and theorems.
2. To understand the concept of lifting line theory and thin aero foil theory
3. Understand the real time viscous flow and boundary layer behaviour

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Euler equation, Incompressible Bernoulli's equation Circulation and Vortices, Streamline, Stream function, Irrotational flow, Potential function, Equipotential line, Elementary flows and their combinations, Ideal Flow over a circular cylinder, D'Alembert's paradox, Magnus effect.	9
2	Thin aerofoil theory and its applications, Vortex filament, Biot Savart law, Bound vortex and Trailing vortex, Horseshoe vortex, Lifting line theory and its limitations. Measurement of speed & Mach number, True, Indicated and Equivalent air speed, Various Types of drag in airplanes, drag polar curve, Methods of drag reduction of airplanes. Aerofoil characteristics and symbols.	9
3	Straight and level flight, Thrust required and available, Power required and available, Effect of altitude on thrust and power Conditions for minimum drag and minimum power required. Gliding and Climbing flight, Range and Endurance, Take-off and landing performance, Turning performance, Horizontal and vertical turn, Motion about three axes such as pitch, roll, yaw and its control, contribution of various components, Aileron control power.	9
4	Boundary layer and Boundary layer thickness, Displacement thickness, Momentum thickness, Energy thickness, Shape parameter, Boundary layer	9

	equations for a steady, two-dimensional incompressible flow, Propeller theory. Basics of turbulent flow.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic of conservative equations and properties of fluids	K2
CO2	Understand the aerofoil theory to predict aerofoil performance and characteristics.	K2
CO3	Understand the performance of aircraft and the concepts of manoeuvring of characteristics of aircraft	K2
CO4	Remember the concepts of viscous flow	K1

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Flight	John D Anderson	Mc Graw Hill	6th Edition, 2017
2	Fundamentals of Aerodynamics	John D Anderson	McGraw Hill	6th Edition, 2016
3	Fluid Mechanics in S.I Units	Frank M White	Paperback	2017

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Flight	Kermode A. C	Pearson Education	11th Edition , 2011
2	Aerodynamics for Engineering Students	E.L. Houghton and P.W. Carpenter	Butterworth-Heinemann.	5 th Edition, 2002

SEMESTER 6

INTRODUCTION TO AIRFRAME

Course Code	OEAOT612	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. To become familiar with different types of aircraft structure, construction & materials and to develop basic idea about the airframe maintenance.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Aircraft History of aircraft, Development trends of aircraft on the aspect of design and scale, Classification of Aircraft based on engine, Commercial application and manufacturer, Modern era of Aircraft	7
2	Main component of Air Frame Fuselage: Construction and pressurization sealing. Wing, stabilizer, pylon and undercarriage attachments. Seat installation and cargo loading system. Doors and emergency exits: construction, mechanisms. Operation and safety devices. Windows and windscreen construction and mechanisms.	9
3	Wings: Construction, Fuel storage, Landing gear, pylon, control surface and high lift/drag attachments Landing Gear: Construction, shock absorbing. Extension and retraction systems: normal and emergency. Indications and warning. Wheels, brakes, antiskid and auto braking, Tyres, Steering Empennage: Construction, Control surface attachment. Tail functions and arrangement, Horizontal Stabilizer, Vertical Stabilizer, Rudder and Elevator	10
4	Flight Control Surfaces Primary controls: aileron, elevator, rudder, and spoiler. Trim control. Active load control, High lift devices, Lift dump, speed brakes, System operation:	10

	manual, hydraulic, pneumatic, electrical. Artificial feel, Yaw damper, Mach trim, rudder limiter, gust. Locks systems. Balancing and rigging Hydraulic & Pneumatic System: Hydraulic systems and its components. Pneumatic system and its components	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the history and development of aircraft	K2
CO2	Understand the components in fuselage structure	K2
CO3	Understand the structure of wing, landing gear and empennage.	K2
CO4	Understand the flight control surfaces and different systems in aircraft	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	1	-	-	-	-	1
CO2	3	-	-	-	-	-	1	-	-	-	-	1
CO3	3	-	-	-	-	-	1	-	-	-	-	1
CO4	3	-	-	-	-	-	1	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Airframe Structural Design	Michael Chun-Yung Niu,	Hong Kong Connilit Press Ltd	2nd Edition,2006
2	Fundamentals of Flight	R. S. Shevell,	Pearson Education, Second Edition.	2nd Edition,1989
3	Aircraft Design: A conceptual Approach	Daniel P. Raymer	American Institute of Aeronautics & Astronautics (AIAA) Education.	5th Edition, 2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	“Performance, Stability, Dynamics, and Control of Airplanes”	Bandu N. Pamadi	American Institute of Aeronautics and Astronautics (AIAA)	3 rd Edition,2015.
2	“Airframe & Power plant Mechanics”	U.S. Department of Transportation, Federal Aviation Administration (FAA), AC65-12A & 15A	FAA	
3	“Aerodynamics for Engineers”	John J. Bertin	Pearson Education	2013

SEMESTER 6

FUNDAMENTALS OF DRONE

Course Code	OEAOT613	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. To understand drone fundamentals: Grasp the basic components, design principles, and diverse applications of drones.
2. To learn the principles of aerodynamics, stability, and control in drone operations.
3. To explore advanced navigation systems
4. To explore the industrial applications and regulations

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Drones: History and Evolution of Drones - Types and Classifications of Drones - Overview of Industrial Applications. Basic Components of Drone- Motors, Propellers, ESCs, Frames - Flight Control Systems and Sensors – Basic Principles of Design	8
2	Aeronautics of Drones: Principles of Lift, Drag, and Thrust - Stability and Control Mechanisms - Impact of Aerodynamics on Drone. Navigation Systems and Communication - GPS, GNSS, and IMU Integration - Communication Protocols: RF, Wi-Fi, and LTE - Navigation Techniques	10
3	Sensors, Payloads, and Autonomous Systems: Sensors and Payload Integration - Camera Systems, LiDAR, and Infrared Sensors. Payload Design and Integration - Payload Weight and Drone Performance - Autonomous Systems and AI in Drones. - Path Planning and Obstacle Avoiding	10
4	Applications and Regulations: Agriculture, Construction, Logistics, and Environmental Monitoring - Challenges and Opportunities in Various Sectors. Regulations, Safety, and Ethical Considerations - International and National Regulations.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental principles of drone technology and design.	K2
CO2	Understand the practical experience in building and operating drones.	K2
CO3	To understand the principles in aerodynamics, navigation, and autonomous systems.	K2
CO4	To understand the various applications of drones	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	2	-	-	-	-
CO2	2	2	-	-	-	-	-	-	-	-	-	-
CO3	2	2	-	-	3	-	-	-	-	-	-	-
CO4	2	2	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Drone Technology	I.V.S.Yeswanth &Dr. A.V.S.Sridhar Kumar	Authors Click Publishing	First Edition,2024
2	Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs	John Baichtal	Pearson Education, Limited	First Edition,2015
3	Drones for Dummies	Mark LaFay	Wiley	First Edition,2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Unmanned Aircraft Systems	R. Kurt Barnhart, Douglas M. Marshall, Eric Shappee	CRC Press	Third Edition,2021
2	Small Unmanned Aircraft: Theory and Practice	Randal W. Beard & Timothy W. McLain	Princeton University Press	Second Edition,2012
3	Drones: The Ultimate Guide	Casey Publishing:	Grey Candle Publishing	2019

SEMESTER 6

JET PROPULSION

Course Code	OEAOT614	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. To introduce the concepts of applying Aero thermodynamics to air breathing propulsion.
2. To familiarize the student's ability to analyze the concepts of different types of compressors and Turbines
3. To understand the basics of Ramjet and Scramjet.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	THERMODYNAMICS OF AIR BREATHING PROPULSION History and classifications of Aero engines, working of gas turbine engine – Thrust equation – Factors affecting thrust – Engine performance parameters – Efficiency, Specific fuel consumption, Methods of thrust augmentation – The propeller, turboprop, turbofan, and turbojet engines characteristics.	9
2	INLETS, COMBUSTION CHAMBER AND NOZZLES. Introduction-Subsonic inlets-Supersonic inlets-Modes of Inlet operation- Gas turbine combustors- Types of combustion chamber-Fuel injector- Flame Tube cooling-Flame Stabilization-Flame holders- Theory of flow through isentropic nozzles – Losses in nozzles –Nozzle efficiency–nozzle choking – Over expanded, optimum expanded and under expanded nozzles – Ejector and variable area nozzles.	9
3	AIR COMPRESSOR Compressor and its classification- Centrifugal compressor - Work and compression ratio – Performance characteristics- Centrifugal compressor staging - Axial compressor - Work and compression ratio- Degree of reaction- Characteristic performance of a single stage axial compressor- Characteristic performance of a multistage axial compressor- Cascading of axial compressor- Compressor efficiency.	

4	AXIAL TURBINES Axial turbine stage -Velocity triangles and Power output - Elementary theory - Vortex theory- Limiting Factors of gas turbine design-Turbine performance- Turbine Blade cooling- Axial flow Turbine and Compressor matching.	9
	RAMJET AND SCRAMJET Operating principle of RAMJET engine- RAMJET with afterburner- RAMJET performance- SCRAMJET working principle- Problems faced in supersonic combustion.	

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the performance and characteristics of turboprop, turbofan and turbojet.	K2
CO2	Understand the process and performance of combustion chambers and its cooling methods.	K2
CO3	Understand the performance and characteristics of compressors. & turbine.	K2
CO4	Understand the performance of RAMJET and SCRAMJET.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	-	-	-	-	-	-	-	-	-	-	-
CO3	3	-	-	-	-	-	-	-	-	-	-	-
CO4	3	-	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Compressible Fluid Dynamics	P.Balachandran	PHI Learning Pvt Ltd,	Ninth edition, 2014.
2	Gas Turbines and Jet & Rocket Propulsion	Dr.M.L.Mathur & R.P Sharma,	Standard Publishers distributors	Fourth Edition, 2014
3	Mechanics & Thermodynamics of Propulsion	Hill, P.G. & Peterson, C.R.	Pearson education	2009
4	Gas Turbine Theory	H.Cohen, GFC Rogers & HIH Saravanamuttoo	Pearson education Ltd	Fifth Edition, 2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Gas Turbines	V.Ganesan	Tata McGraw hill education Pvt Ltd	Third Edition, 2011
2	Engineering Thermodynamics	Nag.P.K	Tata McGraw-Hill, New Delhi	2013
3	Aero-thermodynamics of Aircraft Engine Components	Oates, G.C	AIAA Education Series, New York	1985
4	Turbines, Compressors and fans	S.M.Yahya	Tata McGraw hill education Pvt Ltd,	Fourth Edition, 2011

SEMESTER 6

AIRCRAFT DESIGN

Course Code	OEAOT615	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

- Understand the fundamental principles and processes involved in aircraft design.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	REVIEW OF DEVELOPMENTS IN AVIATION: Categories and types of aircrafts – various configurations – Layouts and their relative merits – strength, stiffness, fail safe and fatigue requirements – Manoeuvring load factors – Gust and manoeuvrability envelopes – Balancing and manoeuvring loads on tail planes.	9
2	POWER PLANT TYPES AND CHARACTERISTICS of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant. PRELIMINARY DESIGN: Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram – Drag estimation of complete aircraft – Level flight, climb, take – off and landing calculations – range and endurance – static and dynamic stability estimates – control requirements.	9
3	SPECIAL PROBLEMS: Layout peculiarities of subsonic and supersonic aircraft – optimization – of wing loading to achieve desired performance – loads on undercarriages and design requirements.	9
4	STRUCTURAL DESIGN: Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections, and joints. Materials for modern aircraft – Methods of analysis, testing and fabrication.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the developments of design in aviation.	K2
CO2	Understanding the power plant types and characteristics and preliminary design concepts.	K2
CO3	Understand the special problems in aircraft design.	K2
CO4	Understand the structural design concepts.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	-	-	-	-	-	-	-	-	2
CO2	3	2	2	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft conceptual design	D.P. Raymer	AIAA Series	2018
2	Supersonic & Subsonic Airplane Design	G. Corning	Edwards Brothers Inc., Michigan,	1973
3	Analysis and Design of Flight Vehicle Structures	E.F. Bruhn	Tristate Offset Co., U.S.A	1975

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Synthesis of Subsonic Airplane Design	E. Torenbeek	Delft University Press, London	1982
2	Integrated design approach to Design fly by wire	H.N.Kota	Lecture notes Interline Pub. Bangalore	2008
3	Notes on airplane design	A.A. Lebedenski	Part-I, I.I.Sc., Bangalore	1980

SEMESTER 6

AIRCRAFT MATERIALS AND PROCESSES

Course Code	OEAOT616	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	-	Course Type	Theory

Course objectives:

1. Acquire comprehensive knowledge of aerospace materials focusing on their properties and applications in aviation.
2. Understand heat treatment processes for aircraft metals and alloys, including their effects on material properties and applications in aerospace engineering.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Mechanical Behaviour of Engineering Materials: Introduction to aerospace materials and their classification, Linear and non-linear elastic properties- Stress and Strain Curves-Yielding and strain Hardening, Toughness- Modules of resilience -- Bauchinger's effect- Effect of notches -Testing and flaw detection of materials and components, knowledge of various material testing machines	9
2	Materials in Aircraft Construction: Magnesium and its alloys: Cast and Wrought alloys -Aircraft application, features specification, fabrication problems, Special treatments. Titanium and its alloys: Applications, machining, forming, welding and heat treatment, Copper alloys. Wood and fabric in aircraft construction and specifications- Glues Use of glass, plastics & rubber in aircraft.Introduction to glass &carbon composite	9
3	Non-ferrous materials in aircraft construction: Aluminium and its Alloys: Types and identification. Properties-Castings-Heat treatment processes – Surface treatments.	9

	Ferrous materials in aircraft construction: Steels: Plain and low carbon steels, various low alloy steels, aircraft steel specifications, corrosion and heat-resistant steels, structural applications. Maraging Steels: Properties and Applications. Super Alloys: Use -Nickel base -Cobalt base- Iron base -Forging and Casting of Super alloys -Welding, Heat treatment.	
4	Ceramics and Composites: Introduction, modern ceramic materials, cermet, glass ceramic, production of semi-fabricated forms, Carbon/Carbon composites, Fabrication processes and its aerospace applications involved in metal matrix composites, polymer composites. Material Testing: Corrosion, its detection, and prevention. Protective finishes. Testing: Destructive and non - destructive testing techniques. Crack detection, inspection of parts by hot oil and chalk, dye-penetrant, fluorescent and magnetic particles, X-ray, ultrasonic, eddy current and acoustic emission methods.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the mechanical properties and behaviour of engineering materials used in aerospace.	K2
CO2	Explain the key materials used in aircraft construction.	K2
CO3	Differentiate the characteristics, applications, and processing techniques of non-ferrous materials and ferrous materials used in aerospace applications.	K2
CO4	Gain a comprehensive understanding of ceramics and composites used in aircrafts and explain about the effective material testing techniques.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	1
CO2	3	-	-	-	-	-	-	-	-	-	-	1
CO3	3	-	-	-	-	-	-	-	-	-	-	1
CO4	3	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Material and Processes	Titterton GF	English Book Store, New Delhi	1998
2	Advanced Composites	Cindy Forema	Springer	2020

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Materials, their properties and applications.	Martin J W	Wykedham publications (London)	1982
2	Material Science for Engineers.	Van Vlack. L H	Addison Weasley	1989
3	Airframe and power plant mechanics- General Hand book.		FAA Himalayan book house, New Delhi	2008

SEMESTER 6

FLIGHT AGAINST GRAVITY

Course Code	OEAOT617	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics	Course Type	Theory

Course objectives:

- To introduce the basic concepts of aerospace engineering and the current developments in the field.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Historical Developments in Aeronautical Activities: Early air vehicles: Balloons, Biplanes and Monoplanes -Helicopters; Developments in aerodynamics, aircraft materials, aircraft structures & aircraft propulsion. Aircraft Configurations: Different types of flight vehicles and their classifications-Components of fixed wing airplane and their functions; Air foils, wings and other shapes.	9
2	Principles of Atmospheric Flight: Physical properties and structure of the atmosphere: The Standard Atmosphere, Temperature, Pressure and Altitude relationships, Mach Number-Evolution of theory of lift and drag, Manoeuvres, Concepts of stability and control.	9
3	Introduction to Space Flight & power plants: Introduction to basic concepts, the upper atmosphere-Power plants used in airplanes: Basic ideas about piston, turboprop and jet engines- Principles of operation of rocket, types of rockets and typical applications	9
4	Introduction to airplane structures and materials: General types of construction, Monocoque, semi-monocoque-Typical wing and fuselage structure. Metallic and non-metallic materials-Use of aluminium alloy, titanium, stainless steel and composite materials.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic concepts on History of aeronautics, helicopters & aircraft propulsion and aircraft configurations	K2
CO2	Understand atmosphere and atmospheric flight	K2
CO3	Understand space flight & rockets.	K2
CO4	Understand aircraft structures and materials	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	3	-	-	-	-	-	-	-	-	3
CO3	2	2	2	-	-	-	-	-	-	-	-	2
CO4	2	2	2	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Flight	J D Anderson Jr. and Mary L.Bowden	Mc Graw Hill	Ninth Edition 2021
2	Mechanics of Flight	AC Kermode, RH Barnard, D R Philpott	Pearson	Eleventh Edition 2006
3	Flight Physics	E Torenbeek, H.Wittenberg	Springer	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Flight without Formulae	A C Kermode	Pearson	2004
2	Fundamentals of Flight	Richard S Shevell	Pearson	2004

SEMESTER 6

ANALYSIS AND SIMULATION LAB

Course Code	PCAOL607	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	0:0:3:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min
Prerequisites (if any)	High Speed Aerodynamics, Computational Fluid dynamics	Course Type	Practical

Course objectives:

- To provide practical knowledge in use of analysis softwares like Ansys for fluid flow analysis, structural analysis, and thermal analysis

Details of Experiment

Expt. No	Experiment
1	Simulation of flow over sphere, cone & cylinder.
2	Simulation of flow over a flat plate at various angle of attack.
3	Simulation of flow over symmetric airfoil.
4	Simulation of flow over unsymmetrical airfoil
5	Simulation of supersonic flow over a wing of bioconvex cross section
6	Simulation of flow over boat-tail configuration.
7	Simulation of flow through a converging duct.
8	Simulation of flow through a divergent duct.
9	Simulation of flow through CD Nozzle.
10	Simulation of flow through subsonic and supersonic diffusers.
11	Simulation of Flow around a wing with aerodynamic twist and Geometric twist.
12	Structural analysis of a tapered wing.

13	Structural analysis of a fuselage structure
14	Structural analysis of landing gear
15	Analysis of a composite laminate structure.
16	Thermal Stress and Heat Transfer analysis of plates.
17	Thermal stress analysis of cylindrical shells.
18	Thermo structural analysis of a composite laminate structures

Course Assessment Method (CIE: 50 Marks, ESE 50 Marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Preparation/Pre-Lab Work, experiments, Viva and Timely completion of Lab Reports / Record (Continuous Assessment)	Internal Exam	Total
10	20	20	50

End Semester Examination Marks (ESE):

Procedure/ Preparatory work/Design/ Algorithm	Conduct of experiment/ Execution of work/ troubleshooting/ Programming	Result with valid inference/ Quality of Output	Viva voce	Record	Total
10	15	10	10	5	50

- Submission of Record: Students shall be allowed for the end semester examination only upon submitting the duly certified record.
- Endorsement by External Examiner: The external examiner shall endorse the record.

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze the flow over 2-D bodies such as cylinders and airfoils.	K4
CO2	Analyze the flow over 3-D bodies such as Sphere, cones and wings with and without Twist.	K4
CO3	Analyse flow through various ducts like convergent, divergent and Convergent-Divergent(CD)	K4
CO4	Analyse structural properties of aircraft component like wing, fuselage and Landing Gear	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	An Introduction to ANSYS Fluen	John E. Matsson	SDC Publication	
2	Ansys Workbench Tutorial Release 14: Structure & Thermal Analysis Using The Ansys Workbench Release 14 Environment	Kent Lawrence	SDC Publication	2012
3	Computational fluid dynamics- An introduction	John F. Wendt	Springer Verlag	2009
4	Analysis and Design of Flight Vehicles Structures	Bruhn. E	Tri-state-off-st Company	1985
5	Computer simulation of flow and heat transfer.	P. S. Ghoshdasidar	McGraw -Hill Book Co	1998

Continuous Assessment (20 Marks)

1. Preparation and Pre-Lab Work (5 Marks)

- Pre-Lab Assignments: Assessment of pre-lab assignments or quizzes that test understanding of the upcoming experiment.
- Understanding of Theory: Evaluation based on students' preparation and understanding of the theoretical background related to the experiments.

2. Conduct of Experiments (5 Marks)

- Procedure and Execution: Adherence to correct procedures, accurate execution of experiments, and following safety protocols.
- Skill Proficiency: Proficiency in handling equipment, accuracy in observations, and troubleshooting skills during the experiments.
- Teamwork: Collaboration and participation in group experiments.

3. Lab Reports and Record Keeping (5 Marks)

- Quality of Reports: Clarity, completeness and accuracy of lab reports. Proper documentation of experiments, data analysis and conclusions.
- Timely Submission: Adhering to deadlines for submitting lab reports/rough record and maintaining a well-organized fair record.

4. Viva Voce (5 Marks)

- Oral Examination: Ability to explain the experiment, results and underlying principles during a viva voce session.

***Final Marks Averaging:** The final marks for preparation, conduct of experiments, viva, and record are the average of all the specified experiments in the syllabus.*

Evaluation Pattern for End Semester Examination (50 Marks)

1. Procedure/Preliminary Work/Design/Algorithm (10 Marks)

- Procedure Understanding and Description: Clarity in explaining the procedure and understanding each step involved.
- Preliminary Work and Planning: Thoroughness in planning and organizing materials/equipment.
- Algorithm Development: Correctness and efficiency of the algorithm related to the experiment.
- Creativity and logic in algorithm or experimental design.

2. Conduct of Experiment/Execution of Work/Programming (15 Marks)

- Setup and Execution: Proper setup and accurate execution of the experiment or programming task.

3. Result with Valid Inference/Quality of Output (10 Marks)

- Accuracy of Results: Precision and correctness of the obtained results.
- Analysis and Interpretation: Validity of inferences drawn from the experiment or quality of program output.

4. Viva Voce (10 Marks)

- Ability to explain the experiment, procedure results and answer related questions
- Proficiency in answering questions related to theoretical and practical aspects of the subject.

5. Record (5 Marks)

Completeness, clarity, and accuracy of the lab record submitted

SEMESTER 7

SEMESTER 7

FUNDAMENTALS OF COMBUSTION

Course Code	PEAOT741	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics Rocket Propulsion	Course Type	Theory

Course Objectives:

1. To understand the fundamental principles of thermodynamics.
2. To familiarize with the mechanisms of ignition, flammability, and flame propagation.
3. To understand the combustion process in rocket propulsion and advancements in combustion technology.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Thermodynamics of reacting mixtures Basics of thermodynamics – Bond energy, Heat of formation, Heat of reaction, Adiabatic flame temperature. Entropy & chemical equilibrium – Entropy changes for reacting mixtures, chemical equilibrium, equilibrium criteria. Evaluation of equilibrium – Equilibrium constants, equilibrium composition.	7
2	Chemical kinetics & Reaction rates Introduction to chemical kinetics – Law of mass action, order and molecularity of reaction, rate equation. Theories of reaction rates – Arrhenius laws, Activation energy, Collision Theory, Transition state theory. Combustion reactions – General theory of chain reactions, Combustion of CO and hydrogen.	7
3	Ignition, Flammability & Flame propagation Ignition and Flammability - Methods of Ignition, Self and Forced Ignition, Thermal Theory of Ignition, Determination of Self-Ignition Temperature, Experimental Results on Ignition, Energy Required for Ignition.	12

	Flammability and Flame Quenching - Limits of Inflammability, Factors Affecting Flammability Limits, Flame Quenching, Effects of Variables on Flame Quenching. Flame Propagation - Factors Affecting Flame Speed, Premixed and Diffusion Flames, Physical Structure and Comparison, Characteristics of Laminar and Turbulent Flames, Theory of Laminar Flame Propagation, Empirical Equations for Laminar and Turbulent Flame Velocities. Flame Stabilization - Stability Diagrams for Open Flames, Mechanisms of Flame Stabilization, Critical Boundary Velocity Gradient, Stabilization by Eddies, Bluff Body Stabilization, Effects of Variables on Stability Limits.	
4	Combustion Technology in rockets Combustion in rockets - Solid Motors: Physical and Chemical Processes, Ignition Process in Rockets, Combustion Instability in Solid Motors, Liquid Propellant Combustion: Process and Zones, Supersonic Combustion in Aeronautics. Advancements in combustion technology - Innovations in Fuel Injection Systems, High-Efficiency Combustion Chambers, Additive Manufacturing in Combustion Components, Hybrid Rocket Propulsion Techniques.	10

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered.	60

(8x3 =24 marks)	Each question can have a maximum of 3 subdivisions.	(4x9 = 36 marks)
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Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental principles of thermodynamics and chemical kinetics.	K2
CO2	Understand the concepts of entropy and chemical equilibrium.	K2
CO3	Apply the factors affecting ignition, flammability, and flame propagation in various combustion systems.	K3
CO4	Understand the combustion processes in rocket propulsion.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	-	-	-	-	-	-	-	-	2
CO2	2	2	2	-	-	-	-	-	-	-	-	1
CO3	2	2	2	2	-	-	2	-	-	-	-	2
CO4	2	2	2	1	-	-	1	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Combustion	Irvin Glassman, Nick G Gumac, Richard A Gutter	Academic press INC	5 th edition, 24 th November 2014

2	Fundamentals of Chemical Reaction Engineering	Mark E. E Davis, Robert J. J Davis	McGraw Hill Higher Education	International Edition, 01 st August 2002
3	Flame & Combustion	J. F. Griffiths, J. A. Barnard	CRC Press	3 rd Edition, 30 th December 1995

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	An Introduction to Combustion: Concepts & Applications (Mechanical Engineering)	Stephen R Turns	McGraw Hill Education	3 rd Edition, 16 th February 2011
2	Rocket Propulsion	George P Sutton, Oscar Biblarz	Wiley	8 th Edition

SEMESTER 7

CRYOGENICS

Course Code	PEAOT742	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics and Heat transfer	Course Type	Theory

Course Objectives:

1. Understanding the cryogenic temperatures, the behaviour of materials under extreme cold conditions, and the thermodynamic principles that govern cryogenic systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction To Cryogenic Systems and application: Historical development, Applications of Cryogenics (Space, Food Processing, Super conductivity, Electrical Power, Biology, Medicine, Electronics and Cutting Tool Industry).Low Temperature Properties: Properties of Engineering Materials (Mechanical properties, Thermal properties, Electric and Magnetic properties), Properties of Cryogenic fluids: liquid hydrogen and liquid	8

	oxygen.	
2	Gas Liquefaction Systems: Introduction, thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde Hampton, precooled Linde Hampton, Linde dual pressure, cascade, claudé, Kapitza, Heylandt, other systems using expanders, comparison of liquefaction systems. General liquefaction systems. Liquefaction systems for Neon, Hydrogen and Helium. Precooled Linde-Hampson system for neon and hydrogen, Claude system for hydrogen or neon, Helium refrigerator-liquefaction system, ortho para hydrogen conversion in the liquefier, Collins helium liquefaction system, Simon helium liquefaction system. Critical components of liquefaction systems.	10
3	Cryogenic Refrigeration Systems: Ideal refrigeration systems, Joule Thomson refrigeration system, expanded refrigeration system, Philips refrigerators, Importance of regenerator effectiveness for the Philips refrigerators, Solvay refrigerator, Gifford single volume refrigerator, Gifford double volume refrigerators analysis, regenerators, pulse tube refrigerators, various types of pulse tube refrigerator. Magnetic cooling, thermodynamics of magnetic cooling, magnetic moment and entropy of paramagnetic material, magnetic refrigeration system, thermal valves, dilution refrigerator	10
4	Cryogenic Fluid Storage and Transfer Systems: Cryogenic storage vessels and transportation. Thermal insulation and their performance at cryogenic temperatures, Super insulations, Vacuum insulation, Powder insulation. Cryogenic fluid transfer systems. Cryogenic Instrumentation: Pressure, flow-rate, liquid-level and temperature measurements. Types of Heat Exchangers used in cryogenic systems (only description with figure). Cryo Pumping Applications.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. • (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand and describe the unique properties of cryogenic fluids and their implications for engineering applications.	K2
CO2	Understand the basic concepts of Gas Liquefaction Systems	K2
CO3	Understand Cryogenic Refrigeration Systems	K2
CO4	Understand Cryogenic Insulation and Fluid Storage Systems	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryogenic Engineering, Revised and Expanded	Thomas Flynn	CRC Press	2th edition, 2004
2	Cryogenic Systems	Randall F. Barron	McGraw-Hill	1986
3	Cryogenic Engineering	Russell B. Scott	Van Nostrand	1959

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Cryogenic Process Engineering,	Klaus D.Timmerhaus and Thomas M.Flynn,	Plenum Press, New York	1989
2	Cryogenic process engineering,	Thomas M Flynn,	Informa HealthCare	2004
3	Cryogenic heat transfer, R F Barron, Taylor & Francis Group	Randall F. Barron, Gregory F. Nellis	CRC Press	2017

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID

1	https://archive.nptel.ac.in/courses/112/101/112101004/
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SEMESTER 7

AEROSPACE GUIDANCE AND CONTROLS

Course Code	PEAOT743	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Type	Theory

Course Objectives:

1. Understand the operating principle of guidance law, autopilot and augmentation system and missile guidance systems and will be able to deploy these skills effectively in the design of control for aerospace systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION: Introduction to Guidance and control - The Standard Atmospheric -Coordinate Frame - Equations of motion – Linearization. AUGMENTATION SYSTEMS: Need for automatic flight control systems, Stability augmentation systems, control augmentation systems, Design of Limited authority and Full Authority Augmentation systems - Gain scheduling concepts.	9
2	LONGITUDINAL AUTOPILOT: Displacement Autopilot -Pitch Orientation Control system, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, Longitudinal control law design using backstepping algorithm. .	9
3	LATERAL AUTOPILOT: Damping of the Dutch Roll, Methods of Obtaining Coordination, Yaw Orientation Control system, turn compensation, Automatic lateral Beam Guidance. Introduction to Flyby-wire flight control systems, Lateral control law design using backstepping algorithm.	9
4	MISSILE AND LAUNCH VEHICLE GUIDANCE: Operating principles and design of guidance laws, homing guidance laws- short range, medium range and BVR missiles, Launch, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the equations governing the aircraft dynamics and understanding various stability and control augmentation system	K2
CO2	Understand the control law for longitudinal autopilots	K2
CO3	Understand the control law for lateral autopilots	K2
CO4	Explain missile and launch vehicle guidance schemes	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	1
CO2	3	-	-	-	-	-	-	-	-	-	-	1
CO3	3	-	-	-	-	-	-	-	-	-	-	1
CO4	3	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year

1	Automatic control of Aircraft and missiles	Blake Lock, J.H	John Wiley Sons, New York,	2007
2	Introduction to Avionics Systems	R.P.G Collinson,	Springer;	3rd ed. edition, 2011
3	Automatic control of Aircraft and missiles	Blake Lock, J.H	John Wiley Sons, New York,	2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	'Flight stability & Automatic Control'	Nelson R.C	McGraw Hill,	2019
2	Guided Weapon control systems	Garnel.P. &East.D.J	Pergamon Press, Oxford	1977.
3	Aircraft control & simulation	Stevens B.L & Lewis F.L	John Wiley Sons, New York,	2015
4	Missile Guidance and Control Systems	George M. Siouris	Springer	2011

SEMESTER 7

MACHINE LEARNING IN AEROSPACE ENGINEERING

Course Code	PEAOT744	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the basics of machine learning (ML)
2. Explore the role of ML in aerospace engineering

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Machine Learning and Aerospace Engineering: Introduction to Machine Learning: Definitions and types of machine learning: supervised, unsupervised, reinforcement. Common algorithms: regression, classification, clustering. Overview of Aerospace Engineering: Key areas: aerodynamics, propulsion, structures, and avionics. Current challenges and opportunities for ML integration. ML Applications in Aerospace: Case studies: predictive maintenance, performance optimization, autonomous systems.	9
2	Data Acquisition, Pre-processing, and Feature Engineering: Data Acquisition: Sources of aerospace data: sensors, simulations, experimental measurements. Data types and formats. Data Preprocessing: Data cleaning: handling missing values, outlier detection. Data transformation: normalization, scaling. Feature Engineering: Techniques for feature selection and extraction. Dimensionality reduction methods: PCA, t-SNE.	9
3	Supervised and Unsupervised Learning Techniques: Supervised Learning: Regression: linear regression, polynomial regression. Classification: logistic regression, decision trees, support vector machines (SVMs), neural networks. Unsupervised Learning: Clustering: K-means, hierarchical clustering, DBSCAN. Dimensionality reduction: PCA, t-SNE. Model Evaluation: Metrics for regression and classification: MAE, RMSE, accuracy, precision, recall, F1 score. Cross-validation and model validation techniques.	9

4	Advanced Topics and Emerging Trends: Advanced ML Techniques: Deep learning: Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs). Reinforcement learning: basics and applications in aerospace, such as autonomous flight control. Emerging Trends: Explainable AI (XAI) and its significance for aerospace safety and reliability. Integration with IoT and smart sensors in aerospace systems. Case Studies and Future Directions: Review of cutting-edge research and emerging applications in ML for aerospace. Discussion on the future of ML in aerospace engineering.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the context and relevance of ML in aerospace.	K2
CO2	Understand feature engineering techniques relevant to aerospace applications.	K2
CO3	Apply supervised and unsupervised learning techniques to aerospace problems.	K3
CO4	Discuss future trends and innovations in ML for aerospace.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Pattern Recognition and Machine Learning	Christopher M. Bishop	Springer	August 17, 2006
2	Machine Learning for Aeronautics and Aerospace Engineering	K. J. K. Jha and S. P. K. Jha	-	-
3	Deep Learning	Ian Goodfellow, Yoshua Bengio, and Aaron Courville	The MIT Press	November 18, 2016

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Data Science for Engineers	A. S. McKinnon		
2	Machine Learning Yearning	Andrew N G		

SEMESTER 7
EXPERIMENTAL STRESS ANALYSIS

Course Code	PEAOT745	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3/5	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Strength of Materials	Course Type	Theory

Course Objectives:

1. To study the various experimental techniques involved for measuring displacements, stresses and strains in structural components.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Principles of measurements, Strain Gauges – Mechanical strain gauges, Optical strain gauges, Acoustical strain gauge and Pneumatic strain gauge.	9
2	Electrical Strain Gauges – Inductance strain gauge, Capacitance strain gauge and Electrical resistance strain gauge – Types, Selection of gauges, Gauge factor, Gauge materials, Carrier materials, Transverse sensitivity, Application techniques and Temperature compensation techniques.	9
3	Strain Rosettes – Two-gauge rosette, rectangular rosette, Delta rosette and T-Delta rosette. Strain Gauge Circuits – Wheatstone bridge circuit and Potentiometer circuit (constant voltage type and constant current type), Strain Indicators.	9
4	Two-dimensional photoelasticity – Concept of light, Double refraction, Stress optic law, Plane polariscope, Circular polariscope, Interpretation of	9

	fringe pattern, Fringe sharpening, Fringe multiplication, Fringe order determination, Calibration techniques, Photoelastic materials and their properties.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the working principle and procedure of strain gauges	K2

CO2	Understand the working principle and procedure of electrical strain gauges	K2
CO3	Understand the working principle of strain rosettes and strain gauge circuits	K2
CO4	Understand the working principle and procedure of photoelasticity	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	1
CO2	2	-	-	-	-	-	-	-	-	-	-	1
CO3	2	2	-	-	-	-	-	-	-	-	-	1
CO4	2	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Experimental Stress Analysis	Sadhu Singh	Khanna Publishers, New Delhi.	2017
2	Experimental Stress Analysis	Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G.RaMachandra, K.	Tata McGraw Hill, New Delhi	2009
3	Experimental Stress Analysis	Dally, J.W., and Riley, W.F.	McGraw Hill Inc., New York.	2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Hand book of Experimental Stress Analysis	Hetenyi, M.	John Wiley and Sons Inc	1972
2	Applied Stress Analysis	Durelli. A.J.	Prentice Hall of India Pvt Ltd.New Delhi	1982
3	Photo Elasticity	Max Mark Frocht	John Wiley and Sons Inc., New York.	1959
4	Digital Photoelasticity	Ramesh, K.	Springer, New York.	2000
5	Hand book of Experimental Stress Analysis	Hetenyi, M.	John Wiley and Sons Inc., New York.	1972

Video Links (NPTEL, SWAYAM)	
Module No.	Link ID
1-4	https://archive.nptel.ac.in/courses/112/106/112106068/

SEMESTER 7

NANOTECHNOLOGY

Course Code	PEAOT746	CIE Marks	40
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Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

To give an introduction to nanotechnology and nanostructures

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction and scope-Classification of nanostructures: Quantum dots, quantum wires, quantum wells, nano clusters, nanotubes, super lattices, nano crystalline materials-Effects of nano meter length scale – Changes to the system total energy, changes to the system structures. Effect of Nanoscale dimensions on various properties – structural, thermal, chemical, mechanical, magnetic, optical, and electronic properties.	9
2	Fabrication methods: Top down and bottom up approaches-Top down processes: Milling, Lithographic, machining process, pulsed laser methods- Bottom up processes: Vapour phase deposition methods, PVD, CVD, electro deposition, plasma assisted deposition process, MBE, chemical methods, colloidal and solgel methods	9
3	Characterization methods: General classification of characterization methods, Microscopy techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunnelling Microscopy, Atomic Force Microscopy, Diffraction Techniques-Spectroscopy Techniques – Raman Spectroscopy, Surface analysis and depth profiling-Mechanical Properties- Magnetic and Thermal properties.	9
4	Applications of Nanotechnology (nano materials and devices)- Applications of nanocomposites, nanocrystalline materials, nano layered structures, nanomagnetic materials-magneto resistance- Carbon nanotubes: SW, MW, nanostructured coatings- nano sensors: order from chaos,	9

	characterization, perception, nano sensor based on quantum size effect, Electrochemical sensors, Sensors based on physical properties, Nano biosensors, smart dust	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understanding classification and effects of nanostructures	K2
CO2	Understanding fabrication methods of nanostructures	K2
CO3	Understanding microscopy techniques (SEM, TEM, STM, AFM),	K2
CO4	Understanding the applications of nanotechnology.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	1
CO2	2	-	-	-	-	-	-	-	-	-	-	1
CO3	2	-	-	-	2	-	-	-	-	-	-	1
CO4	2	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Nanomaterials,,	A.K.Bandyopadhyay	New age international publishers,	2008
2	Handbook of Nanotechnology	Bharat Bhushan	Springer	2010
3	“ Introduction to Nanotechnology ”	Charles P Poole, Frank J Owens,	John Wiley and Sons ,	2003
4	Jeremy Ramsden	Jeremy Ramsden,	William Andrew,Elsevier,	2011
5	Nano: The essentials	T Pradeep	McGraw–Hill education	2007
6	Nanoscience and	V.S.Muralidharan A	Anebooks Pvt	

	Technology	Subramnya,	Ltd	
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Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Nanotechnology,	Gregory Timp	Springer-Verlag	2009
2	NanoTechnology	E John Mongillo	Greenwood Press	2007
3	Nanoscale Science and Technology	Kelsall Robert.W,IanHamley, MarkGeoghegan	Wiley Eastern	2005

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/118102003

SEMESTER 7

SPACE EXPLORATION TECHNOLOGY

Course Objectives:

1. Understand the evolution of space technology and the roles of major space agencies.

Course Code	PEAOT747	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Rocketry and Rocket Propulsion	Course Type	Theory

2. Understand the fundamentals of orbital mechanics and subsystems of spacecraft.

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION TO SPACE EXPLORATION Overview: Early rocketry, Sputnik, Apollo missions. Evolution of space technology and its impact on science and society. Roles and objectives of major space agencies: NASA, ESA, ISRO, CNSA. Importance of international collaboration in space missions. Kepler's laws of planetary motion. Types of orbits: Low Earth Orbit (LEO), Medium Earth Orbit (MEO), Geostationary Orbit (GEO), and Highly Elliptical Orbit (HEO). Orbital manoeuvres: Hohmann transfer, inclination change, and rendezvous. Overview of spacecraft subsystems: Power, thermal, communication, and propulsion. Differences between manned and unmanned spacecraft.	9
2	SPACE PROPULSION SYSTEM AND LAUNCH VEHICLES Fundamentals of chemical propulsion: Solid, liquid, and hybrid rockets. Applications and limitations of chemical propulsion in space missions. Introduction to electric propulsion: Ion thrusters, Hall Effect thrusters. Overview of advanced propulsion concepts: Nuclear thermal rockets, solar sails, and magneto plasma dynamic thrusters. Classification of launch vehicles: Small, medium, and heavy-lift launchers. Reusable launch vehicles: Technology advancements and impact on mission cost (e.g., Falcon 9, SpaceX Starship). Basics of mission design: Launch windows, payload integration, and trajectory planning.	9
3	SPACE ENVIRONMENT AND SATELLITE TECHNOLOGY	9

	Characteristics of space environment: Vacuum, microgravity, radiation, temperature extremes. Impact of space environment on spacecraft design and material selection. Overview of satellite subsystems: Power, communication, attitude control, and propulsion. Applications of satellites: Communication, Earth observation, navigation, and scientific research. Design and development of small satellites: Miniaturization and cost-effectiveness. CubeSats: Standardization, mission roles, and recent advancements in small satellite technology.	
4	ADVANCEMENTS IN SPACE EXPLORATION Challenges of interplanetary travel: Long-duration missions, radiation protection, and deep-space navigation. Case studies of interplanetary missions: Mars rovers, Voyager, New Horizons. Challenges in human spaceflight: Life support systems, psychological factors, and crew safety. Future of human space exploration: Lunar bases, Mars colonization, and space tourism. Space robotics and AI: Autonomous systems for space exploration. Emerging technologies: Space mining, space-based solar power, and advancements in space propulsion. Ethical and legal considerations: Space debris, planetary protection, and space resource utilization.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understanding the historical development of space exploration	K2
CO2	Understanding the roles and objectives of major space agencies	K2
CO3	Understanding the fundamental principles of orbital mechanics	K2
CO4	Understanding the basic subsystems of spacecraft and design considerations for manned and unmanned spacecraft	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year

1	Space Exploration: A History in 100 Objects	Sten Odenwald, John Mather	Springer	01 st November 2019
2	Rocket propulsion elements	George P. Sutton and Oscar Biblarz	Wiley	9 th edition, 07 th February 2017
3	The Space Environment: Implications for Space Design	Alan C. Tribble	Princeton University Press	12 th October 2003
4	Satellite Communications Systems: Systems, Techniques and Technology	Gerard Maral and Michel Bousquet	Wiley	6 th Edition, 06 th February 2020

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to Space Sciences and Spacecraft Applications	Bruce A Campell	Gulf Professional Publishing	1 st edition, 2004
2	Modern Engineering for Design of Liquid-Propellant Rocket Engines	Dieter K. Huzel and David H. Huang	American Institute of Aeronautics & Astronautics	Revised Edition, 31 st December 1992
3	Fundamentals of Electric Propulsion: Ion and Hall Thrusters	Dan M. Goebel and Ira Katz	Wiley	1 st edition, 25 th November 2008

SEMESTER 7

WIND TURBINE ENGINEERING

Course Code	PEAOT748	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Explore and evaluate innovative technologies in wind turbine engineering.
2. Assess environmental impacts and implement sustainable practice
3. Conduct economic analyses and apply project management principles.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Wind Turbines: Development of wind power. Overview of global wind energy trends. Wind Turbine Types and Components: Horizontal-axis vs. vertical-axis wind turbines. Main components: rotor blades, nacelle, tower, and drivetrain. Wind Resource Assessment: Wind speed and direction measurement. Wind resource mapping and analysis. Fundamentals of Aerodynamics: Wind turbine aerodynamics (lift, drag, and thrust). Power coefficient and Betz's law.	9
2	Wind Turbine Technologies: Mechanical Design: Rotor blade design and materials. Drivetrain components: gearbox, generator, and yaw/pitch systems (basic description only). Structural Engineering: Tower design and materials. Load analysis and structural integrity. Control Systems: Turbine control mechanisms (yaw and pitch control). Safety systems and fault detection (basic description only). Fatigue and Reliability Analysis: Fatigue loading and life-cycle analysis. Reliability and maintenance strategies. (no problems)	9
3	Wind Turbine Systems and Integration: Electrical Systems: Electrical generation and grid integration. Power conversion and transmission. Energy Storage and Grid Management: Energy	9

	storage solutions (batteries, flywheels). Grid stability and management with intermittent wind power. System Integration: Offshore vs. onshore wind farm integration. Environmental and site-specific considerations. Regulations and Standards: Industry standards (IEC, ANSI). Environmental and safety regulations.	
4	Advanced Topics and Future Trends: Innovative Technologies: Floating wind turbines and deep-water installations. Advanced blade design and materials. Economics and Project Management: Cost analysis and economic feasibility studies. Project management practices and lifecycle costing. Environmental Impact and Sustainability: Assessing and mitigating environmental impacts. Sustainable practices and future energy scenarios. Future Trends and Research Directions: Emerging technologies and trends in wind turbine engineering. Research opportunities and challenges.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any

one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles of wind energy and turbine types.	K2
CO2	Understand and implement control systems for optimal turbine performance.	K2
CO3	Understand the electrical systems associated with wind turbines and their integration into the grid.	K2
CO4	Understand the innovative technologies in wind turbine engineering.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	1	-	-	-	-	-
CO2	3	-	-	-	-	-	1	-	-	-	-	-
CO3	3	-	-	-	-	-	1	-	-	-	-	-
CO4	3	-	-	-	-	-	1	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year

1	"Wind Energy Explained: Theory, Design and Application"	James F. Manwell, Jon G. McGowan, and Anthony L. Rogers	WILEY	2009
2	"Wind Turbine Engineering Design"	John D. Sorensen	Woodhead Publishers	2010
3	"Wind Turbine Control Systems: Principles, Modelling and Gain Scheduling Design"	Qiang Lu	Springer	2007

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	"Fundamentals of Wind Energy"	Michael J. Pierce	SFCC Library	2007

SEMESTER 7

TURBOMACHINERY

Course Code	PEAOT751	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics and Fluid mechanics	Course Type	Theory

Course Objectives:

1. Understand the working and application of rotary compressors and turbines.
2. Apply the engineering concepts for basic design of turbo machines
3. Understand the working and application of rotary compressors and turbines.
4. Apply the engineering concepts for basic design of turbo machines.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Turbo Machineries: Introduction to turbomachines. Classification of Turbo machines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbomachines.	9
2	CENTRIFUGAL FANS AND BLOWERS: Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles - H-S Diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.	9
3	CENTRIFUGAL AND AXIAL FLOW COMPRESSOR Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor. Performance characteristics and various losses. Geometry and performance calculation. Construction details of axial compressor. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency, and stage losses – Stalling and Surging.	11
4	AXIAL AND RADIAL FLOW TURBINES: Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and	7

	reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types– Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the general design relationships for Turbo machines.	K2
CO2	Apply the fundamental principles of turbomachinery to optimize the performance characteristics of centrifugal fans and blowers.	K3
CO3	Apply the basic laws to find the relations for the design of axial flow compressor and centrifugal compressor.	K3
CO4	Illustrate the working, design procedures of axial and radial turbines	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Gas Turbines	Ganesan, V.	Tata McGraw Hill	3rd Edition, 2011.
2	Turbines, Compressor and Fans	Yahya, S.M.	Tata McGraw Hill	4th Edition, 2011.

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Gas Turbine Theory	Saravanamutto, Rogers, Cohen, Straznicky	Pearson Education Ltd	6th Edition, 2009.
2	Fundamentals of Turbomachinery	Venkanna, B.K	PHI Learning Pvt. Ltd	6th Edition, 2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/112/104/112104305/
2	https://archive.nptel.ac.in/courses/112/104/112104305/
3	https://archive.nptel.ac.in/courses/112/104/112104305/
4	https://archive.nptel.ac.in/courses/112/104/112104305/

SEMESTER 7

HYPERSONIC AND HIGH TEMPERATURE AERODYNAMICS

Course Code	PEAOT752	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	HIGH SPEED AERODYNAMICS, THERMODYNAMICS	Course Type	Theory

Course Objectives:

1. To explain the basic concepts in high-speed flow with chemical reaction.
2. To understand the concept of frozen, equilibrium and non-equilibrium chemically reacting flow.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction, hypersonic shock and expansion wave relations, Newtonian flow model for both 2-D and 3-D flow, modified Newtonian theory, centrifugal correction to Newtonian theory, tangent wedge tangent cone and shock expansion method, Mach number independence, hypersonic small disturbance equation, hypersonic similarity, equivalence and blast wave theory, thin shock wave theory, (Simple numerical examples).	9
2	Hypersonic boundary layer: similarity parameters, boundary layer equation, self-similar solution, non-similar hypersonic boundary layer, transition, turbulent boundary layer, aerodynamic heating, viscous interaction, shock wave boundary layer interaction. (Simple numerical examples).	8
3	Classification of gases: calorically perfect gas, thermally perfect gas, chemically reacting gas and real gas, various forms of perfect equation of state, Dalton's law of partial pressure, entropy calculation for equilibrium and non-equilibrium gases. Basics on statistical thermodynamics, kinetic theory, equilibrium, and non-equilibrium inviscid flows: equilibrium normal and oblique shock wave, chemically equilibrium 1-D nozzle flows, speed of sound in equilibrium flow, equilibrium conical flow, and equilibrium flows on blunt bodies,	10

4	Non-equilibrium normal and oblique shock wave, chemically non-equilibrium 1-D nozzle flows, speed of sound in non-equilibrium flows, non-equilibrium conical flow, and non-equilibrium flows on blunt bodies, binary scaling, and introduction to radiative gas dynamics.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concepts of effect of high speed flow	K2
CO2	Understand the concepts of effect of boundary layer in high speed flow	K2
CO3	Apply the principle of equilibrium chemical reaction across different types of flows.	K3
CO4	Apply the principle of non-equilibrium chemical reaction across different types of flows.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Hyper Sonic and High Temperature Gas Dynamics	John D Anderson	AIAA	3th Edition
2	Fundamentals of Aerodynamics	John D Anderson	John Wiley & Sons	9th Edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Super – and Hyper sonic aero dynamics heat transfer	G K Mikhailov and V Z Parton	CRC Press Inc	1 st edition (10 November 1992)

SEMESTER 7
ROTARY WING THEORY AND HELICOPTER
AERODYNAMICS

Course Code	PEAOT753	CIE Marks	40
Teaching Hours/Week (L:T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fluid Mechanics, Aerodynamics	Course Type	Theory

Course Objectives:

1. The course is meant to give the learners an introduction to the basic ideas of evolution, performance and associated stability problems of helicopters.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction: Evolution of helicopter, Helicopter configurations-rotor arrangements, Compound helicopter, Rotor in vertical flight: Momentum theory for hover, Figure of merit, Momentum theory for vertical climb, Vertical descent, Autorotation, Complexity of real wake, Wake analysis methods, Ground effects, Blade element theory: Basic method, Thrust approximation, Ideal twist, Blade mean lift coefficient, Power approximations, Tip loss.	9
2	Rotor mechanisms for forward flight: The edgewise rotor, Flapping motion, Rotor control, Equivalence of flapping and feathering. Rotor aerodynamics in forward flight: Momentum theory, Wake analysis, blade element theory- Factors involved, Thrust, In-plane H force, Torque and power, Flapping coefficients.	7
3	Aerodynamic design: Introduction, Blade section design, Blade tip shapes, Parasite drag, Rear fuselage upsweep, Higher harmonic control, Aerodynamic design process.	13

	Performance: Introduction, Hover and vertical flight, Forward level flight, Climb in forward flight, Optimum speeds, Maximum level speed, Rotor limits envelope, Accurate performance prediction, Speculation on the really-low-drag helicopter, High altitude operation.	
4	Trim, Stability and Control: Trim, Treatment of stability and control, Static stability-Incidence disturbance, Forward speed disturbance, Angular velocity disturbance, Side slip disturbance, Yawing disturbance. Dynamic stability: Analytical process, Special case of hover. Hingeless rotor, Control, Auto stabilization	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the evolution and different theories used in helicopter aerodynamics.	K2
CO2	Understand the different forces acting in helicopters in different flight conditions.	K2
CO3	Understand the different aerodynamic design process and performance of helicopters in different flight conditions.	K2
CO4	Understand the stability and control in helicopters.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	1
CO3	3	1	-	-	-	-	-	-	-	-	-	1
CO4	3	1	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	“Aerodynamics of Helicopter”	Gessow A & Myers G.C	Mac Millan & Co	1987
2	“Basic Helicopter Aerodynamics”	Seddon. J	AIAA education series,	1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	“Helicopter Engineering”	Gupta. L	Himalayan Books	1996
2	“Foundation of Helicopter Flight”	Newman. S	Halsted Press	1994
3	“Dynamics of Helicopter flight”,	Saunders	John Wiley	1975

SEMESTER 7
ELASTIC ANALYSIS OF PLATES AND SHELLS

Course Code	PEAOT754	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Elastic Analysis of Plates and Shells	Course Type	Theory

Course Objectives:

- 1.To introduce the functions of cryogenic engines and its applications in engineering

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Elasticity, Fundamentals of elasticity: stress, strain, and material behaviour. Constitutive relations: Hooke's law for isotropic materials. Basic concepts: linear elasticity, plane stress, and plane strain. Plate Theory Basics-Definition and classification of plates (thin vs. thick, isotropic vs. anisotropic).Assumptions in plate theory: Kirchhoff-Love theory vs. Mindlin-Reissner theory. Governing differential equations: Derivation and boundary conditions. Displacement and stress functions in plate analysis. Solution Methods for Plates- Analytical methods: Navier's solution for simply supported plates. Classical plate theory solutions: bending of rectangular and circular plates	10
2	Advanced Plate Analysis-Buckling of Plates-Buckling theory: Critical load calculations. Simple cases: uniformly loaded plates, plates with various boundary conditions. Impact of geometric imperfections and nonlinearity. Dynamic Analysis of Plates-Vibration theory: natural frequencies and mode shapes. Free and forced vibration analysis. Damping effects and response to dynamic loads Plates with Complex Boundary Conditions-Analysis of plates with varying thickness, non-uniform properties. Plates with cutouts and discontinuities.	10

3	Introduction to Shell Theory-Fundamentals of Shell Theory-Definition and types of shells: cylindrical, spherical, conical. Basic assumptions: Membrane theory vs. bending theory. Governing equations: Derivation and application for different shell types Analysis of Thin Shells-Membrane analysis: Stress and strain in thin shells. Bending and stretching behaviour: Analytical solutions for simple geometries. Applications: Pressure vessels, storage tanks, and structural shells. Advanced Shell Analysis-Shells with complex shapes and boundary conditions. Numerical methods: Finite element modelling of shells.	9
4	Applications and Case Studies-Case Studies in Plate Analysis-Real-world applications: Bridges, aircraft wings, building floors. Detailed analysis of historical and modern engineering problems. Practical considerations: Material properties, environmental effects. Case Studies in Shell Analysis- Applications in civil, aerospace, and mechanical engineering. Examination of iconic shell structures: domes, shells, and tanks	7

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the concepts of elasticity and plate by analytical method	K2
CO2	Analysis of plates using buckling and vibration conditions	K2
CO3	Analysis of thin shells	K2
CO4	Apply plate analysis in real world applications	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	1
CO3	3	1	-	-	-	-	-	-	-	-	-	1
CO4	3	1	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Theory of Plates and Shells	Reinhold Kienzler, Ingrid Ott Holm Altenbach	springer	2004
2	Progress in Continuum Mechanics	Holm Altenbach Hans Irschik	springer	2023

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Elasticity and Plasticity of Large Deformations	Albrecht Bertram	3rd edition, springer	2012
2	Mechanics of Laminated Composite Plates and Shells: Theory and Analysis	N Reddy	2 nd edition, CRC press	2003
3	Theory and Analysis, Fourth Edition (Applied and Computational Mechanics)	A. C. Ugural	4th Edition, CRC press	2017

SEMESTER 7

ROCKETRY AND SPACE MECHANICS

Course Code	PEAOT755	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3/5	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Rocketry and Rocket propulsion	Course Type	Theory

Course Objectives:

1. The purpose of the course is to introduce students to particle motion and rocket motion in space.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Solar system: Reference frames and coordinate systems, Celestial sphere- The ecliptic- Motion of vernal equinox, Sidereal time Solar time, Standard time, Galilean transformation, Newton's law of gravitation Kepler's law, Estimation of orbital and escape velocity- Many body problem, Lagrange Jacobi Identity, Circular restricted three body problem. Liberation point, Relative motion in the N-Body problem. Two body problem, Satellite orbit relation between position and time Perifocal frame, Lagrange coefficients and points, coordinate transformation, transformation between geocentric equatorial and Perifocal frames, (Numerical problems)	14
2	Orbital position as function of time –, Gibbs method of orbit determination from three position vector, Lambert's problem, orbit determination, Orbit determination by Gauss's method, Orbital manoeuvres: - Hohmann Transfer and non-Hohmann transfer, Chase and phasing maneuverer ,(Numerical problems).	8
3	Principles of operation of rocket motor – Thrust equation, one dimensional and two dimensional rocket motion in free space and homogeneous gravitational field, description of vertical, inclined and gravity turn	7

	trajectories determinations of range and altitude, simple approximation to burnout velocity, need for multi staging of rocket vehicle, multistage vehicle optimization (Numerical problems)	
4	Stage separation dynamics and separation techniques, aerodynamic jet control methods of rocket vehicles, description of various loads experienced by a rocket passing through atmosphere, drag estimation- wave drag, skin friction drag, form drag and base pressure drag, boat tailing in missiles performance at various altitudes, rocket dispersion-launching problems.	7

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain and use basics of solar system and fundamentals of motion of particle in space	K2
CO2	Explain different types of orbit and orbital maneuverer and are able to solve complex problems.	K2
CO3	Describe the theories and positioning of rockets	K2
CO4	Evaluate the concept loads on rockets while moving through the atmosphere.	K4

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	2	2	-	-	-	-	-	-	-	2
CO2	3	2	2	2	-	-	-	-	-	-	-	2
CO3	3	2	2	2	-	-	-	-	-	-	-	2
CO4	3	2	2	2	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Rocket Propulsion Elements	George P Sutton	Wiley	2016
2	Mechanics and Thermodynamics of Propulsion	Hill	Pearson Education	2009
3	The Satellite Experimenter's Handbook	M. Davidoff	American Radio Relay League	1990

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fundamentals of Astrodynamics	Bate R R, Muller D, and White J E	Dover Publications	1971
2	Modern Astrodynamics Fundamentals and Perturbation method.	Bond V R and Allman M C	Princeton University Press	1996

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/101/105/101105029/
2	https://archive.nptel.ac.in/courses/101/106/101106046/
3	https://onlinecourses.nptel.ac.in/noc20_ae06/preview
4	https://onlinecourses.nptel.ac.in/noc20_ae06/preview

SEMESTER 7

ENERGY METHODS IN STRUCTURAL MECHANICS

Course Code	PEAOT756	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Aircraft Structures	Course Type	Theory

Course Objectives:

To introduce the basic concepts of deflection of structures using different methods.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to Energy Methods- Overview of energy principles in mechanics. Historical context and significance in structural analysis. Work and Energy: Definition of work, kinetic energy, and potential energy. Work done by forces and strain energy in structural members. The Principle of Virtual Work: Concept and derivation. Applications to trusses, beams, and frames. Potential Energy: Strain energy and its calculation in elastic members. Application to deformation problems.	9
2	Theorems Based on Energy Methods- Castigliano's Theorems: First theorem: Calculation of displacements. Second theorem: Calculation of forces in structures. Principle of Minimum Potential Energy: Derivation and applications. Applications in finding equilibrium and stability of structures. Rayleigh-Ritz Method: Introduction to approximation techniques for complex problems. Application in beam and plate problems. Method of Displacement: Overview of displacement methods in structural analysis. Application in simple structural systems.	9

3	Advanced Topics in Energy Methods- Nonlinear Analysis: Introduction to nonlinear behaviour in materials and structures. Energy methods in nonlinear structural analysis. Finite Element Method (FEM): Basic principles of FEM and its connection to energy methods. Introduction to discretization and approximation techniques. Dynamic Analysis: Energy methods in dynamic loading and vibration analysis Application of energy principles to dynamic response. Optimization in Structural Design: Using energy methods for optimizing structural designs.	9
4	Practical Applications and Case Studies- Case Studies: Detailed analysis of real-world structures using energy methods. Software Tools: Introduction to software tools for energy method analysis (e.g., MATLAB, ANSYS).	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Discuss the concepts of work and energy	K2
CO2	Apply energy theorems in structural systems	K3
CO3	Apply energy methods in finite element method	K3
CO4	Apply energy methods in real life situations	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics of Materials	Anthony Bedford and Kenneth M. Liechti	Cengage Learning India Pvt. Ltd ,	2022
2	Structural Analysis	Dr. R. Vaidyanathan,M Dr. P. Perumal	Laxmi publication, vol 1	2019
Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Structural analysis II	R. Vaidyanathan, p. Perumal	Laxmi Publications Edition, third edition	2019
2	Energy Methods in Structural Mechanics	Irving H Shames	CRC press,	2017

SEMESTER 7

AIRCRAFT DESIGN APPROACH

Course Code	PEAOT757	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Aircraft Structures	Course type	Theory

Course Objectives:

Understanding of the basic principles and processes involved in aircraft design

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	REVIEW OF DEVELOPMENTS IN AVIATION : Categories and types of aircrafts – various configurations – Layouts and their relative merits – strength, stiffness, fail safe and fatigue requirements – Manoeuvring load factors – Gust and maneuverability envelopes – Balancing and manoeuvring loads on tail planes.	9
2	PRELIMINARY DESIGN : Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram – Drag estimation of complete aircraft – Level flight, climb, take – off and landing calculations – range and endurance – static and dynamic stability estimates – control requirements.	11
3	POWER PLANT TYPES AND CHARACTERISTICS AND STRUCTURAL DESIGN : Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant, Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections, and joints. Materials for modern aircraft – Methods of analysis, testing and fabrication.	8

4	SPECIAL PROBLEMS: Layout peculiarities of subsonic and supersonic aircraft – optimization – of wing loading to achieve desired performance – loads on undercarriages and design requirements.	8
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the developments of design in aviation.	K2
CO2	Solve for range and endurance to obtain the aircraft's operational efficiency.	K3
CO3	Understand the types and characteristics of power plants, along with their structural design concepts.	K2
CO4	Understand the layout peculiarities of subsonic and supersonic aircraft.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	2
CO2	2	2	-	-	-	-	-	-	-	-	-	2
CO3	2	-	-	-	-	-	-	-	-	-	-	2
CO4	2	-	-	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft conceptual design	D.P. Raymer	AIAA Series	2018
2	Fundamentals of Supersonic and Hypersonic Aerodynamics	T. Anderson	Cambridge University Press	2022
3	Analysis and Design of Flight Vehicle Structures	E.F. Bruhn	Tristate Offset Co	1980

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Synthesis of Subsonic Airplane Design	E. Torenbeek	Delft University Press, London	1976
2	Integrated design approach to Design fly by wire	H.N.Kota	Lecture notes Interline Pub	2005
3	Notes on airplane design	A.A. Lebedenski	Part-I, I.I.Sc., Bangalore	1971

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	Course Introduction - Introduction to Aircraft Design

SEMESTER 7

STABILITY AND CONTROL IN AIRCRAFT

Course Code	PEAOT758	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Flight Mechanics	Course Type	Theory

Course Objectives:

To introduce a variety of study techniques and strategies for comprehending the fundamental ideas behind aircraft stability and control.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Aircraft Stability & Control Static and dynamic stability-Aircraft Coordinate system-Need of stability in an airplane, purpose of control. Degree of freedom of system-Inherently and marginally stable airplanes-Basic equation of equilibrium.	9
2	Longitudinal Control and Stability: Contributions of Wing, Tail, and Fuselage Longitudinal control-Wing and tail contribution towards static stability-Effect of fuselage and engine-Centre of gravity location in stability-Elevator control and effectiveness-Stick fixed and stick free neutral point-Tail volume ratio.	9
3	Control Surface Forces and Stability Effects Hinge moment coefficient-Aerodynamic balancing of control surfaces-Stick force gradients-Dihedral effect-Adverse aileron yaw-Dorsal and ventral fin-Aileron reversal. Roll Control and Rudder Effects Roll control effectiveness-Weather cocking effect-Rudder requirements-Rudder lock-One engine inoperative condition-Phugoid motion-short and long period Approximation.	9

4	Stability Derivatives and Aircraft Stability Analysis Stability derivatives-Routh's discriminant, solving the stability quadratic-Dutch roll effect and Approximation-Directional Divergence-Spiral instability-Auto rotation and spin.	9
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Course Assessment Method
(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the importance of stability and control in aircraft.	K2
CO2	Apply the concepts of individual contribution of aircraft components towards stability.	K3
CO3	Apply the principles of aerodynamic balancing in stability.	K3
CO4	Apply stability derivatives to obtain aircrafts' directional and spiral stability	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Airplane Performance, Stability and Control	Perkins, C.D., and Hage, R.E	John Wiley & Son:,Inc, New York	1993
2	Dynamics of Flight Stability and Control	Etkin, B	John Wiley, New York	2018

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Dynamic Stability and Response	Arthur William Babister	Pergamon Press	1979
2	Performance, Stability, Dynamics, and Contro	Bandu N. Pamadi	AIAA (American Institute of Aeronautics and Astronautics)	2004
3	Aeroplane Aero dynamics	.Dommasch, D.O., Shelby, S.S., and Connolly, T.F	McGraw-Hill	1971
4	Flight Stability and Automatic Control	Nelson, R.C	McGraw-Hill Book Co	2002

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1-4	https://archive.nptel.ac.in/courses/101/104/101104062/

SEMESTER 7
ROCKET PROPULSION

Course Code	OEAOT721	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. Understand the principles and components of rocket propulsion systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of rocket engines: Fundamentals and principles of rockets and its operation, types of rocket engines, basic principles and thrust equation, specific impulse, total impulse, exhaust velocity, characteristic velocity, thrust coefficient and mass flow coefficient, design parameters for rocket engine, energy flow and efficiencies. (Numerical)	9
2	Solid propellant rocket motor: General features, solid propellants and its chemical compositions, double basics propellant, composite propellant, desirable properties and its demerits, combustion of solid propellant, burning rate and its relation with temperature, erosive burning, combustion instability, strand, and T- burner, regressive, neutral and progressive, propellant grain configuration restricted and unrestricted burning, ignition, different loads on propellant during flight.	9
3	Liquid propellant rocket engines: Comparison with other propulsion system, disadvantages of liquid engines, liquid propellants, monopropellant, bi-propellant, selection of liquid propellants and bi-	9

	propellant combination, pressure and turbo pump feed system, ignition of propellants, cooling system, regenerate cooling, injectors for liquid propellant rockets Thrust control and cooling in liquid propellant rockets and the associated heat transfer problems. Combustion instability in liquid propellant rockets. Problems associated with operation of cryogenic engines.	
4	Advanced rocket engines: Hybrid rocket engines, inverse hybrid rocket engines, comparisons and its limitations, types of nozzles used for rocket application, effect of back pressure on nozzles, over expanded under expanded and optimum expanded nozzles, effect of altitude on nozzle performance. Nuclear rockets, electric rocket engines, electro thermal propulsion, electrostatic propulsion, solar thermal rocket, solar sail	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO 1	Understand the operating principle of the rocket and spacecraft propulsion systems.	K2
CO 2	Understand the fundamental concepts and operational characteristics of solid propellant rocket motors	K2
CO 3	Understand the basic concepts and operating characteristics of liquid propellant rocket motors	K2
CO 4	Understand the working principles of advanced propulsion systems.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	-	-	-	-	-	-	-	-	1
CO2	2	1	1	-	-	-	-	-	-	-	-	1
CO3	2	1	1	-	-	-	-	-	-	-	-	1
CO4	2	1	1	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Rocket Propulsion and Spaceflight Dynamics	J. W. Cornelisse, H. F. R. Schöyer, K. F. Wakker	Cambridge University Press	04 July 2016
2	Rocket and Spacecraft Propulsion	Truner Martin	Springer,	3 rd edition, 2009
3	Elements of rocket propulsion	Sutton.G.P, Biblarz. O	John Wiley & Sons Inc	7 th edition 2010

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Mechanics and Thermodynamics of Propulsion	Philip Hill and Carl Peterson	PEARSON	2009

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/101/104/101104078/

SEMESTER 7

SPACE TECHNOLOGY

Course Code	OEAOT722	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the foundations of aeronautical propulsion, the orbital movements and mechanics .
2. Understand space mission operations and satellite attitude dynamics.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Fundamentals of Aerospace Propulsion: Space Mission, Types, Space Environment, Launch Vehicle Selection. Introduction to rocket propulsion-fundamentals of solid propellant rockets, Fundamentals of liquid propellant rockets, Rocket equation, Tsiolkovsky rocket equation, Concepts of Specific Impulse.	9
2	Atmospheric Reentry: Introduction-Steep Ballistic Reentry, Ballistic Orbital Reentry, Skip Reentry, “Double-Dip” Reentry, Aero-braking, Lifting Body Reentry.	9
3	Satellite Attitude Dynamics: Torque free Axi-symmetric rigid body, Attitude Control for Spinning Spacecraft, Attitude Control for Non-Spinning Spacecraft, The Yo-Yo Mechanism, Gravity – Gradient Satellite, Dual Spin Spacecraft, Attitude Determination.	9
4	Space Mission Operations: Supporting Ground Systems Architecture and Team interfaces, Mission phases and Core operations, Team Responsibilities, Mission Diversity, Standard Operations Practices. .	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Distinguish the types of aerospace propulsion.	K2
CO2	Explain different types of atmospheric re-entries.	K2
CO3	Define the attitude of the satellites.	K2
CO4	Contrast the space mission operations.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Spaceflight Dynamics	W.E. Wiesel	McGraw Hill, 2nd edition, ISBN-13: 978-9332901650	2014
2	Rocket Propulsion and Space Dynamics	J.W. Cornelisse	J.W. Freeman & Co., Ltd., London,	1982
3	Fundamentals of Space Systems	Vincet L. Pisacane	Oxford University Press	2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Understanding Space: An Introduction to Astronautics	J. Sellers	McGraw Hill, 2nd edition, ISBN-13: 978-0072424683	2000
2	Elements of Space Technology for aerospace Engineers	Meyer Rudolph X	Meyer Rudolph X Academic Press	1999

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/101/106/101106046/
2	https://archive.nptel.ac.in/courses/101/106/101106046/
3	https://archive.nptel.ac.in/courses/101/106/101106046/
4	https://archive.nptel.ac.in/courses/101/106/101106046/

SEMESTER 7

COMPOSITE STRUCTURE DESIGN

Course Code	OEAOT723	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. Understand the concepts of composite materials
2. Understand the various manufacturing processes, quality control methods, and testing procedures for composite materials and structures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	FUNDAMENTALS OF COMPOSITE MATERIALS Introduction to Composites: Definition, classification (polymer matrix, metal matrix, ceramic matrix composites). Constituent Materials: Overview of fibers (glass, carbon, aramid) and matrices (polymer, metal, ceramic). Properties of Composites: Mechanical properties, advantages over traditional materials and limitations. Manufacturing Processes: Overview of fabrication methods (hand lay-up, resin transfer molding, filament winding).	9
2	MECHANICS OF COMPOSITE MATERIALS Basic Mechanics: Stress-strain relationships, Hooke's law for anisotropic materials. Micromechanics and Macromechanics: Analysis of a single layer (micromechanics), behaviour of laminates (Macromechanics). Failure Theories: Introduction to common failure criteria (Tsai-Hill, Tsai-Wu), modes of failure in composites. Environmental Effects: Influence of temperature, moisture, and other environmental factors on composite performance.	9
3	DESIGN OF COMPOSITE STRUCTURES Design Principles: Considerations for composite structure design, weight optimization, load distribution. Lamination Theory: Basics of Classical	9

	Laminate Theory (CLT), stress-strain analysis in composite laminates. Design Criteria: Design against strength and stiffness, failure criteria application, and safety factors. Finite Element Analysis (FEA): Introduction to FEA in composite design, modeling techniques, and analysis.	
4	FABRICATION AND TESTING OF COMPOSITE STRUCTURES Fabrication Techniques: Detailed exploration of composite manufacturing processes. Quality Control: Non-destructive testing methods, inspection techniques for composite structures. Testing Methods: Mechanical testing procedures (tensile, compression, shear tests) for composite materials. Design Verification: Methods for verifying design through testing, ensuring structural integrity and performance.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Explain the basic concepts of composite materials.	K2
CO2	Describe the mechanical properties of composite materials.	K2
CO3	Understand the stress-strain relationships in composites and the fundamentals of failure theories.	K2
CO4	Discuss the various fabrication techniques and quality control methods used in composite material production.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-
CO4	3	2	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Composite Materials: Science and Engineering	Chawla, K. K.	Springer India	01 st January, 2015
2	Engineering Mechanics of Composite Materials	Daniel I. M. and O. Ishai	Oxford University Press	2006
3	Design and Analysis of Composite structures	Christos Kassapoglou	Wiley	2 nd edition, 10 th May 2013

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Fiber-Reinforced Composites: Materials, Manufacturing and Design	Mallick P. K	CRC Press	2007

SEMESTER 7

ADVANCED NON-DESTRUCTIVE TESTING

Course Code	OEAOT724	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives

To comprehend the fundamental ideas, methodologies, tools, applications and constraints of NDT approaches.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Acoustic emission inspection: Principles and Theory – Signal Propagation – Physical Considerations – The AE Process Chain - Time Considerations – AE Parameters –The AE Measurement Chain – Types of displays – Noise – Location calculation and Clustering – Advantages – Limitations – Relationship to other test methods - inspection of pressure vessels/welds/composite materials – AE testing during grinding – pipelines – steam turbines – AE location of faults in power transformers.	9
2	Leak Testing: Introduction to leak testing– objectives – terminologies – measurement of leakage –Types of leak – Types of flow in leaks – Principles of Fluid dynamics – Leak Testing of Pressure Systems Without and with a Tracer Gas – Halogen diode leak testing – Helium mass spectrometer leak testing and subsystems – Choosing the Optimum Leak Testing Method – System response in leak testing – Measurement of Leak Rate Using Calibrated Leaks – Common errors in Leak testing- Leak testing for special applications-standards.	9
3	Digital Radiography: Principles of Digital Radiography-Methods of digital radiography – digitization of X-ray films – computed radiography (CR) and direct radiography (DR) – process of image formation in CR – comparison of	9

	film, CR and DR method.	
4	Computed Tomography (CT): Computed Tomography – CT image reconstruction algorithm – Capabilities, comparison to other NDT methods – industrial CT applications – CT System design and equipment – CT scanning geometries, data acquisition system – Image quality, image artifacts, special features, reconstruction techniques.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand acoustic emission inspection techniques to detect and evaluate defects in materials and structures.	K2
CO2	Understand various leak testing methods in non-destructive testing.	K2
CO3	Understand digital radiography techniques to inspect materials and structures for internal defects and quality assurance.	K2
CO4	Understand and utilize computed tomography techniques for detailed internal inspection.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	2	1	-	-	-	-	-	1
CO2	2	-	-	-	2	1	-	-	-	-	-	1
CO3	2	-	-	-	2	1	-	-	-	-	-	1
CO4	2	-	-	-	2	1	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Nondestructive evaluation of materials by infrared thermography,	X. P. V. Maldague,	Springer-Verlag,	1st edition, 1993
2	Emerging Technologies in Non-Destructive Testing,	A.S. Paipetis, T. E Matikas and D. G. Aggelis,	CRC Press,	2012
3	Acoustic Emission Testing,	C. U. Grosse,	Springer,	2008

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Non-Destructive Testing Handbook; Infrared and Thermal Testing , Vol-3, series III,	X. P.V. Maldague,	American Society for Non-Destructive Testing,	3rd edition 2001
2	Non-Destructive Testing Handbook; Leak Testing , Vol - 1, series VI,	C. N. Jackson and N.Sherlock	American Society for Non-Destructive Testing,	3rd edition 1998
3	Non-Destructive Testing Handbook; Acoustic Emission Testing, Vol-6, series V,	R. K.Miller and V.K.Hill,	American Society for Non-Destructive Testing,	3rd edition 2005
Video Links (NPTEL, SWAYAM...)				
Module No.	Link ID			
1,2,3 & 4 Module	https://archive.nptel.ac.in/courses/113/106/113106070/			

SEMESTER 7

ADVANCED FLIGHT MECHANICS

Course Code	OEAOT725	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

Understand airplane performance and how aircraft respond to different flight conditions and changes.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Aircraft Speed Measurements and Drag Analysis: Measurement of speed & Mach number, True, Indicated and Equivalent air speed, Streamlined and bluff bodies, Various Types of drag in airplanes, drag polar curve, Equations of Motion – Forces Acting on the Aircraft	9
2	Airplane Performance - Steady Flight, Range, Endurance, Conditions for Maximum Range and Endurance, Climb Performance, Turn Performance, Maximum Load Factor During Turn. Glide Performance – Take-Off and Landing Performance. Comparison with Turbojets and Turboprop Performance Evaluation Guidelines	9
3	Static Stability :Degrees of freedom of a system, static and dynamic stability, static longitudinal stability, Contribution of individual components, neutral point, static margin, Hinge moment, Elevator control effectiveness, Aircraft equations of motion, stability derivatives, stability quartic, Phugoid motion	9
4	Dynamics : Yaw and side slip, Dihedral effect, contribution of various components, lateral control, aileron control power, strip theory, Aileron reversal, weather cock stability, directional control, rudder requirements,	9

	dorsal fin, Dutch roll, spiral and directional divergence, autorotation and spin(descriptive)	
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Course Assessment Method
(CIE: 40 marks,ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the drag, power and thrust characteristics	K2
CO2	Understand the airplane performance across various operating conditions.	K2
CO3	Understand the contribution of individual components in the stability of an aircraft.	K2
CO4	Understand the static and dynamic response of aircraft for both voluntary and involuntary changes in flight conditions.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	2
CO2	2	2	-	-	-	-	-	-	-	-	-	2
CO3	2	2	-	-	-	-	-	-	-	-	-	2
CO4	2	2	-	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Aircraft Performance and design	John D Anderson Jr.	McGraw-Hill Education	2017
2	Airplane Performance Stability and Control	Courtland D Perkins, Robert E Hage	John Wiley & Sons	1996
3	Flight stability and automatic control	Nelson R C	McGraw-Hill book Co	2004
4	Advanced Aircraft Flight performance	Filippone, Antonio	Cambridge university	2012

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Steady Aircraft flight and performance	N.Harris, McClamroch	Princeton University	2011
2	Theory and Practice of aircraft performance	Ajoy Kumar Kundu, Mark A Price, David Riordan	Wiley	2016
3	Dynamics of flight stability and control	Bernard Etkin, Lloyd Duff Reid	Wiley	3 rd Edition, 1996
4	Aircraft performance :An Engineering Approach	Mohammed H Sadraey	CRC Press	2023
5	Introduction to Flight	John D Anderson Jr	McGraw-Hill Education	Eighth Edition, 2016

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://nptel.ac.in/courses/101106041
2	
3	
4	

SEMESTER 7
AEROELASTICITY

Course Code	OEAOT726	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course type	Theory

Course Objectives:

1. To understand the basic concepts of aero elastic phenomena.
2. To understand the methods to control and prevent aeroelastic instabilities.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	AEROELASTIC PHENOMENA: Stability versus response problems – introduction to aeroelasticity and aeroelastic phenomena – Examples of aeroelastic phenomena – Galloping of transmission lines – Flow induced vibrations of tall slender structures – Instability of suspension bridges – Fluid structure interaction – The aero-elastic triangle of forces – Prevention of aeroelastic instabilities.	9
2	MODELING OF AEROELASTIC PHENOMENA: Influence and stiffness coefficients – illustration of aeroelastic phenomena using simplified aerodynamic and structural models – different subsonic and supersonic aerodynamic models for aeroelastic analysis – modeling techniques – aeroelastic models in state-space format Flexure – torsional oscillations of beams – Governing differential equation of motion and its solution.	9
3	STATIC AEROELASTIC PHENOMENA AND FLUTTER CALCULATIONS : Simple two dimensional idealization – Strip theory – Successive approximation method – Numerical approximations using matrix equations – Divergence of 2-D airfoil	9

	and Straight Wing – Aileron efficiency & reversal – Control Effectiveness – Wing deformations of swept wings ,Flutter analysis – Two dimensional thin airfoils in steady incompressible flow –Quasi-steady aerodynamic derivatives – Galerkin method for critical flutter speed – Stability of disturbed motion – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter Calculation – U-g Method – P-k Method – Exact Treatment of Bending –Torsion Flutter of a Uniform Wing – Flutter Analysis by Assumed Mode Method.	
4	PREVENTION AND CONTROL : Stiffness criteria – dynamic mass balancing – dimensional similarity – effect of elastic deformation on static longitudinal stability – introduction to aeroelastic control – aeroelastic aspects in the design of aircraft – Panel flutter and its control – Prevention of tail buffeting – Aeroelastic instabilities in helicopter and engine blades and prevention methods	9

Course Assessment Method

(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE):

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24 marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 subdivisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concepts of aeroelasticity in aircraft design	K2
CO2	Describe the use of semi-rigid body assumptions and numerical methods in airplane design	K2
CO3	Understand the concepts of steady state aeroelastic and flutter analysis problems.	K2
CO4	Understand the aeroelastic aspects in design of aircraft.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	A Modern Course in Aeroelasticity	E.H. Dowell et.al.	Sijthoff & Noordhoff	1980
2	Aero elasticity	R.L. Bisplinghoff, H. Ashley and R.L. Halfman	Addison- Wesley,	1955
3	Introduction to Structural Dynamics and Aeroelasticity	D.H. Hodges and G.A. Pierce	Cambridge Aerospace Series,	2002
4	Nonconservative Problems of the Elastic Theory of Stability	V.V. Bolotin	Pergamon Press	1963

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Introduction to the study of Aircraft Vibration and Flutter	R.H. Scanlan and R. Rosenbaum	Macmillan	1951
2	An Introduction to the Theory of Aeroelasticity,	Y.C. Fung	John Wiley & sons	1955
3	Aeroelasticity	H. Ashley	Applied Mechanics Reviews	1970

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	1. Introduction to Aeroelasticity

SEMESTER 7

SATELLITE SYSTEMS AND APPLICATION

Course Code	OEAOT727	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. The purpose of the course is to understand the basics of satellite orbits, segments, satellite access and applications.

Syllabus

Module No.	Syllabus Description	Contact Hours
1	SATELLITE ORBITS: Kepler's Laws, Newton's law, orbital parameters, orbital perturbations, station keeping, geostationary and non Geo-stationary orbits – Look Angle Determination- Limits of visibility –eclipse-Sub satellite point –Sun transit outage-Launching Procedures - launch vehicles and propulsion.	9
2	SPACE SEGMENT AND SATELLITE LINK DESIGN: Spacecraft TechnologyStructure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, Communication Payload and supporting subsystems, Telemetry, Tracking and command. Satellite Uplink and Downlink Analysis and Design, Link Power Budget, C/N calculation, G/T ratio-Performance Impairments-System noise, Intermodulation Noise, Noise Temperature, Propagation Factors, Rain and Ice effects, Polarization	9
3	SATELLITE ACCESS: Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, Assignment Methods, Spread Spectrum communication, compression – encryption	9
4	SATELLITE APPLICATIONS: INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, INMARSAT, LEO, MEO, Satellite Navigational System. Direct Broadcast satellites (DBS)- Direct to home	9

	Broadcast (DTH), Digital audio broadcast (DAB)- World space services, Business TV (BTV), GRAMSAT, Specialized services – E –mail, Video conferencing, Internet.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Analyze the satellite orbits	K4
CO2	Analyze the space segment	K4
CO3	Explain the satellite access	K2
CO4	Understand the various satellite applications	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Satellite Communication	Dennis Roddy	Fourth Edition, McGraw Hill International	2006
2	Satellite Communication Systems Engineering	Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson	Prentice Hall/Pearson	2007
3	Satellite Communication Applications	Bruce R. Elbert	Artech House Boston London	1997

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Manual of Satellite Communications	Emanuel Fthenakis	McGraw Hill Book Co.	1984
2	Satellite Communication Systems-Design Principles	M. Richharia	Macmillan	2003

SEMESTER 8

AERONAUTICAL ENGINEERING

SEMESTER 8

AVIONICS AND AIRCRAFT SYSTEMS

Course Code	PEAOT861	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Fundamentals of aeronautics and aircraft instruments	Course Type	Theory

Course Objectives:

1. To study the various experimental techniques involved for measuring displacements, stresses and strains in structural components.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTEGRATED AVIONICS AND SUBSYSTEMS: Need for avionics in civil and military aircraft and space systems - Integrated avionics and weapon systems - Typical avionics subsystems and their technologies. AVIONICS ARCHITECTURE AND DATA BUSES: Avionics system architecture generations - Data buses: MIL- STD-1553B, ARINC 429, AFDX/ARINC 664 - Fibre optic Data buses: IEEE STD 1393, MIL STD 1773.	11
2	AIRCRAFT DISPLAYS TECHNOLOGIES AND NAVIGATION SYSTEMS: Aircraft cockpit displays: MFD, HUD, HMD, DVI - Synthetic and enhanced vision - situation awareness, HOTAS, virtual cockpit - Radio navigation systems: ADF, DME, VOR, ILS - Inertial Navigation Systems (INS) - Satellite navigation systems – GPS.	9
3	AIRCRAFT CONTROL SYSTEMS: Hydraulic and Pneumatic systems: Types, components, working principles - Aircraft Fuel Systems: components and their types, gravity and pump feed setup, fuelling and defueling procedures – Aircraft Landing Gear system: Types, fixed and retractable landing gear, shock strut operation, break system–Autopilot System: components and their functions, operating principles, –Flyby Wire Systems – RVDT, LVDT and working concept.	9

4	AIRCRAFT SYSTEMS INSTRUMENTS: Pitot-Static instruments: Altimeters, Airspeed Indicator, Vertical Speed Indicator - Gyroscopic instruments: Gyro Horizon Indicator, Turn and Bank Indicator & Directional Gyroscope – Tachometer – Synchroscope – Pressure and Temperature measurement instruments.	7
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the needs of integrated avionics and avionics system architecture.	K2
CO2	Understand the principles of various cockpit displays and navigation system instruments.	K2
CO3	Understand the various control systems used in aircraft.	K2
CO4	Understand the conceptual design and working principles of various aircraft instruments.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	-	-	-	-	1
CO2	2	-	-	-	-	-	-	-	-	-	-	1
CO3	2	-	-	-	-	-	-	-	-	-	-	1
CO4	2	-	-	-	-	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Introduction to Avionics.	Collinson.R.P.G.	Chapman and Hall	1996
2.	Principles of Avionics.	Albert Helfrick. D.	Avionics Communications Inc.	2002
3.	Aircraft Instruments & Principles.	Pallet, E.H.J.	Pitman & Co.	1956

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Aircraft Power Plants.	Mekinley, J.L. and Bent, R.D.	McGraw-Hill	1964
2.	The Avionics Hand Book.	Spitzer. C.R.	CRC Press	2001
3.	Aviation Maintenance Technician Hand Book – Airframe Vol. I & II.	U.S. Dept. of Transportation	Federal Aviation Administration, The English Book Store, New Delhi	1998

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1.	archive.nptel.ac.in/courses/101/104/101104061/
2.	archive.nptel.ac.in/courses/101/104/101104061/
3.	archive.nptel.ac.in/courses/101/104/101104061/
4.	archive.nptel.ac.in/courses/101/104/101104061/

SEMESTER 8
HIGH SPEED PROPULSION SYSTEMS

Course Code	PEAOT862	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics and Fluid mechanics	Course Type	Theory

Course Objectives:

1. Understand the basic working and application of ramjet, scramjet, and rocket engines.
2. Introduction to aerodynamics of hypersonic propulsion system.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	FUNDAMENTALS OF HIGH TEMPERATURE GAS DYNAMICS High temperature effects, Calculation of entropy produced by equilibrium and non-equilibrium chemically reacting gases, governing equations for inviscid non-equilibrium flows, Normal shockwave, Oblique shock waves for equilibrium and non-equilibrium chemically reacting flows, equilibrium and non-equilibrium one dimensional nozzle flows.	8
2	PRINCIPLE OF OPERATION OF RAMJET Ideal ramjet performance, Ram jet calculations, various components of Ramjet engines and their efficiencies, combustion chamber, combustion efficiency, combustion in Ramjet engine, flame stability problems in ramjet combustors –integral ram rockets. Quasi one dimensional heat addition Ram jet intakes with different operation condition, (Numerical calculations).	8
3	PRINCIPLE OF OPERATION OF SCRAMJET Need of supersonic combustion, performance parameters, Scramjet inlets, Starting and contraction limit, high temperature effect, blunt leading-edge effect, viscous phenomenon, boundary layer interaction and separation, design and performance of scram jet inlets, three-dimensional inlet design. Combustor flow, step combustor, isolator combustor, different types of fuel	10

	injection, mixing, combustor reaction, dual mode combustor, isolator, thermal choking, and nozzles.	
4	PRINCIPLE OF OPERATION OF ROCKET ENGINES Solid propellant rocket: - Thrust equation, burning rate, different types of grain for different thrust requirements, propellant casting, importance of particle size, types of ignition systems, combustion of solid propellant, solid propellant motor design, solid propellants. (Numerical calculations). Operating principle of liquid propellant rocket engines, propellants injectors and feed systems, Types of ignition systems, gelled propellants, gaseous propellant, selection of nozzles, combustion chamber and combustion in liquid propellant, cryogenic engines, (Numerical Problems).	10

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic equilibrium and non-equilibrium flow of different flow conditions.	K2
CO2	Apply the law of thermodynamics to find the values of performance parameters of RAMJET engine.	K3
CO3	Describe the fundamentals of SCRAMJET engines and its requirement.	K2
CO4	Elaborate the working of solid and liquid propellant rocket engines	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Gas Turbine Theory	H Cohen. G F C Rogers HIH Saravanamuthoo	Pearson	5 th Edition
2.	Rocket Propulsion Elements	Sutton	Wiley	9 th Edition
3.	Gas Turbine Theory	H Cohen. G F C Rogers HIH Saravanamuthoo	Pearson	5 th Edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Hypersonic Air breathing Propulsion	William H. Heiser and David T. Pratt	AIAA Education Series	
2.	Hypersonic Aerothermodynamics	John J. Bertin	AIAA Education Series	

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1.	https://onlinecourses.nptel.ac.in/noc24_ae12/preview
2.	https://archive.nptel.ac.in/courses/101/104/101104084/
3.	https://archive.nptel.ac.in/courses/101/104/101104084/
4.	https://onlinecourses.nptel.ac.in/noc22_ae03/preview

SEMESTER 8
INTRODUCTION TO FLOW INSTABILITY

Course Code	PEAOT863	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	MECHANICS OF FLUIDS, BOUNDARY LAYER THEORY	Course Type	Theory

Course Objectives:

To introduce students to the section of various instabilities associated with aerodynamic interactions to get a deeper essence of the fluid interactions across various thermodynamic regimes in dynamic mode.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Introduction to flow instabilities: Definition, Historical context and Applications. Classification: Temporal vs. Spatial instabilities. Mathematical tools: Linear Stability Theory, Perturbation Method. Boundary Layer Instabilities: Blasius Solution(s) and Boundary Layer Characteristics. Types: Tollmien - Schlichting waves and Klebanoff modes Mechanism of Boundary Layer Transitions: Effects of surface roughness and influence of free stream turbulence Control of instabilities: Active and Passive techniques, surface modifications and suction systems. Case study: Transition control in modern aircraft design.	10
2	Shock Waves: Formation and properties of shock wave, Shock – Boundary Layer interactions. Shock induced flow instabilities: Shock oscillations, Shock – turbulence interactions. Analysis Techniques for Shock-Induced Instabilities: CFD Simulations, Experimental methods and wind tunnel testing Mitigation strategies: Shock control devices. Design considerations for	9

	supersonic aircrafts. Case study: Examples of shock induced issues in modern aircrafts.	
3	Combustion induced flow instabilities: Thermo-acoustic instabilities, Flame dynamics and interactions with flow. Analysis and Measurement Techniques: Experimental techniques for combustion instabilities, Computational model for predicting instabilities. Control and Mitigation Strategies: Combustion chamber design enhancement, Active control methods and advanced materials.	9
4	Emerging Instability Phenomena: Non-linear stability phenomena, multi-phase flow instabilities. Advanced Computational and Experimental Methods: High-fidelity CFD simulations, Advanced experimental techniques like PIV and LDA. Impact of new technologies: Effects of new materials and propulsion systems. Integration of AI & ML in flow prediction. Future direction in Aeronautical Instability research.	8

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic principles, classifications and mathematical tools pertaining to fluid dynamics involved with instabilities.	K2
CO2	Describe the mechanism behind instabilities and techniques to control and counter it.	K2
CO3	Understand shock wave interaction and associated instabilities and techniques to quantify the same.	K2
CO4	Describe combustion induced instabilities, its measurement and mitigation strategies.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Hydrodynamic Stability	Peter D. G. W. Howard	CAMBRIDGE UNIVERSITY PRESS	1970
2.	Instabilities and Chaos in Supersonic Flows	William W. A. S. Martin	CAMBRIDGE UNIVERSITY PRESS	2015
3.	Turbulence and Flow Instability	Steven L. P. M. Moore	SPRINGER	2004

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Nonlinear Instabilities in Fluid Mechanics	Chris J. R. Parker	Academic Press	2018
2.	Computational Fluid Dynamics for Aeronautics	Thomas J. R. Burgess	Wiley	2010

SEMESTER 8
AERO ACOUSTICS

Course Code	PEAOT864	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Mechanics, Mechanics of Aircraft Materials	Course Type	Theory

Course Objectives:

1. Understand fundamental principles of Aero Acoustics.
2. Understand the generation and propagation of sound in atmosphere, and the physical mechanisms behind noise production.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic acoustic terminology and definitions - Plane waves and harmonic solution - velocity of sound in fluids - relationship between wavelengths, particle velocities, acceleration. Acoustic energy density and intensity - acoustic impedance associated with fluid flows. Logarithmic decibel scales – acoustic reference standards and noise regulations.	9
2	Conservation laws and governing equations of fluid mechanics - Light hill's analogy and derivation of Light hill's equation. Noise generated from flow turbulence – sound generation in subsonic and supersonic fluid flow over solid and flexible boundaries. Sound radiation from simple sources like monopole, dipole and quadruple. Brief introduction to computational aero acoustics.	9
3	Duct acoustics, sound fields in ducts and wave guides – property of duct modes. Cavity noise- turbo-machinery noise and buzz-saw noise - noise suppression devices like mufflers and plenum chambers. Noise insulation and absorption – Acoustic materials. Various sources of noise in an aircraft - noise produced by engine, propellers, fans, combustion chambers, - helicopter rotor noise – noise generated by subsonic and supersonic jets and rocket exhausts.	9

4	Noise produced by boundary layers on external surfaces- like fins and stabilizers or from sonic boom. Impact of noise levels on humans and environment. Phone and Sone scales. Perceived noise levels and noise number index - hearing loss index. Aircraft noise regulations near airports – important noise measurements and common instruments. Noise control by source modification, transmission path alterations and receiver protection.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand acoustics definitions and plane wave solutions in time and frequency domain.	K2
CO2	Explain importance of Light hill's analogy and light hill's equation in turbulence acoustic field.	K2
CO3	Understand the acoustic concepts in duct, cavity and mufflers to reduce noise.	K2
CO4	Describe the types of noise generation and sound measuring instruments in aircraft.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	1	1	-	-	-	-	1
CO2	2	-	-	-	-	1	1	-	-	-	-	1
CO3	2	-	-	-	-	1	1	-	-	-	-	1
CO4	2	-	-	-	-	1	1	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Aero Acoustics	M.E. Goldstein	Mc Graw Hill Publications	1976
2.	Acoustics and Noise Control	R.J. Peters, B.J. Smith and Margret Hollins	Routledge Publications,London	2011

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Aerodynamic Noise – An introduction for physicists and engineers	Tarit. K. Bose	Springer Publications, 2013 ISBN:9781461450191	2013
2.	Fundamentals of physical acoustics.	Blackstock, David T	John Wiley & Sons	2000
3.	Mechanics of Solids	S.Jose, Sudhi Mary Kurian	Pentagon	2009
4.	Engineering Principles of Acoustics	Reynolds D. D.	Allyn and Bacon Inc., Boston	1975

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1.	https://archive.nptel.ac.in/courses/112/106/112106225/
2.	https://archive.nptel.ac.in/courses/112/106/112106225/
3.	https://archive.nptel.ac.in/courses/112/106/112106225/
4.	https://archive.nptel.ac.in/courses/112/106/112106225/

SEMESTER 8
COMPOSITE MATERIALS

Course Code	PEAOT865	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	5/3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Nil	Course Type	Theory

Course Objectives:

1. To understand the characteristics, classifications, and applications of composite materials.
2. To understand the manufacturing processes and techniques used in producing composite materials.
3. To understand the various methods of testing, characterization, and design considerations essential for composite structures.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION TO COMPOSITE MATERIALS Characteristics and Classifications of Composites: Overview of composite materials, advantages, and limitations. Classification of composites: fibre-reinforced, particle-reinforced, and structural composites. Study of fibres: glass, carbon, aramid, and natural fibres. Particulate composites and flake composites. Basic Concepts in Composite Structures: Matrix materials: thermosetting and thermoplastic resins. Interface and interphase in composites. Surface treatments and their effects on composite performance.	9
2	MANUFACTURING OF COMPOSITE MATERIALS Production of Various Fibers: Methods of fiber production: glass, carbon, and aramid fibers. Processing and properties of matrix materials. Surface treatment techniques to enhance fiber-matrix bonding. Fabrication Techniques: Fabrication of thermosetting resin matrix composites. Fabrication of thermoplastic resin matrix composites. Manufacturing of short	9

	fiber composites, metal matrix composites (MMC), and ceramic matrix composites (CMC).	
3	TESTING AND CHARACTERIZATION OF COMPOSITES Mechanical Testing of Composites: Uniaxial tension, compression, and shear tests. Determination of inter laminar fracture toughness. Non-Destructive Evaluation (NDE) Techniques: Ultrasonic testing, acoustic emission, X-radiography. Damage identification and health monitoring in composite structures. Mechanical Behaviour of Composites: Longitudinal and transverse strength and stiffness. Failure modes in composite structures. Stress-strain variation in laminated composites.	9
4	DESIGN AND ANALYSIS OF COMPOSITE STRUCTURES Laminated Composite Structures: Analysis of symmetric laminates, cross-ply laminates, angle-ply laminates, and quasi-isotropic laminates. Design considerations for composite structures in aerospace applications. Repair and maintenance of composites. Advancements in Composite Materials: Carbon-carbon composites, Bucky paper. Nano-composites and smart composites. Application of composites in aerospace, automotive, defence, and industrial sectors. Future trends in composite materials and their impact on design.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental characteristics, classifications, and applications of composite materials.	K2
CO2	Understand the manufacturing processes and techniques used for various composite materials.	K2
CO3	Understand the mechanical behaviour, testing, and characterization methods for composite structures.	K2
CO4	Understanding the principles of design and analysis to composite structures in various engineering applications, particularly in aerospace.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	-	-	-	-	-	-	-	-	-	1
CO2	2	-	-	2	-	-	-	-	-	-	-	2
CO3	2	-	-	-	1	-	-	-	-	-	-	2
CO4	2	-	-	-	2	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Composite Materials: Science and Engineering	Chawla, K. K.	Springer India	2015
2.	Engineering Mechanics of Composite Materials	Daniel I. M. and O. Ishai	Oxford University Press	2006

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Fiber-Reinforced Composites: Materials, Manufacturing and Design	Mallick P. K	CRC Press	2007

SEMESTER 8

DESIGN OF AEROSPACE STRUCTURES

Course Code	PEAOT 866	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Aircraft Structures I & II	Course Type	Theory

Course Objectives:

To understand general design concepts for aerospace structures, components, vehicles, and materials.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION: Semi-Monocoque aerospace structures – Loads and Design considerations – construction concepts – layout – nomenclature and structural function of parts – strength vs. stiffness-based design – Energy Method – Beam bending. Bending, Shear and Torsion of Thin-Walled Beams (TWB): Bending and shear of open, closed, and thin-walled beams – torsion on single-cell thin-walled beams – torsion on multiple-cell thin-walled beams.	9
2	BUCKLING OF THIN-WALLED BEAMS: Concept of structural instability – flexural buckling analysis – bending of beams under combined axial and lateral loads – short column and inelastic buckling – Pure torsional buckling and coupled flexural-torsional buckling of open TWBs – concept of buckling of plates, local buckling of TWBs – buckling and post-buckling of stiffened skin panels – ultimate load carrying capacity of a typical semi-Monocoque TW box section – tension-field beams.	9
3	PLATE THEORY: Two Dimensional and Three-Dimensional Transformation of Stresses and strains – Thin Plate Theory – Stress Resultants and Kinematics – Thin Plate Governing Equations and Boundary Conditions.	9

4	COMPOSITE AND SANDWICH STRUCTURES: Introduction to Advanced Fibre Composites – Analysis of Orthotropic Composite Plies – Laminate theory – Analysis of Composite Laminates: Stiffness Matrix – Stress and Strain – Thermal Expansion – Failure Mechanisms and Analysis – failure criteria – composite beams – sandwich structures.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the design principles and structural behaviour of semi-Monocoque aerospace	K3
CO2	Apply shear stresses and twist angles in torsion for solid sections, closed thin-walled sections and open thin-walled sections.	K3
CO3	Apply thin plate theory to determine stress resultants, kinematics, and the governing equations for flat plate behaviour.	K3
CO4	Understand the suitability of composite materials for the simple structural elements for specific aerospace applications.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Aircraft Structures for Engineering Students	Megson, T. H. G.	Butter worth Heinemann	4th ed., (2007)
2.	Theory of Elasticity	Timoshenko, S. P. and Goodier, J. N.,	McGraw-Hill	(1970)

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Theory of Plates and Shells	Timoshenko, S. P. and Woinowsky-Krieger,	McGraw-Hill	2nd ed.,(1964)
2.	Analysis and Design of Flight Vehicle Structures	Bruhn, E. F.	Jacobs Publishing NC	2nd ed., (1973).

SEMESTER 8

THEORY OF ELASTICITY

Course Code	PEAOT867	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Mechanics of Aircraft Materials	Course Type	Theory

Course Objectives:

To apply the fundamental principles of elasticity, including variation of stress, strain, and material behaviour, to analyse deformation and mechanical response in elastic materials.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Definition and notation of stress, Equations of equilibrium in differential form, Stress components on an arbitrary plane, Equality of cross shear, Stress invariants, Principal stresses, Octahedral stress, Planes of maximum shear, Stress transformation, Plane state of stress, Mohr's diagram for 3-dimensional state of stress. (Numerical problems)	9
2	Displacement field, Strains in terms of displacement field, Infinitesimal strain at a point, Engineering shear strains, Strain invariants, Principal strains, Octahedral strains, Plane state of strain, Compatibility equations, Strain transformation. Principle of superposition, Saint Venant principle.	9
3	Cartesian coordinates, Relation between plane stress and plane strain, stress functions for plane stress and plane strain state, Airy's stress functions, investigation of Airy's stress function for simple beams. Bending of a narrow cantilever beam of rectangular cross section under edge load. Bending of a simply supported beam under UDL, stress concentration, stress distribution in an infinite plate with a circular hole subjected to uniaxial and biaxial loads. General equations in polar	9

	coordinates, stress distribution symmetrical about an axis, thick wall cylinder subjected to internal and external pressures	
4	Stresses in rotating discs of uniform thickness and cylinders. Numerical Problems. Torsion-Torsion of circular, elliptical, and triangular bars, Prandtl's membrane analogy, Torsion of thin-walled thin tubes, Torsion of thin-walled multiple cells closed sections. Thermal stress-Thermo elastic stress strain relations, equations of equilibrium, thermal stresses in thin circular discs and in long circular cylinders.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Apply the concepts of stress variation in elastic materials.	K3
CO2	Apply the concepts of strain variation in elastic materials.	K3
CO3	Apply the concepts plane stress and plane strain in beams and thin cylinders.	K3
CO4	Apply the concepts of torsion and thermal stresses in different cross sections.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	2
CO2	3	3	2	2	-	-	-	-	-	-	-	2
CO3	3	3	2	2	-	-	-	-	-	-	-	2
CO4	3	3	2	2	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Theory of Elasticity	S. P. Timoshenko and J. N Gordier	Mc-Graw Hill International	3rd edition, 2010
2.	Advanced Mechanics of solids	L. S. Srinath	Tata Mc. Graw Hill	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Theory of Elasticity	Sadhu Singh	Khanna Publications	2004
2.	Applied Elasticity	T.G. Seetharamuand Govindaraju	Interline Publishing	2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1.	https://archive.nptel.ac.in/content/syllabus_pdf/105105177.pdf

SEMESTER 8

BOUNDARY LAYER THEORY

Course Code	PEAOT868	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Mechanics Of Fluids	Course Type	Theory

Course Objectives:

To introduce students to the section of Boundary Layers and its associated parameters in order to get a deeper essence of the fluid interactions across various thermodynamic regimes in dynamic mode.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	BASIC CONCEPTS OF VISCOUS FLOWS: Viscous flow characteristics, introduction to hydrodynamic and thermal boundary layer theory, governing equations with effect of viscosity, flow over the flat plate at zero incidences, boundary layer thickness, displacement thickness, momentum thickness, energy thickness, boundary layer equation and their general properties.	5
2	SOLUTIONS TO BOUNDARY LAYER FLOWS: Flat plate at zero angle of incidence, method of exact solution. Blassius' solution to boundary layer problems, Approximate solutions – Von Karman solution to boundary layer flows over the flat plate, flow with pressure gradient, flow over a cylinder, plane Couette flow, circular Couette flow, flow between parallel plates and numericals.	8
3	THERMAL BOUNDARY LAYERS: Heat transfer from heated surface. Heat transfer from cold surface, thermal boundary layer growth over hot and cold surface(s), flow over flat plate with different flow conditions, with heat transfer, exact and approximate solutions to thermal boundary layer flows.	8
4	TURBULENT BOUNDARY LAYERS: Fundamentals of turbulent flow, Mean motion fluctuations, Reynolds Equations, Reynolds stresses, wind tunnel turbulence, Prandtl's mixing length theory, velocity distribution laws and numericals.	15

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the basic fundamentals of different types of boundary layers and associated properties.	K2
CO2	Compute various known methods of solutions to various boundary layer problems	K3
CO3	Describe thermal boundary layers and its associated interactions.	K2
CO4	Understand the fundamentals of turbulent boundary layers and pipe flow.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping and Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Fluid Mechanics	R. K. Bansal	Laxmi Publications	2005
2.	Heat Transfer	R.K. Rajput	S. Chand Publications	2019
3.	Introduction to Fluid Mechanics	Edward J. Shaughnessy, Ira M. Katz and James P. Schaffer	Oxford University Press	2005

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Boundary Layer Theory	Hermann Schlichting	Springer-Verlag	2000
2.	Further Aerodynamics for Engineering Students	E. L. Houghton and R. P. Boswell	Edward Arnold	1969

SEMESTER 8

AIRLINE AND AIRPORT MANAGEMENT

Course Code	OEAOT831	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course Type	Theory

Course Objectives:

To understand basic concepts of airport and airline management systems.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	AIRPORT SYSTEM AND OPERATIONS MANAGEMENT: Airport Management on an international level- Rules that govern airport management- Organization and administration Airport ownership and organization, responsibilities of Airport manager .Components of an airport-The airfield- Navigation aids(NAVAIDS) located on airfields-Air traffic Control and surveillance facilities located on the airfield, Airspace and air traffic management, Airport operations management under FAR Part 139, Airport terminals and ground access, Airport security and Administration -Security at commercial service airports-Security at general aviation airports	11
2	AIRPORT ADMINISTRATION AND FINANCIAL MANAGEMENT, CAPACITY AND DELAY: Concept of Airport planning and financial accounting-Revenue strategies at commercial airports- Pricing of airport facilities and services, The future of airport management. Defining capacity-Factors affecting capacity and delay-estimating capacity-Simulation Models-Defining delay-Estimating delay-Analytical estimates of delay.	9
3	INTRODUCTION TO AIRLINE PLANNING: Structure of Airline Industry (Domestic & International): Growth and Regulation- Deregulation-Major and National Carriers-Regional Carriers-Economic characteristics of the Airlines Airline Planning Process-Airline Terminology and Measures: airline demand, airline supply, average load factor, unit revenue, Airline Planning Decisions	8

4	FLEET PLANNING AND ROUTE EVALUATION: Factors in Fleet Planning-Hub-and-Spoke System: Technical Aspects-Fleet Rationalization-Fleet Commonality-Long Range Aircraft-Noise Restrictions- Factors In Design and Development-Fleet Planning Process; Route Evaluation in Hub Networks-Route profitability estimation issues-Demand Driven Dispatch	8
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the functioning of the airline industry and underlying marketing, financial, operational and competitive factors that influence airline viability.	K2
CO2	Understand the financial management of the aviation industry.	K2
CO3	Understand the principles of supply chain management in aviation systems.	K2
CO4	Understand the fleet planning and route evaluation in the airline industry.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	2	-	-	2	2
CO2	2	-	-	-	-	-	-	2	-	-	2	2
CO3	2	-	-	-	-	-	-	2	-	-	2	2
CO4	2	-	-	-	-	2	-	2	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Airport Planning and Management	Young Seth	Mc GRAW Hills.	6th edition
2.	Airport Management	Ravindran P.C.K	Asian Law House	

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Air Transportation: A Management Perspective	Alexander T.Wells and John G.Wensveen, Brooks Cole	Ashgate Publisher limited	Fifth Edition and 2003

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1.	https://youtu.be/WUq3uN4MDms?si=qeIfahyDl8qOTfiI

SEMESTER 8

PRINCIPLES OF VIBRATION

Course Code	OEAOT832	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Mechanics, Mechanics of Aircraft Materials	Course Type	Theory

Course Objectives:

Basic aim of this course is to examine the dynamic behaviour of various structural elements and vibration control techniques.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	INTRODUCTION: Newton's Law of Motion, Generalised Coordinates, Kinetic Energy , Potential Energy , Degree of Freedom System , Lagrange's Equation of Motion , Simple Harmonic Motion , D' Alembert's Principle , Mechanical System , Spring Combinations. Free and Forced Vibrations of the system with Single Degree of Freedom, Simple and Compound Pendulum, Support Excitation	9
2	MODES OF VIBRATION: Principle Modes, Principle Coordinates, Equation of Motion for Two and Multi Degrees of Freedom Systems, Orthogonality Condition, Influence Coefficients, Eigenvalue Problems	9
3	APPROXIMATE METHODS: Rayleigh's Method, Stodola Method, Matrix Iteration Method, Holzer method, Dunkerley's Method, Longitudinal, Lateral and Torsional Vibrations	9
4	VIBRATION CONTROL: Dynamic Vibration Absorbers, Dynamic Vibration Neutralizers, Self-tuned Pendulum Neutralizer, Gyroscopic Absorber, Impact Absorber, Absorbers attached to Continuous Systems, Vibration Isolators, Isolators with Complex Stiffness, Isolators with Coulomb Damping, Two- stage Isolators, Applications of Isolators, Active Vibration	9

	Control, Introduction to Closed Loop Control, Classical Control System, Piezoelectric Sensors, and Actuators	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concepts of structural dynamics.	K2
CO2	Understand the vibrational concepts of several degrees of freedom systems	K2
CO3	Apply the approximate methods to find the natural frequency	K3
CO4	Understand various vibration control techniques.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Introduction to Structural Dynamics	Bruce K Donaldson	Cambridge University Press, New York	2006
2.	Vibration with Control	Daniel J. Inman	John Wiley & Sons	2006
3.	Principles of Passive and Active Vibration Control	Asok Kumar Mallik, Shhyamal Chatterjee	Affiliated East, West Press	2014
4.	Introduction to Structural Dynamics	Bruce K Donaldson	Cambridge University Press, New York	2006

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Mechanical Vibrations	V P Singh	Dhanpat Rai & Co (P) Ltd	2014
2.	Mechanical Vibrations	J B K Das	Sapna Book House , Bangalore	2008

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1.	https://archive.nptel.ac.in/courses/112/107/112107212/
2.	https://archive.nptel.ac.in/courses/112/103/112103112/
3.	https://archive.nptel.ac.in/courses/112/103/112103112/
4.	http://acl.digimat.in/nptel/courses/video/112107087/L18.html

SEMESTER 8

AIRFRAME MAINTENANCE REPAIR AND OVERHAUL

Course Code	OEAOT833	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course Type	Theory

Course Objectives:

To understand the basic knowledge on airframe systems, repair, overhauling processes, and safety practices.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Airframe: Equipment used in welding shops and their maintenance , Ensuring quality welds, Welding jigs and fixtures , Soldering and brazing, Inspection of damage - Classification ,Repair or replacement , Sheet metal inspection, Non Destructive Testing , Riveted repair design, Damage investigation , reverse technology. Plastics and Composites: Review of types of plastics used in airplanes, Maintenance and repair of plastic components, Repair of cracks, holes etc., and various repair schemes. Inspection and Repair of composite components, Special precautions -Autoclaves.	9
2	Aircraft Systems: Inspection and maintenance of Hydraulic system, sampling Flushing, Draining, Routine maintenance Pneumatic Power System Maintenance. Inspection and maintenance of landing gear systems. Bleeding of Shock Struts ,Aircraft wheel inspection, Brake Inspection and Servicing , Bleeding of Brake System , Inspection and maintenance of air-conditioning and pressurization system	9
3	Aircraft Instruments and Auxiliary Systems : Installation and maintenance of Instruments – handling – Testing – Inspection , Inspection and maintenance of auxiliary systems – Fire protection systems - Ice protection system – Rain removal system - Position and warning system – Auxiliary Power Units (APUs)	9

	Safety Practices: Hazardous materials storage and handling, Aircraft furnishing practices – Equipment. Troubleshooting - Theory and practices.	
4	Aircraft Overhaul: Definition and Importance- Overview of Aircraft Systems Primary Systems, Interdependence of Systems, Types of Overhauls, Major vs. Minor Overhauls and Procedures, Regulatory and Safety Standards Regulations, FAA Regulations, EASA Standards Manufacturer's Maintenance Manuals, Importance and Usage of Safety Protocols, Personal Protective Equipment (PPE), Safety. Overhaul Procedures, Quality Control and Assurance, Common Issues, Techniques, Repair Strategies, Maintenance Manual, Maintenance Records, Bulletins and Airworthiness Directives, Emerging Technologies and Trends Innovations in Overhauling.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination, 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the maintenance practices of airframe, Plastic and composite materials.	K2
CO2	Understand the inspection and maintenance of aircraft system	K2
CO3	Understanding safety protocols and auxiliary system maintenance techniques for aircraft	K2
CO4	Understand the airplane safety procedures and overhauling.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	-	-	-	-	1	-	-	-	2
CO2	2	-	-	-	1	-	-	1	-	-	-	2
CO3	2	-	-	-	1	-	-	1	1	-	-	2
CO4	2	-	-	-	-	-	-	1	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Aircraft Maintenance and Repair	KROES, WATKINS DELP	McGraw-Hill, New York	1992
2.	Aviation Maintenance Technician Handbook - Airframe Vol.I& II	U.S. Dept. of Transportation, Federal Aviation Administration	The English Book Store, New Delhi	
3.	Aircraft Maintenance and Repair	Frank H. Kingston and Michael J. Kroes	McGraw-Hill Education	2020

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Aircraft Repair Manual	LARRY REITHMEIR	Palamar Books, Marquette	1992.
2.	Aircraft Maintenance	BRIMM D.J. BOGGES H.E	Pitman Publishing corp. New York,	1940
3.	Civil Aircraft inspection Procedures-CAP 459-Vol.I & II		Sterling Book house, Mumbai.	

SEMESTER S8

ORBITAL MECHANICS

Course Code	OEAOT834	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

1. Student should be able to explain and use basic theorems in orbital mechanics, Sketch the orbit with the data of orbital elements.
2. Student should be able to transform the object from one orbit to another orbit.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Solar system: Reference frames and coordinate systems, Celestial sphere- The ecliptic- Motion of vernal equinox, Sidereal time Solar time, Standard time, Galilean transformation, Newton's law of gravitation Kepler's law, Estimation of orbital and escape velocity- Many body problem, Lagrange Jacobi Identity, Circular restricted three body problem. Liberation point, (Numerical problems)	9
2	Relative motion in the N-Body problem. Two body problem, Satellite orbit relation between position and time Perifocal frame, Lagrange coefficients and points, coordinate transformation, transformation between geocentric equatorial and Perifocal frames, Orbital position as function of time –, Gibbs method of orbit determination from three position vector, Lambert's problem, orbit determination, Orbit determination by Gauss's method, (Numerical problems).	9
3	Orbital manoeuvres: - Hohmann Transfer and non-Hohmann transfer, Chase and phasing maneuverer, Interplanetary Hohmann transfer, rendezvous opportunities, sphere of influence, Method of patched conics, planetary departure, Planetary rendezvous, flyby, Non Hohmann interplanetary trajectories (Numerical problems)	9

4	Stage separation dynamics and separation techniques, aerodynamic jet control methods of rocket vehicles, performance at various altitudes, rocket dispersion-launching problems.	9
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination, 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
1 Questions from each module. - Total of 4 Questions, each carrying 2 marks (4x2 =8marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 subdivisions. Each question carries 8 marks. (8x4 = 32 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the concepts of effect many bodies under the influence of gravity,	K2
CO2	Understand the principles of orbit and determine its position.	K3
CO3	Understand the transformation techniques from one orbit to another without loss of much energy.	K3
CO4	Understand the different methods for stage separation and attitude control of rockets	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Orbital Mechanics for Engineering Students	Howard D Curtis	Biddles Ltd	7th Edition
2.	Rocket Propulsion Elements	George P. Sutton	John Wiley & Sons	9th Edition
3.	Fundamentals of Astrodynamics	Roger R Bate Donald D. Mueller Jerry E. White	Dover Publications, Inc.	8th edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Rocket Propulsion Elements	George P. Sutton	John Wiley & Sons	9th Edition
2.	Fundamentals of Astrodynamics	Roger R Bate Donald D. Mueller Jerry E. White	Dover Publications, Inc.	8th edition

SEMESTER 8

PRINCIPLES OF COMBUSTION

Course Code	OEAOT835	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	Engineering Thermodynamics	Course Type	Theory

Course Objectives:

1. Understand the fundamental concepts of thermodynamics, chemistry, and kinetics that underpin combustion processes.
2. Examine different combustion systems, such as power plants, engines, and industrial burners, focusing on their effectiveness, efficiency, and effects on the environment.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	FUNDAMENTALS OF COMBUSTION: Definition and Importance of Combustion, Historical Perspective and Applications. Chemical Reactions and Stoichiometry, Fuel Types Oxidizers and Reaction Mechanisms. Enthalpy and Internal Energy, Heat of Combustion, Adiabatic Flame Temperature. Reaction Rate and Order, Rate Laws and Mechanisms, Arrhenius Equation and Activation Energy. Burners, Boilers, and Engines, Basic Components and Operation.	9
2	FLAME DYNAMICS AND STABILITY: Types of Flames- Premixed, Diffusion, Flame Front and Propagation. Temperature Profiles in Flames, Emission Spectra and Measurement. Factors Affecting Flame Stability, Mechanisms of Flame Extinction. Flame Visualisation Methods, Flame Temperature and Concentration Measurement. Computational Fluid Dynamics in Combustion- Basics of CFD Models for Combustion, Case Studies and Applications.	10
3	ENVIRONMENTAL AND INDUSTRIAL CONSIDERATIONS: Formation of NO _x , CO, SO _x , and Particulates, Pollution Control Technologies (SCR, EGR, etc.). Combustion Efficiency Metrics, Techniques for Improving Fuel Utilization. Coal, Gas, and Biomass Power	10

	Plants, Efficiency and Environmental Impact. Combustion-Related Hazards, Safety Protocols and Standards.	
4	ADVANCED COMBUSTION TECHNOLOGIES: New Burner Designs and Innovations, Advanced Gas Turbine and Engine Technologies. Biofuels, Hydrogen, and Synthetic Fuels, Combustion Characteristics and Challenges. Combustion in Space Exploration, Advanced Propulsion Systems, Cutting-Edge Research in Combustion, Trends in Computational and Experimental Methods, System-Level Optimization of Combustion Processes, Multi-Scale and Multi-Physics Approaches	7

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination, 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 3 sub divisions. Each question carries 9 marks. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamental principles of combustion, including reaction mechanisms, flame dynamics, and thermodynamic relationships.	K2
CO2	Understand the efficiency of combustion systems and identify strategies for reducing environmental impact, including pollutant formation and control measures.	K2
CO3	Understand the computational and experimental methods for combustion analysis	K2
CO4	Apply advanced combustion technologies and innovations to real-world problems.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping and Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	-	-	-	-	-	-	1
CO2	3	1	-	-	-	-	-	-	-	-	-	1
CO3	3	1	-	-	-	-	-	-	-	-	-	1
CO4	3	1	-	-	1	-	-	-	-	-	-	1

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Fundamentals of Combustion Engineering	Gary L. Borman and Kenneth W. Ragland	McGraw-Hill Education	2nd Edition
2.	Combustion: A Fundamental Approach	John A. D. Brereton	Wiley	1st Edition

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Combustion	Irvin Glassman and Richard A. Yetter	Academic Press	5th Edition (2022)
2.	Introduction to Combustion: Concepts and Applications	Stephen R. Turns	Wiley	3rd Edition (2018)
3.	Advanced Combustion Engineering	Jean-Luc Fagot and Didier L. B. R. Philippe	Elsevier	1st Edition (2021)

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1.	https://archive.nptel.ac.in/courses/112/106/112106299/
2.	https://archive.nptel.ac.in/courses/112/106/112106299/
3.	https://archive.nptel.ac.in/courses/112/106/112106299/
4.	https://archive.nptel.ac.in/courses/112/106/112106299/

SEMESTER S8

ADVANCED HEAT TRANSFER

Course Code	OEAOT836	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NONE	Course Type	Theory

Course Objectives:

To provide knowledge of the fundamentals and advanced concepts of the various heat transfer modes and mechanisms.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic modes of heat transfer, Fourier's law, General three-dimensional heat conduction equation, One dimensional steady state heat conduction in composite mediums and with variable thermal properties .. Idea of electrical analogy and use of thermal resistance and capacitance concepts. Critical thickness of insulation. Heat transfer in extended surfaces. One dimensional transient heat conduction and lumped mass analysis. Use of similarity solutions for heat transfer problems in semi-infinite and infinite solids. Application of nondimensional parameters Fourier number and Biot number and the use of transient temperature (Heisler's) charts	9
2	Free and forced convection and non-dimensional parameters Nusselt, Prandtl and Eckert and Grashof numbers. Free convection in the atmosphere, vertical flat plate. Concept of Laminar and turbulent convective heat transfer analysis using the boundary layer Concepts in flows between parallel plates over a flat plate and in a circular pipe. Need and application of numerical techniques in solving heat transfer problems. Use of finite difference method for solving steady state heat conduction problems.	9
3	Introduction to the physical mechanism of radiation heat transfer. Radiation properties of materials and their wavelength dependence. Planck's radiation Law. Wein's displacement law and Kirchoff's law. Formulation of radiation shape factors for different geometries, Concept of radiosity. Stefan-Boltzmann law , Heat exchange between non-black bodies. Design of radiation shields. Heat exchangers and their classifications and applications. Temperature	9

	distribution in parallel flow and counter-flow heat exchangers. Concept of overall heat transfer coefficient. Design of heat exchangers using LMTD and e-NTU methods. Special heat exchangers like boilers and condensers and compact heat exchangers	
4	Condensation, Laminar film on a vertical surface, Turbulent film on a vertical surface, Film condensation in other configurations, Drop condensation, effect of non-condensable gases in condensing Equipments Boiling: Pool boiling regimes, Nucleate boiling and peak heat flux, Film boiling and minimum heat flux, Flow boiling. Radiation heat transfer: Radiation effect on temperature measurements, radiation properties of a participating medium, emissivity and absorptivity of gases and gases mixtures, heat transfer from the human body, radiative exchange and overall heat transfer in furnaces.	9

Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• 2 Questions from each module. • Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	• Each question carries 9 marks. • Two questions will be given from each module, out of which 1 question should be answered. • Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	To understand and learn about modes of heat transfer and conduction.	K2
CO2	Types of convection and dimensional analysis	K3
CO3	Different laws of radiation and its applications	K2
CO4	Understand condensation nucleation and boiling.	K2

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	1	-	-	-	-	-	-	-	-	2
CO2	2	2	1	-	-	-	-	-	-	-	-	2
CO3	2	2	1	-	-	-	-	-	-	-	-	2
CO4	2	2	1	-	-	-	-	-	-	-	-	2

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Heat Transfer	J.P.Holman	McGraw Hill Book Company.	2002
2.	Fundamentals of Heat and Mass Transfer-	Sachdeva,	New Age Publications	2009

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Fundamentals of Heat and Mass Transfer	D.P. Incropera, P.P. and Dewitt	Wiley Eastern	1996
2.	Heat Transfer – A Practical Approach,	Cengel Y A,	McGraw Hill	2002

Video Links (NPTEL, SWAYAM...)	
Module No.	Link ID
1	https://archive.nptel.ac.in/courses/103/105/103105052/#

SEMESTER S8

AIRCRAFT SYSTEMS AND INSTRUMENTS

Course Code	OEAOT837	CIE Marks	40
Teaching Hours/Week (L: T:P: R)	3:0:0:0	ESE Marks	60
Credits	3	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	NIL	Course Type	Theory

Course Objectives:

To describe the principle and working of aircraft systems and instruments.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Hydraulic systems – Study of typical workable systems – components – hydraulic systems controllers-modes of operation; pneumatic systems – working principles – typical pneumatic power system brake system – components, landing gear systems – classification-shock absorbers – retractive mechanism. Conventional Systems – power assisted and fully powered flight controls-power actuated systems; -engine control systems-push pull rod system – operating principles.	9
2	Modern control systems-Digital fly by wire systems-auto pilot system-active control technology Fuel systems – piston and jet engines – components-multi-engine fuel systems, lubricating systems piston, and jet engines-starting and ignition systems	9
3	Flight Instruments and Navigation Instruments – Pitot-Static system, Altimeters, Airspeed Indicator, Vertical Speed Indicator Gyroscope- Gyroscopic Properties; Gyro Horizon Turn and Bank Indicator& Directional Gyroscope Accelerometer, Mach Meters, Direct Reading Magnetic Compass, Remote Reading Magnetic Compass.	9
4	Study of various types of engine instruments - Tachometers - Temperature gauges – Pressure gauges – Types of Pressure, Pressure sensing Elements, Oil	9

	pressure gauge, Manifold pressure gauge, Engine Pressure Ratio, Synchroscope.	
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Course Assessment Method
(CIE: 40 marks, ESE: 60 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/ Micro project	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
5	15	10	10	40

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
2 Questions from each module. - Total of 8 Questions, each carrying 3 marks (8x3 =24marks)	- Each question carries 9 marks. - Two questions will be given from each module, out of which 1 question should be answered. - Each question can have a maximum of 3 sub divisions. (4x9 = 36 marks)	60

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand about the hydraulic and pneumatic system	K2
CO2	Know about various control systems.	K1
CO3	Also understands about the fuel systems in aircraft	K2
CO4	Able to handle the various aircraft instruments.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table (Mapping of Course Outcomes to Program Outcomes)

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

Note: 1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High), -: No Correlation

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Aircraft Power Plants	Mekinley, J.L. and Bent, R.D	McGraw-Hill	1993
2.	Aircraft Instruments & Principles	Pallet, E.H.J	Pitman & Co	1993

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1.	Aviation Maintenance Technician Hand Book – Power plant Vol. I & II	U.S. Dept. of Transportation, Federal Aviation Administration	The English Book Store	
2.	Gas Turbine Technology	Treager, S	McGraw-Hill	1997

SEMESTER S3/S4

ECONOMICS FOR ENGINEERS

Course Code	UCHUT346	CIE Marks	50
Teaching Hours/Week (L: T:P: R)	2:0:0:0	ESE Marks	50
Credits	2	Exam Hours	2 Hrs. 30 Min.
Prerequisites (if any)	None	Course Type	Theory

Course Objectives:

1. To provide students with an understanding of fundamental economic principles essential for effective decision-making in engineering contexts.
2. To enable students to apply economic analysis to production decisions, cost management, and market strategies in engineering practice.
3. To equip students with the ability to evaluate macroeconomic scenarios, financial methods, and investment decisions relevant to engineering projects.

SYLLABUS

Module No.	Syllabus Description	Contact Hours
1	Basic economic problems – Production Possibility Curve – Utility – Law of diminishing marginal utility –Demand: Factors determining demand – Law of Demand – Demand curve- Price elasticity of demand- measurement of price elasticity and its applications – Supply: factors determining supply - Law of supply – Supply curve- Equilibrium price determination- Changes in demand and supply and its effects on equilibrium price and quantity Production: Production function - Law of variable proportion –Returns to scale- Cobb-Douglas Production Function	6
2	Cost: Cost concepts – Private cost and social cost – Sunk cost – Opportunity cost -Explicit and implicit cost –Short run cost curves –Long run average cost curve -Revenue concepts – Break-even point Market: Perfect Competition – Monopoly - Monopolistic Competition (features and equilibrium of a firm) - Oligopoly – Features – Kinked demand model	6

3	National income: Concepts (GDP, GNP and NNP)– Final goods and Intermediate goods - Methods of Estimation –output method – expenditure method-- Difficulties in the measurement of national income. Inflation: Causes and Effects – Measures to Control Inflation - Monetary and Fiscal policies – Repo and reverse repo rate	6
4	Value Analysis and value Engineering: Cost Value, Exchange Value, Use Value, Esteem Value - Aims, Advantages and Application areas of Value Engineering - Value Engineering Procedure Capital Budgeting: Time value of money - Net Present Value Method - Benefit Cost Ratio – Internal Rate of Return – Payback – Accounting Rate of Return.	6

Course Assessment Method
(CIE: 50 marks, ESE: 50 marks)

Continuous Internal Evaluation Marks (CIE):

Attendance	Assignment/Case Study/ Microproject	Internal Examination-1 (Written)	Internal Examination- 2 (Written)	Total
10	15	12.5	12.5	50

End Semester Examination Marks (ESE)

In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions

Part A	Part B	Total
• Minimum 1 and Maximum 2 Questions from each module. • Total of 6 Questions, each carrying 3 marks (6x3 =18 marks)	2 questions will be given from each module, out of which 1 question should be answered. Each question can have a maximum of 2 sub divisions. Each question carries 8 marks. (4x8 = 32 marks)	50

Course Outcomes (COs)

At the end of the course students should be able to:

Course Outcome		Bloom's Knowledge Level (KL)
CO1	Understand the fundamentals of various economic issues using laws and learn the concepts of demand, supply, elasticity and production function.	K2
CO2	Develop decision making capability by applying concepts relating to costs and revenue, and acquire knowledge regarding the functioning of firms in different market situations.	K3
CO3	Outline the macroeconomic principles of monetary and fiscal systems and national income.	K2
CO4	Make use of the possibilities of value analysis and engineering, and take investment decisions through capital budgeting techniques.	K3

Note: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create

CO-PO Mapping Table:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	1	-	-	-	-	1	-
CO2	-	-	-	-	-	1	1	-	-	-	1	-
CO3	-	-	-	-	1	-	-	-	-	-	2	-
CO4	-	-	-	-	1	1	-	-	-	-	2	-

Text Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Managerial Economics	Geetika, Piyali Ghosh and Chodhury	Tata McGraw Hill,	2015
2	Engineering Economy	H. G. Thuesen, W. J. Fabrycky	PHI	1966
3	Engineering Economics	R. Paneerselvam	PHI	2012
4	Financial Management	I M Pandey	Vikas Publishing House	2015

Reference Books				
Sl. No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
1	Engineering Economy	Leland Blank P.E, Anthony Tarquin P. E.	Mc Graw Hill	7 TH Edition
2	Indian Financial System	Khan M. Y.	Tata McGraw Hill	2011
3	Engineering Economics and analysis	Donald G. Newman, Jerome P. Lavelle	Engg. Press, Texas	2002
4	Contemporary Engineering Economics	Chan S. Park	Prentice Hall of India Ltd	2001
5	Financial Management: Theory and Practice	Prasanna Chandra	Mc Graw Hill	2007