B.Tech

CURRICULUM and SYLLABUS

Regulation 2021

(For the Students Admitted from the Academic Year 2021-22 Onwards)

DEPARTMENT OF AERONAUTICAL ENGINEERING

(CHOICE BASED CREDIT SYSTEMS)

Employability

Entrepreneurship

Skill Development

Kalasalingam Academy of Research and Education

(Deemed to be University)
Under sec.3 of UGC Ac,1956. Accredited by NAAC with 'A' Grade
Anand Nagar, Krishnankoil-626126,
Srivilliputtur (via), Virudhunagar (Dt), Tamilnadu, India.
www.kalasalingam.ac.in

KALASALINGAM ACADEMY OF RESEARCH AND EDUCATION

VISION

To be a Centre of Excellence of International Repute in Education and Research.

MISSION

To Produce Technically Competent, Socially Committed Technocrats and Administrators through Quality Education and Research.

DEPARTMENT OF AERONAUTICAL ENGINEERING

VISION

To be a Centre of Excellence in Education and Research in the field of Aeronautical Engineering to meet global requirements of Industry and Society.

MISSION

- To impart quality education and research in Aeronautical Engineering through excellence in teaching - learning process and state of art facilities to the students.
- To inculcate students with ethical values and innovative ideas for future leadership in industry and to face societal challenges.

Program Educational Objectives

PEO-1- DIVERSIFIED KNOWLEDGE
Graduates will apply fundamental technical knowledge and skills to find workable solutions to technological challenges and problems in diversified areas such as Aerodynamics, Propulsion, Structures, control systems, Design, and allied fields of Aeronautical Engineering.

PEO-2: CONTEMPORARY ISSUES & SKILLS
Graduates will have an effective communication skills and will recognize the social impacts of problem solving, decision making and creative skills by understanding contemporary issues.

PEO-3: PROFESSIONAL ATTITUDE
Graduates will gain professional and ethical attitude towards their peers, employers, society and prove as a responsible leader in the establishments in government and private sectors.

PEO-4: PROFESSIONAL DEVELOPEMENT
Graduates will become entrepreneurs to confront business challenges or will continue their professional advancement through their knowledge horizon and inculcate lifelong learning.

Program Outcomes (POs)

PO1 - Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 - Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 - Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 - Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 - Modern Tool Usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO6 - The Engineer and Society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 - Environment and Sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.

PO8 - Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 - Individual and Team Work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 - Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 - Project Management and Finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 - Life-long learning: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

PSO1 - An ability to utilize the gained knowledge of Aeronautical engineering in design and development of new products for challenging environment.

PSO2 - An ability to design, analysis and solve the problems of components in flight vehicles imparted by simulation skills.

PSO3 - An ability to fabricate, test and develop the products through in-house and industry practices.

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ACADEMY OF RESEARCH AND EDUCATION
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DEPARTMENT OF AERONAUTICAL ENGINEERING (R-2021)

S. No.	Category	Credits
I	Foundation Core (Mathematics & Science; Engineering Science; Computing; Sustainable Product Development; Human Values & Communication)	44
II	Program Core	52
III	Experimental Elective (CSP / Mini Project)	06
IV	Experimental Core (Design Project; Capstone)	16
V	Program Elective	24
VI	University Elective (Engineering outside school; Liberal arts or Mathematics & Science)	16
VII	Experimental Elective (Internship)	02
VIII	Mandatory courses	--
	Total Credits	**160**

I. Program Core

Core Courses:

S.No.	Course Code	Course Title	Course Nature	L	T	P	C
1	212AER1305	Strength of Materials	IC	3	0	2	4
2	212AER1306	Fluid Mechanics	IC	3	0	2	4
3	212AER1101	Introduction to Aeronautical Engineering	T	3	0	0	3
4	212AER1103	Aero Engineering Thermodynamics	T	3	0	0	3
5	212AER1102	Mathematics for Aeronautical Engineering	T	3	0	0	3
6	212AER2307	Low speed Aerodynamics	IC	3	0	2	4
7	212AER2111	Fundamentals of Aircraft Structures - I	IC	3	0	2	4
8	212AER2309	Air breathing Propulsion	IC	3	0	2	4
9	212AER3108	High speed Aerodynamics	IC	3	0	2	4
10	212AER3312	Analysis of Aircraft Structures	IC	3	0	2	4
11	212AER3110	High speed Propulsion	IC	3	0	2	4
12	212AER2215	UAV Laboratory	PC	0	0	3	2
13	212AER1104	Applied Mechanics	T	3	0	0	3
14	212AER2113	Aircraft Performance	T	0	0	3	2
15	212AER3114	Aircraft Stability and Control	T	3	0	0	3
			Total Credits	52			

Experiential Elective Courses:

S. No.	Course Code	Course Name	Course type	L	T	P	C
1.	214AER2104	Community Service Project	PC	0	0	4	4
2	216AER3202	Internship	PC	0	0	4	4
Total Credits			8				

Experiential core Courses :

S. No.	Course Code	Course Name	Course type	L	T	P	C
1	215AER3201	Aero - Design Project (Phase - I)	PC	0	0	3	3
2	215AER3202	Aero - Design Project (Phase - II)	PC	0	0	3	3
3	215AER4201	Capstone Project (Phase - I)	PC	0	0	2	2
4	215AER4202	Capstone Project (Phase - II)	PC	0	0	8	8
Total Credits				16			

II. Program Elective

S.No.	Course Code	Course Name	Course Type	L	T	P	C
1	213AER2101	Experimental Aerodynamics	TC	3	0	0	3
2	213AER2102	Fundamentals of Control Engineering	TC	3	0	0	3
3	213AER2103	Wind Engineering	TC	3	0	0	3
4	213AER2104	Wind Tunnel Techniques	TC	3	0	0	3
5	213AER2105	Aerospace Materials	TC	3	0	0	3
6	213AER2106	Aircraft Engine Repairs and Maintenance	TC	3	0	0	3
7	213AER3101	Heat Transfer	TC	3	0	0	3
8	213AER3102	Space Mechanics	TC	3	0	0	3
9	213AER3103	Design of Gas Turbine Engine Components	TC	3	0	0	3
10	213AER3104	Helicopter Aerodynamics	TC	3	0	0	3
11	213AER3105	Theory of Vibrations	TC	3	0	0	3
12	213AER3106	Theory of Elasticity	TC	3	0	0	3
13	213AER3107	Experimental Stress Analysis	TC	3	0	0	3

14	213AER3108	Fatigue and Fracture Mechanics	TC	3	0	0	3
15	213AER3109	Acoustics and Noise Control	TC	3	0	0	3
16	213AER3110	Aero Elasticity	TC	3	0	0	3
17	213AER4101	Approximate Methods in Structural Mechanics	TC	3	0	0	3
18	213AER4102	Boundary Layer Theory	TC	3	0	0	3
19	213AER4103	Combustion in Aerospace Vehicles	TC	3	0	0	3
20	213AER4104	Computational Fluid Dynamics	TC	3	0	0	3
21	213AER4105	Finite Element Methods	TC	3	0	0	3
22	213AER4106	Hypersonic Aerodynamics	TC	3	0	0	3
23	213AER4107	Missile Aerodynamics	TC	3	0	0	3
24	213AER4108	Rockets and Launch Vehicles	TC	3	0	0	3
25	213AER4109	Structural Dynamics	TC	3	0	0	3
26	213AER4110	Theory of Plates and Shells	TC	3	0	0	3
27	213AER4111	Cryogenic Engineering	TC	3	0	0	3

III. University Elective (Engineering):

S. No.	Course Code	Course Name	Course Type	L	T	P	C
1	214AER2101	Aircraft Rules and Regulations - CAR (I and II)	TC	3	0	0	3
2	214AER2102	Composite Materials and Structures	TC	3	0	0	3
3	214AER2103	Aircraft System Engineering	TC	3	0	0	3
4	214AER2104	Airframe Repair and Maintenance	TC	3	0	0	3
5	214AER3101	UAV System Design	TC	3	0	0	3
6	214AER3102	Satellite Technology	TC	3	0	0	3
7	214AER3103	Avionics	TC	3	0	0	3

PROGRAM CORE

212AER1305	STRENGTH OF MATERIALS	L	T	P	C
Pre – Requisites	Nil	3	0	2	4
Course Category	Program Core				
Course Type	Integrated Course				

Course Objective:

Students will be able to understand the concepts of deformable bodies including geometry of deformation, and material behaviour. Revelations to systematic methods of problem solving techniques. Knowledge on solving structural members subjected to the different types of loading

Course Outcomes:

After completing this course, the student will be able to:

CO1: Analysing the tensile and compressive strength in bars using various loads, testing the stresses using loads in different materials.
CO2: Evaluating the principal plane and stresses in two dimensional bodies and analyse the deformation in thin cylindrical and spherical shells.
CO3: Demonstrate the types of beams and supports, sketch the shear force and bending moment diagram in various loads and testing the deflections in various beams.
CO4: Analysing the stress distribution of shear and bending in the various section of the beams.
CO5: Illustrate the stress and deformation in circular structures due to combined bending and strain energy, testing the torsion on mild steel and designing the various types of springs

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3		2	2								3		1
CO2	3	2		2	3								3		1
CO3	3		3	3	2								3		1
CO4	3		3	2									3		1
CO5	3		2		2								3		1

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

Stress, Strain and Deformation in Solids

Tension, compression and shear stresses – Hook's law – stress- ultimate stress and working stress – elastic constants and relationships between them – composite bars – temperature stresses – strain energy due to axial load – stress due to suddenly applied load and impact load.

UNIT 2

Stress and Deformation in 2D Bodies

Two dimensional state of stress at a point – normal and shear stresses on any plane, principal planes and principal stresses – graphical method – two dimensional state of strains at a point, principal strains and their directions – stresses and deformations in thin cylinders and spherical shells due to internal pressure.

UNIT 3

Beams and Supports

Types of beams and supports – shear force and bending moment at any cross section, sketching of shear force and bending moment diagrams for cantilever, simply supported and over hanging beams for any type of loading – relationship between rates of loading – shear force and bending moment

UNIT 4

Stresses in Beams

Theory of simple bending – analysis for bending stresses – load carrying capacity of beams – proportioning sections – strain energy due to bending moment – shear stress distribution – strain energy due to transverse shear force.

UNIT 5

Torsion and Springs

Elastic theory of torsion – stresses and deformation in solid circular and hollow shafts – stepped shafts – composite shaft – stress due to combined bending and torsion– strain energy due to torsion-deformations and stresses in helical springs – design of buffer springs -leaf springs.

Text Books:

1. Popov, E.P., Engineering Mechanics of solids, Prentice Hall of India, New Delhi, 8thEdition 2014.

References:

1. Kazimi, S. M. A., Solid Mechanics, Tata McGraw Hill Book Co Ltd., 1998.
2. Rajput, Strength of Materials, S. Chand Publications, 2009.
3. Bansal, R. K., Strength of Materials, Laxmi Publications, 4th Edition, 2015

List of Experiments:

1. Tension test on mild steel rod
2. Torsion test on mild steel rod
3. Impact test on metal specimen
4. Hardness test on metals - Brinell and Rockwell hardness number
5. Deflection test on beams
6. Stiffness test on helical springs.
7. Corrosion test on mild steel plate.
8. Pin on disk – exercise on mild steel plate.

212AER1306	FLUID MECHANICS	L	T	P	C
Pre – Requisites	Nil	3	0	2	4
Course Category	Program Core				
Course Type	Integrated Course				

Course Objective:

To cover the basic principles and equation of fluid mechanics and to present numerous and diverse real world engineering examples to give students a feel for how fluid mechanics is applied in engineering practice

Course Outcomes:

After completing this course, the student will be able to:

CO1: Discuss the basic concepts of fluid mechanics.
CO2: Apply the conservation principles governing fluid flows.
CO3: Apply the viscous flow equations to solve the viscous problems.
CO4: Perform dimensional analysis problems.
CO5: Calculate the boundary layer parameters and aerodynamic forces on bluff bodies

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3											2	2		
CO2	2	2										2	1		
CO3	3	2	2	3								3	3		
CO4	1	3	3	2											
CO5	1	2	2												

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

Basic Concepts and Properties

Properties of fluids, viscosity, thermodynamic properties, compressibility and bulk modulus, surface tension and capillarity, Pascal's law, pressure head, pressures – absolute; gauge; vacuum, pressure measurement – manometer, pressure and temperature at any point in compressible fluid, temperature lapse rate.

UNIT 2

Laws of Conservation

Lagrangian and Eulerian description of fluid flow, types of fluid flow, streamlines, pathlines, and streaklines, Continuity and Momentum equation, velocity potential function and stream function, types of motion, vortex flow, potential flow, Euler's and Bernoulli's equation - Application through various examples including flow measuring devices - Orifice meter, venturi meter, pitot tube.

UNIT 3

Viscous Flow

Laminar and turbulent flow, viscous flow through a circular pipe, viscous flow between parallel plates, kinetic energy and momentum correction factors, Pipe friction, Darcy-Weisbach equation and chezy's formula, Pipe losses, velocity defect, velocity distribution in smooth and rough pipes

UNIT 4

Dimensional Analysis and Similitude

Dimensional Analysis -, Buckingham Pi - theorem, Derivations and applications of important dimensionless numbers, basic modeling and similitude.

UNIT 5

Fluid Flow Over Bodies

Boundary layer theory - boundary layer development on a flat plate, displacement thickness, momentum thickness, Energy thickness, momentum integral equation, drag on flat plate - Nature of turbulence, Separation of flow over bodies - streamlined and bluff bodies, Lift and Drag on cylinder and Aerofoil.

Text Books:

1. Streeter, V.L., and Wylie, E.B., Fluid Mechanics, McGraw-Hill, 2010

References:

1. Kumar, K.L., Engineering Fluid Mechanics, Eurasia Publishing House (P) Ltd, New Delhi, 7th edition, 2002.
2. Vasandani, V.P., Hydraulic Machines - Theory and Design, Khanna Publishers, 11th Edition 2010.
3. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi publications (P) Ltd, New Delhi, 9th edition,2010.
4. White, F.M., Fluid Mechanics, Tata McGraw-Hill, c, 5th Edition, 2003.
5. Ramamirtham, S., Fluid Mechanics and Hydraulics and Fluid Machines, DhanpatRai and Sons, Delhi, 3rd edition 1998.
6. Som, S.K., and Biswas, G., Introduction to Fluid Mechanics and Fluid Machines, Tata McGrawHill, New Delhi, 3rd Edition, 2011.

List of Experiments:

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturimeter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.

212AER1101	INTRODUCTION TO AERONAUTICAL ENGINEERING	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Program Core				
Course Type	Theory				

Course Objective:

Understand the basic concepts of Aeronautical Engineering and current development in the field.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Explain the history of aircraft and development over the years
CO2: Classify the components, control systems of aircraft and its functions **CO3:** Outline the basic concepts of flight and physical properties of atmosphere **CO4:** Categorize the types of fuselage construction and landing gear system **CO5:** Demonstrate the different types of engines and principles of rocket

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3												2		
CO2	2												3		
CO3	3												1		
CO4						2							1		
CO5	3												1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

History of flight

Balloon flight-ornithopters-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT 2

Aircraft configurations and its controls

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

UNIT 3

Basics of Aerodynamics

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag andmoment. Aerofoils, Mach number, Maneuvers.

UNIT 4

Basics of Propulsion

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

UNIT 5

Basics of Aircraft Structures

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

Text Books:

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015

2. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004

References:

1. Kermode, A.C. Flight without Formulae, Pearson Education; Eleven edition, 2011

212AER1103	AERO ENGINEERING THERMODYNAMICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Program Core				
Course Type	Theory				

Course Objective:

Enable the students to understand the basic principles and concepts of classical thermodynamics

Course Outcomes:

After completing this course, the student will be able to:

CO1: Comprehend the basic thermodynamic systems
CO2: Infer the concepts of second law of thermodynamics and Carnot cycle.
CO3: Interpret the one dimensional fluid flow and the application of continuity equation and Rankine cycle.
CO4: Illustrate about air standard cycles and P-V diagrams of four stroke and two stroke IC engines.
CO5: Demonstrate the principles of refrigeration and air conditioning

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3	2										3		3
CO2	3	2	1									2	3		2
CO3	1	3	2	1								3	3		3
CO4	2		1												
CO5	2	1	1												

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

First Law of Thermodynamics

Concept of continuum-Macroscopic approach-thermodynamic systems-properties-state, path and process, quasi-static process- work and heat-zeroth law and first law of thermodynamics-internal energy-enthalpy- applications of first law of thermodynamics to closed and open system

UNIT 2

Second Law of Thermodynamics

Second law of thermodynamics-Kelvin's and Clausius statements of second law-reversibility and irreversibility-carnot theorem-carnot cycle- reversed carnot cycle- clausius inequality-concept of entropy-principle of energy-availability and unavailability-Exergy for closed and an open systems

UNIT 3

Properties of Pure Substances and Power Cycle

Properties of pure substances-Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, H-S diagrams, PVT surfaces thermodynamics properties of steam, calculations of work done and heat transfer in non-flow and flow processes Standard Rankine cycle, Reheat and Regeneration cycle.

UNIT 4

Air Standard Cylces and IC Engines

Cycle-air standard efficiency-Otto cycle-diesel cycle- dual cycle- Brayton cycle-components of IC engines-Two stroke and four stroke cycle engine-performance of IC engine-supercharging.

UNIT 5

Refrigeration, Air Conditioning and Psychrometry

Concepts of psychrometry, Psychrometric relation and charts-processes-Refrigeration systems-Air-conditioning systems and its types- simple vapour compression system-vapour absorption system-Refrigerants.

Text Books:

1. Nag.P.K., "Engineering Thermodynamics", McGraw Hill Education (India) Private Limited; Fifth edition ,April 2013

2. Rathakrishnan E, "Fundamentals of Engineering Thermodynamics", Prentice Hall India, 2 revised edition 2005

3. Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach" McGraw-Hill Science/Engineering/Math; 7thedition 2010.

References:

1. Ramalingam K.K. "Thermodynamics", Sci-Tech Publications, 2006

2. Holman.J.P., "Thermodynamics", 3rd Ed. McGraw-Hill, 2007.

3. Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987

4. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.

5. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004

212AER1102	Mathematics for Aeronautical Engineering	L	T	P	C
Pre – Requisites	MEC17R103	3	1	0	3
Course Category	Program Core				
Course Type	Theory				

Course Objective:

To expose the students the different mechanisms, their method of working, forces involved andconsequent vibration during working.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Enrich the knowledge solving algebra and transcendental equations and determine the unknown values of a function by interpolation.

CO2: Understanding Laplace transforms, and applying inverse Laplace transforms.
CO3: Fitting of a curve and determining the Fourier transform of a function.
CO4: Solving the ordinary differential equations by numerical techniques.
CO5: Formulate to solve partial differential equation.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2									2	3		
CO2	2		3										1	1	
CO3	2		3										1		
CO4	2			1									1		
CO5	2												1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

UNIT 1:

ROOT FINDING TECHNIQUES AND INTERPOLATION

ROOT FINDING TECHNIQUES: Root finding techniques: Solving algebraic and transcendental equations by bisection method, method of false position, Newton-Raphson method.
INTERPOLATION: Interpolation: Finite differences, forward differences, backward differences and central differences; Symbolic relations; Newton 's forward interpolation, Newton 's backward interpolation; Gauss forward central difference formula, Gauss backward central difference formula; Interpolation of unequal intervals: Lagrange 's interpolation.

UNIT 2

LAPLACE TRANSFORMS AND INVERSE LAPLACE TRANSFORMS

LAPLACE TRANSFORMS: Definition of Laplace transform, linearity property, piecewise continuous function, existence of Laplace transform, function of exponential order, first and second shifting theorems, change of scale property, Laplace transforms of derivatives and integrals, multiplied by t, divided by t, Laplace transform of periodic functions.
INVERSE LAPLACE TRANSFORMS: Inverse Laplace transform: Definition of Inverse Laplace transform, linearity property, first and second shifting theorems, change of scale property, multiplied by s, divided by s; Convolution theorem and applications.

UNIT 3

CURVE FITTING AND FOURIER TRANSFORMS

CURVE FITTING: Fitting a straight line; Second degree curves; Exponential curve, power curve by method of least squares.

FOURIER TRANSFORMS: Fourier integral theorem, Fourier sine and cosine integrals; Fourier transforms; Fourier sine and cosine transform, properties, inverse transforms, finite Fourier transforms.

UNIT 4

NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

STEP BY STEP METHOD: Taylor‘s series method; Euler‘s method, modified Euler‘s method for first order differential equations.

MULTI STEP METHOD: Runge-Kutta method for first order differential equations.

UNIT 5

PARTIAL DIFFERENTIAL EQUATIONS AND APPLICATIONS

PARTIAL DIFFERENTIAL EQUATIONS: Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equation by Lagrange method.

APPLICATIONS: Method of separation of variables; One dimensional heat and wave equations under initial and boundary conditions

Text Books:

1. B.S. Grewal, ―Higher Engineering Mathematics ‖, Khanna Publishers, 36th Edition, 2010.

2. N.P. Bali and Manish Goyal, ―A Text Book of Engineering Mathematics ‖, Laxmi Publications, Reprint, 2008.

3. Ramana B.V., ―Higher Engineering Mathematics ‖, Tata McGraw Hill New Delhi, 11th Reprint, 2010

References:

1.Erwin Kreyszig, ―Advanced Engineering Mathematics ‖, 9th Edition, John Wiley & Sons, 2006.

2. Veerarajan T., ―Engineering Mathematics ‖ for first year, Tata McGraw-Hill, New Delhi, 2008.

3. D. Poole, ―Linear Algebra A Modern Introduction ‖, 2nd Edition, Brooks/Cole, 2005.

4. Dr. M Anita, ―Engineering Mathematics-I ‖, Everest Publishing House, Pune, First Edition, 2016.

212AER2307	Low speed Aerodynamics	L	T	P	C
Pre – Requisites	212AER1307	3	0	2	4
Course Category	Program Core				
Course Type	Integrated Course				

Course Objective:

To study aerodynamic concepts and understanding the motion of air around an object enables the calculation of forces and moments acting on the object.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Relate fluid mechanics concepts with aerodynamic problems
CO2: Examine the flow over wing
CO3: Differentiate the ideal and real flows
CO4: Develop the mathematical modelling ability
CO5: Demonstrate the real time viscous flow and boundary layer behavior.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2		2									3	3	
CO2	2	2		2									1	1	2
CO3	1	1		1									1		
CO4	2	2		2	2								1	2	
CO5	3	2											1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

REVIEW OF BASIC FLUID MECHANICS

System and Control volume approach, substantial, local and convective derivative, Continuity, momentum and energy equations, Inviscid flow, Euler equation, incompressible Bernoulli's Equation. Circulation and Vorticity, Green's Lemma and Stoke's Theorem, Barotropic Flow, Kelvin's theorem, Streamline, Stream Function, Irrotational flow, Potential Function, Equipontential Lines, Elementary Flows and their combinations

UNIT 2

TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW

Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, KuttaJoukowski's Theorem, Starting Vortex, Kutta condition, Real flow over smooth and rough cylinder

UNIT 3

AIRFOIL THEORY

Cauchy-Riemann relations, Complex Potential, Methodology of Conformal Transformation, Kutta- Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.

UNIT 4

SUBSONIC WING THEORY

Vortex Filament, Biot - Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory and its limitations.

UNIT 5

INTRODUCTION TO LAMINAR AND TURBULENT FLOW

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, Energy thickness, Shape parameter, Boundary layer equations for a steady, two dimensional incompressible flow, Boundary Layer growth over a Flat plate, Critical Reynolds Number, Blasius solution, Basics of Turbulent flow, Prandtl's mixing length hypothesis, Free shear layers.

Text Books:

1. E. L. Houghton & N. B. Carruthers, "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
2. Anderson, J.D., Fundamentals of Aerodynamics, McGraw-Hill Education; 5th edition, 2010.

References:

1. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985.
2. John J Bertin., Aerodynamics for Engineers, Prentice Hall publishers6th edition, 2013.
3. Clancy, L J., Aerodynamics, Shroff publishers2006

List of Experiments:

1. Calibration of a subsonic wind tunnel
2. Pressure distribution over a smooth circular cylinder
3. Pressure distribution over a rough circular cylinder
4. Pressure distribution over a symmetric airfoil
5. Pressure distribution over a cambered airfoil

212AER2111	FUNDAMENTALS OF AIRCRAFT STRUCTURES	L	T	P	C
Pre – Requisites	212AER2111	3	0	2	4
Course Category	Program Core				
Course Type	Integrated Course				

Course Objective:

To Analyze and Design simple aircraft structural components.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Solve statically indeterminate structures
CO2: Make simplified analysis of aircraft structures and apply energy methods
CO3: Determine the critical buckling load of columns. **CO4:**
Relate failure theories with aircraft structural problems **CO5:**
Design the various joints for loading conditions

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3	1										1	2	
CO2	1		2											2	
CO3	2	1	3										2		
CO4	1			3											1
CO5	1		3											2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

ANALYSIS OF TRUSSES AND BEAMS

Plane truss analysis, plane frame analysis, analysis of a 3-D truss, analysis of continuous beams using Clapeyron's 3-moment equation.

UNIT 2

ENERGY METHODS OF ANALYSIS

Energy expression for various loadings and its application to statically determinate and indeterminate beams, trusses, frames and rings.

UNIT 3

BUCKLING OF COLUMNS

Buckling of Long column and short column- inelastic buckling- columns with different end conditions, empirical methods, the Southwell plot, use of Energy methods, imperfections in columns, stresses and deflections in a beam-column.

UNIT 4

FAILURE ANALYSIS

Failure of Ductile and brittle materials, Theories of failure and their Failure envelopes, Introduction to fatigue failure and fracture mechanics of materials

UNIT 5

DESIGN OF JOINTS

Types of joints and rivets. Failure of joints. Design of bolted joints. Stresses in bolts and nuts due to various loadings - Axial load, shear load and combined loading. Types of welded joints.Strength of welded joints for various loadings

Text Books:

1. ‘Mechanics of Materials’ by James M. Gere & Barry J Goodno, cengage Learning Custom Publishing; 8th edition, 2012.
2. Megson T M G, `Aircraft Structures for Engineering students’ Butterworth-Heinemann publisher, 5th edition, 2012.
3. N.C. Pandya, C.S. Shah, “Elements of Machine Design”, Charotar Publishing House, 15th edition, 2009.

References:

1. Donaldson, B.K., ‘Analysis of Aircraft Structures - An Introduction’ Cambridge University Press publishers, 2 ndedition , 2008
2. Bruhn E F, ‘Analysis and Design of Flight Vehicle Structures’, Tri-State Off-set Company, USA, 1985
3. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.

List of Experiments:

1. Determination of Flexural strength of materials.
2. Deflection of Beams
3. Verification of Maxwell’s Reciprocal Theorem
4. Buckling Load estimation of Slender Eccentric Columns
5. Combined bending and Torsion of a Hollow Circular Tube

212AER2309	Air breathing Propulsion	L	T	P	C
Pre – Requisites	Nil	3	0	2	4
Course Category	Program Core				
Course Type	Integrated Course				

Course Objective:

To study in detail about the fundamentals of aircraft propulsion. To understand the principles of operation and design of aircraft power plants.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Comprehend the working principle of gas turbine engines, thermodynamic cycles and performance characteristics of gas turbine engines
CO2: Interpret the internal flows & external characteristics near the inlets. Starting problems and different modes of operation in supersonic inlets
CO3: Classify the types and working methods in combustion chambers. The flame stabilization and flame techniques
CO4: Summarize the flow through the nozzle, choking, losses in nozzle, variable area nozzle and thrust vector control
CO5: Know the types and working principles of compressors, velocity diagrams, blade design and performance characteristics of compressor

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												2		
CO2	1		3											1	
CO3	1	1	2											1	
CO4	1		3											1	
CO5	1	2		2										1	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

FUNDAMENTALS OF GAS TURBINE ENGINES

Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics

UNIT 2

INLETS

Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and eternal deceleration ratio –

Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External declaration – Models of inlet operation.

UNIT 3

COMBUSTION CHAMBERS

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders – Numerical problems

UNIT 4

NOZZLES

Theory of flow in isentropic nozzles – Convergent nozzles and nozzle choking –Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under – expanded nozzles – Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces – Thrust reversal

UNIT 5

COMPRESSORS

Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of prewhirl – Rotation stall – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Centrifugal and Axial compressor performance characteristics.

Text Books:

Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Pearson education (2009

References:

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Pearson Education Canada; 6th edition, 2008.
2. Oates, G.C., "Aero Engineering Thermodynamics of Aircraft Engine Components", AIAA Education Series,New York, 1985.
3. "Rolls Royce Jet Engine", Rolls Royce; 4th revised edition, 1986.
4. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion",
5. Standard Publishers & Distributors, Delhi, 2nd edition 2014.

List of Experiments:

1. Study of aircraft piston engines and gas turbine engines
2. Velocity profiles of free jets
3. Velocity profiles of wall jets
4. Wall pressure distribution in subsonic diffusers
5. Wall pressure measurements in supersonic nozzles

212AER2215	UAV Laboratory	L	T	P	C
Pre – Requisites	Nil	1	0	3	2
Course Category	Program Core				
Course Type	Laboratory				

Course Objective:
To introduce the concept of design of basic structural components and to draft both manually and using modelling package

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

CO1: Use UAV to Calculate Flight Planning.

CO2: Advanced software's used in Boundary setting.

CO3: Measurement of Aerial and Topography Mapping.

CO4: Application of Post Processing Software's.

CO5: Calculate 2d &3d Reality Modelling.

Mapping of Course Outcome(s):

CO /	PO												PSO		
PO	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1			3											3	
CO2			3											3	
CO3			3											3	
CO4			3											3	
CO5			3											3	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

COURSE CONTENTS:
1. Study About UAV Flight Planning
2. Establish Ground Control Points.
3. Boundary setting and Data Collection by using Flight Mapping.
4. Measure UAV Data Processing Orthomosaic Maps using 3D Point Cloud.
5. Calculate Aerial Mapping using Drones.
6. Calculate Topography Mapping Using Drones
7. Study About Post Processing Softwares In Drone Surveying
8. 3d Reality Modelling with Bentley Context capture Using Unmanned Aerial Vehicle.
9. Identify 2d &3d Reality Modelling with Google Earth Pro and Drone deploy Software Using Unmanned Aerial Vehicle
10. Analyze 2d &3d Reality Modelling with AGI SOFT Metashape Software Using Unmanned Aerial Vehicle.
11. Evaluate Contour Maps by using Unmanned Aerial Vehicle.

212AER3108	High speed Aerodynamics	L	T	P	C
Pre – Requisites	AER18273	3	0	2	4
Course Category	Program Core				
Course Type	Integrated Course				

Course Objective:

To understand the behavior of air flow both internal and external in compressible flow regime with particular emphasis on supersonic flows

Course Outcomes:

After completing this course, the student will be able to:

CO1: Outline the fundamental aspect of compressible flow
CO2: Dissect the physics of shock and expansion waves
CO3: Solve the equations of two dimensional compressible flow
CO4: Find the factors affecting aircraft configurations
CO5: Categorize high speed flows, and flow visualization techniques

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		3										2	3		
CO2	3		2	2									2		
CO3	3	2											2		
CO4	3	2											2		
CO5	3		2										1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW

Compressibility, Continuity, Momentum and energy equation for steady one dimensional flow-compressible Bernoulli's equation-Calorically perfect gas, Mach Number, Speed of sound, Area – Mach number – Velocity relation, Mach cone, Mach angle, One dimensional Isentropic flow through variable area duct, Static and Stagnation properties, Critical conditions,Characteristic Mach number, Area-Mach number relation, Maximum discharge velocity.

UNIT 2

SHOCK AND EXPANSION WAVES

Normal shock relations, Prandtl's relation-Hugoniot equation, Raleigh Supersonic Pitot tube equation-Moving normal shock waves, Oblique shocks, M relation, Shock Polar, Reflection of oblique shocks, left running and right running waves-Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions, operating characteristics of Nozzles, under expansion, over expansion

UNIT 3

TWO DIMENSIONAL COMPRESSIBLE FLOW

Potential equation for 2-dimensional compressible flow, Linearization of potential equation, perturbation potential, Linearized Pressure Coefficient, Linearized subsonic flow, Prandtl-Glauert rule, Linearized supersonic flow, Method of characteristics.

UNIT 4

HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION

Critical Mach number, Drag divergence Mach number, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts.

UNIT 5

CHARACTERIZATION OF HIGH SPEED FLOWS

Shock-Boundary layer interaction, Wind tunnels for transonic, Supersonic and hypersonic flows, shock tube, Gun tunnels, Supersonic flow visualization, Introduction to Hypersonic Flows

Text Books:

1. Anderson, J. D, Modern Compressible Flow: With Historical Perspective McGraw-Hill Education; 3rd edition, 2002

2. Rathakrishnan. E, Gas Dynamics, Prentice-Hall of India Pvt.,Ltd, 2008.

References:

1. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.

2. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill &Co., 1989.

3. Oosthuizen,P.H., &Carscallen,W.E., Compressible Fluid Flow, CRC Press; 2 edition (July 22, 2013)

List of Experiments:

1. Force measurements on aircraft models
2. Calibration of supersonic wind tunnels
3. Flow visualization studies in supersonic flows
4. Pressure distribution over a finite wing of symmetric aero foil sections
5. Pressure distribution over a finite wing of cambered aero foil section

212AER3312	Analysis of Aircraft Structures	L	T	P	C
Pre – Requisites	AER18R274	3	0	2	4
Course Category	Program Core				
Course Type	Integrated Course				

Course Objective:

To study the behavior of various aircraft structural components under different types of loads

Course Outcomes:

After completing this course, the student will be able to:

CO1: Determine the maximum bending stress of unsymmetrical sections
CO2: Interpret the shear center location in thin walled open section **CO3:** Interpret the shear center location in thin walled closed section **CO4:** Determine the buckling allowable load of aircraft skin
CO5: Analyze the aircraft wing, tail, and fuselage

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	3											1		
CO2	1	2	2										1	2	
CO3	1	2	2										1	2	
CO4		2	1												1
CO5	3		2									1			

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

UNSYMMETRICAL BENDING OF BEAMS

Unsymmetrical bending of beams – different methods of analysis (neutral axis method, ‘k’ method, and the principal axis method), stresses and deflections in beams under unsymmetrical bending

UNIT 2

SHEAR FLOW IN OPEN SECTIONS

Definition and expression for shear flow due to bending, shear flow in thin-walled Open sections with and without stiffening elements, torsion of thin-walled Open sections, the shear center of symmetric and unsymmetrical open sections, structural idealization

UNIT 3

SHEAR FLOW IN CLOSED SECTIONS

Shear flow due to bending and torsion in single-cell and multi-cell structures, the shear center of symmetric and unsymmetrical closed sections, effect of structural idealization, shear flow in a tapered beam, stress analysis of thin-webbed beams using Wagner’s theory

UNIT 4

BUCKLING OF PLATES

Behaviour of a rectangular plate under compression, governing equation for plate buckling, buckling analysis of sheets and stiffened panel under compression, concept of the effective sheet width, buckling due to shear and combined loading, crippling

UNIT 5

AIRCRAFT STRESS ANALYSIS

Loading and analysis of aircraft wing, fuselage, and tail unit. Use of V-n diagram for sizing the aircraft wing, fuselage, and tail unit.

Text Books:

1. Megson T M G, 'Aircraft Structures for Engineering Students', Butterworth-Heinemann; 5 edition,2012
2. Bruhn. E.H., 'Analysis and Design of Flight Vehicles Structures', Tri-state off-set company, USA, 1985
3. Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCB-McGraw Hill, 1997

References:

1. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.
2. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999

List of Experiments:

1. Unsymmetrical Bending of a Cantilever Beam
2. Combined bending and Torsion of a Hollow Circular Tube
3. Experiment using Photo elastic setup
4. Shear Centre of a Channel Section
5. Shear center for unsymmetrical section.

212AER3110	High speed Propulsion	L	T	P	C
Pre – Requisites	AER18R275	3	0	2	4
Course Category	Program Core				
Course Type	Integrated Course				

Course Objective:

To have introduction of advanced propulsion system.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Comprehend the working of turbine, blade profiles, performance, cooling methods in turbine blades and its limitations
CO2: Interpret the operating principle of Ramjet, combustion and its performance
CO3: Explain the basics of Scramjet engine and integral Ram Engine
CO4: Demonstrate the rocket operating principles. Rocket nozzle classifications and performance of rockets
CO5: Explain about Electric, ion and nuclear rockets. The basics of Solar Sails and its operating principle

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2		2								1	2		1
CO2		2	2										1		1
CO3		1	2	1											
CO4	3											1	2	1	1
CO5	1		1										1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

TURBINES FOR JET ENGINES

Principle of operation of axial flow turbines – work done and pressure rise – degree of reaction – types of design of turbines – turbine blade cooling- velocity diagrams- limitations of radial flow turbines- compressor & turbine matching – materials for turbine blades

UNIT 2

RAMJET PROPULSION

Operating principle of ramjet engine – various components of ramjet engines and their efficiencies – Combustion in ramjet engine – critical, subcritical and supercritical modes of operation -ramjet engine and its performance characteristics – sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets

UNIT 3

HYPERSONIC AIRBREATHING PROPULSION

Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion – salient features of scramjet engine and its applications for hypersonic vehicles – problems associated with supersonic combustion – engine/airframe integration aspects of hypersonic vehicles – various types scramjet combustors – fuel injection schemes in scramjet combustors – one dimensional models for supersonic combustion using method of influence coefficients.

UNIT 4

CHEMICAL ROCKET PROPULSION

Operating principle – specific impulse of a rocket – internal ballistics – rocket performance considerations – solid propellant rockets – selection criteria of solid propellants – propellant grain design considerations – erosive burning in solid rockets – liquid propellant rockets – selection of liquid propellants – various feed systems for liquid rockets -thrust control in liquid rockets – cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets - introduction to hybrid propulsion – advantages and limitations of hybrid propulsion - static testing of rockets and safety considerations

UNIT 5

ADVANCED PROPULSION TECHNIQUES

Introduction to nozzleless propulsion and basic concepts - Electric rocket propulsion – Ion propulsion – Nuclear rocket – comparison of performance of these propulsion systems with chemical rocket propulsion systems - Solar sail.

Text Books:

1. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; 8th Edition 2010.
2. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.

References:

1. David H. Heiser and David T. Pratt., “Hypersonic Air breathing Propulsion”, AIAA Education Series, 1999.

List of Experiments:

1. Wall pressure measurements of a turbine blade passage
2. Burn rate measurements of solid propellants
3. Cascade testing of compressor blades
4. Prediction of potential core length in co-axial jets
5. Flow visualization of secondary injection in a supersonic cross flow

212AER1104	APPLIED MECHANICS	L	T	P	C
Pre – Requisites	Nil	3	2	0	3
Course Category	Program Core				
Course Type	Theory				

Course Objective:

- Applying the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
- Applying the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
- Applying the concepts of locating centroids/center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
- Applying the concepts of frictional forces at the contact surfaces of various engineering systems.
- Applying the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces

Course Outcomes:

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

CO 1: Apply the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.

CO 2: Apply the concept of reaction forces and moment of various support systems with rigid bodies in 2D and 3D in equilibrium.

CO 3: Apply the concepts of locating centroids / center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.

CO 4: Apply the concepts of frictional forces at the contact surfaces of various engineering systems.

CO 5: Apply the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3		2	3								3		1
CO2	3	2		2	3								3		1
CO3	3		3	3	2								3		1
CO4	3		3	2									3		1
CO5	3		2		2								3		1

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

Fundamental Concepts and Principles

Systems of Units - Method of Problem Solutions - Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into ComponentsRectangular Components of a Force Unit Vectors - Equilibrium of a Particle-Newton's First Law of Motion turbines- compressor & turbine matching – materials for turbine blades Space and Free-Body Diagrams Forces in Space - Equilibrium of a Particle in Space

UNIT 2:

Principle of Transmissibility

Equivalent Forces, Vector Product of Two Vectors - Moment of a Force about a Point, Varignon's Theorem Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors - Mixed Triple Product of Three Vectors Moment of a Force about an Axis Couple - Moment of a Couple, Equivalent Couples Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces Equilibrium in Two and Three Dimensions Reactions at Supports and Connections.

UNIT 3:

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration - Theorems of Pappus-Guldinus, Distributed Loads on Beams - Centre of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies - Determination of Centroids of Volumes by Integration - Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration - Polar Moment of Inertia , Radius of Gyration of an Area - Parallel-Axis Theorem - Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates - Determination of the Moment of Inertia of a Three-Dimensional Body by Integration

UNIT 4:

The Laws of Dry Friction

Coefficients of Friction - Angles of Friction – Wedges - Wheel Friction - Rolling Resistance - Ladder friction

UNIT 5:

Kinematics

Rectilinear Motion and Curvilinear Motion of Particles. Kinetics - Newton's Second Law of Motion - Equations of Motions - Dynamic Equilibrium - Energy and Momentum Methods - Work of a Force - Kinetic Energy of a Particle - Principle of Work and Energy - Principle of Impulse and Momentum, Impact - Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium

Text Books:

1. Beer, F.P., and Johnson, E.R., Vector Mechanics for Engineers – Statics and Dynamics, McGraw Hill, Tenth Edition in SI units

References:

1. Merriam, J.L., Engineering Mechanics, Volume I – Statics, and Volume – II, Dynamics 2/e, Wiley International, Seventh Edition.

2. Irving, H., Shames, Engineering Mechanics, Statics and Dynamics, Prentice Hall of India Ltd., Fourth Editio

212AER2113	Aircraft Performance	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Program Core				
Course Type	Laboratory				

Course Objective:

- To impart knowledge on the concepts of EAS, TAS and ISA.
- To provide the basic equations governing the steady performance of airplanes.
- To describe the gliding and climbing flights and the parameters that decide those performances.
- To provide the methods to calculate the approximate total takeoff and landing distance.
- To introduce the concept of load factor and provides necessary equations to assess the turn performance of an airplane.

Course Outcomes:

Upon completion of the course, Students will be able to

CO1: Prepare the drag polar diagram and associated equations for subsonic airplanes.

CO2: Calculate the range and endurance of jet and propeller airplanes under given operating conditions.

CO3: Assess the performance of airplanes during steady glide and climb.

CO4: Decide the factors for takeoff and landing distance of airplanes.

CO5: Draw the flight envelope of given aircraft

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			2	1								3	1	
CO2	2	1		1	3								2	3	
CO3	2	2	1	3	1								2	1	
CO4	1	2		3	2								1	3	
CO5	2	2		1	3								1	2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

International Standard atmosphere

IAS, EAS, TAS - Propeller theory- Froude momentum and blade element theories - Propeller co-efficients, Use of propeller charts - Performance of fixed and variable pitch propellers - High lift devices, Thrust augmentation

UNIT 2

Streamlined and bluff body

Types of drag - Effect of Reynold's number on skin friction and pressure drag - Drag reduction of airplanes - Drag polar - Effect of Mach number on drag polar - Concept of sweep- effect of sweep on drag

UNIT 3:

General equation of motion of an airplane

Steady level flight - Thrust required and Power required - Thrust available and Power available for propeller driven and jet powered aircraft - Effect of altitude - maximum level flight speed - Conditions for minimum drag and minimum power required - Effect of drag divergence on maximum velocity - Range and Endurance of Propeller and Jet aircrafts - Effect of wind on range and endurance

UNIT 4:

Shallow and steep angles of climb

Rate of climb - Climb hodograph - Maximum Climb angle and Maximum Rate of climb - Effect of design parameters for propeller jet and glider aircrafts - Absolute and service ceiling - Cruise climb - Gliding flight - Glide hodograph

UNIT 5:

Estimation of take-off and landing distances

Methods of reducing landing distance - level turn, minimum turn radius, maximum turn rate - Bank angle and load factor - Constraints on load factor - SST and MSTR - Pull up and pull down maneuvers - V-n diagram

212AER3114	Aircraft Stability and Control	L	T	P	C
Pre – Requisites	NIL	3	1	0	4
Course Category	Program Core				
Course Type	Theory				

Course Objective:

Make the students to solve the preliminary aircraft design calculations using the steady and accelerated flight performance

Course Outcomes:

After completing this course, the student will be able to:

CO1: Evaluate the performance characteristics like aerodynamic forces and power variations of aircraft

CO2: Interpret the range, endurance, climbing, gliding and various maneuvering performances of an aircraft along with load factor and its limitations

CO3: Illustrate the degrees of freedom and static longitudinal stability attained in aircraft.

CO4: Correlate the aircraft's lateral and directional stability

CO5: Estimate the response of aircraft in various oscillatory modes of aircraft stability

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2	1										2		
CO2	3	2	1										2		
CO3	3	2	1										1		
CO4	2	2	2										1		
CO5	2		1												

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

STEADY LEVEL FLIGHT

International Standard atmosphere, IAS, EAS, TAS, Streamlined and bluff body, Types of drag, Effect of Reynold's number on skin friction and pressure drag, Drag reduction of airplanes, Drag polar, Effect of Mach number on drag polar. Concept of sweep- effect of sweep on drag. General equation of motion of an airplane. Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, maximum level flight speed, conditions for minimum drag and minimum power required, Effect of drag divergence on maximum velocity, Range and Endurance of Propeller and Jet aircrafts. Effect of wind on range and endurance

UNIT 2

GLIDING AND CLIMBING FLIGHT

Shallow and steep angles of climb, Rate of climb, Maximum Climb angle and Maximum Rate of climb-, Absolute and service ceiling, Cruise climb, Gliding flight, Estimation of take-off and landing distances, Methods of reducing landing distance, level turn, minimum turn radius, maximum turn rate, bank angle and load factor, Constraints on load factor, Pull up and pull down maneuvers, V-n diagram.

UNIT 3

STATIC LONGITUDINAL STABILITY AND CONTROL

General concepts-Degrees of freedom of a rigid body, Static and dynamic stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, static margin, Hinge moment, , elevator control power, elevator angle to trim, elevator angle.

UNIT 4

STATIC DIRECTIONAL AND LATERAL STABILITY AND CONTROL

Directional stability-yaw and sideslip, Criterion of directional stability, contribution to static directional stability by wing, fuselage, tail, Lateral stability-Dihedral effect, criterion for lateral stability, evaluation of lateral stability- contribution of fuselage, wing, wing fuselage, tail, aileron effectiveness, strip theory estimation of aileron effectiveness.

UNIT 5

DYNAMIC LONGITUDITIONAL STABILITY

Aircraft Equations of motion, small disturbance theory, Estimation of longitudinal stability derivatives stability derivatives, Routh's discriminant, solving the stability quartic, Phugoid motion, Factors affecting the period and damping. Dutch roll and spiral instability, Auto rotation and spin, Stability derivatives for lateral and directional dynamics.

Text Books:

1. Houghton,E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Arnold Publishers, 1988

2. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 199

References:

1. Kuethe, A.M. and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons; 5th Edition, 1997.
2. John J Bertin., Aerodynamics for Engineers, Prentice Hall; 6th edition, 2013.
3. Clancy, L J., Aerodynamics, Shroff publishers (2006)
4. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015

PROGRAM ELECTIVE COURSES

214AER2103	AIRCRAFT SYSTEMS ENGINEERING	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To make the student to understand the principle and working of aircraft systems and instruments.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Explain schematic diagram of a hydraulic system for a modern aircraft and explain its function
CO2: Comprehend the working principle of modern control system & its advantages
CO3: Describe the various systems of piston & gas turbine engines and the purpose of each system
CO4: Describe the working principle of air conditioning system & fire protection system
CO5: Understand the working principle of aircraft instruments and engine instruments in detail

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2			2									3		
CO2	2			2									1		
CO3	2			2			2						1		
CO4	2			1									1		
CO5	3			3									1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

AIRCRAFT SYSTEMS

Hydraulic systems – Study of typical 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.

UNIT 2

AIRPLANE CONTROL SYSTEMS

Conventional Systems – Power assisted and fully powered flight controls – Power actuated systems – Engine control systems – Push pull rod system – operating principles – Modern controlsystems – Digital fly by wire systems – Auto pilot system, Active Control Technology.

UNIT 3

ENGINE SYSTEMS

Piston and Jet Engines- Fuel systems – Components - Multi-engine fuel systems, lubricating systems – Starting and Ignition systems

UNIT 4

AIRCONDITIONING AND PRESSURIZING SYSTEM

Basic Air Cycle systems – Vapour Cycle Systems, Boot-strap air cycle system – Evaporative vapour cycle systems – Evaporation air cycle systems – Oxygen systems – Fire extinguishing system and smoke detection system, Deicing and anti-icing system.

UNIT 5

AIRCRAFT INSTRUMENTS

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 and Pressure gauges.

Text Books:

1. Mekinley, J.L. and R.D. Bent, Aircraft Power Plants, McGraw Hill 1993.
2. Pallet, E.H.J. Aircraft Instruments & Principles, Pitman & Co 1993.

References:

1. Teager, S, "Aircraft Gas Turbine technology, McGraw Hill 1997.
2. McKinley, J.L. and Bent R.D. Aircraft Maintenance & Repair, McGraw Hill, 1993.
3. Handbooks of Airframe and Power plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, the English Book Store, New Delhi, 1995

213AER2105	AEROSPACE MATERIALS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Enhance the students to select the material for an aircraft components.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Distinguish the requirements of aerospace materials and atomic structure of materials
CO2: Classify the material based on its mechanical behavior.
CO3: Acquire knowledge about the properties of material, the process of machining them and heat treating them.
CO4: Acquire knowledge about the specification of materials, their structural applications and properties.
CO5: Illustrate the high temperature material characterization.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	2		2									2		
CO2	3	2		2									2		
CO3	3	2											2		
CO4	3	2											2		
CO5	3	1											2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

ELEMENTS OF AEROSPACE MATERIALS

Structure of solid materials – Atomic structure of materials – Crystal structure – Miller indices – Density – Packing factor – Space lattices – X-ray diffraction – Imperfection in crystals – general requirements of materials for aerospace applications.

UNIT 2

MECHANICAL BEHAVIOUR OF MATERIALS

Linear and non linear elastic properties – Yielding, strain hardening, fracture, Bauchinger's effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT 3

CORROSION & HEAT TREATMENT OF METALS AND ALLOYS

Types of corrosion – Effect of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles Heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys – Effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys, powder metallurgy.

UNIT 4

CERAMICS AND COMPOSITES

Introduction – physical metallurgy – modern ceramic materials – cermets - cutting tools – glass ceramic –production of semi fabricated forms - Plastics and rubber Carbon/Carbon composites, Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design

UNIT 5

HIGH TEMPERATURE 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 – super alloys – High temperature material characterization.

References:

1.Titterton.G., Aircraft Materials and Processes, V Edition, Pitman Publishing Co., 1995.

2.Martin, J.W., Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd., 1987.

3. Van Vlack.L.H., Elements of Materials Science and Engineering Prentice Hall; publishers, 6th edition, 1989

4. Raghavan.V., Materials Science and Engineering, Prentice Hall of India, New Delhi,5th edition, 2004.

215AER3201	AIRCRAFT DESIGN PROJECT	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Enable the students to design the aircraft.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Infer the design parameters affecting the aircraft configuration and check the feasibility of Manufacturing.

CO2: Estimate the weight of the individual components of aircraft

CO3: Select and locate the aircraft engines in the configuration.

CO4: Determine the wing, fuselage and tail sizing parameters

CO5: Interpret the loads acting on aircraft and estimate the landing gear sizing parameters.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												2		
CO2		3	2	2										1	
CO3	2												2		
CO4	2												2		
CO5		2	2	3									2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

INTRODUCTION

State of art in airplane design, Purpose and scope of airplane design, Classification of airplanes based on purpose and configuration. Factors affecting configuration, Merits of different plane layouts. Stages in Airplane design. Designing for manufacturability, Maintenance, Operational costs, Interactive designs.

UNIT 2

PRELIMINARY DESIGN PROCEDURE

Data collection and 3-view drawings,· their purpose, weight estimation, Weight equation method – Development & procedures for evaluation of component weights. Weight fractions for various segments of mission. Choice of wind loading and thrust Loading.

UNIT 3

OWER PLANT SELECTION

Choices available, comparative merits, Location of power plants, Functions dictating the locations.

UNIT 4

DESIGN OF WING, FUSELAGE AND EMPHANAGE

Selection of aerofoil. Selection of Wing parameters, selection of sweep, Effect of Aspect ratio, Wing Design and Airworthiness requirements, V-n diagram, loads, Structural features. Elements of fuselage design, Loads on fuselage, Fuselage Design. Fuselage and tail sizing. Determination of tail surface areas, Tail design, Structural features, Check for nose wheel lift off.

UNIT 5

DESIGN OF LANDING GEAR AND CONTROL SURFACE

Landing Gear Design, Loads on landing gear, Preliminary landing gear design. Elements of Computer Aided and Design, Special consideration in configuration lay-out, Performance estimation. Stability aspects on the design of control surface.

Text Books:

1. Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 1986
2. Raymer, D.P. Aircraft conceptual Design, AIAA series, 5th edition, 2012.

References:

Kuechemann, D, “The Aerodynamic Design of Aircraft, American Institute of Aeronautics publishers, 2012

213AER2106	AIRCRAFT ENGINE REPAIRS AND MAINTENANCE	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To make the students to understand the maintenance and repair procedures of both piston and gas turbine engines and their procedures followed for overhaul of aero engines.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Describe the function of each component in piston engines and its materials. Carryout inspections and maintenance checks on aircraft piston engines; Piston engine overhaul procedure.
CO2: Investigate the performance of propeller and to detect the damages in the propeller.
CO3: Inspect damage in engine components using NDT.
CO4: Know the overhaul procedures and functions of each component in gas turbine engines; describe the trouble shooting and rectification procedures of gas turbine engines
CO5: Know the overhaul procedures and balancing of gas turbine components

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			2								2	2		
CO2	2	1		1									1		
CO3	1	1		2										1	2
CO4	3			2								2	2		
CO5	2			1								1	1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

Classification of piston engines - Principles of operation - Function of components - Materials used- Details of starting the engines - carburetion and Fuel injection systems for small and large engines - Ignition system components - spark plug detail - Engine operating conditions at various altitudes – Engine power measurements – Classification of engine lubricants and fuels – Induction, Exhaust and cooling system - Maintenance and inspection check to be carried out. Inspection and maintenance and troubleshooting - Inspection of all engine components - Daily and routine checks-Overhaul procedures - Compression testing of cylinders - Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and super charger - Checks and inspection procedures.

UNIT 2

Propeller theory - operation, construction assembly and installation -Pitch change mechanism-Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions – Damage and repair criteria.

UNIT 3

Symptoms of failure - Fault diagnostics - Case studies of different engine systems - Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods and instruments for non-destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance.

UNIT 4

Types of jet engines – Fundamental principles – Bearings and seals - Inlets - compressors- turbines- exhaust section – classification and types of lubrication and fuels- Materials used - Detailsof control, starting around running and operating procedures – Inspection and Maintenance- permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of instruments for online maintenance - Special inspection procedures-Foreign Object Damage - Blade damage .

UNIT 5

Engine Overhaul - Overhaul procedures - Inspections and cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for trouble shooting - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods.

References:

1. Kroes& Wild, "Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994.

2. Turbomeca, "Gas Turbine Engines ", the English Book Store ", New Delhi, 1993. 3. United Technologies’ Pratt & Whitney, " The Aircraft Gas turbine Engine and its Operation”, The English Book Store, New Delhi.

214AER2101	AIRCRAFT RULES AND REGULATIONS - CAR I AND II	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To make the students to understand the Indian aviation rules 1937, relating to aviation and civil aviation requirement in India (DGCA)

Course Outcomes:

After completing this course, the student will be able to:

CO1: Know the procedure for keeping the aircraft in airworthiness conditions and describe the use of MEL, and the procedure for releasing the Aircraft under MEL.
CO2: Describe the different types of maintenance program.
CO3: Comprehend the requirements for getting AO in different categories
CO4: Describe the overhaul and inspection procedure of various instruments
CO5: Describe the detail procedure of flight test

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1								3		2	1		1		
CO2								3		2	1		1		
CO3								3		2	1		1		
CO4								3		2	1		1		
CO5								3		2	1		1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

C.A.R SERIES 'A' - PROCEDURE FOR CIVIL AIR WORTHINESS EQUIREMENTS AND RESPONSIBILITY OPERATORSVIS-A-VIS AIRWORTHINESS DIRECTORATE

Responsibilities of operators / owners; Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations and safety oversight of engineering activities of operators. C.A.R. SERIES 'B' - ISSUE APPROVAL OF COCKPIT CHECK LIST, MEL, CDL - Deficiency list(MEL & CDL); Preparation and use of cockpit check list and emergency list.

UNIT 2

C.A.R. SERIES 'C' - DEFECT RECORDING, MONITORING,INVESTIGATION AND REPORTING

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-fight readings & recordings; Maintenance control by reliability Method.C.A.R. SERIES 'D' - AND AIRCRAFT

MAINTENANCE PROGRAMMES Reliability Programme (Engines); Aircraft maintenance programme& their approval; On condition maintenance of reciprocating engines; TBO - Revision programme - Maintenance of fuel and oil uplift and consumption records - Light aircraft engines; Fixing routine maintenance periods and component TBOs - Initial & revisions.

UNIT 3

C.A.R. SERIES 'E' - APPROVAL OF ORGANISATIONS

Approval of organizations in categories A, B, C, D, E, F, & G; Requirements of infrastructure at stations other than parent base.C.A.R. SERIES 'F' - air worthiness and continued air worthiness: Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

UNIT 4

C.A.R. SERIES 'L' - AIRCRAFT MAINTENANCE ENGINEER - LICENSING

Issue of AME License, its classification and experience requirements, Complete Series 'L'.C.A.R. SERIES 'M' MANDATORY MODIFICATIONS AND INSPECTIONS: Mandatory Modifications /Inspections.

UNIT 5

C.A.R. SERIES 'T' - FLIGHT TESTING OF AIRCRAFT

Flight testing of (Series) aircraft for issue of C of A; Fight testing of aircraft for which C or A had been previously issued. C.A.R. SERIES 'X' - MISCELLANEOUS REQUIREMENTS: Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of taxy permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

References:

1. "Aircraft Manual (India) ", Volume - Latest Edition, The English Book Store, 171,Connaught Circus, New Delhi.
2. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness) ", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.
3. "Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA. AdvisoryCirculars ", form DGCA.

213AER4101	APPROXIMATE METHODS IN STRUCTURAL MECHANICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Enable the students to analyze the statically indeterminate structures by approximate methods.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Define the analytical and numerical methods used in the structural mechanics
CO2: Solve the structural mechanics problems using approximate methods
CO3: Analyze the statically determinate and indeterminate structures using approximate methods.
CO4: Analyze the statically determinate and indeterminate structures using finite difference methods.
CO5: Create code generation for structural mechanics problems using approximate methods

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	1	2											1		
CO2			2	2										1	
CO3	1	2												2	
CO4		1			2									1	
CO5		1		2	3									2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

ANALYTICAL AND NUMERICAL METHODS

Review of analytical methods for solving ordinary differential equations related to structural mechanics problems, boundary conditions, initial conditions, Need for approximate methods, different forms of approximate solution, Numerical integration, Elementary study on calculus of variation.

UNIT 2

APPROXIMATE METHODS

Weighted residual methods: Least square method, collocation method, sub-domain method, method of moments, basic Galerkin form and modified Galerkin form, Variational method: Rayleigh Ritz method.

UNIT 3

STATIC, DYNAMIC AND STABILITY ANALYSIS

Application to statically determinate and indeterminate structures: bar, beam, torsional member. Free vibration and stability analysis, Improvement of solution accuracy.

UNIT 4
FINITE DIFFERENCE METHOD

Application to statically determinate and indeterminate structures: bar, beam, torsional member. Free vibration and stability analysis.

UNIT 5
CODE DEVELOPMENT

Numerical integration; Solution of simultaneous algebraic equations; Code generation for structural mechanics problems using approximate methods.

Text Books:

1. Szilard, R., Theory and Analysis of Plates – Classical and Numerical Methods, Prentice Hall, 1984
2. Chajes, A., Principles of Structural Stability Theory, Prentice Hall. Inc., 1987.
3. Asghar Bhatti, M., Fundamental Finite Element Analysis andApplications: with Mathematica and MATLAB Computations, John Wiley & Sons Inc, 2005
4. Ansel C Ugural and Saul K Fenster, 'Advanced Strength and Applied Elasticity', 4th Edition, Prentice Hall, New Jersey, 2003.

References:

1. Tauchert, T.R., Energy Principles in Structural Mechanics, McGraw Hill, International Student Edition, 1989.
2. Bathe, K.J., and Wilson, E. L., Numerical Methods in Finite Element Method, Prentice Hall (India) Ltd., 1985.
3. Chandrupatla R. Tirupathi, Belegundu D Ashok., Introduction to Finite Elements in Engineering, Prentice Hall (India) Ltd, 2007.
4. Reddy, J. N., An Introduction to the Finite Element Method, McGraw-Hill, 2004.

213AER4105	FINITE ELEMENT METHODS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

- To provide in depth knowledge in approximate methods in Structural mechanics problems.
- To offer understanding of One Dimensional Finite Element Analysis with various types of Elements.
- To get exposed to plane problems in Engineering Analysis including Two Dimensional Finite Element Analysis.
- To analyze any Engineering Component using FEA.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Recognize the basic fundamental equations of elasticity and solving linear system of equation.
CO2: Make familiar of basic approximate methods in Structural applications.
CO3: Recognize the basic principle of Finite Element Analysis in 1D structural and thermal application.
CO4: Ability to solve structural and non-structural problem using 2D FEM.
CO5: Equip them to effectively employ finite element method in order to simulate and launch a new engineering component to the market.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3	3											2		1
CO2	3	3	2	2									2		1
CO3	3	3			3										
CO4	2	3	3	2						2			2		1
CO5	2	3	2	2	3					2			2		1

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

Elasticity

Introduction Stress at a point -Stress Tensor -Elementary view-differential equations of equilibrium; Strain -Displacement relation; Stress-Strain relationship in two dimensions and three dimension-Solving linear system of equations by Gaussian elimination method.-Numerical integration -Gaussian quadrature.

UNIT 2

Approximate Methods

Solution to complex engineering problems -Exact solution -Approximate Solution -mathematical modeling -differential forms of beams -Strain energy -principle of minimum total potential energy -Rayleigh Ritz method -general weighted residual statement -Weighted residual Techniques - Method of Collocation, Sub domain method, Method of least square, Galerkin's method, Method of Moments-Comparison of approximate solutions with exact solution.

UNIT 3

One Dimensional FEA

Introduction to FEM -engineering applications of FEA -Governing equation of FEM -Finite element modeling -Global Coordinates; Local Coordinates -nodal approximation -Element connectivity -shapes functions for various elements -Stiffness matrices and load vectors -global stiffness matrix -Boundary conditions -Computation of deflection, strains and stresses for axial (bar) element; tapered bar element; spring element; plane truss (spar) element; beam element - Thermal stress problem -Higher order elements -quadratic element (Shape function expressions only) -One dimension heat transfer analysis -Composite wall.

UNIT 4

Two Dimensional FEA

Introduction -Plane problems in elasticity -Plane Stress, Plane Strain and axi-symmetry - approximation of geometry and field variable -natural coordinates and global coordinates - Constant Strain Triangular (CST) element -Jacobian matrix -elasticity matrix -strain displacement matrix -element stiffness matrix -load vectors -global stiffness matrix -Computation of deflection, strains and stresses for CST element subjected to in plane load; surface traction -plane stress and plane strain problems -shape functions for CST -Thermal stress problem in two dimension -Higher order elements -six-noded triangular element (Shape function expressions only) -Two dimension heat transfer analysis -Axisymmetric formulation using triangular element -Cylinder under internal pressure.

UNIT 5

Isoparametric Element Formulation

Isoparametric formulation -Four node quadrilateral Element -Shape functions -Element stiffness matrix and force vector -Eight node quadrilateral Element (Shape function expressions only).

Text Books:

1. Chandrupatla T.R. and Belegundu A.D, "Introduction to Finite Elements in Engineering", Pearson Education, 4th Edition, 2012.
2. Rao S.S, "The Finite Element Method in Engineering", Pergammon Press, Elsevier, 2013

References:

1. Reddy J.N, "An Introduction to Finite Element Method", McGraw-Hill International Student Edition, 2005
2. Bhavikatti S.S, "Finite Element Analysis", New Age International Publishers, 2011.

3. Logan D.L, "A First course in the Finite Element Method", Thomson Learning, sixth Edition, 2016.
4. Robert D Cook, David S and Malkucs Michael E Plesha, "Concepts and Applications of Finite Element Analysis", Wiley, 4th Edition, 2003.
5. Raamachandran J, "Boundary and Finite Elements-Theory and problems", Narosa Publishing House, 2000.
6. Seshu P, "Textbook of Finite Element Analysis", PHI Learning Private Limited, 2015.
7. David V Hutton, "Fundamentals of Finite Element Analysis", McGraw-Hill Int. Ed., 2005.

213AER4102	BOUNDARY LAYER THEORY	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Make the students to understand the fundamentals of viscous flow and adapt methods of boundary layer control in laminar flow.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Illustrate the fundamentals of viscous flow
CO2: Solve the viscous flow equations
CO3: Infer the laminar boundary layer **CO4:**
Explain the turbulent boundary layer
CO5: Adapt the methods of boundary layer control in laminar flow

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3												3		
CO2		3	2											2	
CO3	2												2		
CO4	2												2		
CO5		3	1	2										2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

FUNDAMENTAL EQUATIONS OF VISCOUS FLOW

Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum-Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Non-dimensionalizing the basic equations andboundary conditions, vorticity considerations, creeping flow, boundary layer flow

UNIT 2

SOLUTIONS OF VISCOUS FLOW EQUATIONS

Solutions of viscous flow equations, Couette flows, Hagen-Poisuelle flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness.

UNIT 3

LAMINAR BOUNDARY LAYER

Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold's analogy, Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations

UNIT 4
TURBULENT BOUNDARY LAYER

Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity, mixing length , Turbulence modelling

UNIT 5
BOUNDARY LAYER CONTROL

Boundary layer control in laminar flow-Methods of Boundary layer control: Motion of the solid wall- Acceleration of the boundary layer-Suction- Injection of different gas-Prevention of transition- Cooling of the wall-Boundary layer suction-Injection of a different gas.

Text Books:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill Education; 3rd edition, 2005.

References:

1. Schlichting, H., Boundary Layer Theory, Springer publishers, 8th edition, 2000.
2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980.

213AER3108	FATIGUE AND FRACTURE MECHANICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Facilitate students to explain the cause for crack initiation, crack propagation direction.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Become familiar with definition of fatigue and fracture mechanics
CO2: Analysis of cumulative damage
CO3: Analyze for crack initiation and crack growth.
CO4: Analyze for strength of cracked bodies
CO5: Analyze the damage tolerance structures

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2	2											2	
CO2	1			1										1	
CO3	2			1											1
CO4	2	2	1												1
CO5			2												3

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 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

UNIT 2

STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR

Low cycle and high cycle fatigue - Coffin - Manson’s relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques Cumulative damage - Miner’s theory - Other theories.

UNIT 3

FRACTURE MECHANICS

Bodies - Effect of thickness on fracture toughness - stress intensity factors for typical geometries.

UNIT 4

FATIGUE DESIGN AND TESTING

Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.

UNIT 5

FATIGUE DESIGN AND TESTING

Safe life and Fail- safe design philosophies- Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures

Text Books:

1. Prashant Kumar – Elements of fracture mechanics" Tata McGraw Hill Education Private Limited ,2009.
2. Barrois W, Ripley, E.L., "Fatigue of aircraft structure," _ Pergamon press. Oxford, 1983.

References:

1. Sih C.G., Sijthoff and W Noordhoff, "Mechanics of fracture Vol - I" International Publishing Co., Netherlands, 1989.
2. Knott, J.F., "Fundamentals of Fracture Mechanics," - Buterworth& Co., Ltd., London, 1983.
3. KareHellan ,'Introduction to Fracture Mechanics', McGraw Hill, Singapore,1985

213AER2102	FUNDAMENTALS OF CONTROL ENGINEERING	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To Understand the basic concepts of flight control system.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Relate the pneumatic, hydraulic and thermal systems with electrical system.
CO2: Deduce the block diagram of the control system and to draw the signal flow graph.
CO3: Characterize the control system inputs and their response.
CO4: Check the stability criteria of control systems using Routh-Hurwitz criteria, Root locus and Bode plot techniques.
CO5: Utilize the digital PID controllers

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2												1	
CO2			2		1										2
CO3			2	3	1								1		
CO4		2												2	
CO5	1												1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

INTRODUCTION

Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Development of flight control systems.

UNIT 2

OPEN AND CLOSED LOOP SYSTEMS

Feedback control systems – Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.

UNIT 3

CHARACTERISTIC EQUATION AND FUNCTIONS

Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

UNIT 4

CONCEPT OF STABILITY

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

UNIT 5

SAMPLED DATA SYSTEMS

Z-Transforms Introduction to digital control system, Digital Controllers and Digital PID controller

Text Books:

1. OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
2. Azzo, J.J.D. and C.H. Houpis, Feedback control system analysis and synthesis, McGraw- Hill international 3rs Edition, 1998.

References:

1. Kuo, B.C. Automatic control systems, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
2. Houpis, C.H. and Lamont, G.B. Digital control Systems, McGraw Hill Book co., New York, U.S.A. 1995.
3. Naresh K Sinha, Control Systems, New Age International Publishers, New Delhi,1998.

213AER4107	MISSILE AERODYNAMICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:
Facilitate students to analyze the missile aerodynamic characteristics, formulate go

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

CO1: Explain the basic characteristics of Missile aerodynamics
CO2: Summarize the missile configuration and drag estimation
CO3: Classify the aerodynamics of slender and blunt bodies
CO4: Develop the aerodynamic aspects of launching phase **CO5:**
Formulate the stability and control of missiles

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3												3		
CO2		1											1		
CO3	1	1	2										1		
CO4	1	2	3										2		
CO5		2	3	2									2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:
UNIT 1
BASICS ASPECTS OF MISSILE AERODYNAMICS

Classification of missiles-Aerodynamics characteristics and requirements of air to air missiles, air to surface missiles and surface to air missiles-Missile trajectories-fundamental aspects of hypersonic aerodynamics.

UNIT 2
MISSILE CONFIGURATIONS AND DRAG ESTIMATION

Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation

UNIT 3
AERODYNAMICS OF SLENDER AND BLUNT BODIES

Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects

UNIT 4
AERODYNAMIC ASPECTS OF LAUNCHING PHASE

Booster separation-cross wind effects-specific considerations in missile launching-missile integration and separation-methods of evaluation and determination- Wind tunnel tests – Comparison with CFD Analysis.

UNIT 5

STABILITY AND CONTROL OF MISSILES

Forces and moments acting on missiles-Lateral, rolling and longitudinal moments-missile dispersion-stability aspects of missile configuration-Aerodynamic control methods-Jet control methods-Stability derivatives.

References:

1. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 1985.
2. Chin SS, Missile Configuration Design, McGraw Hill, New York, 1961.
3. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA; 2nd edition, 2006
4. Nielsen, Jack N, Stever, Gutford, "Missile Aerodynamics", McGraw Hill, New York, 1960.
5. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", McGraw Hill Publishing Company, 3rd edition, 2002.

213AER4109	STRUCTURAL DYNAMICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Facilitate students to analyze the vibrational effects on structure using direct and approximate methods.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Explain the force deflection properties of structures
CO2: Inspect the vibrations and response to vibration of the system.
CO3: Examine the natural modes of vibrations.
CO4: Dissect the choice of energy methods for vibration analysis.
CO5: Examine a range of approximate methods for vibration analysis.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	1											1		
CO2	1		2												
CO3	2														
CO4			3	1									2		
CO5	2												1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

FORCE DEFLECTION PROPERTIES OF STRUCTURES

Constraints and Generalized coordinates – Virtual work and generalized forces – Force – Deflection influence functions – stiffness and flexibility methods.

UNIT 2

PRINCIPLES OF DYNAMICS

Free and forced vibrations of systems with finite degrees of freedom – Response to periodic excitation – Impulse Response Function – Convolution Integral

UNIT 3

NATURAL MODES OF VIBRATION

Equations of motion for Multi degree of freedom Systems - Solution of Eigen value problems – Normal coordinates and orthogonality Conditions. Modal Analysis.

UNIT 4

ENERGY METHODS

Rayleigh’s principle – Rayleigh – Ritz method – Coupled natural modes – Effect of rotary inertia and shear on lateral vibrations of beams – Natural vibrations of plates.

UNIT 5

APPROXIMATE METHODS

Approximate methods of evaluating the Eigen frequencies and Eigen vectors by reduced, subspace, Lanczos, Power, Matrix condensation and QR methods.

Text Books:

1. F.S. Tse, I.E. Morse and H.T. Hinkle, "Mechanical Vibrations: Theory and Applications" ,Prentice Hall of India Pvt. Ltd, New Delhi, 2004.
2. W.C. Hurty and M.F. Rubinstein, "Dynamics of Structures", Prentice Hall of India Pvt. Ltd., New Delhi 1987.

References:

1. R.K. Vierck, "Vibration Analysis", 2nd Edition, Thomas Y. Crowell & Co Harper &Row Publishers, New York, U.S.A. 1989.
2. S.P. Timoshenko ad D.H. Young, "Vibration Problems in Engineering", John Willey& Sons Inc., 1984.
3. V.Ramamurthi, "Mechanical Vibration Practice and Noise Control" Narosa Publishing House Pvt. Ltd, 2008.

213AER4110	THEORY OF PLATES AND SHELLS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Enable the students to formulate the governing equation for thin plates under different loading conditions

Course Outcomes:

After completing this course, the student will be able to:

CO1: Formulate the governing equation for thin plates under different loading conditions
CO2: Determine reaction forces acting on a simply supported rectangular plates using Navier's Method and Levy's Method
CO3: Determine reaction forces acting on a simply supported circular plates
CO4: Interpret the natural frequency of rectangular plates with different loading conditions
CO5: Determine natural frequency of rectangular plates using approximate methods

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		3											2		
CO2		3	2											2	
CO3		3	2											2	
CO4				2											2
CO5					3									2	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

CLASSICAL PLATE THEORY

Assumptions – Governing Equation – Boundary Conditions – Methods of Solution

UNIT 2

RECTANGULAR PLATES

Navier's Method of Solution for Simply Supported Rectangular Plates – Levy's Method of Solution for Rectangular Plates under Different Boundary Conditions and loadings.

UNIT 3

CIRCULAR PLATES

Governing equation. Boundary conditions. Bending of circular and annular plates for different support conditions and loading cases.

UNIT 4

STABILITY AND FREE VIBRATION ANALYSIS

Governing equation for buckling of plates. Buckling analysis of simply supported plates for different loadings. Governing equation for free vibration of rectangular plates. Natural frequency for rectangular plates for different boundary conditions.

UNIT 5

APPROXIMATE METHODS

Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis.

Text Books:

1. Timoshenko, S.P. Winowsky. S., and Kreger, Theory of Plates and Shells, McGraw Hill Book Co., 1990.
2. AnselUgural, Stresses in Plates & Shells, McGraw Hill, 1981
3. Varadhan.T.K. &Bhaskar.K., "Analysis of Plates – Theory and Problems", Narosa Publishing House, 2000

References:

1. Flugge, W. Stresses in Shells, Springer – Verlag, 1985.
2. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, Dover Publications Inc.; 2nd Revised edition, 2009
3. Harry Kraus, 'Thin Elastic Shells', John Wiley and Sons, 1987.
4. Lloyd Hamilton, Donald, "Beams, Plates and Shells", McGraw Hill, 1976.
5. Reddy.J.N., "Theory & Analysis of Elastic Plates and Shells (Series in Systems and Control)", CRC press, 2nd Edition, 2006

213AER2103	WIND ENGINEERING	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Facilitate students to understand the properties of atmosphere, formulate the governing equations of atmospheric boundary layer.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Infer the properties of atmosphere
CO2: Formulate the governing equations of atmospheric boundary layer
CO3: Characterize the flow within a boundary layer
CO4: Estimate wind loading using various assessment methods
CO5: Interpret the structural and aerodynamic factor that influences the aerodynamic problems

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												1		
CO2					2									2	
CO3		2												2	
CO4			2										3		
CO5			2	3											2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

THE ATMOSPHERE

Atmospheric Circulation - Stability of atmospheres -definitions & implications - Effects of friction - atmospheric motion - Local winds, Building codes, Terrains different types.

UNIT 2

ATMOSPHERIC BOUNDARY LAYER

Governing Equations - Mean velocity profiles, Power law, logarithmic law wind speeds, Atmospheric Turbulence profiles - Spectral density function -. Length scale of turbulence, .Roughness parameters simulation techniques in wind tunnels.

UNIT 3

BLUFF BODY AERODYNAMICS

Governing equations Boundary layers and separations - Wake and Vortex formation two dimensional- StroUhal Numbers, Reynolds numbers-Separation and Reattachments Oscillatory Flow.patterns Vortex shedding flows -Time varying forces to Wind velocity in turbulent flow - Structures in three dimensional

UNIT 4

WIND LOADING

Introduction, Analysis and synthesis. Loading coefficients, local• & global coefficients pressure shear stress coefficients, force and moment coefficients - Assessment methods - Quasi steady method - Peak factor method - Extreme value method.

UNIT 5

AERO ELASTIC PHENOMENA

Vortex shedding and lock in phenomena in turbulent flows, across wind' galloping wakegalloping Torsional divergence, along wind galloping of circular cables, cross wind galloping of circular dibble’s', Wind loads &. Turbulent effects on tall. Structure - Launch vehicles.

Text Books:

Emil Simiu& Robert H Scanlan, 'Wind effects of structures fundamentals and applications to design; John Wiley & Sons INC New York, 3rd edition, 1996.

References:

1. Tom Lawson, “Building Aerodynamics”,Imperial College Press London, 1st edition, 2001.
2. Cook N J, Design Guides to wind loading of buildings structures. Part I & II, Burterworths, London, 1990 .

213AER3109	ACOUSTICS AND NOISE CONTROL	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To make students acquire knowledge in Acoustics study and Noise Control methods.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Understand the importance of noise control.
CO2: Analyze the concepts of Acoustics waves, and its frequencies
CO3: Distinguish the characteristics of Acoustic waves
CO4: Understand the Acoustic measurements
CO5: Know the concepts of Electro Mechanical analogies of Acoustics

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1			3									2		
CO2			1										1		
CO3	1													1	
CO4			1										1		
CO5	1												2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

Introduction

Sound, sources of sound, acoustic wave propagation, importance of noise control, Noise legislation in India, Noise quality norms and standards, governing equation of acoustics

UNIT 2

Plane waves and frequency analysis

Plane waves, Forward waves, Backward waves, reflection of plane waves, Frequency analysis-Introduction to harmonic analysis, periodic quantities, Phasors, Frequency in acoustics, stationary non-stationary signal, Broadband, narrow broadband noise.

UNIT 3

Harmonic waves

Harmonic waves, 1-D harmonic acoustic waves, characteristic impedance, Travelling and standing waves, Acoustic mode shapes and reflection, Reflection and transmission, Flexural waves, evanescent waves, near field acoustic waves, cuton waves in duct.

UNIT 4

Measurements

Power calculation- acoustic intensity, decibel scale, decibel arithmetic, SPL, SWL, SIL, Frequency bands, Human factors in acoustic Engineering, Acoustic measurements, Microphone, parameters of microphone selection, Condenser microphone, Moving coil microphone, Piston phone, Sound power measurement, Sound level meter, Sound intensity measurement.

UNIT 5

Muffler analysis

Muffler analysis, transfer matrix method for expansion chamber muffler, Electro mechanical analogies, source impedance, insertion loss, analysis of industrial mufflers, spherical waves, monopole and dipole, Inhomogeneous wave equation, green's function, Kirchhoff Helmholtz integral equation

Text Books:

1. Fundamentals of Acoustics by L. E. Kinsler, A. R. Frey, A. B. Coppens and J. V. Sanders, John Wiley Sons(2000).
2. Foundations of Engineering Acoustics by F. H. Fahy, Academic Press (2001).
3. Acoustics of ducts & Mufflers by M. L. Munjal, Wiley 2014.

213AER3110	AERO ELASTICITY	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Facilitate the students to comprehend effect aero-elastic problems in an aircraft stability.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Interpret the interaction between aerodynamics and aircraft structures

CO2: Determine the divergence speed using strip theory and successive approximation.

CO3: Estimate the aileron reversal speed using semi-rigid theory

CO4: Interpret the effect of moment of inertia on flutter speed.

CO5: Comprehend the aero-elastic problems in civil, electrical lines and helicopters.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1		2											2		
CO2	2												1		
CO3	1													2	
CO4			3											1	
CO5		3												1	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

AERO ELASTICITY PHENOMENA

Vibration of beams due to coupling between bending and torsion - The aero-elastic triangle of forces - Stability versus response problems – Aeroelasticity in Aircraft Design – Vortex induced vibration – Introduction to aero servo elasticity.

UNIT 2

DIVERGENCE OF A LIFTING SURFACE

Simple two dimensional idealizations – Strip theory – Fredholm integral equation of the second kind – Exact solutions for simple rectangular wings – Semi rigid assumption and approximate solutions – Generalized coordinates – Successive approximations – Numerical approximations using matrix equations.

UNIT 3

STEADY STATE AEROELASTIC PROBLEMS

Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency – Semi rigid theory and successive approximations – Lift distributions – Rigid and elastic wings.

UNIT 4

FLUTTER ANALYSIS

Non-dimensional parameters – Stiffness criteria Dynamic mass balancing – Model experiments – Dimensional similarity – Flutter analysis – Two dimensional thin airfoils in steady incompressible flow – Quasi steady aerodynamic derivatives – Galerkin's method for critical speed – Stability of distributed motion – Torsion flexure flutter – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter prevention and control.

UNIT 5

EXAMPLES OF AEROELASTIC PROBLEMS

Galloping of transmission lines and flow induced vibrations of tall slender structures and suspension bridges – Aircraft wing flutter- Vibrational problems in Helicopters.

Text Books:

1. Fung, Y.C. An Introduction to the theory of Aeroelasticity, Dover Publications Inc., 2008

References:

1. Bisplinghoff., R.L. Ashley, H., and Halfman, R.L, " Aeroelasticity" Addison Wesley Publishing Co., Inc. II ed. 1996.
2. Broadbent, E.G., Elementary Theory of Aeroelasticity, Bunhill Publications Ltd., 1986.
3. Scanlan, R.H. and Rosenbaum, R., Introduction to the Study of Aircraft Vibration and Flutter, Macmillan Co., N.Y., 1991.
4. Blevins R.D, "Flow induced vibrations", Krieger Pub Co; 2 Reprint edition, 2001.

214AER3101	UAV SYSTEM DESIGN	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:
Enable the students to design the UAV systems.

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

CO1: Outline the fundamentals of UAV
CO2: Illustrate the designs of UAV systems.
CO3: Select the avionics hardware systems for the configuration
CO4: Estimate the payloads and operation range
CO5: Test the UAV and develop ground control software

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												3		
CO2	2												3		
CO3	3												2		
CO4										3					
CO5			3										1		2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:
UNIT 1
INTRODUCTION TO UAV

History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications

UNIT 2
THE DESIGN OF UAV SYSTEMS

Introduction to Design and Selection of the System- Aerodynamics and AirframeConfigurations- Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and Europe- Design for Stealth--control surfaces-specifications.

UNIT 3
AVIONICS HARDWARE

Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply- processor, integration, installation, configuration, and testing

UNIT 4
COMMUNICATION PAYLOADS AND CONTROLS

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting

UNIT 5

DEVELOPMENT OF UAV SYSTEMS

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

References:

1. Reg Austin "unmanned aircraft systems UAV design, development and deployment", Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
3. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
4. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998

213AER3101	HEAT TRANSFER	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

The course is intended to build up necessary background for understanding the physical behavior of various modes of heat transfer like conduction, convection, and radiation.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Explain the difference between various modes of heat transfer and the resistance concepts used in heat conduction
CO2: Learn to use the basic methods in conduction. Understand the concept of lump parameter analysis and when it is applicable and earn the concepts of boundary layer
CO3: Learn to apply various correlation used in convective heat transfer and understand the concepts of black body, grey body, view factor, Radiation shielding
CO4: Solve 1-D and 2-D steady, and unsteady state heat conduction using numerical methods
CO5: Learn to apply various technique used for high speed flow heat transfer.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3												2		
CO2		3	2	2									1		
CO3		3	2	2									1		
CO4	3	2	1	2									1		
CO5				3									1		2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

CONDUCTION

Governing equation in Cartesian, cylindrical and spherical coordinates. 1-D steady state heat conduction with and without heat generation. Composite wall- Electrical analogy – Critical thickness of insulation – Heat transfer from extended surface – Effect of temperature on conductivity- 1-D Transient analysis

UNIT 2

CONVECTION

Review of basic equations of fluid flow – Dimensional analysis- Forced convection – Laminar flow over flat plate and flow through pipes-Flow across tube banks. Turbulent flow over flat plateand flow through pipes – Free convection – Heat transfer from vertical plate using integral method – Empirical relations - Types of heat exchangers – Overall heat transfer coefficient – LMTD and NTU methods of analysis

UNIT 3

RADIATION

Basic definitions – Concept of black body - Laws of black body radiation-Radiation between black surfaces – Radiation heat exchange between grey surfaces – Radiation shielding – Shape factor-Electrical network analogy in thermal radiation systems

UNIT 4

NUMERICAL METHODS

1-D and 2-D steady and unsteady state heat conduction – composite walls-heat generation- variable thermal conductivity- extended surfaces analysis using finite difference method- Convective heat transfer- Stream function- vorticity method- Creeping flow analysis-convection- diffusion 1-D, 2-D analysis using finite difference approximation. Numerical methods applicable to radiation heat transfer.

UNIT 5

CASE STUDIES IN AEROSPACE ENGINEERING

Numerical treatment of heat transfer problems pertaining to Aerospace Engineering like in gas turbines, rocket thrust chambers, Aerodynamic heating and Ablative heat transfer in thermal protection systems.

Text Books:

1. Yunus,A.Cengel, Heat Transfer -A Practical Approach, Tata McGraw Hill, Second edition, 2003

2. Holman,J.P., Heat Transfer, McGraw Hill Book Co.,Inc., New York, 8thEdition,1996.

3. Sachdeva,S.C., Fundamentals of Engineering Heat and Mass Transfer, new age publishers,2010.

4. NecatiOzisik, Finite Difference Method in Heat Transfer, CRC Press, second edition, 1994

References:

1. John H. Lienhard IV & John H. Lienhard V, “A Heat Transfer Text Book, Prentice Hall Inc.,1981.

2. Sutton,G.P., Rocket Propulsion Elements, John Wiley & Sons; 8th Edition 2010.

3. Mathur,M.L. and Sharma,R.P,“Gas Turbine, Jet and Rocket Propulsion”,Standard Publishers & Distributors, Delhi, 2nd edition 2014.

213AER4108	**ROCKETS & LAUNCH VEHICLES**	**L**	**T**	**P**	**C**
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To introduce the basic concepts of design and trajectory estimation of rocket and missiles, to study the performance of rocket and missiles under various operating conditions, and the fundamentals of design concepts

Course Outcomes:

After completing this course, the student will be able to:

CO1: Outline diverse varieties of Rockets and demonstrates the aerodynamics of launch vehicles
CO2: Examine the aerodynamics of launch vehicles
CO3: Inspect the 1-D and 2-D rocket motions in free space and homogeneous gravitational fields
CO4: Construct the staging and stage separation dynamics of rockets and launch vehicles
CO5: Inspect a range of control methods of rockets and launch vehicles.

Mapping of Course Outcome(s):

CO / PO	**PO**												**PSO**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
CO1	3					1							1		
CO2	1		2										1		
CO3	2												1		
CO4	1	2											1		
CO5	1												1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

CLASSIFICATION OF ROCKETS AND LAUNCH VEHICLES

Various methods of classification of missiles and rockets-Basic Aerodynamics characteristics of launch vehicle configurations-Examples of various Indian space launch vehicles-Current statusof Indian rocket programme with respect to international scenario.

UNIT 2

AERODYNAMICS OF ROCKETS AND LAUNCH VEHICLES

Airframe components of rockets and Launch Vehicles – forces acting on a missile while passing through atmosphere – slender body aerodynamics - method of describing forces and moments – lift force and lateral moment –lateral aerodynamic damping moment – longitudinal moment – drag estimation-Rocket Dispersion

UNIT 3

ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD

One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude – simple approximations to burn out velocity and altitude – estimation of culmination time and altitude.

UNIT 4

STAGING OF ROCKETS AND LAUNCH VEHICLES

Design philosophy behind multistaging of launch vehicles– multistage vehicle optimization– stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics.

UNIT 5

CONTROL OF ROCKETS AND LAUNCH VEHICLES

Introduction to aerodynamic control and jet control methods- thrust control methods – various types of thrust vector control methods including secondary injection thrust vector control for launch vehicles.

Text Books:

1. Cornelisse, J.W., “Rocket Propulsion and Space Dynamics”, J.W. Freeman &Co.,Ltd, London, 1982
2. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; 8th Edition 2010.

References:

1. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.

214AER2104	AIRFRAME REPAIR AND MAINTENANCE	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

Airframe maintenance & repair deals with the maintenance and safety precautions and procedures of airframe systems and their troubleshooting practices.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Explain the welding, brazing process with the requirements of the process and significance of NDT

CO2: Interpret the various maintenance practices in plastic and composite parts of aircraft

CO3: Comprehend the precautionary steps involved in rigging, Jacking process

CO4: Gain through Understanding in parts, working methodology of basic aircraft systems.

CO5: Get a clear idea about safety practices and troubleshooting on an aircraft.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2										1		1		2
CO2	2			2											1
CO3											1	1	1		
CO4	1											1			1
CO5						2	1						1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

WELDING IN AIRCRAFT STRUCTURAL COMPONENTS

Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing. Sheet metal repair and maintenance: Selection of materials; Repair schemes; Fabrication of replacement patches; Tools - power/hand; Repair techniques; Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight - change on surrounding structure. Sheet metal inspection -
N.D.T. Testing. Riveted repair design - Damage investigation - Reverse engineering

UNIT 2

PLASTICS AND COMPOSITES IN AIRCRAFT

PLASTICS IN AIRCRAFT: Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., and various repairs schemes - Scopes. ADVANCED COMPOSITES IN AIRCRAFT: Cleaning of fibre reinforced plastic (FRP) materials prior to repair; Break test - Repair Schemes; FRP/honeycomb sandwich materials; laminated FRP structural members and skin panels; Tools/equipment; Vacuum-bag process. Special precautions – Autoclaves

UNIT 3

AIRCRAFT JACKING, ASSEMBLY AND RIGGING

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces - Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

UNIT 4

REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM

Trouble shooting and maintenance practices - Service and inspection - Inspection and maintenance of landing gear systems. - Inspection and maintenance of air-conditioning and pressurization system, water and waste system. 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).

UNIT 5

SAFETY PRACTICES

Hazardous materials storage and handling, Aircraft furnishing practices - Equipments. Trouble shooting.Theory and practices

Text Books:

1. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair ", McGraw Hill, New York, 1992

References:

1. Larry Reithmeir, “Aircraft Repair Manual ", Palamar Books, Marquette, 1992.
2. Brimm D.J. Bogges H.E., "Aircraft Maintenance ", Pitman Publishing corp., NewYork, 1940.
3. Delp. Bent and Mckinely “Aircraft Maintenance Repair”, McGraw Hill, New York,1987.

214AER3103	AVIONICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

To introduce the basic concepts of navigation and communication systems of aircraft

Course Outcomes:

After completing this course, the student will be able to:

CO1: Design and fabricate of modern aircraft component cockpit.

CO2: Identify various cockpits in real time

CO3: Identify real time applications of microprocessor in aircraft

CO4: Apply basic concepts to aircraft instruments for efficient output

CO5: Aware of communication and navigation systems and their applications

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2												2
CO2	3														2
CO3	2		2												2
CO4	2		2												2
CO5	2														2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

INTRODUCTION TO AVIONICS

Need for avionics in civil and military aircraft and space systems – Integrated avionics and weapon systems – Typical avionics subsystems, design, technologies – Introduction to Digital Computer and memories

UNIT 2

DIGITAL AVIONICS ARCHITECTURE

Avionics system architecture – Data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629.

UNIT 3

FLIGHT DECKS AND COCKPITS

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

UNIT 4

INTRODUCTION TO NAVIGATION SYSTEMS

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.

UNIT 5

AIR DATA SYSTEMS AND AUTO PILOT

Air data quantities – Altitude, Air speed, Vertical speed, Mach number, Total air temperature Mach, warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

Text Books:

1. Albert Helfrick.D., Principles of Avionics, Avionics Communications Inc., 2004
2. Collinson.R.P.G. Introduction to Avionics, Chapman and Hall, 1996.

References:

1. Middleton, D.H., Ed., Avionics systems, Longman Scientific and Technical,Longman Group UK Ltd., England, 1989.
3. Spitzer, C.R. Digital Avionics Systems, Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
4. Spitzer. C.R. The Avionics Hand Book, CRC Press, 2000

213AER4103	COMBUSTION IN AEROSPACE VEHICLES	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

To make the students to examine the characteristics of flame and factors influencing the combustion efficiency.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Examine the characteristics of flames
CO2: Interpret the factors affecting the combustion efficiency and to prevent the detonation.
CO3: Estimate the combustor sizing parameters and its combustion efficiency
CO4: Examine the influences of shock waves in supersonic combustion **CO5:** Categorize the performance characteristics of different chemical rockets

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3		2												2
CO2	3														2
CO3	2		2												2
CO4	2		2												2
CO5	2														2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

FUNDAMENTAL CONCEPTS IN COMBUSTION, CHEMICAL KINETICS AND FLAMES

Thermochemical equations – heat of reaction- first, second and third order reactions – premixed flames – diffusion flames – laminar and turbulent flames - measurement of burning velocity – various methods – effect of various parameters on burning velocity – flame stability – deflagration – detonation – Rankine-Hugoniot curves – radiation by flames

UNIT 2

COMBUSTION IN AIRCRAFT PISTON ENGINES

Introduction to combustion in aircraft piston engines – various factors affecting the combustion efficiency - fuels used for combustion in aircraft piston engines and their selection – detonation in piston engine combustion and the methods to prevent the detonation

UNIT 3

COMBUSTION IN GAS TURBINE AND RAMJET ENGINES

Combustion in gas turbine combustion chambers - recirculation – combustion efficiency, factors affecting combustion efficiency, estimation of adiabatic flame temperature in gas turbine combustion chambers – combustion stability –differences between the design of combustion chambers of ramjet and gas turbine engines - various types of flame holders for combustion chambers – salient features of after-burners

UNIT 4

SUPERSONIC COMBUSTION

Introduction to supersonic combustion – supersonic combustion controlled by diffusion, mixing and heat convection – analysis of reactions and mixing processes - supersonic burning with detonation shocks - various types of supersonic combustors – high intensity combustors.

UNIT 5

COMBUSTION IN SOLID, LIQUID AND HYBRID ROCKETS

Solid propellant combustion - double and composite propellant combustion – various combustion models – combustion in liquid rocket engines – single fuel droplet combustion model – combustion models for hybrid rockets

Text Books:

1. Sharma, S.P., and Chandra Mohan, “Fuels and Combustion”, Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, 1987.
2. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.

References:

1. Loh, W.H.T., “Jet, Rocket, Nuclear, Ion and Electric Propulsion: Theory and Design(Applied Physics and Engineering)”, Springer Verlag, New York, 2012.
2. Beer, J.M., and Chegar, N.A. “Combustion Aerodynamics”, Applied Science Publishers Ltd., London, 1981.
3. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; 8th Edition 2010.

213AER3103	DESIGN OF GAS TURBINE ENGINE COMPONENTS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:
Enable the students to design the aircraft engine components.

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

CO1: Estimate the preliminary design parameters of aircraft engine components
CO2: Characterize the flow properties and examine the engine performance
CO3: Investigate the rotary components and its aerodynamic performance **CO4:** Design the subsonic combustion chamber
CO5: Differentiate nozzle and diffuser functions, its geometry.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		3	1										3	
CO2			3											3	
CO3			3	1										3	
CO4			3	1										3	
CO5			3	1										3	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:
UNIT 1
GAS TURBINE ENGINE DESIGN FUNDAMENTALS
Design Process- compressible flow relationship; Constrain Analysis- Concept-Design tools-preliminary estimates; Mission analysis-Concept- design tools-Aircraft weight and fuel consumption data-Example problems on Constrain analysis, Mission analysis

UNIT 2
ON DESIGN AND OFF-DESING PARAMETRIC ANALYSIS
Total and static properties-corrected mass flow rate-Engine Cycle Design- One-Dimensional Through flow Area-Flow path force on components- aircraft constraint analysis, aircraft mission analysis, engine parametric (design point) analysis, engine performance (offdesign) analysis engine installation drag and sizing.

UNIT 3
DESIGN OF ROTATING COMPONENTS
Engine Component Design-Fan and Compressor Aerodynamics-Diffusion factorAerofoil geometry-Flow path dimension-Radial variation-Turbine Aerodynamics- Constant axial velocity-adiabatic-selected Mach number-Mean line stage Design-stage pressure ratio-Airfoil geometry-

radial variation-turbine cooling-range of turbine parameter-Engine lifeDesign Example –fan-compressor-turbine.

UNIT 4
COMBUSTION CHAMBER DESIGN

Engine Component Design: Combustion system components- Combustion- Chemical reactor theory. Combustor Stability map-Stirring and mixing-Total pressure loss-FuelsIgnition-Combustion Systems of Main Burner Design: Air partitioning- Main burner component Design: Diffuser-types of burner-inner and outer casing Design-Fuel- nozzle-
Dome and liner-Primary zone- swirler- Secondary holes-Dilution holes-Transition duct-
Example Design calculation: Design of Afterburners-Design parameters-ComponentsDiffuser-Fuel injection-Ignition-Flame stabilization- Flame spread and after burner lengthExamples design calculation.

UNIT 5
INLET AND NOZZLE DESIGN

Inlets and Exhaust Nozzles Design: Elements of a Successful Inlet-Engine IntegrationProgram-Definition of Subsonic Inlet-Engine Operational Requirements- Definition ofSupersonic Inlet-Engine Operational Requirements- Engine Impact on Inlet Design- Inlet Impact on Engine Design-Validation of Inlet-Engine System-Exhaust nozzle design-Nozzle types and their design -Jet control methods for reduction of infrared signature-Simple design problem on dimensional nozzle flow

Text Books:

1. Aircraft Engine Design,Second Edition,by J.D. Mattingly, W.H. Heiser, and D.T. Pratt, 2002, AIAA Education Series, AIAA
2. Aircraft Propulsion Systems Technology and Design, by G.C. Oates (ed.), 1989, AIAA Education Series, AIAA
3. H.I.H. Saravanamuttoo , G.F.C. Rogers, "Gas Turbine Technology", Pearson Education Canada; 6th edition, 2008.

References:

1. High-Speed Flight Propulsion Systems, by S.N. Murthy and E.T. Curran(eds.), 1991, Volume 137, Progress in Astronautics and Aeronautics, AIAA
2.N.Cumpsty, JetPropulsion: A Simple Guide to the Aerodynamics and thermodynamics Design and Performance of Jet Engines" , Cambridge University Press; 2 edition, 2003
3. Applied Gas Dynamics, by E.Rathakrishnan, John Wiley & Sons (Asia) Pvt Ltd, 2010.
4. Aircraft Gas Turbine Engine Technology,3rd ed., by I.E. Treager, 1995, Glencoe McGraw- Hill, Inc.

213AER3104	HELICOPTER AERODYNAMICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

Facilitate students to determine the geometry parameters of main rotor, analyze the aerodynamic characteristics of main rotor blade.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Determine the geometry parameters of main rotor
CO2: Construe the aerodynamic characteristics of main rotor blades
CO3: Characterize the aerodynamic performance of helicopter
CO4: Characterize the static and dynamic stability performance of helicopter at low Mach numbers.
CO5: Infer the vibrational effects of helicopter main rotors.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		2										2		
CO2			2										2		
CO3		2											2		
CO4		2												1	
CO5			3										2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

INTRODUCTION

Helicopter as an aircraft, Basic features, Layout, Generation of lift, Main rotor, Gearbox, tail rotor, power plant, considerations on blade, flapping and feathering, Rotor controls and various types of rotor, Blade loading, Effect of solidity, profile drag, compressibility etc., Blade area required, number of Blades, Blade form, Power losses, Rotor efficiency.

UNIT 2

AERODYNAMICS OF ROTOR BLADE

Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect

UNIT 3

POWER PLANTS AND FLIGHT PERFORMANCE

Piston engines, Gas turbines, Ramjet principle, Comparative performance, Horsepower required, Range and Endurance, Rate of Climb, Best Climbing speed, Ceiling in vertical climb, Autorotation.

UNIT 4

STABILITY AND CONTROL

Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.

UNIT 5

ROTOR VIBRATIONS

Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration absorbers, Measurement of vibration in flight. Rotor Blade Design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions, Stress analysis.

Text Books:

1. John Fay, Helicopter: history, piloting and How It Flies, Himalayan Books 1995.
2. Lalit Gupta, Helicopter Engineering; Himalayan Books New Delhi 1996.

References:

1. Joseph Schafer, Basic Helicopter Maintenance (Aviation Technician Training Course-JS312642), Jeppesen 1980.
2. R W Prouty, Helicopter Aerodynamics, Phillips Pub Co, 1993.

213AER4106	HYPERSONIC AERODYNAMICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

Enable the students to estimate lift coefficient, examine the high temperature effects on airframe.

Course Outcomes:

After completing this course, the student will be able to:

CO1: differentiate hypersonic aerodynamics from supersonic aerodynamics
CO2: Estimate lift co-efficient using Newtonian theory.
CO3: Infer the effect of boundary layer and aerodynamic heating on airframe
CO4: Summarize viscous interaction in hypersonic flow
CO5: Examine the high temperature effects on airframe

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												1		
CO2	2												1		
CO3	2												1		
CO4	1			3											2
CO5	1			3											2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

FUNDAMENTALS OF HYPERSONIC AERODYNAMICS

Introduction to hypersonic aerodynamics – differences between hypersonic aerodynamics and supersonic aerodynamics - concept of thin shock layers and entropy layers – hypersonic flight paths – hypersonic similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT 2

SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS

Local surface inclination methods – Newtonian theory – modified Newtonian law tangent wedge and tangent cone and shock expansion methods – approximate methods - hypersonic small disturbance theory – thin shock layer theory- blast wave theory-hypersonic equivalence principle

UNIT 3

VISCOUS HYPERSONIC FLOW THEORY

Boundary layer equations for hypersonic flow – hypersonic boundary layers – self similar and non self-similar boundary layers – solution methods for non self-similar boundary layers – aerodynamic heating and its adverse effects on airframe.

UNIT 4

VISCOUS INTERACTIONS IN HYPERSONIC FLOWS

Introduction to the concept of viscous interaction in hypersonic flows - Strong and weak viscous interactions - hypersonic viscous interaction similarity parameter – introduction to shock wave boundary layer interactions.

UNIT 5

HIGH TEMPERATURE EFFECTS IN HYPERSONIC FLOWS

Nature of high temperature flows – chemical effects in air – real and perfect gases – Gibb's free energy and entropy - chemically reacting boundary layers – recombination and dissociation.

Text Books:

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA; 2ndEdition, 2006

References:

1. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", McGraw Hill Publishing Company, 3rd edition,, 2002.
2. John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington.D.C., 1994.

214AER3102	SATELLITE TECHNOLOGY	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

Facilitate students to examine the structural configurations and to select the materials for satellite.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Define the stabilization axis, spacecraft orbits
CO2: Ensure the orbit orientation of satellites
CO3: Examine the structural configurations and to select the materials for satellite
CO4: Estimate moment co-efficient for trajectory controls
CO5: Outline the ground control systems to control the spacecraft

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		1										1		
CO2	1		2										1		
CO3	1		2										2		
CO4	1			2									2		
CO5	1			2									1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

INTRODUCTION TO SATELLITE SYSTEMS

Common satellite applications and missions – Typical spacecraft orbits – Definitions of spin the three axis stabilization-Space environment – Launch vehicles – Satellite system and their functions (structure, thermal, mechanisms, power, propulsion, guidance and control, bus electronics).

UNIT 2

ORBITAL MECHANICS

Fundamental of flight dynamics – Time and coordinate systems – Orbit determination and prediction – Orbital maneuvers – GPS systems and application for satellite/orbit determination – Ground station network requirements

UNIT 3

SATELLITE STRUCTURES & THERMAL CONTROL

Satellite mechanical and structural configuration: Satellite configuration choices, launch loads, separation induced loads, deployment requirements – Design and analysis of satellite structures – Structural materials and fabrication – The need of thermal control: externally induced thermal environment – Internally induced thermal environment - Heat transfer mechanism: internal to the spacecraft and external heat load variations – Thermal control systems: active and passivemethods.

UNIT 4

SPACECRAFT CONTROL

Control requirements: attitude control and station keeping functions, type of control maneuvers – Stabilization schemes: spin stabilization, gravity gradient methods, 3 axis stabilization – Commonly used control systems: mass expulsion systems, momentum exchange systems, gyro and magnetic torque - Sensors star and sun sensors, earth sensor, magnetometers and inertial sensors

UNIT 5

POWER SYSTEM AND BUS ELECTRONICS

Solar panels: Silicon and Ga-As cells, power generation capacity, efficiency – Space battery systems – battery types, characteristics and efficiency parameters – Power electronics. Telemetry and telecommand systems: Tm & TC functions, generally employed communication bands (UHF/VHF, S, L, Ku, Kaetc), their characteristics and applications- Coding Systems – Onboard computer- Ground checkout Systems.

Text Books:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Rilay, FF, McGraw Hill, 1982.
3. Principles of Astronautics Vertregt.M.,Elsevier Publishing Company, 1985.
4. Introduction Space Flight, Francis J. Hale Prentice Hall, 1994.

References:

1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
2. Structural Design of Missiles & Space Craft Lewis H. Abraham, McGraw Hill, 92.
3. Space Communications Systems, Richard.F, FilipowskyEugen I Muehllorf, Prentice Hall, 1995.
4. Hughes, P.C. Spacecraft Altitude Dynamics, Wilsey, 1986.
5. Space Vehicle Design, Michael D. Griffin and James R. French, AIAA Education Series, 1991.

213AER3102	SPACE MECHANICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

Facilitate students explain the laws for planetary motion, evaluate influence coefficient, perturbation velocity.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Describe the space environment, its effect on materials
CO2: Explain the laws for planetary motion.
CO3: Evaluate the perturbation velocities using Cowell's method and Encke's method.
CO4: Interpret the interplanetary trajectory motion
CO5: Infer the influence co-efficient on ballistic missile trajectory

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												2		
CO2	2												2		
CO3														2	
CO4															
CO5															

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

SPACE ENVIRONMENT

Peculiarities of space environment and its description– effect of space environment on materials of spacecraft structure and astronauts- manned space missions – effect on satellite life time

UNIT 2

BASIC CONCEPTS AND THE GENERAL N- BODY PROBLEM

The solar system – reference frames and coordinate systems – terminology related to the celestial sphere and its associated concepts – Kepler's laws of planetary motion and proof of the laws – Newton's universal law of gravitation - the many body problem - LagrangeJacobi identity – the circular restricted three body problem – libration points – the general N-body problem – two body problem – relations between position and time.

UNIT 3

SATELLITE INJECTION AND SATELLITE PERTURBATIONS

General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – Cowell's method and Encke's method – method of variations of orbital elements – general perturbations approach.

UNIT 4

INTERPLANETARY TRAJECTORIES

Two-dimensional interplanetary trajectories – fast interplanetary trajectories – three dimensional interplanetary trajectories – launch of interplanetary spacecraft – trajectory estimation about the target planet – concept of sphere of influence – Lambert's theorem

UNIT 5

BALLISTIC MISSILE TRAJECTORIES

Introduction to ballistic missile trajectories – boost phase – the ballistic phase – trajectorygeometry – optimal flights – time of flight – re-entry phase – the position of impact point – influence coefficients

Text Books:

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman&Co.,Ltd, London, 1982
2. Parker, E.R., "Materials for Missiles and Spacecraft", Mc.Graw Hill Book Co. Inc., 1982.

References:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons; 8th Edition 2010

213AER3106	THEORY OF ELASTICITY	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

To study the behavior of various aircraft structural components under different types of loads.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Formulate stress tensor matrix, find its components
CO2: Estimate stress components using Airy's stress function
CO3: Derive the equations of equilibrium for rotating discs
CO4: Determine polar moment of inertia for shafts with cross section such as circular, elliptical, equilateral triangle
CO5: Derive the equation of equilibrium for plates and shells with different loading conditions.

Mapping of Course Outcome(s):

CO / PO	PO												PSO			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	
CO1	3	2														
CO2		3														
CO3	3															
CO4		2		2										2		
CO5	3															

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

BASIC EQUATIONS OF ELASTICITY

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants

UNIT 2

PLANE STRESS AND PLANE STRAIN PROBLEMS

Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.

UNIT 3

POLAR COORDINATES

Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy's stress function, Axi – symmetric problems, Introduction to Dunder's table, Curved beam analysis, Lame's, Kirsch, Michell's and Boussinesque problems – Rotating discs.

UNIT 4

TORSION

Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.

UNIT 5

INTRODUCTION TO THEORY OF PLATES AND SHELLS

Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions

Text Books:

1. Timoshenko, S.P, and Goodier, T.N., Theory of Elasticity, McGraw – Hill Ltd., Tokyo, 1990.
2. Ansel C Ugural and Saul K Fenster, 'Advanced Strength and Applied Elasticity', 4th Edition, Prentice Hall, New Jersey,4th edition 2003.
3. Bhaskar, K., and Varadan, T. K., Theory of Isotropic/Orthotropic Elasticity, CRC Press USA, 2009.

References:

1. Wang, C. T., Applied Elasticity, McGraw – Hill Co., New York, 1993.
2. Sokolnikoff, I. S., Mathematical Theory of Elasticity, McGraw – Hill, New York, 1978.
3. Volterra& J.H. Caines, Advanced Strength of Materials, Prentice Hall, New Jersey, 1991
4. Barber, J. R., Elasticity (Solid Mechanics and Its Applications), Springer publishers, 3rd edition,2010.

213AER3105	THEORY OF VIBRATIONS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

Vibration and Aero Elasticity's deals with the motion of aircraft motions alongside their interactions and their vibrations

Course Outcomes:

After completing this course, the student will be able to:

CO1: Examine the frequency of damped and un-damped mechanical systems
CO2: Interpret the natural frequency of multi degree of freedom systems through linear algebra
CO3: Estimate the frequency of beams and shafts
CO4: Compare the natural frequency of the system by different approximate methods
CO5: Interpret the structural and aerodynamic factor that influences the aerodynamic problems

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	3												2	
CO2	1	3												2	
CO3	1	3		1										2	
CO4		2	2	2										1	
CO5		2		3											2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

SINGLE DEGREE OF FREEDOM SYSTEMS

Introduction to simple harmonic motion, D'Alembert's Principle, Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Transmissibility - Vibration measuring instruments

UNIT 2

MULTI DEGREES OF FREEDOM SYSTEMS

Two degrees of freedom systems - Static and Dynamic couplings - vibration absorber- Principal co-ordinates - Principal modes and orthogonal conditions - Eigen value problems - Hamilton's principle - Lagrangean equations and application

UNIT 3

CONTINUOUS SYSTEMS

Vibration of elastic bodies - Vibration of strings – Longitudinal, Lateral an d Torsional vibrations.

UNIT 4

APPROXIMATE METHODS

Approximate methods - Rayleigh's method - Dunkerlay's method – Rayleigh-Ritz method, Matrix Iteration method

UNIT 5

ELEMENTS OF AEROELASTICITY

Coupled flexural–Torsional oscillation of beam- Aeroelastic problems - Collars triangle – Wing Divergence - Aileron Control reversal – Flutter – Buffeting. – Elements of servo elasticity

Text Books:

1. Leonard Meirovitch, 'Elements of Vibration Analysis' – McGraw HillInternational Edition,2007
2. G.K.Grover, "Mechanical Vibrations", 7th Edition, Nem Chand Brothers,Roorkee, India,2009
3. William T. Thomson & Marie Dillon Dahleh, 'Theory of Vibration with Application",Prentice Hall publishers, 5th edition, 1997

References:

1. William Weaver, Stephen P. Timoshenko, Donovan H. Young, Donovan H.Young. 'Vibration Problems in Engineering' – John Wiley and Sons, New York, 2001
2. Bisplinghoff R.L., Ashely H and Hogman R.L., Aero elasticity – Addison Wesley Publication, New York, 1983.
3. William W Seto, 'Mechanical Vibrations' – McGraw Hill, Schaum Series.
4. TSE. F.S., Morse, I.F., Hinkle, R.T., 'Mechanical Vibrations' – Prentice Hall, New York, 1984.
5. Den Hartog, 'Mechanical Vibrations' Crastre Press, 2008.

213AER2101	EXPERIMENTAL AERODYNAMICS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To determine the stress and strain in materials and structure subjected to static or dynamic forces or loads

Course Outcomes:

After completing this course, the student will be able to:

CO1: Interpret basic measuring techniques and various measuring instruments in fluid mechanics
CO2: Comprehend the operation of wind tunnels, and experiment with the performance of wind tunnels.
CO3: Determine the fluid flow properties using flow visualization techniques
CO4: Demonstrate the pressure, velocity, and temperature measurements
CO5: Examine the special flows and uncertainty analysis

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												1		
CO2	2			1									1		
CO3	1			1										2	
CO4	3	1		2											2
CO5	2												1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

BASIC MEASUREMENTS IN FLUID MECHANICS

Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization – Components of measuring systems – Importance of model studies

UNIT 2

WIND TUNNEL MEASEUREMENTS

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Turbulence- Wind tunnel balance – Wire balance – Strut-type – Platform-type – Yoke-type – Pyramid type – Strain gauge balance – Balance calibration

UNIT 3

FLOW VISUALIZATION AND ANALOGUE METHODS

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe-Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps – Electrolytic tank

UNIT 4

PRESSURE, VELOCITY AND TEMPERATUREMEASUREMENTS

Pitot - static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Pressure measurement techniques - Pressure transducers – Temperature measurements

UNIT 5

SPECIAL FLOWS AND UNCERTAINTY ANALYSIS

Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers - Data acquisition and processing – Signal conditioning – Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation - Uses of uncertainty analysis

Text Books:

1. Rathakrishnan, E., “Instrumentation, Measurements, and Experiments in Fluids,” CRCPress – Taylor & Francis, 2007
2. Robert B Northrop, “Introduction to Instrumentation and Measurements”,Second Edition, CRC Press, Taylor & Francis, 2006.

213AER2104	WIND TUNNEL TECHNIQUES	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

Wind tunnel techniques course depicts the types, working and characteristics of wind tunnels in the laboratory. The flow characteristics, flow visualization in the tunnel are recorded for further observations.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Determine the Non dimensional numbers
CO2: Classify the wind tunnels, and estimate wind tunnel sizing parameters.
CO3: Calibrate the low and high speed wind tunnels
CO4: Measure the fundamental flow properties using conventional equipment's
CO5: Outline the working principle of high speed tunnels

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2												1		
CO2	1												1		
CO3				2											2
CO4	2	2		1											2
CO5	1												1		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

PRINCIPLES OF MODEL TESTING

Buckingham Theorem – Non dimensional numbers – Scale effect – GeometricKinematic and Dynamic similarities.

UNIT 2

TYPES AND FUNCTIONS OF WIND TUNNELS

Classification and types – special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters.

UNIT 3

CALIBRATION OF WIND TUNNELS

Test section speed – Horizontal buoyancy – Flow angularities – Flow uniformity &turbulence measurements – Associated instrumentation – Calibration of subsonic &supersonic tunnels.

UNIT 4

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 – Flow visualization techniques- surface flow, oil and tuft - flow field visualization, smoke and other optical and nonintrusive techniques.

UNIT 5

SPECIAL WIND TUNNEL TECHNIQUES

Intake tests – store carriage and separation tests - Unsteady force and pressure measurements – wind tunnel model design

Text Books:

1. Rae, W.H. and Pope, A., Low Speed Wind Tunnel Testing, John Wiley Publication, 1984.
2. NAL-UNI Lecture Series 12: Experimental Aerodynamics, NAL SP 98 01April,1998

References:

1. Pope, A., and Goin, L., High Speed Wind Tunnel Testing, John Wiley, 1985.
2. Bradsaw Experimental Fluid Mechanics. Short term course on Flow visualization techniques, NAL , 2009
3. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008NAL, Bangalore

213AER3107	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

To determine the stress and strain in materials and structures subjected to static or dynamic forces or loads.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Measure the deflection in the structure using extensometers

CO2: Determine the stress at a point in the structure using strain gauges

CO3: Show the stress pattern using photo elastic materials

CO4: Interpret the effect of coating on stress components

CO5: Test and find the crack in the specimen using different NDT techniques.

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	3			1											2
CO2	2				1								1		
CO3		2	1												1
CO4		2		2											2
CO5	3			2									2		2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

EXTENSOMETERS AND DISPLACEMENT SENSORS

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages, Capacitance gauges, Laser displacement sensors.

UNIT 2

ELECTRICAL RESISTANCE STRAIN GAUGES

Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells, Data acquisition, six component balance.

UNIT 3

PHOTOELASTICITY

Two dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects, stress optic law, Transmission photoelasticity, Jones calculus, plane and circular polariscopes, Interpretation of fringe pattern, Calibration of photoelastic materials, Compensation and separation techniques, Introduction to three dimensional photo elasticity.

UNIT 4

BRITTLE COATING AND MOIRE TECHNIQUES

Relation between stresses in coating and specimen, use of failure theories in brittle coating, Moire method of strain analysis.

UNIT 5

NON – DESTRUCTIVE TESTING

Fundamentals of NDT, Acoustic Emission Technique, Radiography, Thermography,Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing,

Text Books:

1. Dally, J.W., and Riley, W.F., Experimental Stress Analysis, McGraw Hill Inc., New York 1998.
2. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., Experimental Stress Analysis, Tata McGraw Hill, New Delhi, 1984.
3. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 2009.

References:

1. Hetenyi, M., Hand book of Experimental Stress Analysis, John Wiley and Sons Inc., New York, 1972.
2. Pollock A.A., Acoustic Emission in Acoustics and Vibration Progress, Ed. Stephens R.W.B., Chapman and Hall, 1993.
3. Max Mark Frocht, Photo Elasticity, John Wiley and Sons Inc., New York, 1968
4. A.J.Durelli, Applied Stress Analysis, Prentice Hall of India Pvt Ltd., New Delhi, 1970
5. Ramesh, K., Digital Photoelasticity, Springer, New York, 2000.

213AER4111	CRYOGENIC ENGINEERING	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To make students acquire knowledge in Cryogenic Systems and cryogenic power generation.

Course Outcomes:

After completing this course, the student will be able to:

CO1: Know the properties of Cryogenic Fluids.
CO2: Understand the concepts of Gas separation and Purification systems
CO3: Know the method of Cryogenics measurement systems
CO4: Design Cryogenic Fluid Storage Systems
CO5: Apply the concepts of Cryogenic Engineering for various applications

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2			3									2		
CO2	2		1										2		
CO3	2														
CO4	2		1										2		
CO5	2												2		

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

Introduction to Cryogenic Systems

Introduction to Cryogenic Systems, Properties of materials at low temperature, Properties of Cryogenic Fluids, Air and Gas Liquefaction Systems: Thermodynamically ideal system, Production of low temperatures, Liquefaction systems for gases other than Neon, Hydrogen and Helium, liquefaction systems for Neon, Hydrogen and Helium, Cryogenic Refrigeration System

UNIT 2

Gas Separation and Gas Purification Systems

Gas Separation and Gas Purification Systems, The thermodynamically ideal separation system properties of mixtures, Principles of gas separation, air separation systems, Hydrogen, Argon, Helium air separation systems, Gas purification methods

UNIT 3

Vacuum Techniques

Vacuum Techniques, System for production of high vacuum such as mechanical, diffusion, ion and cryopumps. Cryogenics measurement systems, Temperature pressure, flow rate, liquid level measurement, Introduction to Cryocoolers.

UNIT 4

Cryogenic Fluid Storage Systems

Cryogenic Fluid Storage Systems, Introduction, Basic Storage vessels, inner vessel, outer vessel design, piping, access manways, safety device, Cryogenic insulations, Vacuum insulation, gas filled powders and fibrous materials, solid foam, selection and comparison of insulations Cryogenic fluid transfer systems. Transfer through uninsulated lines, vacuum insulated lines, porous insulated lines etc.

UNIT 5

Advances in Cryogenics

Advances in Cryogenics, Vortex tube and applications, Pulse tube refrigerator, Cryogenic Engine for space vehicles, Cryogenic Applications, Applications in gas industry, cryogenic fluids, space research, Cryobiology, food processing, electronics, nuclear and high energy physics, chemical processing, metal manufacturing, cryogenic power generation, medicine, analytical physics and chemistry

Text Books:

1. Fundamentals of Cryogenic Engineering - Mukhopadhyay and Mamata – 2010.
2. Cryogenic Engineering – R.B. Scott – D.Van Nostrand Company, 1959

References:

1. John F Wendt (Ed.), “Computational Fluid Dynamics – An Introduction”, Third Edition, Springer- Verlag, Berlin Heidelberg, 2009.
2. H.K. Versteeg and W. Malalsekera “An Introduction to Computational Fluid Dynamics, The Finite Volume Method”, PHI; 2 edition 2007.
3. T. J. Chung, “Computational Fluid Dynamics”, Cambridge University Press; 2 edition (27 September 2010)
4. C. Hirsch, “Numerical Computation of Internal and External Flows” Volume-2, John Wiley and Sons, 1994
5. Joel H. Ferziger & Milovan Peric, “Computational Methods for Fluid Dynamics” Springer; 3rd ed. 2002 edition 2001.

213AER4104	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
Pre – Requisites	Nil	3	0	1	4
Course Category	Major Elective				
Course Type	Theory				

Course Objective:

To make the students to understand the basic concepts of fluid dynamics and to set a clear picture of the condition of a flow in real motion

Course Outcomes:

After completing this course, the student will be able to:

CO1: Describe the flow phenomena in a flow field with correspondence with elliptic, parabolic and hyperbolic equations
CO2: Explain the steps involved in source and panel methods
CO3: Describe the upwind concept and its effects in a given flow. Interpret the discretization of a flow model for analysis
CO4: Apply the weighted variational formulae and Galerkin method for finite volume technique
CO5: know the numerical finite volume methods in computational analysis

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2		1										1	1	
CO2		3	1	3										2	
CO3		3												1	
CO4	2													1	
CO5	1													3	

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

INTRODUCTION TO NUMERICAL METHODS IN FLUID DYNAMICS

Introduction to numerical fluid dynamics - Introduction to governing equations of fluid dynamics and modeling of fluid flow – The substantial derivative and the physical meaning of divergence of a vector. Boundary conditions for various types of fluid flow conditions - Introduction to mathematical properties of fluid dynamic equations and classification of partial differential equations - General behaviour of different classes of partial differential equations and their relation to fluid dynamics - A general discussion on hyperbolic, parabolic and elliptic equations

UNIT 2

SOLUTION OF FLUID FLOW EQUATIONS

Introduction to boundary layer equations and their solution - Discretization of the boundary layer equations and illustration of solution– Solution methods for elliptic, parabolic and hyperbolic equations-velocity potential equation

UNIT 3

GRID GENERATION

Introduction to grid generation in computational fluid dynamics - Structured grid generation techniques – algebraic methods, conformal mapping and methods using partial differential equations - Basic ideas in numerical grid generation and mapping - Boundary value problem of numerical grid generation- grid control functions- branch cut - The boundary conditions of first kind– orthogonality of grid lines- boundary point grid control.

UNIT 4

TIME DEPENDENT METHODS

Introduction to time dependent methods - Explicit time dependent methods –Description of Lax- Wendroff Scheme and Mac Cormack's two step predictor – corrector method - Description of time split methods. Introduction to implicit methods and respective stability properties of explicit and implicit methods - Construction of implicit methods for time dependent problems - Linearization, choice of explicit operator and numerical dissipation aspects

UNIT 5

FINITE VOLUME METHOD

Introduction to Finite volume Method - Different Flux evaluation schemes, central, upwind and hybrid schemes - Staggered grid approach - Pressure-Velocity coupling - SIMPLE, SIMPLER algorithms- pressure correction equation (both incompressible and compressible forms) - Application of Finite Volume Method -artificial diffusion

Text Books:

1. C.A.J. Fletcher, "Computational Techniques for Fluid Dynamics 1" Springer Verlag,1996.
2. C.A.J. Fletcher, "Computational Techniques for Fluid Dynamics 2", Springer Verlag, 1995

References:

1. John F Wendt (Ed.), "Computational Fluid Dynamics – An Introduction", Third Edition, Springer-Verlag, Berlin Heidelberg, 2009.
2. H.K. Versteeg and W. Malalsekera "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", PHI; 2 edition 2007.
3. T. J. Chung, "Computational Fluid Dynamics", Cambridge University Press; 2 edition (27 September 2010)
4. C. Hirsch, "Numerical Computation of Internal and External Flows" Volume-2, John Wiley and Sons, 1994
5. Joel H. Ferziger&MilovanPeric, "Computational Methods for Fluid Dynamics" Springer; 3rd ed. 2002 edition 2001.

214AER2102	COMPOSITE MATERIALS AND STRUCTURES	L	T	P	C
Pre – Requisites	Nil	3	0	0	3
Course Category	Major elective				
Course Type	Theory				

Course Objective:

Analysis and design of composite structures using Moulding methods of construction, fabrication to evaluate and understand the concepts of laminated plate

Course Outcomes:

After completing this course, the student will be able to:

CO1: Determine the elastic moduli of composite structures
CO2: Identify the number of elastic constants for different composite materials.
CO3: Analyze sandwich and laminated plates
CO4: Demonstrate the fabrication and repair techniques of composite materials
CO5: construct and analysis different composite technique

Mapping of Course Outcome(s):

CO / PO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	1	2													1
CO2	1	2													1
CO3	2			2									1		
CO4	1		1	2	1										2
CO5	1		2	2											2

3- Strong Correlation; 2- Medium Correlation; 1- Low Correlation

Course Topics:

UNIT 1

MICRO MECHANICS

Introduction - Advantages and application of composite materials – Types of reinforcements and matrices - Micro mechanics – Mechanics of materials approach, elasticity approach- Bounding Techniques – Fiber Volume ratio – Mass fraction – Density of composites. Effect of voids in Composites.

UNIT 2 MACRO MECHANICS

Generalized Hooke's Law - Elastic constants for anisotropic, orthotropic and isotropic materials - Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of In plane strengths of a lamina - Experimental characterization of lamina. Failure theories of a lamina. Hygrothermal effects on lamina.

UNIT 3

LAMINATED PLATE THEORY

Governing differential equation for a Laminate. Stress – Strain relations for a laminate. Different types of laminates. In plane and Flexural constants of a laminate. Hygrothermal stresses and strains in a laminate. Failure analysis of a laminate. Impact resistance and Interlaminar stresses. Netting analysis

UNIT 4

FABRICATION PROCESS AND REPAIR METHODS

Various open and closed mould processes, Manufacture of fibers, Importance of repair and different types of repair techniques in Composites – Autoclave and non-autoclave methods.

UNIT 5

SANDWICH CONSTRUCTIONS

Basic design concepts of sandwich construction - Materials used for sandwich construction - Failure modes of sandwich panels - Bending stress and shear flow in composite beams.

Text Books:

1. Isaac M. Daniel &OriIshai , "Mechanics of Composite Materials," OUP USA publishers, 2ndedition, 2005.
2. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 2nd edition, 2005.
3. MadhujitMukhopadhyay, Mechanics of Composite Materials and Structures, University Press, 2004

References:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wiley & Sons, 3rd edition, July 2006.
2. Lubing, Handbook on Advanced Plastics and Fibre Glass, Von Nostran Reinhold Co., New York, 1989.
3. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York 1998.
4. Allen Baker, Composite Materials for Aircraft Structures, AIAA Series, 2ndEdition, 2004.