## LIST OF COURSES

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### Course Objectives:
1. To introduce the basic concepts of aircrafts, rockets and their functions.
2. To give an introduction on aerodynamics, aircraft structure and aircraft propulsion.
3. To provide knowledge about the basic parts and their function and construction details of aerospace vehicles.

### Course Outcomes:
After completing the course the student will be able to
1. Understand the nature of aerospace technologies.
2. Identify the different types of Aircraft components and their functions.
3. Assess the forces and moments due to flow over the aircraft components.
4. Apply the principles of aerodynamics to different parts of an aeroplane.
5. Evaluate the performance of propulsion system.
6. Apply the knowledge of gravitational law, Kepler’s law and Newton’s law to the space vehicle.
MODULE 1: HISTORICAL EVOLUTION AND STANDARD ATMOSPHERE (8 LECTURE HOURS)

MODULE 2: PRINCIPLES OF FLIGHT (8 LECTURE HOURS)
Basic aerodynamics, Aerofoils, wings and their nomenclature; lift, drag and pitching moment coefficients, centre of pressure and aerodynamic centre, NACA airfoil nomenclature.

MODULE 3: AEROSPACE STRUCTURES (8 LECTURE HOURS)
General types of construction, Types of structure, typical wing and fuselage structure-monocoque- Semi-monocoque, Honeycomb and Sandwich structure, Aircraft materials.

MODULE 4: PROPELION SYSTEMS (7 LECTURE HOURS)
Principles of Thrust generation, Reciprocating engine, propeller, turboprop engine, Basic ideas about jet propulsion, Types of jet engines - turbofan and turbojet engines.

MODULE 5: ROCKETS & MISSILES (7 LECTURE HOURS)
Principles of operation of rocket, Rocket engine-specific impulse, Rocket equation, Single and Multi-stage rockets, Types of Rockets, Types of Missiles. Rocket and Missile developed by India.

MODULE 6: SPACE FLIGHT (7 LECTURE HOURS)
Introduction to space mission, Kepler’s, laws, Introduction to earth and planetary entry.

Text Books:

Reference:

18AE2002 | AEROSPACE MATERIALS AND PROCESSES |
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Course Objectives:
1. To impart the knowledge on crystal structure and microstructures of metals and alloys
2. To impart the knowledge on Aerospace Materials properties
3. To impart the knowledge on Material Characterisation

Course Outcomes:
After completing the course the student will be able to
1. Explain how the mechanical properties of metals and alloys are influenced by their microstructure
2. Understand the material properties
3. Classify the different materials
4. Choose the manufacturing methods
5. Identify the testing method of materials
6. Select the right material for a particular application
7. Develop new material combination based on requirement
MODULE 1: THE STRUCTURE OF METALS AND ALLOYS & PHASE DIAGRAMS. (8 LECTURE HOURS)


MODULE 2: TESTING OF AIRCRAFT MATERIALS (7 LECTURE HOURS)

Basics terms: Hardness; Brittleness; Malleability; Ductility; Elasticity, Density Fusibility; Conductivity; Contraction and Expansion. Heat-treatment Terms: Critical Range, Annealing; Normalizing; Heat Treatment; Hardening; Quenching, Tempering; Carburizing; Casehardening. Physical-test Terms: Strain; Stress; Tensile Strength; Elastic Limit; Proportional Limit; Proof Stress; Yield Strength; Yield Point; Elongation (Percentage); Reduction of Area (Percentage); Modulus of Elasticity. Testing: Tension Testing, Hardness Testing Bending Tests, Reverse Bend Test, Flattening Test, Impact Tests: Crushing Tests, Hydrostatic Test, Torsion Test, Fatigue Testing, Inspection Methods: NDT. ASTM. Standards for testing materials.

MODULE 3: STEEL AND ITS ALLOYS (8 LECTURE HOURS)

Plain Carbon Steels, Alloy Steels, Effect of Individual Elements: Carbon; Manganese; Silicon, Sulphur; Phosphorus; Nickel; Chromium; Molybdenum; Vanadium; Tungsten; Titanium, S.A.E. Steel Numbering System, Air Force-Navy Aeronautical Specifications, Military specifications. Carbon Steels, Nickel Steels, Nickel-chromium Steels, Molybdenum Steels, Chrome-vanadium Steels, Special Steels: Silicon-chromium Steel; Nitriding Steel; Austenitic Manganese Steel. Heat Treatment of Steel.

MODULE 4: NICKEL, COPPER AND ITS ALLOYS (8 LECTURE HOURS)

Inconel, Monel, K Monet: Chemical Properties; Physical Properties; Annealing and Stress Relieving; Working Properties; Welding; Soldering and Brazing; Corrosion Resistance: Available Shapes; Uses, Specifications. Copper: Copper Tubing; Copper-Silicon-Bronze Tubing; Copper Wire; Beryllium Copper. Brass: Muniz Metal; Manganese Bronze (Brass); Hy-Ten-SI Bronze; Naval Brass (Tobin Bronze); Red Brass. Bronze: Gun Metal; Phosphor Bronze; Phosphor Bronze Casting Alloy; Aluminum Bronze; Aluminum Bronze Casting Alloy; Bronze Cable, Season Cracking. Pure Magnesium: Production Methods; Physical Properties,

MODULE 5: MAGNESIUM, TITANIUM AND ITS ALLOYS (7 LECTURE HOURS)

Magnesium Alloys: Chemical Composition, Magnesium-alloy. wrought Magnesium Alloys: Extrusions; Forgings; Sheet, Plate, Strip Shop Fabrication Processes: Machining; Shearing. Titanium: Physical Properties: Metallurgy; Chemical Composition; Specifications; Mechanical Properties; Elevated Temperature. Shape memory alloys.

MODULE 6: WROUGHT ALUMINUM ALLOYS (7 LECTURE HOURS)


Text Book:

References:

Aerospace Engineering
Course Objectives:
1. To introduce the basic concepts of fluid statics
2. To provide knowledge of basic laws governing fluid motion and its application
3. To introduce the concept of basic airflow

Course Outcomes:
After completing the course the student will be able to
1. Know the properties of different fluids and pressure measurements
2. Apply mathematical knowledge to predict the properties and characteristics of a fluid.
3. Understand the nature of buoyancy of submerged and floating bodies
4. Attain the Knowledge of flow measurement systems
5. Estimate the friction factor of pipe flow and losses associated it
6. Get knowledge of the non-dimensional parameters used in airflow.

MODULE 1: BASICS OF FLUID FLOW (8 LECTURE HOURS)

MODULE 2: BASIC EQUATIONS (8 LECTURE HOURS)

MODULE 3: INCOMPRESSIBLE INVISCID FLOW (8 LECTURE HOURS)

MODULE 4: INCOMPRESSIBLE VISCOUS FLOW(7 LECTURE HOURS)

MODULE 5: DIMENSIONAL ANALYSIS (7 LECTURE HOURS)
Dimensional analysis – The Buckingham-Pi theorem – Nondimensional numbers-Mach Number, Reynolds Number, Strouhal Number, Knudsen Number, etc.,

MODULE 6: IMPACT OF JETS (7 LECTURE HOURS)
Impact of jets –Force exerted by a jet on stationary and moving vertical, horizontal and inclined plates.

Text Books:

References:
5. Fluid Mechanics : http://nptel.ac.in/courses/1121051711/
Co-requisite: 18AE2003 Basics of Fluid Mechanics

Course Objectives:
1. To give hands on training on principle and working of different flow measuring instruments
2. To impart knowledge on working of different types of turbines.
3. To demonstrate energy losses in pipe connections

Course Outcomes:
After completing the course the student will be able to
1. Recall the principles of instruments used in flow related measurements
2. Describe the flow measurement methods
3. Demonstrate energy losses in pipe connections
4. Appraise the flow measurement techniques
5. Select flow measuring techniques.
6. Investigate the operation of flow measuring instruments

List of Experiments
1. Determination of Darcy’s Friction Factor.
3. Flow over Weirs / Notches.
4. Flow through Mouth piece / orifice.
5. Determination of Minor Losses in pipes
6. Determination of Manning’s Co-efficient of Roughness.
7. Calibration of pressure Gauges.
8. Impact of jet on vanes.
9. Reynolds’ Experiment.

NOTE: The faculty conducting the Laboratory will prepare a list of minimum 6 experiments and get the approval of HoD and notify it at the beginning of the semester.

Course Objectives:
1. To provide an understanding the concepts of stress and strain, Shear force and Bending moment
2. To provide knowledge regarding the methods of determining the deflections of beams and Torsion of shaft
3. To impart basic knowledge about Joints and springs

Course Outcome:
After completing the course the student will be able to
1. Understand the basic material behaviour like elasticity, plasticity etc.
2. Draw the shear force and bending moment diagram for different loading of beams
3. Predict the deflection of beams under bending loads
4. Arrive at the methods to solve torsional problems
5. Analysis of a spring under different load condition
6. Identify the structural Joints for Aircraft repair in different applications

MODULE 1: STRESSES AND STRAINS (7 LECTURE HOURS)
Introduction, types of structures, Elasticity, Plasticity, loads and stresses, Hooke’s law, stress-strain curve, Analysis of bars of varying sections, Analysis of bars of composite sections, thermal stresses, thermal stresses in composite bars, elastic constants; Principle planes and stresses, Analytical and graphical methods for determining stresses on oblique section.

MODULE 2: SHEAR FORCE AND BENDING MOMENT DIAGRAM (10 LECTURE HOURS)
Types of beams, important points for drawing shear force and bending moment diagram, Shear force and bending moment for different beams carrying point load, uniformly distributed load, gradually varying loads and combinations of these at different sections of the beam.
MODULE 3: DEFLECTION OF BEAMS (10 LECTURE HOURS)
Simple bending, Theory of simple bending, Expression for bending stress, bending stress in symmetrical section, Relation between deflection, slope and radius of curvature, Methods for determining deflection- Double integration method, Macaulay’s method and Moment Area method.

MODULE 4: TORSION OF SHAFTS (7 LECTURE HOURS)
Shear stress produced in a shaft subjected to torsion, torque and power transmitted by a solid and circular shaft, Strength of a shaft and Polar moment of inertia, Torque in terms of polar moment of inertia, strength of a shaft of varying sections and composite shaft, combined bending and torsion, strain energy stored in a body due to torsion.

MODULE 5: SPRINGS & JOINTS (7 LECTURE HOURS)

MODULE 6: THEORIES OF FAILURE (4 LECTURE HOURS)
Introduction, Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, Maximum strain energy theory, Maximum shear strain energy theory.

Text Books:

References:

18AE2006 STRENGTH OF MATERIALS LABORATORY 

Co-requisite: 18AE2005 Strength of Materials

Course Objective
1. To apply the theory of structural mechanics on real specimens
2. To give hands on training on testing of real specimens
3. To provide knowledge in failure of material

Course Outcome
After completing the course the student will be able to
1. Determine the important mechanical properties of materials
2. Identify the materials behavior
3. Verify the theorems studied in structural mechanics
4. Understand the structural behavior based on various loads, supports and shape
5. Estimate stiffness of springs
6. Choose material based on requirement

Experiments
1. Tensile Test of solid rod using Universal Testing Machine
2. Verification of Maxwell Theorem on Cantilever Beam
3. Verification of Maxwell Theorem on Simply Supported Beam
4. Torsion Test of shaft and Beam
5. Rockwell’s Hardness Test
6. Brinell’s Hardness Test

Aerospace Engineering
7. Vickers Hardness Test
8. Charpy’s Impact test
9. Izod Impact Test
10. Compression of open coil helical spring

The faculty conducting the Laboratory will prepare a list of minimum 6 experiments and get the approval of HoD and notify it at the beginning of the semester.

Reference:

18AE2007 THERMODYNAMICS

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<td>1. To impart the knowledge of work, heat, and laws of thermodynamics.</td>
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<td>2. To impart the knowledge of the concept of entropy and exergy</td>
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<td>3. To impart the knowledge of the working of gas turbine cycles</td>
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<td>1. Define fundamental thermodynamic laws and concepts, work, various types of works and heat and its applications,</td>
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<td>2. Explain Zeroth, First &amp; Second law of thermodynamics and its applications.</td>
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<td>3. Explain entropy and Exergy in thermodynamic systems</td>
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<td>4. Calculate the performance of various gas power cycles.</td>
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<td>5. Explain the principles of combustion in engines</td>
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<td>6. Explain the selection of air conditioning system; evaluate thermal performance of refrigeration cycles.</td>
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MODULE 1: FUNDAMENTALS OF THERMODYNAMICS (9 LECTURES HOURS)
Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Thermodynamic properties; definition and units, intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium.

Work and Heat: Thermodynamic definition of work; examples, sign convention, Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention.

MODULE 2: THERMODYNAMIC LAWS (8 LECTURE HOURS)

MODULE 3: ENTROPY (7 LECTURE HOURS)

MODULE 4: GASES AND GAS MIXTURES (7 LECTURE HOURS)

MODULE 5: COMBUSTION THERMODYNAMICS AND GAS POWER CYCLES (7 LECTURE HOURS)
Fuels and combustion – Theoretical and Actual combustion – Enthalpy of formation and combustion – Adiabatic flame temperature. Gas power cycles: Basic considerations – Carnot cycle – Air

**MODULE 6: REFRIGERATION AND PSYCHROMETRY (7 LECTURE HOURS)**

Refrigeration: Vapour absorption refrigeration system, vapor compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties. 

Psychrometry: Dry bulb temperature, wet bulb temperature, dew point temperature; specific and relative humidity - psychrometric processes; heating, cooling, dehumidifying and humidifying. Adiabatic mixing of moist air. Summer and winter air conditioning.

**Text Books:**

**References:**
6. Basic Thermodynamics: http://nptel.ac.in/courses/112105123/
8. https://www.edx.org/course/thermodynamics-iitbombayx-me209-1x-1
9. Combustion: http://nptel.ac.in/courses/101106037/

18AE2008 THERMODYNAMICS LABORATORY

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**Co-requisite:** 18AE2007 Thermodynamics

**Course Objectives:**
1. To impart the knowledge of laws of thermodynamics
2. To give hands on training to Estimate the performance of thermodynamics system
3. To impart knowledge on working of IC Engines.

**Course Outcomes:**
After completing the course the student will be able to
1. Estimate the performance of Heat pump,
2. Estimate the performance of Refrigerator
3. Estimate the performance of Air-conditioning
4. Measure the performance of compressors and draw the characteristic curves
5. Measure the performance of blowers and draw the characteristic curves blowers
6. Study the valve timing and port timing of IC engines

**List of Experiment:**
1. Determination of COP of Heat pump
2. Determination of Performance of Refrigeration
3. Determination of Performance of Air compressor
4. Performance characteristics of Compressor
5. Performance of Blower
6. Performance test on IC engine
7. Heat balance test on IC engine
8. Valve timing diagram of Four stroke Engine
9. Port timing diagram of Two stroke engine
10. Study of Nozzle and Diffuser
The faculty conducting the Laboratory will prepare a list of minimum 6 experiments and get the approval of HoD and notify it at the beginning of the semester.

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**Prerequisite:** 18AE2003 Basics of Fluid Mechanics

**Course Objectives:**
1. To impart knowledge of basics of air flow
2. To provide details regarding the flow over aerofoils and wings
3. To impart knowledge of forces and moments over an aerofoil

**Course Outcomes:**
After completing the course the student will be able to
1. Understand the aerodynamic variable connected with airflow
2. Apply the conservation laws for given aerodynamic situation
3. Analyse the basic flows satisfying the governing equations
4. Assess the flow field over the aerofoils
5. Estimate the flow over aircraft wings and Fuselage
6. Evaluate the forces and moments over vehicles utilizing different kinds of flows

**MODULE 1: BASICS OF AIR FLOW (8 LECTURE HOURS)**
Fundamental Aerodynamic variables, Aerodynamic forces and moments, Centre of pressure, Aerodynamics Centre, Types of flow, Gradient of Scalar and vector fields, Line, surface and volume integrals and the relationships between them. Continuity equation. Momentum equation and drag of a two dimensional body. Energy equation

**MODULE 2: FLUID FLOW (8 LECTURE HOURS)**

**MODULE 3: INCOMPRESSIBLE FLOW OVER AIRFOIL (8 LECTURE HOURS)**

**MODULE 4: INCOMPRESSIBLE FLOW OVER FINITE WINGS (7 LECTURE HOURS)**

**MODULE 5: NUMERICAL METHODS (7 LECTURE HOURS)**
2-D Panel Methods-Source panel method-vortex panel methods, Vortex Lattice Methods.

**MODULE 6: BOUNDARY LAYERS (7 LECTURE HOURS)**
Introduction to Boundary Layers and Reynolds number effects. Development of Boundary Layer equations. Boundary layer thickness-Displacement thickness – Momentum Thickness – Energy Thickness. Momentum integral theorem and applications.

**Text Books:**

**References:**
2. L.M Milne Thomson, "Theoretical Aerodynamics", 1996
18AE2010 AEROSPACE STRUCTURES – I  

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**Prerequisite:** 18AE2005 Strength of Materials

**Course Objective:**
1. To impart the knowledge of aircraft material and its behaviour.
2. To impart the knowledge on the methods of structural analysis under different types of loads.
3. To provide the knowledge on basic theory of vibrations, elasticity and failures.

**Course Outcome:**
After completing the course the student will be able to
1. Identify the suitable aircraft material and its behaviour
2. Apply the methods of statically determinate and indeterminate structural analysis under different conditions
3. Understand the concept of Column buckling
4. Solve the vibration problem with different DOF
5. Get the knowledge in basic theory of elasticity
6. Analyse the airframe structures

**MODULE 1: INTRODUCTION TO AEROSPACE STRUCTURES ANALYSIS (5 LECTURE HOURS)**
Stress strain curve- Young’s modulus- Poisson’s ratio, basics of elasticity: Plane stress, Plane strain, Stress-Strain Relationships, Two dimensional problems, St. Venant’s Principle.

**MODULE 2: TRUSS (8 LECTURE HOURS)**

**MODULE 3: BEAMS (12 LECTURE HOURS)**

**MODULE 4: BUCKLING OF COLUMN (7 LECTURE HOURS)**
Buckling of columns, Inelastic buckling, Effect of initial imperfections, Stability of beams under transverse and axial loads, Energy method for the calculation of buckling loads in columns, Flexural-torsional buckling of thin-walled columns.

**MODULE 5: BASIC THEORY OF VIBRATION (8 LECTURE HOURS)**
Free and forced vibrations of undamped and damped SDOF systems, free vibrations of undamped 2-DOF systems- Mode shape, Oscillation of beams, Approximation methods for determining natural frequencies Problems.

**MODULE 6: FATIGUE AND FRACTURE MECHANICS (5 LECTURE HOURS)**
Historical background and overview-Case Study: Fatigue -Comet airplane, Different approaches to fatigue. Fracture mechanics and its implications for fatigue-Griffith fracture theory- Case study: Damage –tolerant design of aircraft fuselage.

**Text Book:**

**References:**


9. Aerospace Structural Dynamics: http://nptel.ac.in/courses/101105022/


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**Prerequisite:** 18AE2007 Thermodynamics

**Course Objective:**
1. To familiarize with Principles of Propulsion systems
2. To introduce working principles of Compressors and turbines
3. To familiarize with the concept of Matching of compressors and turbines and Off design performance

**Course Outcome:**
After completing the course the student will be able to
1. Understand the performance of air breathing engines
2. Analyse the performance of different propulsion cycles.
3. Understand the working of sub-systems of the propulsion system.
4. Assess the performance of compressor and turbine
5. Evaluate the combustion chamber, cooling and afterburner performance
6. Find the causes of under-performance and remedial measures

**MODULE 1: FUNDAMENTALS OF AIR-BREATHING ENGINES (7 LECTURE HOURS)**
Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, cycle analysis jet engines. Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust

**MODULE 2: AIR-BREATHING ENGINES PERFORMANCE (8 LECTURE HOURS)**
Efficiency and engine performance of turbojet, turboprop, turbo shaft, turbofan and ramjet engines, thrust augmentation of turbojets and turbofan engines. Principles of pulsejets and ramjets, thermodynamic cycle, performance parameters

**MODULE 3: CENTRIFUGAL COMPRESSOR: (7 LECTURE HOURS)**
Thermodynamics of Compressors, types of compressor, Centrifugal compressor: Centrifugal compressor stage dynamics, inducer, impeller and diffuser work done and pressure rise – Velocity diagrams.

**MODULE 4: AXIAL COMPRESSOR: (7 LECTURE HOURS)**
Angular momentum, work and compression, characteristic performance of a single axial compressor stage, efficiency of the compressor and degree of reaction – Velocity triangles – degree of reaction.

**MODULE 5: COMBUSTION CHAMBERS: (7 LECTURE HOURS)**

**MODULE 6: TURBINES: (9 LECTURE HOURS)**
Text Books:

References:
5. Jet Aircraft Propulsion: http://nptel.ac.in/courses/101101002/
6. Aerospace Propulsion: http://nptel.ac.in/courses/101106033/

Co-requisite: 18AE2011 Propulsion -I

Course Objectives:
1. To impart knowledge on basic concepts and operation of various parts of jet engine
2. To provide practical exposure to the operation of various propulsion systems.
3. To impart knowledge on shock waves.

Course Outcomes:
After completing the course the student will be able to
1. Analyse the working of different parts of aircraft engine
2. Estimate of calorific value of fuels
3. Understand the performance of injector.
4. Evaluate the performance of axial compressor blades
5. Estimate ignition delay of fuels using shock tube
6. Evaluate the performance of nozzle.

LIST OF EXPERIMENTS
1. Study of an aircraft jet engine
2. Estimation of calorific value of fuels
3. Study on injector calibration
4. Shock speed measurement studies
5. Ignition delay studies using shock tube.
7. Cascade testing of a model for axial compressor blade row (symmetrical)
8. Cascade testing of a model for axial compressor blade row (cambered)
9. Study of convective heat transfer coefficient for liquids
10. Free convection heat transfer
11. Forced convection heat transfer

NOTE: The faculty conducting the Laboratory will prepare a list of minimum 9 experiments and get the approval of HoD and notify it at the beginning of the semester.
Prerequisite: 18AE2001 Introduction to Aerospace Engineering

Course Objectives:
1. To impart knowledge about the concepts of Flight performance
2. To introduce the various parameters affecting the performance
3. To introduce the various theories of propeller analysis and design

Course Outcomes:
After completing the course the student will be able to
1. Understand the preliminary design of aircraft based on the performance.
2. Differentiate performance characteristics of jet engine from propeller engine
3. Estimate the performance characteristics in level Flight
4. Assess the performance during turning maneuvers of aircraft
5. Realize the ground effects on performance
6. Estimate the pitch angle from performance characteristics of propeller and its applications

MODULE 1: BASICS OF AERODYNAMICS AND WING GEOMETRY (7 LECTURE HOURS)

MODULE 2: EFFECTS OF ENGINE CHARACTERISTICS ON PERFORMANCE (8 LECTURE HOURS)

MODULE 3: PERFORMANCE CHARACTERISTICS OF LEVEL FLIGHTS (8 LECTURE HOURS)

MODULE 4: PERFORMANCE CHARACTERISTICS OF CLIMBING FLIGHTS (8 LECTURE HOURS)

MODULE 5: TURNING CHARACTERISTICS (07 LECTURE HOURS)
Introduction- Level Turn- Minimum Turn Radius- Maximum Turn Rate- Instantaneous turn-Pull up and Pull down maneuvers, Cobra Maneuver. Numerical Problems.

MODULE 6: TAKEOFF AND LANDING CHARACTERISTICS (07 LECTURE HOURS)

Text Books:

Reference:
Prerequisite: 18AE2009 Aerodynamics

Course Objectives:
1. To provide information regarding the behavior of compressible fluid flow
2. To impart knowledge regarding the difference between subsonic and supersonic flow
3. To Estimate flow over flying vehicles at subsonic and supersonic speeds

Course Outcome:
After completing the course the student will be able to
1. Understand the influence of compressibility to distinguish between the flow regime
2. Apply compressibility corrections for flow in C-D passages and instrument like Pitot static tube
3. Estimate the sudden changes in the flow field
4. Analyse the compressible flow field over an airfoil and finite wings
5. Estimate the influence of friction and heat transfer in the flow field
6. Choose proper flow visualisation techniques for the given situation

MODULE 1: ONE DIMENSIONAL COMPRESSIBLE FLOW: (8 LECTURES HOURS)
Compressibility, Velocity of sound, Concept of Mach Number, Isentropic relations, Normal shock and its relations, Prandtl equation and Rankine – Hugoniot relation, Flow through converging-diverging passages, Performance under various back pressures, corrections of Pitot static tube for subsonic and supersonic Mach numbers.

MODULE 2: OBLIQUE SHOCKS AND EXPANSION WAVES: (8 LECTURES HOURS)
Oblique shocks and corresponding equations, Hodograph and flow turning angle, shock polar, Flow past wedges, Strong, weak and detached shocks, Expansion waves & its corresponding equations, Flow

MODULE 3: FANNO AND RAYLEIGH FLOW (8 LECTURES HOURS)
Influence of Friction on compressible flow, governing equations, relation between flow parameters and length, diameter and friction coefficient of pipe. Limiting Mach number, Length and Mach number, Limiting length of pipe, Influence of Heat transfer on compressible flow, governing equations, relation between flow parameters and Heat Transfer. Limiting Mach number, Maximum heat transfer

MODULE 4: DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOWS: (7 LECTURES HOURS)
Potential equations, Small perturbation potential theory, solutions for supersonic flows - flow over a wavy wall and flow over airfoil, Prandtl-Glauert correction for subsonic flows.

MODULE 5: HIGH SPEED FLOW OVER AIRFOIL: (7 LECTURES HOURS)
Linearised two dimensional supersonic flow theory, Lift, drag, pitching moment and center of pressure of supersonic profiles, Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation.

MODULE 6: HIGH SPEED FLOW OVER FINITE WING: (7 LECTURES HOURS)
Finite wing, tip effects, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, transonic area rule, flow visualisation Techniques.

Text Books

References:
6. Gas Dynamics: http://www.nptel.ac.in/courses/101106044/

<table>
<thead>
<tr>
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Co-requisite: 18AE2014 Gas Dynamics

Course Objectives:
1. To provide details regarding the flow over aerofoils and wings
2. To impart knowledge of forces and moments over an aerofoil
3. To impart knowledge of shock wave over various model

Course Outcomes:
After completing the course the student will be able to
1. Understand the aerodynamic variable connected with airflow
2. Draw pressure distribution over the various aerofoils.
3. Visualize subsonic flow over various model
4. Estimate effect of Reynolds number of low speed airfoil
5. Evaluate the forces and moments over aircraft model
6. Visualize shock wave and Estimate shock angle over various model

List of Experiments:
1. Calibration of subsonic wind tunnel for different velocities.
2. The pressure distribution over a symmetric and cambered aerofoil.
3. Smoke and Tuft flow visualization of symmetric and cambered aerofoil.
4. Estimation of the Lift and drag of symmetric and cambered aerofoil.
5. The pressure distribution over a cascade aerofoil.
6. Identify the trailing vortices over a rectangular wing using smoke and tuft flow visualization technique.
7. Force and moment measurements of rectangular wing
8. Smoke and tuft flow visualization Flow visualization over a car, building and aircraft using Water tunnel facility.
9. Boundary layer calculation in the test section of subsonic wind tunnel.
10. Assessment of small scale wind turbine by using Wind turbine tunnel.
11. Effect of Reynolds number of low speed airfoil using subsonic wind tunnel.
12. The calibration of Pitot tube for different velocities and different shapes.
13. Calibration and runtime calculation of supersonic wind tunnel for different Mach.
14. Flow visualisation over a sharp and blunt cone model using Schlieren technique.
15. Flow visualisation over a double wedge model using Schlieren technique.
16. Flow visualisation over a sharp and blunt cone model using shadowgraph technique.
17. Flow visualisation over a double wedge model using shadowgraph technique.
18. Flow visualisation over a sharp and blunt edge delta wing model using shadowgraph and Schlieren technique.

NOTE: The faculty conducting the Laboratory will prepare a list of minimum 9 experiments and get the approval of HoD and notify it at the beginning of the semester.

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<tr>
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Prerequisite: 18AE2011 Aerospace Structures-I

Course Objective:
1. To impart the knowledge on the structural behaviour of aircraft components under different types of loads
2. To provide the understanding in structural design methods for aerospace vehicles

Aerospace Engineering
3. To impart the knowledge on the force distribution of different structures in Aircraft.

**Course Outcome:**
After completing the course the student will be able to
1. Predict the shear flow and shear centre in open and closed sections with effective and ineffective wall
2. Analysis the buckling characteristics of plates
3. Choose proper methods to analysis aerospace structural members.
4. Assess the load and stress distribution of wing and fuselage section.
5. Design the fail-safe and safe-life Aircraft structures.
6. Selection composites material for aerospace application.

**MODULE 1: STRUCTURAL IDEALIZATION (8 LECTURE HOURS)**
Principle, Idealization of a panel, Effect of idealization on the analysis of open and closed section beams, Deflection of open and closed section beams.

**MODULE 2: SHEAR FLOW IN OPEN SECTIONS (8 LECTURE HOURS)**
Thin walled beams, Concept of shear flow, Shear center, Elastic axis, with one axis of symmetry with effective and ineffective wall in bending, Unsymmetrical beam section.

**MODULE 3: SHEAR FLOW IN CLOSED SECTION (8 LECTURE HOURS)**
Bredt- Batho formula, Single and multi-cell structures, approximate methods, Shear flow in single and multi-cell structures under torsion, Shear flow in single and multi-cell structures under bending with effective and ineffective wall, Box Beams.

**MODULE 4: BUCKLING OF PLATE (8 LECTURE HOURS)**
Buckling of thin plates, Inelastic buckling of plates, Local instability, Instability of stiffened panels, Failure stress in plates and stiffened panels, Crippling stresses by Needham’s and Gerard’s methods. Buckling of Thin Walled Beam of Open and Closed section.

**MODULE 5: WING & FUSELAGE ANALYSIS (9 LECTURE HOURS)**
Shear force, bending moment and torque distribution along the span of the Wing-Tension field beam and Semi tension field beam (Wagner Bam). Shear and bending moment distribution along the length of the fuselage. Aeroelasticity: Introduction to Aeroelasticity, Aeroelasticity Triangle, instability and failures of Aircraft structure.

**MODULE 6: COMPOSITE MATERIALS (4 LECTURE HOURS)**

**Text Book:**

**References:**
6. Composite Materials and Structures: http://www.nptel.ac.in/courses/101104010/

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**18AE2017 AEROSPACE STRUCTURES LABORATORY**

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**Co-requisite:** 18AE2016 Aerospace Structures-II

**Course Objective:**
1. To provide the basic knowledge of the testing equipment for various structural components.
2. To impart the practical exposure with the measuring equipments and sensors.
3. To impart the practical exposure with composite material manufacturing
Course Outcome:
After completing the course the student will be able to
1. Select test equipment for different types of static loading
2. Conduct tests, analyze results, document and compare with analytical/theoretical results
3. Analyse the different types of structural failures
4. Manufacture the different Composite laminates
5. Choose strain gauge for different application
6. Understand the stress distribution based on cross-section shape and loading condition

Experiments
1. Deflection of simply supported and cantilever beams - Verification of Castigliano’s Theorem
2. Determine the stiffness factors of an Elastically Supported Beam
3. Determine the tensile strength of Flat plates, riveted joints and bolted joints using UTM.
4. Compression test on columns, critical buckling loads – Southwell plot
5. Unsymmetrical bending of beams
6. Determination of the effective bending stiffness of a composite beam with the combination of Aluminium and steel
7. Determination of the natural frequency of vibrations of a cantilever beam
8. Shear center location for open sections
9. Torsion of a thin walled tube having closed cross section at the ends
10. Structural behaviour of a semi tension field beam (Wagner Beam)
11. Using photo elastic techniques: Calibration of circular disc in compression to find the fringe value and Determination of stress concentration factor due to compression in circular ring
12. Composite material Manufacturing and Testing- Tensile and Three point bending

The faculty conducting the Laboratory will prepare a list of 9 experiments and get the approval of HoD and notify it at the beginning of each semester.

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Prerequisite: 18AE2011 Propulsion-I

Course Objective:
1. To impart knowledge on fundamentals of rocket propulsion
2. To impart knowledge on solid and liquid propulsion systems
3. To impart knowledge on advanced propulsion systems

Course Outcome:
After completing the course the student will be able to
1. Understand and evaluate the performance of chemical propellant
2. Select and design a suitable air inlets and nozzles
3. Select and design a suitable solid rocket motor
4. Select and design a suitable liquid rocket motor
5. Understand the working of sub-systems of the propulsion system.
6. Assess the performance of electric propulsion systems

MODULE 1: INLETS FOR AIR-BREATHING ENGINES AND NOZZLES: (8 LECTURE HOURS)

MODULE 2: FUNDAMENTAL OF ROCKET PROPULSION (7 LECTURE HOURS)
Overview of rockets, thrust equation and specific impulse, performance parameters, mass flow rate, characteristic velocity, thrust coefficient, efficiencies vehicle acceleration, drag, gravity losses, multistaging of rockets staging and clustering, classification of chemical rockets.

MODULE 3: CHEMICAL PROPULSION: (7 LECTURE HOURS)
Molecular mass, specific heat ratio, energy release during combustion, stoichiometric & mixture ratio, types and classifications, criteria for choice of propellant, solid propellants, requirement, composition and processing, liquid propellants, energy content, storability.

**MODULE 4: SOLID PROPULSION SYSTEMS: (8 LECTURE HOURS)**
Classifications, booster stage and upper stage rockets, hardware components and functions, propellant grain configuration and applications, burn rate, burn rate index for stable operation, mechanism of burning, ignition and igniters types, relation between web shape and thrust, action time and burn time, factors influencing burn rates, thrust vector control, performance of solid rockets. Micro grain structure of solid rocket motor.

**MODULE 5: LIQUID PROPULSION SYSTEMS: (8 LECTURE HOURS)**
Liquid propellant engines, thrust chamber and its cooling, injectors and types, propellant feed systems, turbo pumps, bipropellant rockets, mono propellant thrusters, cryogenic propulsion system, special features of cryogenic systems and performance of liquid rockets.

**MODULE 6: ADVANCE PROPULSION SYSTEMS: (7 LECTURE HOURS)**
Hybrid propellants and gelled propellants, electrical rockets, types and working principle of nuclear rockets, solar sail, concepts of advance propulsion systems, introduction to scramjet – preliminary concepts in supersonic combustion, integral ram-rocket.

**Text books:**

**References:**
7. Aerospace Propulsion: http://nptel.ac.in/courses/101106033/
8. Jet and Rocket Propulsion: http://nptel.ac.in/courses/101104019/

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<tr>
<th>18AE2019</th>
<th>AIRCRAFT STABILITY AND CONTROL</th>
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**Prerequisite:** 18AE2013 Aircraft Performance

**Course Objectives:**
1. To introduce the concept of Stability and control of Aircraft.
2. To impart knowledge about various Aircraft motions and related stability.
3. To introduce the concept of dynamic stability of Aircraft.

**Course Outcomes:**
After completing the course the student will be able to
1. Understand the degree of freedom of aircraft system.
2. Analyse the static stability behaviour of the aircraft.
3. Understand the dynamic longitudinal stability of aircraft.
4. Perform the dynamic analysis to determine stability of aircraft.
5. Estimate the requirement of control force and power plant.
6. Assess the motion of unstable aircraft and related modes of instability.
MODULE 1: STATIC LONGITUDINAL STABILITY-I (09 LECTURE HOURS)
Degrees of Freedom of a system, Basic equations of motion- Wing and tail contribution; Effects of Fuselage and nacelles- Stick fixed neutral points- Power effects-Jet driven airplane and Propeller driven airplane, Elevator Requirements

MODULE 2: STATIC LONGITUDINAL STABILITY-II (08 LECTURE HOURS)
Basic equations of motion Elevator hinge moment, Estimation of hinge moment parameters, Stick Force gradients and Stick force per g load; Stick free Static Longitudinal Stability: Trim Taps, Stick free Neutral Point

MODULE 3: STATIC DIRECTIONAL STABILITY (08 LECTURE HOURS)
Basic equations of motion

MODULE 4: STATIC LATERAL STABILITY (08 LECTURE HOURS)


MODULE 6: DYNAMIC STABILITY-II (5 LECTURE HOURS)
Equation of motion- Lateral Dynamic Stability- Aileron fixed and free, Routh’s discriminant, Dutch roll and Spiral instability, Auto rotation and Spin recovery

Text Books:

Reference:
13. Flight Dynamics II (Stability): http://nptel.ac.in/courses/101106042/
14. Flight dynamics II - Airplane stability and control: http://nptel.ac.in/courses/101106043/
Co-requisite: 18AE2019 Aircraft Stability and Control

Course Objectives:
1. To incorporate awareness about the basic terminology, models and prototypes of UAV
2. To impart knowledge on design considerations of UAV systems
3. To obtain knowledge on aerodynamics and communication systems of UAV

Course Outcomes:
After completing the course the student will be able to
1. Know the evolution of UAS and the various models and prototypes
2. Understand the design parameters of UAV systems
3. Obtain knowledge on the application of aerodynamic principles to design UAS
4. Understand the principles of communication systems used in UAVs
5. Obtain knowledge on payloads and launch systems for UAS
6. Understand the application of UAS to various societal applications

List of Experiments:
1. Modelling and Testing of Paper Planes
2. Modelling and Testing of Unpowered Glider
3. Modelling and Testing of Powered Glider
5. Aircraft “Jacking” procedure
6. Aircraft “Leveling” procedure
7. Calculation of CG of the Cessna 152 Aircraft
8. Parameters measurement of the Cessna 152 Aircraft.
12. Aircraft Stability Check using Flight Simulator

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD and notify it at the beginning of each semester.

Course Objective:
1. To impart the knowledge on the usage of computer in design and manufacturing
2. To impart the knowledge to visualization of objects in three dimensions and producing orthographic, sectional and auxiliary views of it.
3. To impart the knowledge of drafting.

Course Outcome:
After completing the course the student will be able to
1. Understand the CAD packages like Solid Works.
2. Develop 2D and 3D aircraft parts using software.
3. Create parts and assemble these for functional assembly
4. Draw the drafting diagram for manufacturing
5. Write CNC Program for different machining process
6. Get the hands-on experience of CNC manufacturing

List of Experiments:
Computer Aided Design (CAD)
1. 2D Sketch
2. Solid Modelling
3. Surface modelling
4. Sheet Metal Design
5. Assembly of the Aircraft parts.
6. Drafting of Different parts.

Computer Aided Manufacturing (CAM)

7. CNC - Profile cut using Linear and circular interpolation codes
8. CNC - Step turning
9. CNC - Taper turning
10. CNC - Circular pocketing and slotting
11. CNC - Drilling
12. CNC - Thread cutting

The faculty conducting the Laboratory will prepare a list of minimum 9 experiments (Minimum 3 experiments from each CAD and CAM) and get the approval of HoD and notify it at the beginning of each semester.

18AE2022 AIRCRAFT INSTRUMENTATION & AVIONICS

<table>
<thead>
<tr>
<th>Course Objectives:</th>
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<tbody>
<tr>
<td>1. To provide the knowledge regarding basic concepts of flight instruments, their significance and operation.</td>
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<td>2. To impart the concepts of measurements using air data sensor, Gyroscope and engine data.</td>
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<td>3. To provide understanding of the basic concepts and functioning of the avionic system data buses</td>
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Course Outcomes:

After completing the course the student will be able to
1. Understand the basics of measurements and different parameters
2. Identify the fundamental cockpit instruments and their working principles
3. Differentiate various sensors and transducers used in aerospace vehicles
4. Apprehend the principles behind temperature, pressure, fuel flow and engine measurements
5. Analyse the functioning of military/civil aircraft data buses and communication process between them.
6. Identify display technologies and their working principles.

MODULE 1: GENERAL CONCEPTS OF MECHANICAL INSTRUMENTATION (8 LECTURE HOURS)

Generalized measurement system, Classification of instruments as indicators, recorders and integrators - their working principles, Precision and accuracy: measurement error and calibration, Functional elements of an instrument system and mechanisms

MODULE 2: CLASSIFICATION OF AIRCRAFT INSTRUMENTS (8 LECTURE HOURS)

Classification of aircraft instruments - Air data instruments – pitot static systems and instruments, gyroscopic instruments - Gyroscope and its properties, vacuum driven systems, heading instruments

MODULE 3: AIRCRAFT INSTRUMENTS & SENSORS (8 LECTURE HOURS)

Position and displacement transducers and accelerometer, Temperature measuring instruments, Pressure measuring instruments, Engine Instruments, Fuel Quantity measurement, Fuel flow measurement, Position and displacement transducers and accelerometers

MODULE 4: DIGITAL AVIONICS (7 LECTURE HOURS)

Introduction to Avionics, Role for Avionics in Civil and Military Aircraft systems, Avionics sub-systems and design, defining avionics System/subsystem requirements-importance of ‘ilities’ of avionic sub-system, Avionics system architectures.

MODULE 5: AVIONICS DATA BUSES (7 LECTURE HOURS)


MODULE 6: COCKPIT DISPLAY SYSTEMS (7 LECTURE HOURS)

Trends in display technology, Alphanumeric displays, character displays etc., Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit. Power requirements.
Text Books:

Reference Books:

18AE2023  SPACE DYNAMICS  L  T  P  C  3 0 0 3

Prerequisite: 18AE2001 Introduction to Aerospace Engineering

Course Objectives:
1. To familiarize with the performance and stability of rockets
2. To impart knowledge of basics of orbital mechanics and its applications.
3. To familiarize with various factors affecting the satellite orbits

Course Outcome:
After completing the course the student will be able to
1. To estimate performance and stability of rockets.
2. To attain a general knowledge of laws governing the orbital motion.
3. To compute the orbits of the satellites.
4. To study the effects of perturbations on the orbital motion.
5. To compute preliminary orbit of a space object based on the initial data.
6. To generate preliminary design of inter-planetary trajectories.

MODULE 1: PERFORMANCE AND STABILITY OF ROCKETS (6 LECTURES)
Rocket performance – Specific impulse; Derivation of rocket equation; Single and two stage rockets. Static and dynamic stability of rockets.

MODULE 2: THE SOLAR SYSTEM (6 LECTURES)
Solar system – planets, moons, asteroids, comets and meteoroids; Kepler’s laws of motion; Reference frames – geocentric, geographic, topocentric, heliocentric; Time systems, Julian days; The ecliptic - motion of vernal equinox.

MODULE 3: THE TWO-BODY PROBLEM (8 LECTURES)
Properties of conics; Angular momentum; Computation of position and velocity vectors from orbital elements and vice-versa; Solution of Kepler’s equation – elliptic and hyperbolic orbits; Central force motion.

MODULE 4: ORBIT PERTURBATIONS (10 LECTURES)
Orbit perturbations – Osculating ellipse, In-plane and out-of-plane perturbation components, Earth’s oblateness, Sun-synchronous orbits, air drag; Introduction to general and special perturbation methods; Cowell’s and Encke’s methods.

MODULE 5: PRELIMINARY ORBIT DETERMINATION (7 LECTURES)
Laplace method; Gauss method; Gibbs method from three position vectors.
MODULE 6: ORBITAL MANEUVERS (9 LECTURES)
Single impulse maneuvers; Plane change maneuvers; Hohmann transfers from circular to circular orbits; Sphere of influence; Synodic period, Method of patched conics; planetary rendezvous.

Textbooks:

References:
10. Space Technology: http://nptel.ac.in/courses/101106046/
11. Introduction to Aerospace Engineering: Astronautics and Human Spaceflight: https://www.edx.org/course/introduction-aerospace-engineering-mitx-16-00x-1

18AE2024 AIRCRAFT DESIGN PROJECT L T P C
Prerequisite: 18AE2019 Aircraft Stability and Control
Course Objectives:
1. To impart the knowledge of Aerodynamic design of Aircraft.
2. To impart the knowledge of Performance analysis and stability aspects of different types of aircraft/Spacecraft.
3. To impart the knowledge of the structural design of the aircraft/space craft.
Course Outcomes:
After completing the course the student will be able to
1. Choose the type of aircraft/spacecraft for comparative studies
2. Calculate the aerodynamic parameter
3. Design the aircraft and assess the performance of the design
4. Analyse the stability of the designed vehicle
5. Design the aircraft wings, tail, fuselage, landing gears
6. Design and assess the strength of a structure
Activities to be carried out:
1. Comparative studies of different types of airplanes and their specifications and performance details with reference to the design work under taken.
2. Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces Landing gear selection. Area Rule.

Aerospace Engineering
3. Preparation of layout drawing, construction of balance and three view diagrams of the airplane under consideration.
5. Preliminary design of an aircraft wing – Shrenck’s curve, structural load distribution, shear force, bending moment and torque diagrams
6. Detailed design of an aircraft wing – Design of spars and stringers, bending stress and shear flow calculations – buckling analysis of wing panels
   Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shear flow calculations – buckling analysis of fuselage panels
8. Design of control surfaces - balancing and maneuvering loads on the tail plane and aileron, rudder loads
9. Design of wing-root attachment
10. Landing gear design
11. Preparation of a detailed design report with CAD drawings

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**16AE3002 INSTRUMENTATION MEASUREMENTS AND EXPERIMENTS IN AERODYNAMICS**

Credits: 3:0:0

**Course Objective:**
- To familiarize with the various experimental facilities and flow measurement techniques
- To conduct the test, acquire the data and analyze and document.
- To estimate experimental error involved

**Course Outcome:**
By the end of the course, the students will be able to:
- Choose proper experimental facilities
- Configure the experiment and draw inferences from acquired data
- Interpret uncertainty in experiments

**Description:**
References:

16AE3003 AIRCRAFT STRUCTURAL HEALTH MONITORING

Credits 3:0:0

Course Objective:
• Identify various structural health monitoring (SHM) techniques
• Interpret the acquired data using LABVIEW
• Choose appropriate SHM system based on availability of resource

Course Outcome:
By the end of the course, the students will be able to:
• Understand fundamental concepts in structural health monitoring and decide on required sensors
• Demonstrate understanding of working principles of sensors and actuators made from smart materials
• Describe and classify various diagnostic methods of structural health monitoring, with their associated advantages and disadvantages

Description:

References

16AE3004 WIND TURBINE AERODYNAMICS

Credits: 3:0:0

Course Objective:
• To provide knowledge on aerodynamics modelling of wind turbine blade
• To provide the knowledge and skills in aerodynamics required for a detailed understanding of the turbine design
• To impart the knowledge regarding effect of ground

Course Outcome:
By the end of the course, the students will be able to:
• Predict the structural forces and moments experienced by modern utility-scale wind turbines
• Design blades for wind turbine
• Account the ground effect by the atmospheric boundary layer

Description:
Introduction and types of turbine blade, 1-D momentum theory and Betz Limit; Effect of wake rotation; Blade element momentum theory; vortex line/lattice method; Introduction to wind turbine aero acoustics; Atmospheric boundary layers and its influence on wind mill performance.

References:

16AE3005 WIND TUNNEL MODEL DESIGN AND DEVELOPMENT

Credits: 3:0:0

Course Objective:
• To provide knowledge of types of model for different wind tunnel tests
• To introduce the basic concepts of model design and realization methods
• To introduce the basic concept of mounting system for the models

Course Outcome:
By the end of the course, the students will be able to:
• Understanding of the various types of wind tunnel model requirements
• Choose the different model size and balance
• Choose the mounting system based on the model

Description:
Model sizing, strength requirements, materials characteristics- wood (Balsa, Andaman Padak, teak) ,stainless steel and special high strength steels; Realization techniques; geometry measurements, selection of Pressure tappings, tubing, conventional machining and rapid prototyping, electro forming, Estimation of loads on models; Mounting systems, Model design for hypersonic tunnel.

References:

17AE2001 INTRODUCTION TO AEROSPACE ENGINEERING

Credits: 3:0:0

Course Objective:
• To introduce the basic concepts of aircrafts, rockets and their functions.
• To provide knowledge about the basic parts and their function and construction details of aerospace vehicles.
• To provide information about the national and international aerospace agencies.

Course Outcome:
Students will be able to
• Understand the nature of aerospace technologies.
• Assess the forces and moments due to flow over the aircraft components.
• Identify the various types of structural components and their functions.
• Evaluate the performance of propulsion system.
• Apply the knowledge of gravitational law, Kepler’s law and Newton’s law to the space vehicle.
• Knowledge in various types of aerospace vehicles and their applications.

**Unit I - Historical Evolution:** History of aviation, Different types of flight vehicles and Classifications, Components of an airplane and their functions, Standard atmosphere-Isothermal layer and gradient layer.

**Unit II - Principles Of Flight:** Basic aerodynamics, Airfoils, wings and their nomenclature; lift, drag and pitching moment coefficients, center of pressure and aerodynamic center, NACA airfoil nomenclature.

**Unit III - Introduction to Aircraft Structures:** General types of construction, Types of structure, Typical wing and fuselage structure, Honeycomb and Sandwich structure, Aircraft materials, Aircraft instruments.

**Unit IV - Propulsion Systems:** Principles of Thrust generation, Reciprocating engine, propeller, turboprop engine, Basic ideas about jet propulsion, Types of jet engines - turbofan and turbojet engines.

**Unit V - Rockets and Orbital Dynamics:** Principles of operation of rocket, Rocket engine-specific impulse, Rocket equation, Chemical rockets: Solid and liquid propellants, Introduction to orbital dynamics, Aerospace industries and institutions worldwide.

**Text Books:**

**Reference Books:**

**17AE2002 FUNDAMENTALS OF FLUID FLOW**

**Credit 3:1:0**

**Course Objective**
- To introduce the basic concepts of fluid statics.
- To make the student understand the basic laws governing fluid motion and its application.
- To give an introduction on fluid machines and aerodynamics.

**Course Outcome**
Students will be able to
- Evaluate the properties of different fluids
- Understand the fundamentals of fluid flow equations
- Apply the aerodynamics concepts to fluid flow situations
- Analyse the fluid flow equations for real time aerodynamic applications
- Apply mathematical knowledge to predict the properties and characteristics in a given fluid flow situation
- Arrive at the proper non-dimensional parameters and thus devise simulation procedure


**Unit II - Basic Equations:** Motion of a fluid particle – Types of flow-Continuity equation-Velocity and acceleration – velocity potential and stream function- Path lines, Stream lines and Streak lines.-Fluid deformation – Rotation-Vorticity. Elementary flows- Uniform flow, Source flow, Sink flow, Doublet flow, Vortex flow, Super imposed flows- Semi-Infinite Body, Rankine Body.

**Unit III - Incompressible Inviscid Flow:** Equations of motion-Euler’s equation of motion- Energy equation- Momentum equation – Bernoulli’s equation and its Applications — Flow measurement – Orifice meter – Venturi meter-Pitot tube.

**Unit IV - Incompressible Viscous Flow:** D’Alembert’s Paradox, Viscous stress-strain rate relationship, Flow of viscous fluid through circular pipes – Velocity profiles – Frictional loss in pipe flow-Calculation of minor and major energy losses in pipes
Unit V - Dimensional Analysis and Impact of Jets - Dimensional analysis – The Buckingham-Pi theorem – Non-dimensional numbers – Mach Number, Reynolds Number, Strouhal Number, Knudsen Number, etc., Impact of jets – Force exerted by a jet on stationary and moving vertical, horizontal and inclined plates.

Text Books

Reference Books

17AE2003 FLUID MECHANICS LABORATORY

Credits: 0:0:1

Course Objective:
- To impart knowledge on the calibration of flow measurement devices
- To impart knowledge to predict losses due to friction and pipe fittings
- To provide hands on training for flow measurements

Course Outcome:
Students will be able to
- Recall the principle of instruments used in flow related measurements
- Describe the flow measurements methods
- Conduct flow measurements in pipes
- Evaluate performance of pumps and turbines
- Determine the head losses for internal flows
- Investigate influence of flow parameters

List of Experiments:
1. Determination of Darcy’s Friction Factor.
2. Calibration of Venturi Meter.
3. Calibration of orifice Meter.
4. Determination of Minor Losses in sudden expansion and contracting pipe
5. Determination of Minor Losses in bends and elbows of the pipe
6. Reynolds experiments

17AE2004 SOLID MECHANICS

Credits: 3:0:0

Course Objective:
- To provide an understanding the concepts of stress and strain, Shear force and Bending moment
- To provide knowledge regarding the methods of determining the deflections of beams and Torsion of shaft
- To impart basic knowledge about Joints and springs

Course Outcome:
Students will be able to
- Understand the basic material behaviour like elasticity, plasticity etc.
- Draw the shear force and bending moment diagram for different loading of beams
- Predict the deflection of beams under bending loads
- Arrive at the methods to solve torsional problems
- Analyse behaviour of a spring under different loading conditions
- Identify the structural joints for repair

Unit I - Stresses and strains: Introduction, types of structures, loads and stresses, Hooke’s law, stress-strain curve, Analysis of bars of varying sections, Analysis of bars of composite sections, thermal stresses, thermal stresses in
composite bars, elastic constants; Principal planes and stresses, Analytical and graphical methods for determining stresses on oblique section.

**Unit II - Shear force and bending moment diagram:** Types of beams, important points for drawing shear force and bending moment diagram, Shear force and bending moment for different beams carrying point load, uniformly distributed load, gradually varying loads and combinations of these at different sections of the beam.

**Unit III - Deflection of beams:** Simple bending, Theory of simple bending, Expression for bending stress, bending stress in symmetrical section, Relation between deflection, slope and radius of curvature, Methods for determining deflection- Double integration method, Macaulay’s method and Moment Area method.

**Unit IV - Torsion of shafts:** Shear stress produced in a shaft subjected to torsion, torque and power transmitted by a solid and circular shaft, Strength of a shaft and Polar moment of inertia, Torque in terms of polar moment of inertia, strength of a shaft of varying sections and composite shaft, combined bending and torsion, strain energy stored in a body due to torsion.

**Unit V - Springs and Joints:** Stiffness of a spring, Types of spring, Closely-coiled Helical Springs- Axial load-Axial twist, Open coiled helical spring, Torsion spring – Problems. Joints - Types of Structural joints, bonded joints, Bolted joints- Riveted Joints, Structural repair of Joints.

**Text Books:**

**References:**

**17AE2005 SOLID MECHANICS LABORATORY**

**Credits:** 0:0:1

**Co-requisite:** 17AE2004 Solid Mechanics

**Course Objective**
- To apply the theory of structural mechanics on real specimens
- To give hands on training on testing of real specimens
- To provide knowledge on failure of materials

**Course Outcome**
Students will be able to
- Determine the important mechanical properties of materials
- Identify the behaviour of materials
- Verify the Maxwell’s theorem
- Understand the structural behaviour under various loads, shapes and supports
- Estimate stiffness of springs
- Choose material based on requirement

**Experiments**
1. Tensile Test of solid rod using Universal Testing Machine
2. Verification of Maxwell Theorem on Cantilever Beam
3. Verification of Maxwell Theorem on Simply Supported Beam
4. Torsion Test of shaft and Beam
5. Rockwell’s Hardness Test
6. Brinell’s Hardness Test
7. Vickers Hardness Test
8. Charpy’s Impact test
9. Izod Impact Test
10. Compression of open coil helical spring

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD / Director and notify it at the beginning of the semester.
17AE2006 AIRCRAFT INSTRUMENTATION

Credits: 3:0:0

Course Objectives:
- To provide the knowledge regarding basic concepts of flight instruments, their significance and operation.
- To impart the concepts of measurements using air data sensor, Gyroscope and engine data.
- To impart the basic concepts regarding Avionics systems and also the necessary knowledge on working of avionics system in aircraft.

Course Outcome:
Students will be able to
- Understand the basics of measurements and different parameters
- Appreciate the need for general measurements in aviation industry
- Identify the fundamental cockpit instruments and their working principles
- Select proper instrumentation requirements for aerospace vehicles
- Differentiate various sensors and transducers used in aerospace vehicles
- Apprehend the principles behind temperature, pressure, fuel flow and engine measurements

Unit I - General concepts of Mechanical Instrumentation: Generalized measurement system, Classification of instruments as indicators, recorders and integrators - their working principles, Precision and accuracy: measurement error and calibration, Functional elements of an instrument system and mechanisms


Unit III - Classification of aircraft instruments: Classification of aircraft instruments - Air data instruments – pitot static systems and instruments, gyroscopic instruments - Gyroscope and its properties, vacuum driven systems, heading instruments.

Unit IV - Temperature, Pressure Measurements: Temperature measurement using physical parameter, Thermocouples, Air temperature sensors – RAT sensor – TAT Probe, Ratiometer, radiation pyrometer system, Pressure measurement- elastic type pressure gauges-Bourdon tube bellows-diaphragms- Bell Gauge, Direct reading pressure gauges, pressure switches.

Unit V - Engine Instruments & Fuel flow measurements: Engine Instruments - measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, engine vibration, monitoring, Fuel Quantity measurement – float type, capacitance type, and basic gauge system, Fuel flow measurement – rotating vane type indicator, fuel flow transmitter.

Text Book

References:
17AE2007 CAD/CAM LABORATORY

Credits: 0:0:2

Course Objective:
- To impart the knowledge on the usage of computer in design and manufacturing
- To impart the knowledge to visualization of objects in three dimensions and producing orthographic, sectional and auxiliary views of it.
- To impart the knowledge of drafting.

Course Outcome:
Students will be able to
- Understand the CAD packages.
- Develop 2D and 3D aircraft parts using software.
- Create parts and assemble these for functional assembly
- Draft for manufacturing
- Write CNC Program for different machining process
- Get the hands-on experience of CNC manufacturing

List of Experiments:
1. 2D Sketch
2. Solid Modelling.
3. Surface modelling
4. Sheet Metal Design
5. Assembly of the Aircraft parts.
6. Drafting of Different parts.
7. Photogrammetry
8. CNC -Profile cut using Linear and circular interpolation code
9. CNC –Circular pocketing and slotting
10. CNC –Step turning, taper turning,
11. CNC- Thread cutting and Drilling
12. Additive manufacturing

17AE2008 AERO THERMAL ENGINEERING

Credit 3:0:0
Pre-Requisites: 17ME2004 Engineering Thermodynamics

Course Objective:
- To integrate the concepts, laws and methodologies from the first course in thermodynamics into analysis of cyclic processes
- To apply the thermodynamic concepts into various thermal application like IC engines, Compressors, Turbines and Nozzle.
- To impart the knowledge on Aircraft Refrigeration and Air conditioning systems

Course Outcome:
Students will be able to
- Understand the concepts of thermodynamic cycles
- Understand the working principles of internal combustion engines
- Know the function of nozzles and turbines
- Know the working principle of air compressors
- Understand the concepts of refrigeration systems
- Apply the different gas power cycles in IC and R&AC applications.

(Use of standard refrigerant property data book, Gas Tables and Psychometric chart permitted)

Unit I - Thermodynamic air cycles -Otto, Diesel, Dual combustion, Brayton cycles, Calculation of mean effective pressure, and air standard efficiency - Comparison of cycles.
Unit II - Internal combustion engines- Classification - Components and their function. Valve timing diagram and port timing diagram - actual and theoretical p-V diagram of four stroke and two stroke engines. Simple and complete Carburettor- MPFI, Engine Fuel system: Fuel Metering Devices, and Ignition system and Types. Engine starting

Unit III - Air compressor-Classification and working principle of various types of compressors, work of compression with and without clearance, Volumetric efficiency, Isothermal efficiency and Isentropic efficiency of reciprocating compressors. Multistage air compressor and inter cooling –work of multistage air compressor


Text Books:

References:

17AE2009 THERMAL ENGINEERING LABORATORY

Co-requisite: 17AE2008 Aero Thermal Engineering
Credits: 0:0:1

Course Objectives:
- To impart knowledge on the performance characteristics of various thermal systems and internal combustion engines
- To impart knowledge on the design calculations of different thermal equipment
- To provide hands on training for performance measurements of different thermal system

Course Outcomes:
Students will be able to
- Evaluate the performance of refrigeration, heat pump and air–conditioning cycles
- Conduct a variety of experiments in internal combustion engines
- Analyze the efficiency and performance of two stage reciprocating air compressor
- Calculate & compare the performance parameters of air blower
- Determine the performance of 4 stroke petrol engine
- Determine the performance of four stroke single cylinder Diesel engine

List of Experiments
1. Measurement of coefficient of performance in a vapour compression refrigeration cycle
2. Measurement of coefficient of performance in a heat pump apparatus
3. Determination of coefficient of performance in air–conditioning cycle
4. Measurement of performance parameters on air blower
5. Measurement of performance parameters on two stage reciprocating air compressor
6. Performance test on variable compression ratio, 4 stroke petrol engine
7. Performance test on four stroke single cylinder Diesel engine

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD / Director and notify it at the beginning of the semester.
14AE2010 AERODYNAMICS

Credits: 3:0:0
Pre-requisites: 17AE2002–Fundamentals of fluid flow

Course Objectives:
- To impart knowledge of basics of air flow
- To provide details regarding the flow over airfoils and wings
- To impart knowledge of forces and moments over an aerofoil

Course Outcome:
Students will be able to
- Understand the aerodynamic variable connected with airflow
- Apply the conservation laws for given aerodynamic situation
- Analyse the basic flows satisfying the governing equations
- Assess the flow field over the aerofoils
- Estimate the flow over aircraft wings and Fuselage
- Evaluate the forces and moments over vehicles utilizing different kinds of flows


Text Books:

References:

17AE2011 AERODYNAMICS LABORATORY

Credit 0:0:2
Co-requisites: 17AE2010– Aerodynamics

Course Objective:
- To impart knowledge of basics of air flow
- To provide details regarding the flow over airfoils and wings
- To impart knowledge of forces and moments over an aerofoil

Course Outcome:
Students will be able to
- Understand the aerodynamic variable connected with airflow
- Predict pressure distribution over the various airfoils.
- Estimate lift and drag of various stream line and bluff bodies
- Visualize subsonic flow over various model
- Estimate effect of Reynolds number of low speed airfoil
- Evaluate the forces and moments over aircraft model

**List of Experiments:**
1. Calibration of subsonic wind tunnel.
2. The pressure distribution over a symmetric and cambered aerofoil.
4. The pressure distribution over a cascade aerofoil.
5. Force and moment measurements of rectangular wing by using strain gauge balance.
6. Force and moment measurements of car model by using strain gauge balance.
7. Boundary layer measurements in the test section of subsonic wind tunnel.
8. Assessment of performance of a small scale wind turbine by using Wind turbine tunnel.
9. Simulation of earth boundary layer in subsonic wind tunnel.
10. Smoke and tuft flow visualization Flow visualization over a car.
11. Flow visualization over cylinder and aircraft using Water tunnel facility.
12. Smoke and Tuft flow visualization of symmetric and cambered aerofoil.
13. Oil flow visualization in subsonic tunnel.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of the semester.

**17AE2012 AIRCRAFT STRUCTURES - I**

**Credits:** 3:0:0

**Pre-requisites:** 17AE2004 Solid Mechanics

**Course Objective:**
- To impart the knowledge of aircraft material and its behaviour.
- To impart the knowledge on the methods of structural analysis under different types of loads.
- To provide the knowledge on basic theory of vibrations, elasticity, fatigue and failures.

**Course Outcome:**
Students will be able to
- Identify the suitable aircraft material and its behaviour
- Apply the methods of statically determinate and indeterminate structural analysis under different conditions
- Perceive the concept of Column buckling
- Solve the vibration problem with different DOF
- Apply the knowledge in basic theory of elasticity
- Analyse the airframe structures

**Unit I - Introduction to Aircraft Structures Analysis:** Stress strain curve- young’s modulus- Poisson’s ratio, basics of elasticity: Plane stress, Plane strain, Stress-Strain Relationships, Two dimensional problems, St. Venant’s Principle. Aerospace Materials, Properties and structural application of Non-ferrous; Ferrous Composites – Classification, properties and usage


**Unit III - Buckling of Column:** Buckling of columns, Inelastic buckling, Effect of initial imperfections, Stability of beams under transverse and axial loads, Energy method for the calculation of buckling loads in columns, Flexural-torsional buckling of thin-walled columns.

**Unit IV - Theories of failure:** Introduction, Maximum principal stress theory, Maximum principal strain theory, Maximum shear stress theory, Maximum strain energy theory, Maximum shear strain energy theory; Introduction to Fatigue-Different types of Fracture Modes -SN Curve - Stress Concentration -Fatigue and Fracture of engineering Alloys.

**Unit V - Basic Theory of Vibration:** Free and forced vibrations of undamped and damped Single DOF systems, free vibrations of undamped 2-DOF systems- Mode shape, Oscillation of beams, Approximation methods for determining natural frequencies Problems.
Text Book:

References:

17AE2013 AIRCRAFT PERFORMANCE

Credits: 3:1:0
Pre-requisites: 17AE2001 - Introduction to Aerospace Engineering

Course Objective:
- To impart knowledge about the concepts of Flight performance
- To introduce the various parameters affecting the performance
- To introduce the various theories of propeller analysis and design

Course Outcome:
Students will be able to
- Understand the preliminary design of aircraft based on the performance.
- Differentiate performance characteristics of jet engine from propeller engine
- Estimate the performance characteristics in level flight.
- Assess the performance during turning manoeuvres of aircraft
- Realize the ground effects on performance
- Estimate the pitch angle from performance characteristics of propeller and its applications


Unit II - Effects of Engine Characteristics in performance: Introduction - Performance - Variation of Power and Specific fuel consumption with Velocity and Altitude - Reciprocating Engines - Gas Turbine Engines.


Unit IV - Turning Characteristics: Introduction - Level Turn - Minimum Turn Radius - Maximum Turn Rate - Instantaneous turn - Pull up and Pull down manoeuvres, Cobra Maneuver.

Unit V - Takeoff and Landing characteristics: Introduction to Take-off, Estimation of take-off distance - ground roll, obstacle clearing distance and height, Take off assist devices - Spoilers and landing distance - approach distance and flare distance.

Text Books:

Reference:
17AE2014 ELEMENT OF AVIONICS

Credits: 3:0:0
Pre-requisites: 17AE2006 Aircraft Instrumentation

Course Objectives:
- To impart knowledge about basic concepts of micro-processors and controllers, their significance and functioning.
- To provide understanding of the basic concepts and functioning of the avionic system data buses.
- To inculcate the knowledge about integrated avionics systems and the need for them.

Course Outcome:
Students will be able to
- Understand the fundamentals of processors, controllers and their applications
- Analyse the functioning of military/civil aircraft data buses and communication process between them.
- Identify display technologies and their working principles.
- Evaluate the modular avionics systems, electromagnetic interference & compatibility testing.
- Assess the working of fault tolerant systems and its applications
- Know the importance of integrated avionics systems and their build.

Unit I - Introduction to Avionics: Introduction to microprocessors and controllers, Role for Avionics in Civil and Military Aircraft systems, Avionics sub-systems and design, defining avionics System/subsystem requirements-importance of ‘ilities’, Avionics system architectures.

Unit II - Data Buses and Architecture: MIL-STD-1553B, ARINC-429, ARINC-629, CSDB, AFDX and its Elements, Avionics system design, Development and integration-Use of simulation tools, stand alone and integrated Verification and Validation.

Unit III - Cockpit Display Systems: Trends in display technology, Alphanumeric displays, character displays etc., Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit. Power requirements.

Unit IV - Modular Avionics: Packaging - Trade-off studies - ARINC and DOD types - system cooling - EMI/EMC requirements & standards.


Textbooks:

References:

17AE2015 FOUNDATIONS OF SPACE ENGINEERING

Credits: 3:0:0

Course objective:
- To impart the knowledge on coordinate systems used in astronautics
- To impart fundamental knowledge on rocket and spacecraft trajectories
- To impart a basic knowledge of space environment

Course outcome:
Students will be able to
• Comprehend the fundamental concepts of space engineering
• Understand the most common coordinate system used in astronautics: inertial vs. body-fixed frames.
• Transform between these systems using rotational matrices.
• Understand the fundamental principles of orbital motion.
• Perceive the design of trajectories in the atmosphere and space.
• Attain a general knowledge on the composition of space environment

Unit I - Mathematical fundamentals: Vectors and scalars, Dot and cross product of vectors, Derivative of a vector function, Gradient, Integral of a vector function, Plane motion – radial and transverse components, tangential and normal components, Spherical trigonometry laws and applications.
Unit II - Physical principles and time measures: Kepler’s laws, Newton’s laws, Work and energy, Force and momentum, Impulse and momentum, Law of conservation of total energy, Angular momentum, Universal time, Dynamical time, Julian date, Solar and sidereal days.
Unit III - Coordinate systems and transformation: Two and three dimensional coordinate systems, Polar and Cartesian coordinates, Spherical polar coordinates, Inertial and body-fixed coordinate systems, Rotation and rotation matrices, Two and three dimensional rotation, Three-angle sets for specifying orientation: Roll-pitch-yaw, Euler angles, Euler parameters.
Unit IV - Introduction to atmospheric and spacecraft trajectory: Rocket equation, Staging, Launch sites, Selection criteria for optimal launch trajectory, Central force motion, Newtonian gravitation, Properties of conic sections, Escape velocity, Two-body motion: energy and velocity on orbit, Classical orbital elements, Velocity azimuth and flight path angle.
Unit V - Introduction to space environment: Sun and solar wind, Earth's atmosphere, Ionosphere and communications, Geomagnetic field, Space debris, Micro-meteoroids.

Text Book:

References:

17AE2016 GAS DYNAMICS

Credits: 3:1:0
Pre-requisites: 14AE2010 - Aerodynamics

Course Objective:
• To provide information regarding the behavior of compressible fluid flow
• To impart knowledge regarding the difference between subsonic and supersonic flow
• To Estimate flow over flying vehicles at subsonic and supersonic speeds

Course Outcome:
Students will be able to
• Understand the influence of compressibility to distinguish between the flow regime
• Apply compressibility corrections for flow in C-D passages and instrument like Pitot static tube
• Estimate the sudden changes in the flow field
• Analyse the compressible flow field over an airfoil and finite wings
• Estimate the influence of friction and heat transfer in the flow field
Choose proper flow visualisation techniques for the given situation

Unit I - One dimensional compressible flow: Compressibility, Velocity of sound, Concept of Mach Number, Isentropic relations, Normal shock and its relations, Prandtl equation and Rankine – Hugoniot relation, Flow through converging-diverging passages, Performance under various back pressures, corrections of Pitot static tube for subsonic and supersonic Mach numbers.


Unit III - Differential equations of motion for steady compressible flows: Potential equations, Small perturbation potential theory, solutions for supersonic flows - flow over a wavy wall and flow over airfoil, Prandtl-Glauert correction for subsonic flows.

Unit IV - High speed flow over airfoil: Linearised two dimensional supersonic flow theory, Lift, drag, pitching moment and center of pressure of supersonic profiles, Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation.

Unit V - High speed flow over finite wing: Finite wing, tip effects, Characteristics of sweptwings, Effects of thickness, camber and aspect ratio of wings, transonic area rule, flow visualisation Techniques.

Text Books

References:

17AE2017 GAS DYNAMICS LABORATORY

Co-requisites: 17AE2016 – Gas Dynamics

Course Objective:
- To impart knowledge of basics of high speed flow over the model
- To provide details regarding the supersonic flow over various model
- To impart knowledge of shock wave over various model

Course Outcome:
Students will be able to
- Calibrate of supersonic wind tunnel
- Predict pressure distribution over the various airfoils.
- Visualize supersonic flow over various model
- Visualize shock wave and Estimate shock angle over various model
- Estimate effect of Reynolds number of low speed airfoil
- Assess the effect of back pressure in C-D nozzle

List of Experiments:
1. Calibration and runtime calculation of supersonic wind tunnel.
2. Flow visualisation using Schlieren technique.
3. Flow visualisation using shadowgraph technique.
4. Oil Flow visualisation
5. Flow visualisation of - Correctly expanded, under expanded and over expanded circular jets.
6. Flow visualisation of - Correctly expanded, under expanded and over expanded elliptic jets.
7. Flow visualisation of - Correctly expanded, under expanded and over expanded rectangular jets.
8. Pressure distribution in a C-D Nozzle using OJF facility.
9. Axis switching characteristics (pressure measurements) of elliptic nozzle
10. Axis switching characteristics (pressure measurements) of rectangular nozzle
11. Jet pluming study using high altitude jet facility.

2017 | Aerospace Engineering
12. Multiple jet interaction studies
13. Background noise study in supersonic tunnel.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of the semester

**17AE2018 AIRCRAFT STRUCTURE-II**

**Credits:** 3:0:0  
**Pre-requisites:** 17AE2012 Aircraft Structures -I

**Course Objective:**
- To impart the knowledge on the structural behaviour of aircraft components under different types of loads
- To provide the understanding in structural design methods for aerospace vehicles
- To impart the knowledge on the force distribution of different structures in Aircraft

**Course Outcome:**
Students will be able to
- Predict the shear flow and shear centre in open sections with effective and ineffective wall
- Predict the shear flow and shear centre in closed sections with effective and ineffective wall
- Analyse the buckling characteristics of plates
- Choose proper methods to analyse aerospace structural members
- Assess the load and stress distribution of wing and fuselage section
- Design the fail-safe and safe-life Aircraft structures

**Unit I - Structural Idealization:** Principle, Idealization of a panel, Effect of idealization on the analysis of open and closed section beams, Deflection of open and closed section beams.

**Unit II - Shear flow in open sections:** Thin walled beams, Concept of shear flow, Shear center, Elastic axis, with one axis of symmetry with effective and ineffective wall in bending, Unsymmetrical beam section.

**Unit III - Shear flow in closed section:** Bredt-Batho formula, Single and multi-cell structures, approximate methods, Shear flow in single and multi cell structures under torsion, Shear flow in single and multi cell structures under bending with effective and ineffective wall, Box Beams.

**Unit IV - Buckling of plate:** Buckling of thin plates, Inelastic buckling of plates, Local instability, Instability of stiffened panels, Failure stress in plates and stiffened panels, Crippling stresses by Needham’s and Gerard’s methods.

**Unit V - Wing and Fuselage Analysis:** Shear force, bending moment and torque distribution along the span of the Wing-Tension field beam and Semi tension field beam (Wagner Bam). Fuselage Analysis - Shear and bending moment distribution along the length of the fuselage.

**Text Book:**

**References:**

**17AE2019 AIRCRAFT STRUCTURES AND COMPOSITE LABORATORY**

**Credits:** 0:0:2  
**Co-requisites:** 17AE2018 Aircraft Structure-II

**Course Objective:**
- To provide the basic knowledge of the testing equipment for various structural components.
- To impart the practical exposure with the measuring equipment and sensors.
- To impart the practical exposure with composite material manufacturing

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Course Outcome:
Students will be able to
- Select test equipment for different types of static loading
- Conduct tests, analyse results, document and compare with analytical/theoretical results
- Analyse the different types of structural failures
- Manufacture the different Composite laminates
- Choose strain gauge for different application
- Understand the stress distribution based on cross-section shape and loading conditions

List of Experiments:
1. Deflection of simply supported and cantilever beams - Verification of Castigliano’s Theorem
2. Determine the stiffness factors of an elastically supported beam
3. Determine the tensile strength of flat plates, riveted joints and bolted joints using UTM.
4. Compression test on columns, critical buckling loads – Southwell plot
5. Unsymmetrical bending of beams
6. Determination of the effective bending stiffness of a composite beam with the combination of aluminium and steel
7. Determination of the natural frequency of vibrations of a cantilever beam
8. Shear centre location for open sections
9. Torsion of a thin walled tube having closed cross section at the ends
10. Structural behaviour of a semi tension field beam (Wagner Beam)
11. Using photo elastic techniques: Calibration of circular disc in compression to find the fringe value and Determination of stress concentration factor due to compression in circular ring
12. Composite material Manufacturing and Testing- Tensile and Three point bending

17AE2020 AIRCRAFT STABILITY AND CONTROL

Credit: 3:0:0
Pre-requisites: 17AE2013 Aircraft Performance

Course Objective:
- To introduce the concept of Stability and control of Aircraft
- To impart knowledge about various Aircraft motions and related stability
- To introduce the concept of dynamic stability of Aircraft

Course Outcome:
Students will be able to
- Understand the degree of freedom of aircraft system
- Analyse the static stability behaviour of the aircraft.
- Understand the dynamic longitudinal stability of aircraft
- Perform the dynamic analysis to determine stability of aircraft
- Estimate the requirement of control force and power plant
- Assess the motion of unstable aircraft and related modes of instability

Unit I - Static Longitudinal Stability : Degrees of Freedom of a system, Basic equations of motion- Wing and tail contribution; Effects of Fuselage and nacelles- Stick fixed neutral points- Power effects-Jet driven airplane and Propeller driven airplane, Elevator Requirements.

Unit II - Stick Fixed Static Longitudinal Stability: Basic equations of motion Elevator hinge moment, Estimation of hinge moment parameters, Stick Force gradients and Stick force per g load; Stick free Static Longitudinal Stability: Trim Taps, Stick free Neutral Point.


Unit V - Dynamic Longitudinal Stability: Equations of motion-stick fixed and stick free, stability derivatives, Phugoid and short period, Lateral Dynamics- Equation of motion- Aileron fixed and free, Routh’s discriminant, Dutch roll and Spiral instability, Auto rotation and Spin recovery.
Text Book:

References:

17AE2021 AIRCRAFT PROPULSION

Credits: 3:0:0
Pre-requisites: 17AE2006 – Thermal Engineering for Aerospace Engineering

Course Objective:
- To familiarize with Principles of Propulsion systems
- To introduce working principles of Compressors and turbines
- To familiarize with the concept of Matching of compressors and turbines and Off design performance

Course Outcome:
Students will be able to
- Understand the performance of air breathing engines
- Analyse the performance of different Propulsion cycles.
- Understand the working of sub-systems of the propulsion system.
- Assess the performance of compressor and turbine
- Evaluate the combustion chamber, cooling and afterburner performance
- Find the causes of under-performance and remedial measures


Text Books:

References:

17AE2022 SPACE DYNAMICS

Credits: 3:0:0
Pre-requisite: 17AE2015 Foundations of Space Engineering

Course Objective:
- To familiarize with the performance of rockets
- To impart knowledge of basics of orbital mechanics
- To familiarize with various factors affecting the satellite orbits

Course Outcome:
Students will be able to
- Estimate performance of the rockets
- Attain a general knowledge of laws governing the orbital motion
- Use proper reference coordinate system for space trajectory analysis
- Compute the orbits of the satellites
- Study the effects of perturbations on the orbital motion
- Generate a preliminary design of inter-planetary trajectories

Unit I - Atmospheric rocket flight: Rocket performance – Specific impulse, Derivation of rocket equation; Single and two stage rockets.

Unit II - Solar system and coordinate frames: planets, moons, asteroids, comets and meteoroids, Kepler’s laws of motion; Reference frames – geocentric and heliocentric; the ecliptic - Motion of vernal equinox.

Unit III - Orbit classification: Properties of conics, Angular momentum; Computation of position and velocity vectors from orbital elements and vice-versa; Solution of Kepler’s equation – elliptic and hyperbolic orbits.

Unit IV - Orbit perturbations: Earth’s Oblateness, Sun-synchronous orbits, air drag, luni-solar perturbations; General and special perturbation methods; Cowell’s and Encke’s methods.

Unit V - Interplanetary trajectory: Single impulse maneuvers; Change of orbital inclination; Hohmann transfers from circular to circular orbits; Sphere of influence; Synodic period.

Textbooks:

References:
17AE2023 COMPUTATIONAL FLUID DYNAMICS

Credits: 3:0:0
Pre-requisites: 17AE2016 Gas Dynamics

Course Objective:
- To provide knowledge on governing equations of fluid dynamics
- To provide an understanding of the solution methodologies of discretised equations
- To provide knowledge on turbulence behaviour and its models of the flow

Course Outcome:
Students will be able to
- Understand the governing equations for fluid flow and its classification
- Choose the proper turbulent models for the given flow situation
- Apply proper solution methodology for PDE
- Arrive the proper domain for the numerical simulation for the given flow situation
- Define the boundary conditions and generate the grids
- Solve the real life fluid dynamic problems

Unit I - Governing equations: Governing equations of fluid flow and heat transfer, Navier-Stoke’s equations, Conservative, differential and integral form of transport equations; Classifications of PDEs and Numerical methods for different PDEs.


Unit III - Convection diffusion problems: Steady one dimensional convection - diffusion, central difference, upwind differencing and hybrid schemes, Properties of discretisation schemes and convergence, Assessment of central difference, upwind differencing and hybrid schemes, Overview of Power law and QUICK schemes.

Unit IV - Various schemes: Staggered grid and momentum equations, SIMPLE, SIMPLER and SIMPLEC algorithms, Implementation of Boundary Conditions – Inlet, outlet, Wall, constant pressure, symmetric and cyclic.

Unit V - Turbulence: Turbulence, Transition from Laminar to turbulent flows. Time averaged Navier-Stokes equations. Turbulence Models – zero equation- One equation - two equation and Reynolds stress models, Usage of turbulence models.

Text Books

References:

17AE2024 COMPUTATIONAL FLUID DYNAMICS LABORATORY

Credits: 0:0:2
Co-requisites: 17AE2023 Computational Fluid Dynamics

Course Objective:
- To familiarize the students with the working of CFD codes
- To familiarize the students with actual setting up of the problem and solution procedure
- To extract the required data, post process and compare with available data

Course Outcome:
Students will able to
- Define the body shape in a CFD code
- Create the solution domain and grid generation
- Apply boundary conditions and generate the solution
- Validate the aerodynamic quantities from computed data
- Perform CFD Analysis over 2D and 3D objects.
- Solve the problems using different turbulence models.

List of Experiments:
1. Laminar Pipe Flow
2. Turbulent Pipe Flow
3. Modelling a mixing Elbow (2-D)
4. Flat Plate Boundary Layer
5. Forced Convection over a Flat Plate
6. Steady Flow past a Cylinder
7. Unsteady Flow past a Cylinder
8. Flow Over an Airfoil
9. Flow simulation over an aircraft
10. Flow simulation over a rocket
11. Supersonic Flow over a Wedge
12. Compressible Flow in a Nozzle
13. Analysis of 1D unsteady conduction by explicit and implicit schemes.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

**17AE2025 ROCKET PROPULSION**

**Credit 3:0:0**

**Pre-requisites:** 17AE2021 Aircraft Propulsion

**Course Objective:**
- To impart knowledge on concepts of Solid Propulsion rocket motor
- To impart knowledge on concepts of Liquid Propulsion rocket motor
- To impart knowledge on concepts of Advanced Propulsion systems

**Course Outcome:**
Students will be able to
- Evaluate the performance of rocket nozzle
- Understand and evaluate the performance of chemical propellant
- Select and design a suitable solid rocket motor
- Select and design a suitable liquid rocket motor
- Evaluate the performance of cooling system
- Select and design advanced propulsion systems

**Unit I - Fundamentals Of Rocket Propulsion:** Overview of rockets, Rocket equation, Performance parameters, Staging and Clustering, Classification of rockets. Rocket nozzle and performance, Nozzle area ratio, conical nozzle and contour nozzle, under and over-expanded nozzles, Flow separation in nozzles, unconventional nozzles, Mass flow rate, Characteristic velocity, Thrust coefficient, Efficiencies, Specific impulse.

**Unit II - Chemical Propellants:** Molecular mass, specific heat ratio, Energy release during combustion, Stoichiometric & mixture ratio, Types and classifications, Criterion for choice of propellant, Solid propellants, requirement, composition and processing. Liquid propellants, energy content, storability.

**Unit III - Solid Propulsion Systems:** Classifications, Booster stage and upper stage rockets, Hardware components and functions, Propellant grain configuration and applications, Burn rate, burn rate index for stable operation, mechanism of burning, ignition and igniters types, Action time and burn time, Factors influencing burn rates, thrust vector control.

**Unit IV - Liquid Propulsion Systems:** Liquid Propellant engines, Thrust chamber and its cooling, injectors and types, Propellant feed systems, Turbo pumps, Bipropellant rockets, Mono propellant thrusters, Cryogenic propulsion system, special features of cryogenic systems.

Text books:

References:

17AE2026 PROPULSION LABORATORY
Co-requisites: 17AE2025 Rocket Propulsion
Credit: 0:0:2

Course Objectives:
- To impart knowledge on basic concepts and operation of various propulsion system
- To provide practical exposure to the operation of various propulsion systems.
- To impart knowledge on shock tube.

Course Outcomes:
Students will be able to
- Understand the design the experiment for rocket motor performance.
- Assess the real time situation and corrective measures associated with rocket motors.
- Analyze the working of different parts of aircraft engine
- Estimation of calorific value of fuels
- Force distribution of axial compressor blade
- Solve Ignition delay studies using shock tube

List of Experiments
1. Study of an aircraft jet engine
2. Estimation of calorific value of fuels
3. Study on injector calibration
4. Shock speed measurement studies
5. Ignition delay studies using shock tube.
7. Cascade testing of a model for axial compressor blade row (symmetrical)
8. Cascade testing of a model for axial compressor blade row(cambered)
9. Study of convective heat transfer coefficient for liquids
10. Free convection heat transfer
11. Forced convection heat transfer

17AE2027 COMPUTATIONAL STRUCTURAL ANALYSIS LABORATORY
Pre-requisites: 17AE2018 Aircraft Structures-II
Credit 0:0:2

Course Objective:
- To provide the knowledge on various structural analysis software packages
- To impart the understanding of the stress analysis of different types of structural components
- To impart the Knowledge on programming for various structural analysis
Course Outcome:
Students will be able to
- Understand the various structural software packages
- Solve the static structural analysis of one dimensional members
- Solve the static structural analysis of two dimensional & three dimensional problem
- Analyze the Static Thermal analysis of various objects
- Understand the various structural programming – open source software packages
- Program for various structures problem

List of Experiments:
1. Static stress analysis axial bar
2. a. Two dimensional (truss) frame with multiple materials and element types
   b. Three dimensional truss- Airframe
3. Simple two dimensional heat transfer problem
4. Modal analysis of Aircraft wing
5. Plate buckling analysis
7. Fluid-structure interaction-Oscillating plate using Ansys workbench.
8. Programming of one dimensional bar with single material and axial load using Scilab.
9. Programming of one dimensional step bar, multiple material with different axial load direction using Scilab.

17AE2028 AIRCRAFT/SPACECRAFT DESIGN PROJECT

Credits: 0:0:4
Pre-requisites: 17AE2020 Aircraft Stability and Control

Course Objective:
- To impart the knowledge of Aerodynamic design of Aircraft.
- To impart the knowledge of Performance analysis and stability aspects of different types of aircraft/Spacecraft.
- To impart the knowledge of the structural design of the aircraft/space craft.

Course Outcomes:
Students will be able to
- Choose the type of aircraft/spacecraft for comparative studies
- Calculate the aerodynamic parameter
- Design the aircraft and assess the performance of the design
- Analyse the stability of the designed vehicle
- Design the aircraft wings, tail, fuselage, landing gears
- Analysis the aircraft using XFLR5 (open source) software

Activities to be carried out:
1. Comparative studies of different types of airplanes and their specifications and performance details with reference to the design work under taken.
2. Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces Landing gear selection.
3. Preparation of layout drawing, construction of balance and three view diagrams of the airplane under consideration.
5. Preliminary design of an aircraft wing – Shrenck’s curve, structural load distribution, shear force, bending moment and torque diagrams
6. Detailed design of an aircraft wing – Design of spars and stringers, bending stress and shear flow calculations – buckling analysis of wing panels
8. Design of control surfaces - balancing and maneuvering loads on the tail plane and aileron, rudder loads
9. Design of wing-root attachment
10. Landing gear design
11. Preparation of a detailed design report with CAD drawings

17AE2029 INSTRUMENTATION AND AVIONICS LABORATORY

Credit: 0:0:2
Pre-requisites: 17AE2014 - Elements of Avionics

Course Objective:
- To impart the knowledge about different types of Instruments and control systems
- To train students to measure parameters accurately and their importance in different applications in the field of Avionics
- To provide a complete knowledge on navigation systems like GPS.

Course Outcome:
Students will be able to
- Understand the fundamentals of measurements.
- Understand the applications of these fundamental measurement systems.
- Understand the enormous amount of pressure that is put on these simple instrumentation in real time applications.
- Work with the avionics systems on an aircraft
- Apprehend the design concept of new control systems
- Familiarize with methods of troubleshoot and rectification of faulty instruments.

List of Experiments:
1. Stepper motor control
2. Displacement measurement using LVDT
3. Characteristics of load cells
4. Measurement of Pressure
5. Study of ON-OFF temperature control system
6. Design of Longitudinal autopilot for jet airplane
7. Measurement of Angular position using Gyroscope
8. Measurement of Air velocity using Hot wire Anemometer
9. Measurement of Acceleration using Accelerometer
10. Temperature measurement using thermocouple
11. Temperature measurement using RTD
12. Study on global positioning system
13. Programming with microprocessors

17AE2030 WIND TUNNEL TECHNIQUES

Credits: 3:0:0

Course Objective:
- To provide knowledge of various types of wind tunnels and test techniques.
- To introduce the basic concepts of measurement of pressure, velocity, forces and moments on models.
- To provide knowledge of various flow visualization techniques.

Course Outcome:
Students will be able to
- Understand the various types of wind tunnels and test techniques.
- Choose proper high speed wind tunnel for required test.
- Choose correct model for wind tunnel testing
- Estimate the forces and moments for given model
- Arrive the pressure, velocity and temperature using measurement techniques
- Choose the proper flow visualization techniques
Unit I - Low speed wind tunnels: Flow similarity, Types of Wind Tunnel- subsonic, supersonic, transonic and hypersonic, Low Speed: layouts and nomenclature, types - closed circuit and open circuit, closed jet and open jet test section – application, Special purpose tunnels - Smoke Tunnels – Water Tunnels – Spin tunnel etc.,

Unit II - Supersonic wind tunnel: Classification, Blow down, continuous and intermittent tunnel, Runtime calibration, mass flow rate, Size of pressure vessel, Starting and stopping Loads, Model Sizing.

Unit III - Hypersonic wind tunnel: Classification; Runtime Calculation; Shock Tube: Driver – driven section – Diaphragm – Type of operation – Shock Speed and Initial Diaphragm Pressure Ratio, Model sizing; Starting and stopping Loads - Calibration of test section for various Tunnels.


Unit I - Flow visualization techniques: Path – Streak – Stream and Timelines; Techniques: Smoke, Tuft, Streaks, Surface oil flow, Interferometer, Schlieren and Shadowgraph technique.

Text Book:

References:

17AE2031 FINITE ELEMENT ANALYSIS IN AEROSPACE APPLICATION

Credits: 3:0:0

Course Objectives:
- To impart the basic concept of finite element theory
- To introduce concept of finite element method for analysis of aerospace structural components
- To provide the knowledge on various finite element procedures and solution techniques

Course Outcome:
Students will be able to
- Understand the different numerical solution to the FEA Problems
- Analyse the discrete and continuum problem using finite element method.
- Analyse the functions of different elements and stiffness matrix
- Solve the Axisymmetric problems
- Identify mathematical model for solution of common engineering problems
- Describe the usage of professional-level finite element software to solve engineering problems


Unit II - One dimensional finite element analysis – Co-ordinate systems - shape functions and stiffness matrix for bar element - shape functions and stiffness matrix beam element - shape functions and stiffness matrix for Truss element – related problems; Applications- MATLAB/SCI-LAB Programming- 1 D Elements – Truss Problems.


Unit IV - Higher order elements – Shape function of quadratic and cubic element-Shape function of eight noded quadrilateral element - Shape function of Nine noded quadrilateral element – Axisymmetric elements – problems – consistent mass matrix for various elements – lumped mass matrix – evaluation of Eigen values and Eigen vectors; Applications- MATLAB/SCI-LAB Programming- Higher order elements

Text Books:

References:

17AE2032 HEAT TRANSFER
Credit 3:0:0
Pre-requisites: 17ME2004 Engineering Thermodynamics

Course Objective:
- To understand the mechanisms of heat transfer under steady and transient conditions.
- To understand the concepts of heat transfer through extended surfaces.
- To learn the thermal analysis and sizing of heat exchangers and to understand the basic concepts of mass transfer.

Course Outcome
Students will be able to:
- Understand the fundamental modes of heat transfer
- Understand the phase change heat transfer
- Use the heat transfer correlation for different heat transfer applications
- Understand the concept of hydrodynamic and thermal boundary layers
- Analyse and design the different types of heat exchangers
- Apply heat transfer principles of different applications.

(Use of standard HMT data book permitted)


Unit II - Convection: Dimensional analysis – forced and free convection - Significance of dimensionless number - Hydrodynamic and Thermal Boundary Layer. Free and Forced Convection during external flow over Plates and Cylinders and Internal flow through tubes.


Text Books:

Reference Books:

17AE2033 EXPERIMENTAL STRESS ANALYSIS

Credits: 3:0:0

Course Objectives:
- To impart the knowledge in experimental method of finding the response of the structure to different types of load.
- To provide the basic knowledge in Electrical-Resistance strain gauges and its application
- To impart the knowledge in photo-elasticity techniques

Course Outcome:
Students will be able to
- Get the knowledge of the general aspects of strain measurements
- Ability to understand the principle of operation of different type of strain gauges.
- Choose the electrical resistance strain gauge for different application
- Get the knowledge of the 2D Photo elastic stress analysis
- Get the knowledge of the three dimensional photo elasticity
- Identify the suitable stress coating methods

Unit I - Basics: Principle of measurements-Accuracy, sensitivity and range- Definition of strain and its relation to experimental determinations Properties of strain gauge systems, Types of strain gauge systems- Mechanical, Optical, Acoustical and Electrical extensometers.

Unit II - Strain Gauges: Electrical-Resistance strain gauges and circuits, Principle of operation and requirements - Types and their uses- Materials for strain gauge-Calibration and temperature compensation-Cross sensitivity-Rosette analysis- Wheatstone bridge-Potentiometer circuits for static and dynamic strain measurements Strain indicators- Transducer applications- Load cells- Diaphragm pressure transducers. Case Study-Six component strain gauge balancing, foil type strain gauge mounting on plate - cantilever beam- Aircraft wing section- strain analysis with respect to different load.


Unit V - Birefringent Coatings: Coating stresses and strain- Coating sensitivity – Coating materials- Application of coatings- Effect of coating thickness-Fringe-Order Determinations in coatings- Stress separation methods. – Applications.

Text Book:

References:

17AE2034 COMPOSITES MATERIALS

Credits: 3:0:0

Course Objectives:
- To impart knowledge on Types and applications of composite materials
- To impart knowledge on Nature of various forms of reinforcement and matrix.
- To impart knowledge on Processing and testing of composite materials

Course Outcomes:
Students will be able to
- Understanding the mechanics of composite materials
- Understand the behaviour Composite Materials under Various Loads
- Understand the structure of the composite materials
- Analyze the different Failure modes of Composite Materials
- Analyze the laminated composites for various loading eases
- Get knowledge in manufacture of composites

Unit I - Micromechanics:

Unit II - Macromechanics:

Unit III - 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, hydrothermal stresses and strains in a laminate, Failure analysis of a laminate, impact resistance and inter laminar stresses; Netting analysis

Unit IV - 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 V - 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:

References:

17AE2035 NAVIGATION, GUIDANCE AND CONTROL OF AEROSPACE VEHICLES

Credits: 3:0:0

Course Objectives:
- To impart the concept of Control system fundamentals and its analysis.
- To introduce the concepts and working principles of different navigation methods and guidance.
- To model of aerospace vehicles and flight control system.
Course Outcomes:
Students will be able to
- Understand the control system and assess its performance and stability using routh Hurwitz criterion and root locus.
- Analyze time and frequency domain specifications and perform analysis using bode plot, polar plot and Nyquist stability criteria.
- Deploy the skills effectively in design of control for aerospace vehicle systems
- Understand the working principles and specifications of navigation methods.
- Simulate and assess the performance of autopilots, augmentation systems and missile guidance systems.
- Apprehend the functionality of advanced navigation and guidance systems.

Unit I - Introduction to Control System:
Introduction to Control System - open loop and closed loop control system-Transfer function poles and zeroes - block diagram reduction- signal flow graph - Mason’s gain formula - Characteristics equation-concept of stability - Routh’s stability Criteria, Root Locus.

Unit II - Time and Frequency Domain Analysis:
Time domain - Transient and Steady State Response-Time domain Specifications - Second Order system. Frequency Domain Analysis Closed Loop Frequency Response-Bode Plot-Polar Plot-Nyquist Stability Criteria-Stability Analysis from Bode Plot

Unit III - Introduction to navigation systems:
Introduction to navigation systems - Types Different co-ordinate systems - Transformation Techniques; Different types of radio navigation; - Introduction to Inertial Sensors; INS components; Introduction to GPS - system description - basic principles - position and velocity determination.

Unit IV - Introduction to guidance and control:
Introduction to guidance and control, Need for automatic flight control systems; Displacement Autopilot - Pitch Orientation Control system; Methods of Obtaining Coordinates, Yaw Orientation Control system, Lateral Autopilot, Missile Autopilot.

Unit V - Introduction to Advanced systems:
Introduction to Advanced systems, Introduction to Fly-by-wire flight control systems, Instrument Landing System, microwave landing system, Operating principles and design of guidance laws, Radar systems, command and housing guidance systems.

Text Books:

References:

17AE2036 CRYOGENIC PROPULSION

Course Objective
- To impart the knowledge on cryogenic fluids
- To impart the knowledge on Liquefaction & Cryogenic refrigeration systems
- To know the various application of these propulsion in Aerospace field

Course Outcome
Student will be able to
- Understand the thermal, physical and fluid dynamic properties of cryogenic fluids.
- Recognize the liquefaction systems to produce cryogenic fluids
- Known the Cryogenic refrigeration systems
- Recognize the methods of Cryogenic fluid storage and transfer systems for Aerospace application
- Categorize the Cryogenic Engine for Rockets
- Design the various cryogenic equipment used in Aerospace application.

Unit II - Liquefaction systems: Thermodynamically ideal system – Joule-Thomson effect –Adiabatic expansion – Liquefaction systems- Simple Linde Hampson system-Precooled Linde Hampson system-Claude system – kapitza system – Heylandt system – comparison of liquefaction systems.


Unit IV - Cryogenic fluid storage and transfer systems: Cryogenic fluid storage vessels- Basic storage vessels – Inner and outer vessel design – Piping- Draining the vessels –Safety devices – Insulations – Cryogenic fluid transfer systems- Uninsulated and porous insulated lines –Vacuum insulated lines – Cryogenic valves.

Unit V - Cryogenic Engine: Introduction to cryogenic engines, types and their application- Schematic diagram-working principle of Cryogenic engine, Precaution for testing the engine. Numerical problems

Text Books:

Reference Books:
Text Books

References

17AE2038 INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS

Credits: 3:0:0

Course Objective:
- To incorporate awareness about the basic terminology, models and prototypes of UAS
- To impart knowledge on design considerations of UAV systems
- To obtain knowledge on aerodynamics and communication systems of UAS

Course Outcome:
Students will be able to
- Know the evolution of UAS and the various models and prototypes
- Understand the design parameters of UAV systems
- Obtain knowledge on the application of aerodynamic principles to design UAS
- Understand the principles of communication systems used in UAVs
- Obtain knowledge on payloads and launch systems for UAS
- Understand the application of UAS to various societal applications

Unit I - Introduction to Unmanned Aircraft Systems - Aviation History and unmanned flight – Definitions and terminology – Classification of UAVs – UAV categories - Unmanned Aircraft systems
Unit II - Design and selection of UAV system - Conceptual phase – Preliminary design – detail design – selection of system – UAV mission – UAV design specifications – Initial sizing – Airfoil selection – structural requirements and engine selection
Unit III - Aspects of Airframe design - Lift induced drag – parasitic drag – Scale effects - Structure and Mechanics - Mechanical design - Selection of power plants
Unit IV - Payloads - Dispensable and non-dispensable pay loads – Communication media - Radio communication – Radio tracking - Antenna types
Unit V - Launch of HTOL & VTOL systems - recovery of HTOL & VTOL systems - Naval roles – Army roles – Civilian roles – paramedical and commercial roles – commercial applications

Text Books:

References:

17AE2039 AERO-ELASTICITY

Credits: 3:0:0

Pre-requisites:17AE2020 Aircraft Stability and Control

Course Objectives:
- To impart the basic concepts of Aeroelasticity
- To provide knowledge about the Static Aeroelastic phenomena
- To understand the Dynamic Aeroelastic phenomena
Aerospace Engineering

Course Outcome:
Students will be able to
- Understand the Aero-elastic phenomena
- Get Knowledge in preventing body (i.e. Aircrafts) from Aeroelastic instability
- Understand the vibration system
- Analyse the static Aeroelastic behaviour of the Aircraft
- Analyse the Dynamic Aeroelastic behaviour of the Aircraft
- Analyse the Flutter and Gust behaviour of the Aircraft.

Unit I - Introduction to Aero-elasticity: Introduction to Aero-elasticity- The aero-elastic triangle of forces-Prevention of Aero-elastic instabilities- Influence and stiffness coefficients-History of Aero-elasticity- Introduction to Unsteady Aerodynamics and Loads, introduction of elasticity to be introduced


Unit III - Static Aero-elasticity: Effect of Wing Flexibility on Lift Distribution and Divergence- Static aero-elastic behaviour of a two-dimensional rigid airfoil with spring attachment- Static aero-elastic behaviour of a fixed root flexible wing- Effect of trim on static aero-elastic behaviour- Effect of wing sweep on static aero-elastic behaviour

Unit IV - Dynamic Aero-elasticity-Flutter: General form of the aero-elastic equations- Simplified unsteady aerodynamic model- Aero-elastic behaviour of the binary model - Eigen value solution of flutter equations - Aero-elastic behaviour of a flexible wing- Aero-elastic behaviour of a multiple mode system- Flutter speed prediction for binary systems.

Unit V - Dynamic Aero-elasticity-Gust: Introduction to Gust - General form of equations in the time domain - Rigid aircraft in heave/pitch Motion- Frequency domain turbulence response – General form of equations in the frequency domain

Text Book

References:

Credits: 3:0:0

17AE2040 ANALYTICS FOR AEROSPACE ENGINEERS

Course Objectives:
- To impart knowledge on various operations research techniques to ensure the effective utilization of resources
- To understand network models for project planning and scheduling
- To obtain knowledge on Quality Management Systems

Course Outcome:
Students will be able to
- Understand the importance of customer satisfaction and motivation
- Distinguish the roles of a manager and customer
- Apply mathematical models for physical problems to find optimal Solutions
- Design network models for project planning, scheduling and project management
- Understand the principles of quality management
- Apply Quality management concepts in product/service industry to the end users


Unit III - Analysis Models: Network analysis: Project Networks – Critical Path Method – Project Evaluation and Review technique - Queuing Models, Decision Models

Unit IV - Quality Management: Quality Planning – Quality Costs, Total Quality Management (TQM) – Deming’s Philosophy – Quality Function Deployment – Procedures and Benefits

Unit V - Benchmarking: Procedures and Benefits Statistical Methods: Introduction to Seven tools of quality Six Sigma Concepts.

Text Books:

References:

17AE2041 ADVANCED SPACE DYNAMICS

Credits: 3:0:0
Pre-requisites: 17AE2022 - Space Dynamics

Course Objective:
- To impart the knowledge related to the basics of celestial mechanics,
- To impart the knowledge of orbital transfers
- To impart the knowledge related to the orbits in restricted three-body problem

Course Outcome:
Students will be able to
- Understand two-body orbital motion
- Gain knowledge of orbital transfer technique
- Understand the concept of dynamical systems
- Understand orbital motion in restricted three-body problem
- Attain knowledge of equilibrium points and its uses
- Gain knowledge of orbits in 3-dimensional restricted three-body problem

Unit I - Fundamental principles and definitions: Two-body problem: Central orbits, Derivation of equation of motion, Derivation of Lambert’s theorem.

Unit II - Restricted three-body problem (RTBP): Planar circular restricted three-body problem - Equations of motion in sidereal and synodic coordinate systems, Derivation of Jacobi integral, Tisserand’s criterion for the identification of comets.

Unit III - Solutions in RTBP: Totality of solutions; Concept of phase space; Manifold of the states of motion and their singularities; Computation of location of collinear and equilateral points.

Unit IV - Orbital motion in RTBP: Motion near the equilibrium points, derivation of variational equations, Characteristic equation, Motion around the collinear and equilateral points, Critical mass.

Unit V - 3-dimensional RTBP: Three-dimensional restricted three-body problem, Motion around the equilibrium points, Halo orbits, Lissajous orbits, Hill's problem.

Textbooks:
17AE2042 AIR TRAFFIC CONTROL AND AERODROME DETAILS

Credits: 3:0:0

Course objective:
- To impart the knowledge on the scope and purpose of Air traffic services.
- To inculcate the importance of radar services in air traffic control.
- To impart the knowledge in procedure of the formation of aerodrome and its design and air traffic control.

Course outcome:
Students will be able to
- Understand the basic concepts of ATS and its services.
- Identify the flight operations between different altitudes.
- Know the working routines of radar services
- Appreciate the concepts of Aerodrome layouts and its design.
- Differentiate the runway restrictions and limitations.
- Apprehend the various approach and guidance systems.

Unit I - Air Traffic Services:
Objectives of ATS - Parts of ATC service – Scope and Provision of ATCs – VFR & IFR operations – Classification of ATS air spaces – Varies kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control.

Unit II - Area control service:
Assignment of cruising levels minimum flight altitude ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance – ATC clearances – Flight plans – position report

Unit III - Radar services and control:

Unit IV - Aerodrome Details:

Unit V - Visual Aids:
Visual aids for navigation Wind direction indicator – Landing direction indicator – Location and characteristics of signal area – Markings, general requirements – Various markings – Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.

Text Books:

References
Course Objectives:
- To provide the knowledge in various processes involved in non-destructive testing
- To get trained in locating discontinuities
- To impart knowledge in NDT application in Aerospace maintenance field

Course Outcome:
Students will be able to
- Understand various types of discontinuities
- Knowledge in non-destructive testing, its scope and purpose
- Understand the different NDT processes
- Evaluate the properties of material without causing damage
- Learn dynamic behavior of defect with NDT tools
- Choose the best NDT method for different application


Unit III - Radiography: Electromagnetic Radiation Sources, Radiation attenuation in the specimen, Effect of radiation on film, Radiographic Imaging, Inspection Techniques in Radiography, Applications and limitations.


Unit V - Thermography: History and development, theory and basic principles, Detectors and Equipment, Techniques, Variables, Evaluation of test results and reports, Applications-electronics industry, aerospace applications and electrical applications, advantages and limitations, Standards.

Text Books:

References:
• Estimate the high temperature effects in hypersonic aerodynamics
• Assess the design issues for hypersonic wings
• Apply the computational tools to evaluate hypersonic flows
• Distinguish the high Mach number flow from the supersonic flows
• Estimate flow parameters over a vehicle under hypersonic conditions


Unit II - Inviscid hypersonic flows

Unit III - Hypersonic inviscid flow field: Approximate Methods for inviscid hypersonic flows, Mach number independence Principle, Hypersonic slender body theory for all angle of attack, hypersonic similarity laws, Thin Shock layer theory.

Unit IV - Viscous hypersonic flows: Viscous hypersonic flows-Boundary layer Equations, Navier-Stokes equations, Similarity Parameters, Boundary Conditions, Hypersonic Boundary Layer Theory, Self-similar Solution – Flat Plate and Stagnation Point, Non-similar Boundary Layer, Local similarity Method, Hypersonic Transition, Turbulent Boundary layer.

Unit V - Aerodynamic heating and viscous-inviscid interaction: Turbulent boundary layer, Hypersonic Aerodynamic Heating, axisymmetric analogue for three dimensional bodies, hypersonic viscous interactions.

Text Books:

Reference Books:

17AE2045 AIRCRAFT SYSTEMS

Credits: 3:0:0

Course Objective:
• To impart knowledge on different aircraft systems
• To impart knowledge on aircraft environmental and flight conditions
• To impart knowledge on different aircraft systems inspection and maintenance

Course Outcome:
• Ability to understand the working of hydraulic and pneumatic systems in aircrafts
• Ability to understand the concept of landing gear and braking systems in aircrafts
• Ability to understand the environmental control systems inside the aircraft
• Ability to characterize the different engine systems and their functioning
• Ability to understand and gain knowledge about fuel systems
• Ability to inspect and maintain different parts in an aircraft system


Text Books:

References:

17AE2046 THEORY OF VIBRATION

Credits: 3:0:0

Course Objective:
- To impart knowledge on mathematical modeling of a vibratory system and find the response
- To impart skills in analyzing the vibration behavior of mechanical systems under different types of loading.
- To impart knowledge about the methods of reducing unwanted vibration

Course Outcome:
Students will be able to
- Classify vibration systems and derive equations of motion from free -body diagrams.
- Solve vibration problems with multi degrees of freedom.
- Identify modes of a system and compute its natural frequencies.
- Propose solutions to reduce vibration using Isolation
- Identify instruments used in noise and vibration control tests
- Understand the Damping Concepts


Unit II - Multi degrees of freedom systems: Two degrees of freedom systems - static and dynamic couplings - vibration absorber- principal coordinates - principal modes and orthogonal conditions - eigen value problems - hamilton’s principle - lagrangean equations and application

Unit III - Continuous systems: Vibration of elastic bodies - vibration of strings – longitudinal, lateral and torsional vibrations

Unit IV - Approximate methods: Approximate methods - Rayleigh’s method - Dunkerlay’s method – Rayleigh-ritz method, matrix iteration method

Unit V - Damping: Vibration isolation- Structural vibration limits - Vibration intensity- Vibration velocity - Structural damage - Effects of damping on vibration response of structures - The measurement of structural damping - Sources of damping- Inherent damping – Added Active damping systems - Energy dissipation in non-linear structures
Text Books:

References:
3. Thomson, W.T., "Theory of Vibration with Applications” CBS Publishers and Distributers, NewDelhi,2002

17AE2047 BASICS OF AEROSPACE ENGINEERING
(University)- This course is offered to other dept/school students

Credits: 3:0:0

Course Objective:
- To introduce the basic concepts of aircrafts, rockets, satellites and their development
- To impart knowledge about the basic parts and their function and construction
- To know the basics of propulsion and application of rockets

Course Outcome:
Students will be able to
- Understand the evolution of aircrafts and flying vehicles
- Understand the parts and function of aircrafts
- Obtain knowledge on principles of flight
- Understand the fundamentals of structures and materials used
- Understand the principles of aircraft and rocket propulsion
- Obtain knowledge on the engines used in aircraft propulsion

Unit I - Introduction: Historical evolution; Developments in aerodynamics, materials, structures and propulsion over the years.
Unit II - Mechanics of Flight: Principles of flight - Components of an airplane and their functions; Different types of flight vehicles, classifications; Basic instruments for flying
Unit III - Aerodynamics- Evolution of lift, drag and moment; altitude and standard atmosphere – Airfoil and nomenclature – Basic aerodynamics
Unit IV - Aircraft Structures: General types of Aircraft construction, Fuselage and Wing Structure; Aerospace materials, metallic and non-metallic materials;
Unit V - Propulsion: Basic ideas about piston, turboprop and jet engines, Basic Propeller theory; Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

Text Book:

References:
2. Course material of Faculty Enablement Programme on “Introduction to Aircraft Industry”, conducted by Infosys, Mysore through Campus connect programme.

17AE3001 VIBRATION AND AERO-ELASTICITY

Credits: 3:0:0

Course Objective:
- To impart knowledge on mathematical modeling of a vibratory system and find the response
- To impart skills in analyzing the vibration behavior of mechanical systems under different types of loading.
- To impart knowledge about the methods of reducing unwanted vibration

Course Outcome:
Students will be able to
- Classify vibration systems and derive equations of motion from free -body diagrams.
• Solve vibration problems with multi degrees of freedom.
• Identify modes of a system and compute its natural frequencies.
• Propose solutions to reduce vibration using Isolation
• Identify instruments used in noise and vibration control tests
• Understand the Damping Concepts


Unit II - Multi degrees of freedom systems: Two degrees of freedom systems - static and dynamic couplings - vibration absorber- principal coordinates - principal modes and orthogonal conditions - eigen value problems - Hamilton’s principle - Lagrangean equations and application


Unit IV - Damping: Vibration isolation- Structural vibration limits - Vibration intensity- Vibration velocity - Structural damage - Effects of damping on vibration response of structures - The measurement of structural damping - Sources of damping- Inherent damping – Added Active damping systems - Energy dissipation in non-linear structures.

Unit V - Elements of Aero-elasticity: Concepts – Coupling – Aero elastic instabilities and their prevention – Collar’s Triangle- Basic ideas on wing divergence, loss and reversal of aileron control- Flutter and its prevention.

References:
2. V.P Singh “Mechanical Vibrations” DHANPAT RAI & CO,2016

17AE3002 ADVANCED AERODYNAMICS

Credits: 3:0:0

Course Objective:
• To familiarize student with the airfoils and wings and the flow over them
• To impart knowledge of compressibility effects over an aerofoil and finite wings
• To provide knowledge of high temperature effects over an hypersonic wings

Course Outcome:
Students will be able to
• Understand the flow behaviour over various body shapes
• Assess the forces and moments due to flow
• Apply the compressibility corrections for flow in C-D passages and instrument like Pitot static tube
• Assess the nature of compressible flow over airfoils and finite wings
• Solve the problems involving in-viscid and viscous hypersonic flows
• Use the computational tools to evaluate hypersonic flows

Unit I - Incompressible Flow: Aerodynamic forces and moments. Centre of pressure. Rotation, deformation, vortex theorems, and Conservation laws: integral and differential formulations- mass, momentum and energy equation,


Unit III - Introduction to Compressible Flow: Compressibility, Velocity of sound, Concept of Mach Number, Isentropic relations, Flow through converging-diverging passages, Performance under various back pressures, corrections of Pitot static tube for subsonic and supersonic Mach numbers


References:
2. Rathakrishnan, E, Theoretical Aerodynamics, John Wiley & Sons, 2013

17AE3003 ADVANCED AERODYNAMICS LABORATORY

Credits: 3:0:0

Course Objective:
- To impart knowledge of basics of subsonic and supersonic flow over the model
- To impart knowledge of forces and moments over an aerofoil
- To impart knowledge of basics of
- To impart knowledge of shock wave over various model

Course Outcome:
Students will be able to
- Understand the aerodynamic variable connected with airflow
- Estimate lift and drag of various stream line and bluff bodies
- Visualize subsonic flow over various model
- Calibration of supersonic wind tunnel
- Visualize shock wave and Estimate shock angle over various model
- Effect of back pressure in C-D nozzle

List of Experiments:
1. Velocity distribution at three transverse locations of the test section of subsonic wind tunnel.
2. Estimation of the Lift and drag of symmetric and cambered aerofoil using pressure measurements.
3. The pressure distribution over a cascade aerofoil.
4. Force and moment measurements of aircraft model by using strain gauge balance.
5. Boundary layer measurements on an airfoil around flow separation region.
6. Flow visualisation of multi-storey building simulating the earth boundary layer in subsonic wind tunnel.
7. Smoke flow visualization over a car.
9. Study of starting process of supersonic wind tunnel.
10. Flow visualisation using oil flow, Schlieren and shadowgraph technique.
11. Study of Mach disc formation in the conical nozzle flow exhaust.
12. Flow separation studies in an over expanded nozzle.
13. Jet pluming study using high altitude jet facility.
14. Multiple jet interaction studies
15. Background noise study in supersonic tunnel.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of the semester.
17AE3004 AEROSPACE PROPULSION

Credits: 3:0:0
Course Objective:
- To impart knowledge on working principles, operation and performance of Gas Turbine Engine (GTE),
- To impart knowledge on characteristics of GTE modules and its matching
- To impart knowledge on Ramjet, Scramjet and Rocket engines

Course Outcome:
Students will be able to
- Assess the performance of engine for aerospace application
- Evaluate GTE performance at component and system level
- Design the inlets for aircraft engines.
- Analyze the combustion chamber related issues
- Evaluate different rocket engines.
- Analyze the performance of space thrusters

Unit I - Elements of aircraft propulsion: Classification of power plants- Method of aircraft propulsion- Propulsive efficiency- Specific Fuel consumption- Thrust and power- Factors affecting thrust and power- Illustration of work cycle of gas turbine engine- Characteristics of turboprop, turbofan and turbojet, Ramjet working principle, use of ramjet in missiles.


Unit IV - Inlets: Subsonic and Supersonic inlets- Relation between minimum area ratio and external deceleration ratio- Starting problem in supersonic inlets- Performance and characteristics- Modes of inlet operation.

Unit V - Nozzle: Jet nozzle- Efficiencies- Over expanded, under expanded and optimum expansion in nozzles- Thrust Reversals- Off design operation and matching of various GTE. Introduction to High Altitude test facility - working principle – Introduction to open Jet facility and its working Principle.

References:

17AE3005 AEROSPACE PROPULSION LABORATORY

Credit: 0:0:2
Course Objective:
- To introduce the concept of systems of rocket motors
- To assess the performance of air-breathing engines
- To impart knowledge on various engine component

Course Outcome:
Students will be able to
• Design the experiment for rocket motor performance.
• Assess the real life situation and corrective measures associated with rocket motors.
• Analyze the working of different parts of aircraft engine.
• Get knowledge in combustion
• Identify suitable fuel injector
• Calculate of convective heat transfer coefficient for real time application.

List of Experiments:
1. Shock velocity measurement using a shock tube.
2. Ignition Delay studies in shock tube.
3. Heat transfer measurement in shock tube.
4. Blast pressure measurement in shock tube.
5. Injector Performance study.
7. Cooling requirement studies for a Rocket exhaust over a ‘J’ type jet deflector.
8. Ramjet engine testing of a scaled engine.
10. Estimation of convective heat transfer of the fluid with and without additives.
11. Cascade testing of a model for axial compressor blade row (symmetrical)
12. Cascade testing of a model for axial compressor blade row(cambered)
15. Thrust measurements of propeller

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of the semester

17AE3006 ADVANCED COMPUTATIONAL FLUID DYNAMICS

Credits: 3:0:0

Course Objective:
• To provide knowledge on governing equations of fluid dynamics
• To provide an understanding of the solution methodologies of discretised equations,
• To impart knowledge of turbulence and combustion models and its behaviour.

Course Outcome:
Students will be able to
• Understand the governing equations for fluid flow and its classification
• Knowledge about turbulent behaviour of flow and methods to accounts for it
• Attain the numerical simulation of PDE and its applications to thermal problems
• Apply the numerical procedure for convection – diffusion problems
• Knowledge of performing CFD Analysis
• Apply the boundary conditions and solve CFD problems using turbulence and combustion models

Unit I - Governing Equations: Governing equations of fluid flow and heat transfer, Navier-Stoke’s equations, Conservative, differential and integral form of transport equations; Classifications of PDEs and Numerical methods for different PDEs.


Unit III - Solution Methodology: Introduction, TDMA, application of TDMA, point iterating method- Jacobi, Gauss Seidel, Relaxation Methods, Multi-grid Techniques-Multigrid procedure with examples, multi grid cycles.


References:

17AE3007 COMPUTATIONAL HEAT TRANSFER

Credits: 3:0:0

Course Objective:
- To understand the different solution methods of heat transfer under steady and transient conditions.
- To understand the concepts of computational heat transfer through extended surfaces.
- To learn the heat transfer analysis in practical applications of heat transfer.

Course Outcome:
Students will be able to
- Know the mathematical concepts of computational heat transfer
- Know the different applications of heat transfer
- Understand the different computational methods of heat transfer
- Understand the heat transfer methods in FDM and FEM
- Apply the computational heat transfer methods in practical applications
- Analyse the real time problems of heat transfer in aerospace applications
- Understand the working of various sensors and instruments for thermal measurements.


References:

17AE3008 ADVANCED COMPUTATIONAL FLUID DYNAMICS LABORATORY

Credits: 0:0:1

Course Objective:
- To familiarize the students with the working of CFD codes.
- To familiarize the students with actual setting up of the problem and solution procedure.
- To extract the required data, post process and compare with available data.

Course Outcome:
Student will be able to
- Define the body shape in a CFD code
- Understand the solution domain and grid generation.
- Apply boundary conditions and generate the solution.
- Validate the aerodynamic quantities from computed data.
- Perform CFD Analysis over 2D and 3D objects.
- Solve problems using turbulence models.

List of Experiments:
1. Flow past over a flat plate at M=0.1, α = 0° and 10°
2. Supersonic Flow over a flat plate
3. Flow Over an Airfoil
4. Flow simulation over ONERA M6 wing.
5. Flow analysis of gaseous combustion
6. Flow with thermal boundary layer.
7. Coding-One Dimensional flow in duct

14AE3009 FLIGHT PERFORMANCE AND DYNAMICS

Credits: 3:0:0

Course Objective:
- To introduce the parameters effecting the Flight performance
- To impart knowledge about the concept of Stability and control of Aircraft
- To introduce with the concept of dynamic stability of Aircraft

Course Outcome:
Students will be able to
- Understand the preliminary performance estimation
- understand the performance characteristics in level Flight
- perform the Static longitudinal analysis in the stability of aircraft
- perform the Static lateral & Directional analysis in the stability of aircraft
- perform the Static longitudinal analysis in the stability of aircraft
- identify the Aircraft response to control

Unit I - Performance Characteristics in Level Flights: Assumptions for Aircraft Performance - Drag Components- Drag Polar, Performance characteristics of aircraft steady level flight- Maximum speed- Range and Endurance - Breguet formula: Rate of Climb- Maximum Climb Angle - Maximum Rate of Climb Velocity- Angle of climb; Gliding Flight - Turn flight; V - n diagram.

Unit II - Static Longitudinal Stability: Degrees of Freedom of a system; Static Longitudinal Stability- Basic equations of equilibrium- Stability criterion: Stick fixed Longitudinal Stability- Wing and tail contribution; Effects of Fuselage and nacelles-Power effects- Neutral Point- Elevator hinge moment; Stick Free Longitudinal Stability – Neutral point and Static Margin; Stick Force gradients and Stick force.

Unit III - Static Lateral and Directional Stability: Static Lateral Stability – Basic equations of equilibrium- Stability criterion Contribution of wing –Fuselage –Vertical tail; Dihedral Effect; Roll Control- Rolling moment due to aileron- Damping moment -Rate of roll achieved-Aileron reversal-Aerodynamic Balance; Static Directional Stability – Basic equations of equilibrium- Stability criterion - Contribution of wing –Fuselage –Vertical tail-
Propeller - Weather cocking Effect, Rudder Requirements, One engine In-operative Conditions, Rudder Lock-Problems

**Unit IV - Dynamic Longitudinal Stability:** Dynamic Longitudinal Stability – Equations of motion, stability Derivatives, Routh’s discriminant; Phugoid Motion and short term Motions Dutch roll and Spiral instability, Auto rotation and Spin-Problems.

**Unit V - Aircraft Response to Control:** Introduction - Equation of motion in a Non uniform atmosphere - Pure vertical/Plunging motion, Atmospheric turbulence, Harmonic analysis - Turbulence models, Wind shear - Problems.

**References:**

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**Credits: 3:0:0**

**Course Objective:**
- To impart the knowledge on the structural behavior of aircraft components under different types of loads
- To provide the understanding in structural Analysis methods for aerospace vehicles
- To impart the knowledge stress distribution various section of aerospace component.

**Course Outcome:**
Students will be able to
- Get knowledge in various methods of analysis of aerospace structural members.
- Analyze the buckling property of plates and to predict the failure stress
- Understand the basic structural members of an Aircraft and launch vehicle.
- Predict the shear flow, and shear center in various open and close section of Aircraft structures
- Solve stress problem in aircraft components
- Design the Aircraft composite panel for Aerospace structure.

**Unit I - Virtual work & Matrix methods:** Principle of virtual work - Applications of the principle of virtual work. Energy methods - Unit load method. Flexibility method, Total potential energy, the principle of the stationary value of the total potential energy, Principle of superposition, the reciprocal theorem, Temperature effects. Matrix methods - Stiffness matrix for an elastic spring - Stiffness matrix for two elastic springs in line - Matrix analysis of pin-jointed frameworks - Application to statically indeterminate frameworks - Matrix analysis of space frames - Stiffness matrix for a uniform beam Finite element method for continuum structures.

**Unit II - Buckling of thin plates:** Inelastic buckling of plates - Experimental determination of critical load for a flat plate - Local instability - Instability of stiffened panels - Failure stress in plates and stiffened panels - Tension field beams.

**Unit III - Bending, Shear and Torsion of Thin-Walled Beams** - Bending of open and closed, thin-walled beams – Symmetrical and Unsymmetrical bending. Shear of beams - General stress, strain and displacement relationships for open and single cell closed section thin-walled beams - Shear of open section beams and closed section beams. Torsion of beams - Torsion of closed and open section beams. Structural idealization-Principle of Idealization of a panel - Effect of idealization on the analysis of open and closed section beams - Deflection of open and closed section beams.

**Unit IV - Stress Analysis of Aircraft Components** - Wing spars and box beams- Tapered wing spar- Open and closed section beams-Beams having variable stringer areas. Fuselages - Bending - Shear-Torsion - Cut-outs in fuselages. Wings-Three-boom shell – Bending-Torsion - Shear - Shear center - Tapered wings - Deflections - Cut-outs in wings. Fuselage frames and wing ribs - Principles of stiffener/web construction - Fuselage frames - Wing ribs.
Unit V - Composite Materials: Laminated composite structures - Elastic constants of a simple lamina - Stress–strain relationships for an orthotropic ply (macro- approach) - Thin-walled composite beams.

References:

17AE3011 AEROSPACE STRUCTURE AND COMPOSITE LABORATORY

Credits: 0:0:2
Co-requisite: 17AE3010 - Aerospace Structural Analysis

Course Objective:
- To provide the basic knowledge on the testing equipment for various structural components.
- To impart the practical exposure with the measuring equipment and sensors.
- To impart the practical exposure with composite material manufacturing

Course Outcome:
Students will be able to
- Select test equipment for different types of static loading.
- Conduct tests, analyse results, document and compare with analytical/theoretical results
- Assess different types of structural failures
- Make Composite material and Laminate
- Choose strain gauge for different application and get knowledge in strain gauge installation.
- Understand the stress distribution with respect to different cross-section shape and loading condition

List of Experiments:
1. Compression test on columns, critical buckling loads – Southwell plot.
2. Unsymmetrical bending of beams-Z section.
3. Determination of the natural frequency of vibrations of a cantilever beam
4. Shear centre location for open sections
5. Bending of beam with and without shear.
6. Torsion of a thin walled tube having various closed cross section at the ends
7. Structural behaviour of a semi tension field beam (Wagner Beam)
8. Using photo elastic techniques: Calibration of circular disc in compression to find the fringe value and Determination of stress concentration factor due to compression in circular ring
9. Composite material Manufacturing and Testing- Tensile and Three point bending
10. Strain Gauge Calibration
11. Thin wall cylinder - Hoop Stress Analysis
12. Brittle Lacquer Method

17AE3012 ADVANCED AVIONICS

Credits: 3:0:0

Course Objective:
- To impart the understanding in basic principles, theory and operation of flight instruments and modern avionics systems
- To familiarize the student with the concepts of guidance and control of an aircraft and to provide the necessary mathematical knowledge that are needed in modeling the guidance and control methods.
- To familiarize the student with the advanced concepts of remote sensing and image processing for aerospace applications.

Course Outcome:
Students will be able to
- Understand the theory of transmission and reception of radio waves and functioning of radar systems.
• Understand the various approach guidance systems.
• Understand the advanced guidance and navigation systems.
• Design autopilots and missile guidance systems and ability to deploy these skills effectively in the design of control of aerospace systems.
• Appreciate the operation of various navigational systems used in the history of aviation
• Apprehend vision based navigation and control and modeling physical process.


Unit III - Inertial systems. Inertial guidance systems, Inertial navigation systems, Avionics system requirements, EFIS, Autopilot flight detector system, Flight management systems, Flight data and cockpit voice recorder


Unit V - Autopilot and other applications. Longitudinal Autopilot, Lateral Autopilot, Fundamentals of UAV, Electronic warfare. Case studies - vision based navigation and control.

References:

17AE3013 AIRCRAFT MODELING LABORATORY

Credits: 0:0:1

Course Objective:
• To train the students with CAD packages like Solid Works.
• To impart the 2D and 3D modeling skills to the students.
• To enable Students to design different parts of Aircraft.

Course Outcome:
Students will be able to
• Understand the construction of various parts of wing and fuselage
• Create solid model of different types of structural components
• Create surface model of different types of structural components
• Create sheet metal model of different types of structural components
• Design and assemble different parts of propeller
• Assemble different parts of aircraft

List of Experiments:
1. Part modelling of internal structural components - wing/fuselage.
3. Surface modeling of airframe
4. Assembly of components, joints and airframe.
5. Modeling of propeller blade(Propeller/Helicopter)
7. Assembly of hub and propeller blade.
17AE3014 ADVANCED INSTRUMENTATION AND AVIONICS LABORATORY

Credit: 0:0:1

Course Objective:
- To impart the knowledge about different types of Instruments and control systems
- To train students to measure parameters accurately and their importance in different applications in the field of Avionics
- To provide a complete knowledge on navigation systems like GPS.

Course Outcome:
Students will be able to
- Familiarize Matlab and LabVIEW programming.
- Understand the applications of these fundamental measurement systems.
- Understand the enormous amount of pressure that is put on this simple instrumentation in real time applications.
- Work with the avionics systems on an aircraft
- Understand the design concept of new control systems
- Familiarize with methods of troubleshoot and rectification of faulty instruments.

List of Experiments:
1. Matlab programming of displacement autopilot for a jet airplane.
2. Matlab programming of lateral autopilot for an airplane.
3. Matlab programming of missile autopilot.
5. LabVIEW Programming of Measurement of Air velocity using Hot wire Anemometer
7. LabVIEW Programming of Temperature measurement using thermocouple.
8. LabVIEW Programming of Temperature measurement using RTD.
10. LabVIEW Programming of Aircraft data bus communication.

17AE3015 ORBITAL SPACE DYNAMICS

Credits: 3:0:0

Course Objective:
- To impart the knowledge in two-body problem
- To impart the knowledge in restricted three-body problem
- To provide necessary knowledge to compute the orbits of satellites and interplanetary trajectories.

Course outcome:
Students will be able to
- Apply laws governing the orbital motion
- Compute the orbits of the satellites
- Study the effects of perturbations on the orbital motion
- Generate preliminary design of inter-planetary trajectories
- Understand orbital motion in restricted three-body problem
- Use knowledge of equilibrium points and its uses

Unit I - Fundamental principles: Kepler's laws, Problem of two bodies - Derivation of equation of motion, Solution of Kepler’s equation, Computation of orbital elements from state vectors.

Unit II - Orbit perturbations: Force model, Perturbations - Oblateness, Computation of Sun-synchronous orbit, Special perturbation techniques: Cowell’s and Encke’s method.

Unit III - Orbital maneuvers: Single impulse Maneuvers, Hohmann transfer, Sphere of influence, Derivation of Lambert’s theorem.


Unit V - Motion in restricted three-body problem: Location of equilibrium points, Characteristic equation, Motion near the collinear and the equilateral points.
References:

17AE3016 BOUNDARY LAYER THEORY

Credits 3:0:0

Course Objective:
- To introduce the concept of boundary layers and its applications
- To familiarize the students with viscous flow phenomena.
- To impart knowledge on laminar and thermal boundary layer equations

Course outcome:
Students will be able to
- Define the fundamentals Boundary layer theory
- Solve the equations involved in boundary layer theory
- Analyze the different kinds of Boundary Layer control
- Differentiate between the turbulent and laminar boundary layers
- Estimate the boundary layer thickness for flow over a different body
- Attain the knowledge of boundary layer effects in hypersonic flows

Unit I - Fundamentals of boundary layer theory: Boundary layer concept-Laminar and Turbulent boundary layer on a flat plate, Boundary layer on an airfoil-separation of the boundary layer. Description of Flow fields, continuity, Momentum and Navier-Stokes equations. Energy equation, Stokes Hypothesis.


Unit III - Laminar boundary layer equations: Boundary Layer equations, Wall friction, separation and displacement. Dimensional representation of the boundary layer equations, friction drag, Plate boundary layer. Integral relations of boundary layer-Momentum Integral equation, Energy Integral equation, Moment of Momentum Integral equations

Unit IV - Thermal boundary layer: Thermal boundary layers with coupling of the velocity field of the temperature field-Boundary layer equations. Compressible Boundary layers- Simple solutions of energy equation, Integral methods, Boundary layers in Hypersonic flows

Unit V - Boundary layer control: Different Kinds of Boundary Layer control, Continuous suction and blowing-Massive suction, Massive Blowing, Plate flow with uniform suction or blowing, Airfoil. Three –Dimensional boundary layers-boundary layer at cylinder, Boundary layer at a yawing cylinder.

References:-
1. Schlichting, Herrmann, Gersten, Klaus Translated by Mayes-“Boundary Layer Theory” 8th rev. and enlarged ed, 2000

**17AE3017 THEORY OF ELASTICITY**

Credits: 3:0:0

Course Objective:
- To impart an understanding of the basic concepts of stress, strain, displacement and transformations
- To provide the in-depth knowledge in formulating stress and strain equations
- To solve two-dimensional elasticity problems

Course Outcome:
Students will be able to
- Understand the elastic properties of solids
- Get the knowledge in various elasticity theory
- Formulate the governing equations of elastic behaviour for real problem
- Calculate the stresses in simplified form
- Constitute elasticity equations in polar form to solve axisymmetric problems
- Predict stress distribution of various section due to torsional load

Unit I - Assumptions in elasticity: Definitions- notations and sign conventions for stress and strain, Components of stress and strain, Hooke’s law, Plane stress and Plane strain, Equations of equilibrium.

Unit II - Basic equations of elasticity: Strain – displacement relations, Stress – strain relations, Lame’s constant – cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for strains, Principal stresses and principal strains, Mohr’s circle, Saint Venant’s principle.

Unit III - 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, etc.

Unit IV - Polar coordinates: Equations of equilibrium, Strain displacement relations, Stress – strain relations, Axi – symmetric problems, Kirsch, Michell’s and Boussinesque problems.

Unit V - Torsion: Navier’s theory, St. Venant’s theory, Prandtl’s theory on torsion, The semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

References:

**17AE3018 AIRCRAFT DESIGN**

Credits: 3:0:0

Course Objective:
- To impart knowledge about inputs required for Aircraft design
- To introduce methodology for aerodynamic design of aircraft
- To introduce power plant selection to meet performance requirements
- To introduce the methodology for structural design of aircraft

Course Outcome:
Students will be able to:
- Design an aircraft/Spacecraft with given configuration
- Estimate the design parameters required for its better performance
- Understand the design requirements of the Aircraft
- Analyze the weight estimation characteristics
- Understand the configuration of fuselage structures

Aerospace Engineering
• Analyze the Materials selection for the Aircraft Components


Unit II - Power Plants Selection: Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant.

Unit III - Aerodynamic Parameter Estimation: Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram, Aerofoil and Wing Selection.

Unit IV - Performance and Stability Calculation: Drag estimation of complete aircraft – Level flight, climb, takeoff and landing calculations – range and endurance – static and dynamic stability estimates – control requirements. Layout peculiarities of subsonic and supersonic aircrafts – optimization of wing loading to achieve desired performance, loads on undercarriages and design requirements.

Unit V - Structural Design: Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints, Materials for modern aircraft – Methods of analysis, testing and fabrication.

References:

17AE3019 ROCKETS AND MISSILES

Credits: 3:0:0

Course Objective:
• To impart the knowledge on rocket and missile aerodynamics
• To impart the knowledge on rocket and missile in free space and gravitational field
• To impart the knowledge on staging & control of rockets

Course Outcome:
Students will be able to
• Discuss types of rockets and missiles with respect to Indian & international scenario
• Understand aerodynamics of rocket and missiles
• Design the basic staging of rockets and missiles
• Estimate the rocket motion in free space and gravitational field
• Understand the control of rockets missiles
• Design the basic launch vehicle

Unit I - Classification of rockets and missiles: Various methods of classification of missiles and rockets – Basic aerodynamic characteristics of surface to surface, surface to air, air to surface and air to air missiles – Examples of various Indian space launch vehicles and missiles – Current status of Indian rocket programme with respect to international scenario.


Unit III - 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 determine burn out velocity and altitude – estimation of culmination time and altitude.
Unit IV - Staging of rockets and missiles: Design philosophy behind multi-staging of launch vehicles and ballistic missiles – optimization of multi-stage vehicles – stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics.

Unit V - Control of rockets and missiles: Introduction to aerodynamic and jet control methods – various types of aerodynamic control methods for tactical and short range missiles- aerodynamic characteristics - various types of thrust vector control methods including secondary injection thrust vector control for launch vehicles and ballistic missiles.

References

17AE3020 UNMANNED AERIAL SYSTEMS

Credits: 3:0:0

Course Objective:
- To incorporate awareness about the basic terminology, models and prototypes of UAV system
- To impart the knowledge on design considerations of UAV systems
- To be able to design a UAV system for specific requirements

Course Outcome:
Students should be able to:
- Understand the basic terminologies and classification of UAS
- Relate the design parameters of UAV systems
- Obtain knowledge on the application of aerodynamic principles to design UAS
- Understand the principles of communication systems used in UAVs
- Obtain knowledge on payloads and launch systems for UAS
- Apply the principles to design UAS for specific applications


Unit II - Design of UAV Systems : Design and selection of UAS – Aerodynamics and airframe configurations – Aspects of airframe design - Unmanned Aircraft characteristics – Long range, Medium and Close range UAVs – Mini, Micro and Nano UAVs – Novel hybrid combinations

Unit III - UAV Standards : Unmanned Design standards and Regulatory aspects – Airframe design – Ancillary equipment – Design of Stealth

Unit IV - UAV Payloads : Sensors and payloads – payload types – Communications, Control and stability, Navigation – Launch and recovery

Unit V - UAV Testing : Certification and ground testing – inflight testing - Human factors in UAS – Future of UAS and challenges

References:
17AE3021 FINITE ELEMENT ANALYSIS AND PROGRAMMING

Credits: 3:0:0

Course Objective:
- To impart the basic concept of finite element Analysis (FEA)
- To provide the knowledge on various finite element procedures and solution techniques
- To impart the basic knowledge in FEA programming for Aerospace structural problems

Course Outcome:
Students will be able to
- Understand the different numerical solution to the FEA Problems
- Analyse the discrete and continuum problem using finite element method
- Identify the boundary condition for various aerospace structural problems.
- Program the various type of elements to solve different type of problems
- Solve the one dimension, Two dimensional and Three dimensional problems
- Find the solution for various complex problem in aerospace structures

Unit I - Approximation Techniques in Finite Element Analysis (FEA):
History and Stages of Finite Element Method, Approximation Techniques in FEA: Methods of Weighted Residual, Weak Formulation, Piecewise Continuous Trial Function, Galerkin”s Finite Element Formulation, Variational Method, Rayleigh-Ritz Method; MATLAB/SCI-LAB programming- Application to Approximation Techniques.

Unit II - Two-Dimensional and Isoparametric Elements:
Governing Equation, Linear Triangular Element, Bilinear Rectangular Element, Boundary Integral, Axisymmetric Analysis. Application to 2-D Steady State Analysis, Axisymmetric Analysis and Transient Analysis, One-Dimensional Elements, Quadrilateral Elements, Triangular Elements, Gauss Quadrature, MATLAB/SCI-LAB programming- Application to Gauss Quadrature.

Unit III - Truss and Beam Structures:
One-Dimensional Truss, Plane Truss, Space Truss, MATLAB Application to Static Analysis, Eigen Value Analysis and Transient Analysis. Euler-Bernoulli Beam, Beam Elements with only displacement degrees of freedom, MATLAB/SCI-LAB programming- Application to Static Analysis, Eigenvalue Analysis and Transient Analysis.

Unit IV - Elasticity Problems:

Unit V - Plate Structures:
Classical Plate Theory, Classical Plate Bending Elements, Shear Deformable Plate Element, Plate Element with Displacement Degrees of Freedom, Mixed Plate Element, Hybrid Plate Element , MATLAB/SCI-LAB programming- Application.

References:
17AE3022 ELEMENTS OF AEROSPACE ENGINEERING

Credits: 3:0:0

Course Objectives:
- To introduce the basic concepts of aircrafts, rockets, satellites and their application
- To familiarize with the basic parts and their function and construction
- To provide knowledge and understanding of aerospace materials

Course Outcomes:
Students will be able to
- Understand standard atmosphere and properties
- Understand Principles of flight
- Get Knowledge in aerodynamic shapes
- Understand Aerospace materials and aircraft structural component
- Classify the Aircraft instrumentation systems
- Categorize the Power plants used in various aircraft

Unit I - History of aviation: Early flying vehicles – hot air balloons – heavier than air flying machines – Classification of flight vehicles, airplanes and Helicopters – Components of an airplane and their functions.

Unit II - Basics of flight: International Standard Atmosphere, Temperature, pressure and altitude relationships, lift, drag and moment, Airfoil nomenclature, Flow characteristics of airfoils, NACA nomenclature, propagation of sound, Mach number, subsonic, transonic, supersonic, hypersonic flows.

Unit III - Aircraft Structures: General types of construction, Monocoque and Semi monocoque - construction, typical wing and fuselage Structures - Materials used in Aircraft.

Unit IV - Systems and instruments: Conventional control, Powered controls, Basic instruments for flying, typical systems for control actuation.

Unit V - Power plants used in aircrafts: Basic ideas about piston, turboprop and jet engines – comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

References
3. Course material of Faculty Enablement Programme on “Introduction to Aircraft Industry”, conducted by Infosys, Mysore through Campus connect programme.
LIST OF COURSES

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16AE2001 STRUCTURAL MECHANICS

Credits: 3:0:0

Course Objectives:
- To provide an understanding regarding the concepts of stress and strain, Shear force and Bending moment
- To provide knowledge in the methods of determining the deflections of beams

Course Outcome:
- An understanding of material properties like elasticity, plasticity etc
- Knowledge in shear force and Bending moment diagram
- Ability to solve the bending and torsional problems.
- Knowledge in various methods of analysis of beam deflections

Stresses and strain due to different types of loads (including impact load); Principle Stress and Strain, Mohr Circle, Thermal and Hoop stresses. Theory of bending – simple equation, Shear force and bending moment on beams under different load conditions; Flinched beams Torsion equation – problem solution, Strain Energy due to axial load and torsion load, Stresses due to combined bending and Torsion; Deformations and Stresses in Springs, Study of deflection of beams - double integration method, Macaulay’s method, area moment method, Three-dimensional Hooke's law.

References:
16AE2002 AIRCRAFT STRUCTURES - I

Credits: 3:0:0
Pre-requisites: 16AE2001 Structural Mechanics

Course Objective:
- To impart the knowledge on the methods of structural analysis under different types of loads
- To provide the knowledge on basic theories of vibration, elasticity and failures.

Course Outcome:
- Understand the concepts of principle stress and strain
- Familiarity with the methods of structural analysis under different conditions.
- Knowledge in basic theories of vibration, elasticity and failures.

Aerospace Materials, Properties and structural application of Non-ferrous; Ferrous and Composites. Column buckling - Euler’s and Rankine’s formulae, 2D and 3D Truss Analysis, Clayperon’s three moment equation, Castigliano's principles, Maxwell's Reciprocal theorem, Unit load method and Moment Distribution Method. Energy methods of analysis, Virtual Load method, Stresses and deflections in beams of symmetrical and unsymmetrical sections. Shear center location of different sections, Basic Theory of Vibration - Free and forced vibrations of undamped and damped systems, Theories of Failure

References:

16AE2003 AIRCRAFT STRUCTURES - II

Credits: 3:0:0
Pre-requisites: 16AE2002 Aircraft Structures -I

Course Objective:
- To impart the knowledge on the structural behavior of aircraft components under different types of loads
- To provide the understanding in structural design methods for aerospace vehicles

Course Outcome:
- Understand the concepts of shear flow in both open and closed sections
- Familiarity with the buckling property of plates and the concepts of shear flow
- Knowledge in various methods of analysis of aerospace structural members.

Shear flow in open sections - stiffened panels - thin walled open tubes – sections with stiffeners, Shear flow in closed sections - sections with stiffeners–two flange and three flange box beams- thin walled closed tubes, Bredt-Batho theory -Torsional shear flow in multi cell tubes, Flexural shear flow in multi
cell stiffened structures. Stability problems of thin walled structures— Buckling of sheets under compression, shear, bending and combined loads - Crippling stresses by Needham’s and Gerard’s methods. Wing Analysis—Shear force, bending moment and torque distribution along the span of the Wing. Fuselage Analysis - Shear and bending moment distribution along the length of the fuselage. Introduction to Aeroelasticity.

References:

**16AE2004 CRYOGENIC PROPULSION**

Credits: 3:0:0

Course Objectives:
- To study the engineering concept of cryogenic propulsion
- To know the various application of these propulsion in Aerospace field.

Course outcome:
- Understand the thermal, physical and fluid dynamic properties of cryogenic propellant.
- Know the various method of cryogenic insulations, its storage and instrumentation
- Understand the various cryogenic equipments used in Aerospace application.


References:
16AE2005 INDUSTRIAL AERODYNAMICS

Credits: 3:0:0
Pre-requisites: 16AE2001 Fluid Mechanics

Course Objectives:
- To impart information about non-aeronautical uses of aerodynamics, such as road vehicle aerodynamics, building aerodynamics
- To provide the knowledge on solution of problems in flow induced vibrations

Course Outcome:
- Familiarity in the wind energy system in atmosphere
- Understanding the concept of vehicle and building aerodynamics.
- Knowledge in flow induced vibrations.


References:

16AE2006 INTRODUCTION TO UNMANNED AIRCRAFT SYSTEMS

Credits: 3:0:0

Course Objectives:
- To incorporate awareness about the basic terminology, models and prototypes of UAV system
- To impart the knowledge on design considerations of UAV systems

Course Outcome:
- Knowledge of the concepts of UAV models and prototypes
- Relate the design parameters of UAV systems


References

16AE2007 ANALYTICS FOR AEROSPACE ENGINEERS

Credits: 3:0:0

Course Objectives:
- To impart knowledge on various operations research techniques to ensure the effective utilization of resources
- To understand network models for project planning and scheduling
- To obtain knowledge on Quality Management Systems

Course Outcome:
- Ability to Apply mathematical models for physical problems to find optimal Solutions
- Design network models for project planning, scheduling and project management
- Apply Quality management concepts in product/service industry to the end users


References:

16AE2008 ADVANCED SPACE DYNAMICS

Credits: 3:0:0

Pre-requisites: 14AE2016 - Space Dynamics

Course Objectives:
- To impart the knowledge related to the basics of celestial mechanics,
- To impart the knowledge related to the orbits in restricted three-body problem.

Course Outcome:
- Ability to understand the different kinds of orbits
- Ability to understand the orbits in the restricted three-body problem.

Fundamental principles and definitions, Two-body problem: Derivation and solution of equation of motion, Derivation of Lambert’s theorem, Planar circular restricted three-body problem - Equations of motion in sidereal and synodic coordinate systems, Derivation of Jacobi integral, Tisserand's criterion for the identification of comets, Location of equilibrium points, Characteristic equation, Critical mass,
Motion near the collinear and the equilateral points, Three-dimensional restricted three-body problem, Halo orbits.

References:

16AE3001 ORBITAL SPACE DYNAMICS

Credits: 3:0:0

Course Objectives:
- To impart the knowledge in two-body, restricted three-body problem
- To provide necessary knowledge to compute the orbits of satellites and interplanetary trajectories.

Course outcome:
- Ability to solve the orbital problems related to Earth satellite orbits.
- Ability to generate interplanetary orbits in the frame work of restricted three-body problem.

Fundamental principles - Kepler's laws, Problem of two bodies - Derivation of equation of motion, Solution of Kepler’s equation, Computation of orbital elements from state vectors, Force model, Perturbations - Oblateness, Computation of Sun-synchronous orbit, Special perturbation techniques: Cowell’s and Encke’s method, Single impulse Maneuvers, Hohmann transfer, Sphere of influence, Derivation of Lambert’s theorem, Planar circular restricted three-body problem - Equations of motion, Derivation of Jacobi integral, Tisserand's criterion for the identification of comets, Location of equilibrium points, Characteristic equation, Motion near the collinear and the equilateral points.

References:

14AE2004 ELEMENTS OF AVIONICS

Course Objectives:
- To impart knowledge about basic concepts of micro-processors and controllers, their significance and functioning.
- To provide understanding of the basic concepts and functioning of the avionic system data buses.

Course Outcome:
- An understanding of and ability to analyze the functioning of the digital systems.
- Exposure to the working of the air data buses and the trends in display technology.
- An understanding of the basic Avionics systems in Civil and Military Aircrafts.

Basic electronic controllers – microprocessors and microcontrollers, Introduction to Avionics - Role for Avionics in Civil and Military Aircraft systems, Avionic systems, - Civil and Military Electrical Power requirement standards and its comparison. Data Buses - MIL standard and its elements; Avionics System/subsystem and its requirement and design, Various Avionic architecture. Trends in display technology, Alphanumeric displays, character displays etc., MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit

References:

14AE2027 NAVIGATION, GUIDANCE AND CONTROL OF AEROSPACE VEHICLES

Course Objectives:
- To provide the information regarding the concepts of navigation, guidance and control of an aircraft.
- To provide necessary mathematical knowledge required for modeling the guidance and control methods.

Course Outcome:
- To deploy the skills effectively in design of control for aerospace vehicle systems and in understanding the functioning of navigation methods.
Exposure to various topics such as 6-DOF equations of motions, autopilots and augmentation systems and missile guidance systems.

Introduction to navigation systems- Types Different co-ordinate systems - Transformation Techniques; Different types of radio navigation; - Introduction to Inertial Sensors; INS components; Introduction to GPS - system description - basic principles - position and velocity determination. Introduction to Guidance and control; Need for automatic flight control systems; Displacement Autopilot Introduction to Fly-by-wire flight control systems, Lateral Autopilot; Operating principles and design of guidance laws, homing guidance laws. Stability Analysis – root locus method, Routh Hurwitz, Bode plot, Polar plot.

References:

14AE3009 ADVANCED AVIONICS

Credits: 3:0:0

Course Objectives:
- To impart the understanding in basic principles, theory and operation of flight instruments and modern avionics systems
- To familiarize the student with the concepts of guidance and control of an aircraft and to provide the necessary mathematical knowledge that are needed in modeling the guidance and control methods.
- To familiarize the student with the advanced concepts of remote sensing and image processing for aerospace applications.

Course Outcomes:
- An understanding of the theory of transmission and reception of radio waves and functioning of radar systems.
- An understanding of autopilots and missile guidance systems and ability to deploy these skills effectively in the design of control of aerospace systems.
- An understanding of vision based navigation and control and modeling physical process.

References:
3. IAP. Avionics Fundamentals, IAP., 1987
### LIST OF SUBJECTS

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### REVISED VERSION SUBJECT

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<td>Advanced Computational Fluid Dynamics Lab</td>
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### 15AE3001 AERO-ELASTIC THEORY

**Credits:** 3:0:0

**Course Objectives:**
- To impart the concepts of Aeroelasticity
- To provide knowledge about the Static and dynamic Aeroelastic phenomena

**Course Outcome:**
On completion of the course, students should be able to:
- Explain the Aero-elastic phenomena
- Predict the Aeroelastic behavior
- Prevent the body (i.e. Aircrafts) from Aeroelastic instability.


**References:**
15AE3002 BOUNDARY LAYER THEORY

Credits: 3:0:0

Course Objectives:
- To familiarize the students with viscous flow phenomena.
- To impart knowledge on laminar and thermal boundary layer equations.

Course outcome:
On completion of the course, students should be able to:
- Define the fundamental Boundary layer theory
- Solve the equations involved in boundary layer theory
- Analyze the different kinds of Boundary Layer control

Navier-Stokes Equations, Creeping motion, Couette flow, Poiseuille flow through ducts, Ekman drift. Development of boundary layer. Review on the estimation of boundary layer thickness; displacement thickness; momentum and energy thicknesses for two dimensional flow; two dimensional boundary layer equations, Similarity solutions, Blasius solution. Physical and mathematical description of turbulence, Transition from laminar to turbulent boundary layers, turbulent boundary layer on a flat plate, mixing length hypothesis. Approximate integral methods (Von Karman and Polhausen Method). Two-dimensional turbulent boundary layer equations, Velocity profiles for Inner, outer and overlap layers.

References:
15AE3003 THEORY OF VIBRATION

Credits: 3:0:0

Course Objectives:
- To familiarize the fundamentals of Vibration Theory.
- To impart knowledge on how to apply theory of vibration to engineering problems
- To enable the students to mathematically formulate real-world vibration problems in engineering

Course outcome:
On completion of the course, students should be able to:
- Outline the basic mathematical modeling of vibrating mechanical systems
- Specify the basic equations of motion of vibratory systems
- Analyze the Model applied in vibration theory


References:
15AE3004 AIRCRAFT DESIGN

Credits: 3:0:0

Course Objectives:
- To impart knowledge about inputs required for Aircraft design
- To introduce methodology for aerodynamic design of aircraft
- To introduce power plant selection to meet performance requirements
- To introduce the methodology for structural design of aircraft

Course Outcome:
On completion of the course, students should be able to:
- Design an aircraft/Spacecraft with given configuration
- Estimate the design parameters required for its better performance

Categories and types of aircrafts, Layouts and their relative merits, Selection of Wing Loading and Thrust –Weight Ratio, Air Vehicle Configuration, Maneuvering load factors, Balancing and maneuvering loads on tail planes, Power plant Selection, Aerodynamic Design, Weight estimation and balance diagram, Drag estimation of complete aircraft, Aircraft Performance analysis, Loads on undercarriages and design requirements, Estimation of loads on complete aircraft and components. Structural design, Material selection for different components.

References:
15AE3005 FLIGHT CONTROL SYSTEM

Credits: 3:0:0

Course Objectives:
- To impart the concepts of Fly by wire system
- To impart knowledge on the principles of guidance laws and augmentation systems
- To instruct the principles of working and the design of longitudinal and lateral autopilot

Course Outcome:
On completion of the course, students should be able to:
- Define the principles of FBW and augmentation systems
- Summarize the design parameters of autopilot systems

Conventional Systems - Power actuated systems – Modern control systems. Introduction to fly-by-wire control:

References:
15AE3006 ROCKET DYNAMICS

Credits: 3:0:0

Course Objectives:
- To impart the basic concepts of trajectory estimation.
- To impart knowledge on performance, stability and control of rockets

Course Outcome:
On completion of the course, students should be able to:
- Identify the motion of rocket in gravitation field and in an atmosphere
- Relate the stability concepts of the rockets.

Equations of motion, the thrust equation. Rocket performance, restricted staging in field-free space, motion of rocket in gravitation field and in an atmosphere, Staging and optimal staging – two and three stage rockets, Rocket Stability and control: static and dynamic stability; Static Longitudinal Stability and Control, Lateral and directional Stability and Control.

References
15AE3007 ADVANCED AIRCRAFT SYSTEMS

Credits: 3:0:0

Course Objectives:
- To impart knowledge in concepts of flight systems, their significance and operation.
- To impart exposure in sensors and measurements.
- To instruct the usage of electrical systems and engine systems.

Course Outcome:
On completion of the course, students should be able to:
- Specify the major flight instruments, sensors and operations
- Relate the concepts of electrical systems.


References

15AE3008 UNMANNED AIRCRAFT SYSTEMS

Credits: 3:0:0

Course Objectives:
- To incorporate awareness about the basic terminology, models and prototypes of UAV system
- To impart the knowledge on design considerations of UAV systems

Course Outcome:
On completion of the course, students should be able to:
- Specify the concepts of UAV models and prototypes
- Relate the design parameters of UAV systems


References
15AE3009 FINITE ELEMENT ANALYSIS IN AEROSPACE APPLICATION

Credits: 3:0:0

Course Objectives:
- To impart the basic concept of finite element and
- To introduce the finite element modeling in designing Aerospace Structural Components
- To provide the knowledge on various finite element procedures and solution techniques

Course Outcome:
On completion of the course, students should be able to:
- Analyze the discrete and continuum problem using finite element method.
- Identify mathematical model for solution of common engineering problems.
- Describe the usage of professional-level finite element software to solve engineering problems in Solid mechanics, fluid mechanics and heat transfer.


References:
15AE3010 ADVANCED AVIONICS LAB

Credit: 0:0:1
Co-requisites: 14AE3009 Advanced Avionics

Course Objectives:
- To impart the knowledge about different types of Instruments and control systems
- To train students to measure parameters accurately and their importance in different applications in the field of Avionics

Course Outcome:
On completion of the course, students should be able to:
- Manage the work with the avionics systems on an aircraft
- Relate the design concept of new control systems
- Apply the methods of troubleshoot and rectification of faulty instruments.

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

15AE3011 LINEAR AND REGULAR ORBITAL MECHANICS

Credits: 3:0:0

Course Objective:
- To impart the knowledge of orbital mechanics through linear and regular equations of motion.
- To impart the knowledge of orbital perturbations in terms of KS elements.

Course Outcome:
On completion of the course, students should be able to:
- Apply the knowledge of KS transformation to the satellite orbit predictions.


References
15AE3012 NUMERICAL METHODS IN ORBIT APPLICATION

Credits: 3:0:0

Course Objective:
- To impart the knowledge to solve problems in space dynamics numerically.

Course Outcome:
On completion of the course, students should be able to:
- Apply the knowledge of Numerical Methods to the applications of orbital Mechanics


References

14AE3010 ADVANCED COMPUTATIONAL FLUID DYNAMICS LAB (V-1.1)
(Changes in Course outcomes and Co-requisites)

Credits: 0:0:1

Co-requisites: 14AE3002 – Advanced Computational Fluid Dynamics

OR

14ME3003 – Advanced Fluid Mechanics.

Course Objective:
- To familiarize with the working of CFD codes
- To familiarize the students with actual setting up of the problem and solution procedure
- To extract the required data, post process and compare with available data

Course Outcome:
On completion of the course, students should be able to:
- Distinguish CFD Analysis.
- Apply the boundary conditions and solve CFD problems.
- Solve problems using turbulence and combustion models.

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.
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13AE201 FLUID MECHANICS

Credits: 4:0:0

Objective
- The purpose of this course is to learn the fluid properties and fundamentals of fluid statics and fluid flow
- To introduce the concepts of flow measurements and flow losses in pipes
- To impart the knowledge on pumps and turbines

Outcome:
- Understanding the requirement of flow measurements and flow losses in pipes
- Knowledge in maintenance and operation of the pumps and turbines

Unit I
FLUID PROPERTIES
Fluid Statics: Pressure relation – Pascal’s law – Measurement of pressure – Manometers, gauges and pressure transducers, Forces on plane and curved surfaces – Total pressure and centre of pressure.

Unit II
EQUATIONS OF FLUID FLOW
Types of flow – Stream line – Stream tube – Control volume – Continuity equation – One dimensional and three dimensional flow – Velocity potential and stream function, rotation and circulation, Free and forced vortex flow. 
Unit III
DIMENSIONAL ANALYSIS AND SIMILITUDE
Dimensions and Units, Dimensional analysis, Buckingham’s theorem, Non-dimensional numbers and their significance, geometric, Kinematic and dynamic similarity, Application of Non-dimensional numbers.

Unit IV
HYDRAULIC PUMPS AND TURBINES
Turbine classification - Working principles - Pelton wheel, Francis, Kaplan turbines – Velocity triangles.

Unit V
BOUNDARY LAYER AND APPLICATIONS: Concepts of boundary layer- Flow over a flat plate, Boundary layer thickness – displacement, momentum and energy thickness. The momentum equation for the boundary layer. Laminar and turbulent boundary layer - Blasius solution.

Text Books:

Reference books:

13AE202FLUID MECHANICS LABORATORY

Credit: 0:0:2

Objective:
• To give hands on training on Flow measurement, Losses due to friction in pipes.
• To give hands on training on working of different types of Pumps and turbine

Outcome:
• Knowledge to carry out flow measurements
• An understanding of performance of pumps.

LIST OF EXPERIMENTS
1. Determination of Darcy’s Friction Factor.
3. Flow through Mouth piece / orifice.
4. Determination of Minor Losses in pipes
5. Calibration of manometer.
7. Impact of jet on vanes.
8. Reynolds’ Experiment.
11. Load Test on Pelton Wheel.
12. Load Test on Francis Turbine
13. Load Test on Kaplan Turbine

(Any 12 experiments can be offered)

13AE203 THERMODYNAMICS

Credit: 4:0:0

Objective:
- To achieve an understanding of principles of thermodynamics and to apply it for simple physical systems
- To provide in-depth study of thermodynamic principles, thermodynamics of state, Principle of Psychometric & Properties of pure substances

Outcome:
- Knowledge of thermodynamics laws and principles and their applications

Unit I
BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS

Unit II
PROPERTIES OF PURE SUBSTANCE AND ENERGY ANALYSIS
Properties of pure substances – Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, Phase change process with T-v, p-v, p-T diagrams, p-v-T surface
Energy balance for closed systems – conservation of mass – Energy analysis of steady flow and unsteady flow process

Unit III
SECOND LAW OF THERMODYNAMICS AND ENTROPY

Unit IV
GAS MIXTURES AND CHEMICAL REACTIONS
Fuels and combustion – Theoretical and actual combustion process

Unit V
PSYCHROMETRY

Text Books:
Reference books:

13AE204 THERMAL ENGINEERING

Credits: 3:0:0

Objective:
- To integrate the concepts, laws and methodologies of Thermodynamics into analysis of cyclic processes
- To apply the thermodynamic concepts into various thermal application like IC engines, Steam Turbines, Compressors and Refrigeration and Air conditioning system

Outcome:
- Understanding the working of various gas power cycles and its thermodynamic basics.
- Knowledge on the operation of Engines, turbines, Refrigeration and Air-conditioning.

Unit I
INTERNAL COMBUSTION ENGINES
Classification - Components and their function – Parts of IC Engine - Two stroke engine – Four stroke Engine - Comparison of two stroke and four stroke engines - Carburetor system, Fuel Injection system - Lubrication system - Battery and Magneto Ignition System – Combustion in SI and CI engines

Unit II
AIR STANDARD CYCLES
Air standard cycle – Air standard Efficiency – Carnot cycle – Otto Cycle- Diesel cycle – Dual cycle – Comparison of cycles – Brayton cycle

Unit III
STEAM NOZZLES AND TURBINES
Steam flow through nozzles - Nozzle efficiency – Supersaturated and metastable expansion – general relationship between area, velocity and pressure – Steam injector
Classification of steam turbines - Impulse and Reaction principles - compounding - velocity diagram – Turbine efficiencies

Unit IV
AIR COMPRESSORS
Classification - Working principle of reciprocating compressors, work of compression with and without clearance, volumetric efficiency, Isothermal efficiency and isentropic efficiency of reciprocating compressors, Multi-stage air compressor and inter cooling – Rotary compressors – classification

Unit V
REFRIGERATION AND AIR CONDITIONING
Fundamentals of Refrigeration – Air refrigeration system – simple Vapour compression refrigeration cycle - working principle of vapour absorption system
Aircraft air conditioning system - Introduction and need, Ram air cooling, Air cycle refrigeration system, Turbo fan cooling system, Vapor cycle system, Expandable heat sinks, Humidity control system

Text Books:
Reference Books:

13AE205 INTRODUCTION TO AEROSPACE ENGINEERING

Credits: 4:0:0

Objective:
- To introduce the basic concepts of aircrafts, rockets, satellites and their application
- To familiarize with the basic parts and their function and construction details
- To familiarize with the national and international aeronautical and aerospace agencies

Outcome:
- Understanding the nature of aerospace technologies,
- Knowledge in various types of aerospace vehicles, satellites and their applications,
- Familiarize with various national and international aerospace agencies

Unit I
HISTORICAL EVOLUTION AND MAJOR AIRCRAFT COMPONENTS
History of air vehicles and space vehicles- Historical developments of Aerodynamics, Structures and Propulsion system throughout the years - Different types of flight vehicles and its classification - Major components of an airplane and their functions - Conventional flight control surfaces

Unit II
BASIC THEORY OF FLIGHT

Unit III
INTRODUCTION TO STRUCTURES: General types of aircraft construction and structural layout, Fuselage construction - monocoque, semi-monocoque, and geodesic construction, Wing structure, aerospace materials - metallic and nonmetallic materials, use of aluminum alloy, titanium, stainless steel, composite materials.

Unit IV
PROPULSION SYSTEMS: Basic ideas about piston, turboprop and jet engines, Principles of Thrust generation-propeller and jets, comparative merits.
ROCKETS AND SATELLITES: Principles of operation of rocket, types of rockets and typical applications, Exploration into space, Satellites –types and applications.

Unit V
FLIGHT TESTING: Introduction to flight-testing, Purpose and Scope of Flight Testing, Basic instruments for flying.
AEROSPACE INDUSTRIES AND INSTITUTIONS: Introduction to aerospace industries – Research and Development organizations and Academic institutions in India and worldwide

Text Book

Reference Books
13AE206 INSTRUMENTATION AND AVIONICS LABORATORY

Credit: 0:0:2

Objectives:
- To introduce different types of Instruments and control systems
- To train students to measure parameters accurately and their importance in different applications in the field of Avionics

Outcome:
- Working with the avionics systems on an aircraft
- Understand the Design concept of new control systems
- Familiarize the methods of troubleshoot and rectification of faulty Instruments.

List of Experiments
1. Study on basic electronics and radio wave principles.
2. Temperature measurement using different thermocouple
3. Temperature measurement using RTD
4. Temperature measurement pyrometer.
5. Steady Pressure measurements using pressure transducer
6. Unsteady Pressure measurements using pressure transducer
7. Force measurements using load cells
9. Heat Flux measurements
10. Instrumentation study of the cockpit.
11. Controls in weather radar systems.
12. Controls in airborne ATC transponder.
13. Controls in Mems gyroscope.
14. Controls in Mems accelerometer.
15. Study on air navigation systems.
16. Study on avionic systems/aids/simulation software.

(Any 12 experiments can be offered)

13AE207 GAS DYNAMICS

Credits: 4:0:0

Objective:
- To familiarize with behavior of compressible gas flow
- To understand the difference between subsonic and supersonic flow
- To familiarize with effect of transonic and supersonic flow over flying vehicles

Outcome:
- Knowledge of design and configuration of the flying vehicles for transonic and supersonic flights
- Understanding the effect of shock wave on aircraft/engine performance
- Knowledge of the flow behavior and consequent loads

Unit I:
EQUATIONS OF MOTION FOR COMPRESSIBLE FLOWS:
Introduction to gas dynamics, Energy equation, Continuity equation, Gas momentum and momentum equation, Velocity of sound, Stream tube area-velocity relationship, Isentropic flow equations for convergent, divergent and C-D nozzle, Rayleigh flow, Fanno flow
Unit II: INTRODUCTION TO SHOCK AND EXPANSION WAVES:
Line of disturbance, Flow in convex and concave corners, Formation of normal & oblique shock and expansion wave, Methods of supersonic C-D nozzle design, C-D nozzle performance under various back pressures

NORMAL SHOCKS
Normal shock equation (Prandtl equation), Rankine – Hugoniot relations, Pitot static tube and correction factors for subsonic & supersonic flows

Unit III: OBLIQUE SHOCKS AND EXPANSION WAVES
Oblique shocks and corresponding equations, Relationship between flow turning and shock angle, Hodograph and shock polar, Flow over wedges, Strong, weak and detached shocks, Expansion polar, Reflection and intersection of shocks & expansion waves

Unit IV: HIGH SPEED FLOW OVER AIRFOIL
Small perturbation potential flow theory, Prandtl-Glauert affine transformation for subsonic flows, Supersonic flow over thin plate, Lift, drag, pitching moment and center of pressure for supersonic profiles, Lower and upper critical Mach numbers, Lift and drag divergence Mach number, Shock induced flow separation

Unit V: HIGH SPEED FLOW OVER FINITE WING
Finite wing, Tip effects, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule

Text Books:

Reference Books:

13AE208 AIRCRAFT PROPULSION

Credits: 4:0:0

Objective:
- To familiarize with working principles of Gas Turbine Engine (GTE)
- To familiarize with working principle of GTE individual modules and matching of all modules
- To familiarize with performance characteristic of GTE

Outcome:
- Evaluation of the performance at component level and matching all to achieve the system level performance requirement
- Understanding the design concept of the GTE for aircraft/helicopter application

Unit I INTRODUCTION
Classification of propulsion system and Gas Turbine Engine (GTE), Review of thermodynamic laws and processes, GTE working cycle, parameters, losses and efficiencies, Elements & operating principles of GTE, Standard atmospheres and operational envelope
Unit II
COMPRESSORS
Centrifugal Compressor: Basic concepts and principles of operation, Work done, Velocity triangle and blade design, Impeller channel, Compressibility effect, Compressor characteristics
Axial Flow Compressor: Basic operation, Elementary theory, Blade design, Factors affecting stage pressure ratio, Degree of reaction, Off-design performance, Compressor characteristics

Unit III
COMBUSTION AND TURBINES
Combustion Systems: Design/operational requirements, Factors affecting combustion process, Types of combustion systems, Combustion process
Axial Flow Turbines: Basic operation & elementary theory, Impulse and reaction turbine blade, Vortex theory, Choice of blade profiles and pitch & chord, Limiting factor in turbine design, Overall performance, Methods of blade cooling

Unit IV
INLETS AND NOZZLES
AFTER BURNERS: Purpose and operational requirements, Design parameters, After burner components and operation (Fuel injection, Atomization & vaporization, Ignition, Flame stabilization, Combustion)
INLETS: Introduction and requirement parameters, subsonic inlet and operations, Supersonic inlets and operations with internal & external compression
Exhaust Nozzle: Types of exhaust nozzle and its operation

Unit V
ENGINE PERFORMANCE
Performance Prediction of Simple GTE: Introduction, Component characteristics, Off design operation of single shaft GTE, Equilibrium running of a gas generator, Off design operation of free turbine GTE, Off design operation of turbo jet engine
Performance Prediction of Turbo-Fan GTE: Introduction and purpose of twin spool GTE, Matching of turbo-fan engine, Some Notes on behavior of twin spool GTE
Performance Characteristics of Single Shaft GTE: Transient behavior of GTE, Principles of control systems, Jet engine performance characteristics (Altitude, Mach number and Shaft speed)

Text Books:

Reference Books:

13AE209 ROCKET PROPULSION

Credits: 4:0:0

Objective:
- To introduce the concepts of Rocket Propulsion
- To introduce the concept of combustion in RAM Jet and SCRAM Jet
- To familiarize with Advanced propulsion Techniques

Outcome:
Students will be able to
- Knowledge of the performance of rocket propulsion system
Understanding the need for different propulsion systems and their usage

Unit I
FUNDAMENTALS OF ROCKET PROPULSION

Unit II
CHEMICAL ROCKETS

Unit III
RAMJET PROPULSION

Unit IV
ADVANCED PROPULSION TECHNIQUES

Unit V
ROCKET TESTING
Types of tests- Test facilities and safeguards –Monitoring the environment and control toxic material – Instrumentation and data management- measurement system terminology –Test measurements- Health monitoring system- Flight testing- post accident procedures.

Text Books

Reference Books:

13AE210 ANSYS LABORATORY

Objective:
- To understand the load and stress analysis of different types of structural components
- To evaluate and find deflection calculations so as to estimate the performance of the software.

Outcome:
- Understand the basics of ANSYS Software
- Analyze and design various structural elements using the software

2014 Department of Aerospace Engineering
LIST OF EXPERIMENTS:
1. Static structural analysis of 2D truss
2. Static structural analysis of tensile bar
3. Deflection of cantilever Beam
4. Deflection of SSB (Simply Supported Beam)
5. Deflection of rectangular wing
7. Buckling of plates.
8. Buckling of columns.
9. 2D steady heat conduction problem
10. Thermal stresses in bar
11. 3D conduction problem
12. Transient heat conduction problem

13AE211 EXPERIMENTAL STRESS ANALYSIS

Credits: 4:0:0

Objective:
- To understand experimental method of finding the response of the structure to different types of load.

Outcome:
- Knowledge of the general aspects of strain measurements
- Understanding the principle of operation of different type of strain gauges, circuits
- Familiarize with the optical methods of stress analysis and Nondestructive techniques

Unit I
INTRODUCTION AND STRAIN MEASUREMENTS METHODS AND RELATED INSTRUMENTATIONS
Principle of measurements-Accuracy, sensitivity and range- Definition of strain and its relation to experimental determinations, Properties of strain gauge systems, Types of strain gauge systems- Mechanical, Optical, Acoustical and Electrical extensometers.

Unit II
ELECTRICAL-RESISTANCE STRAIN GAUGES AND CIRCUITS
Principle of operation and requirements - Types and their uses-Materials for strain gauge-Calibration and temperature compensation-Cross sensitivity-Rosette analysis- Wheatstone bridge-Potentiometer circuits for static and dynamic strain measurements-Strain indicators, Transducer applications- Load cells- Diaphragm pressure transducers.

Unit III
PRINCIPLES OF PHOTOELASTICITY

Unit IV
PHOTOELASTICITY AND INTERFEROMETRY TECHNIQUES
Fringe sharpening and Fringe multiplication techniques - Compensation and separation techniques-Calibration methods – Photo elastic materials. Introduction to three dimensional photoelasticity. Moire fringes – Laser holography – Grid methods-Stress coat
Unit V
NON DESTRUCTIVE TECHNIQUES
Radiography- Ultrasonics- Magnetic particle inspection- Fluorescent penetrant technique-Eddy current testing- Acoustic emission technique.

Text Books:

Reference books:

13AE212 MATERIALS IN AEROSPACE APPLICATIONS

Credits: 3:0:0

Objective:
- To understand various materials used in Aerospace industry,
- To help the students in various Mechanical behavior of the materials and its testing methods

Outcome:
- Knowledge of the mechanical behavior of various Aerospace Materials and its heat treatment process.
- Familiarize with the application of ferrous and nonferrous alloys in Aerospace Engineering.
- Understanding the non-metallic materials and adhesives used and its properties

Unit I:
MECHANICAL BEHAVIOUR OF ENGINEERING MATERIALS
Knowledge of various types of hardness testing machines and various types of hardness numbers Linear and non-linear elastic properties - Stress and Strain Curves – Yielding and strain Hardening ,Toughness – Modules of resilience - Bauchinger’s effect – Effect of notches – Testing and flaw detection of materials and components .

Unit II :
NON-FERROUS MATERIALS
Magnesium and its alloys: Cast and Wrought alloys, Aircraft application, features specification, fabrication problems, Special treatments.
Copper Alloys:- Monel, K-Monel

Unit III:
FERROUS MATERIALS
Steel:- Plain and low carbon steels , various low alloy steels , aircraft steel specifications, corrosion and heat resistant steels , structural applications.
MARAGING STEELS:- Properties and Applications,
Unit IV:  
NON METALLIC MATERIALS  
Wood and fabric in aircraft construction and specifications – Glues, Use of glass, plastics and rubber in aircraft,  
Introduction to composite materials  

Unit V:  
ADHESIVE AND SEALANTS  
Advantages of Bonded structure in airframes, Crack arresting, Weight saving, Technology of adhesive Bonding  
Structural adhesive materials, Typical bonded joints & nondestructive tests for bonded joint  
Bonded Sandwich structures, Methods of construction of honeycombs  

Text Books:  
1. Aircraft General Engineering by Lalith Gupta, Himalaya Book House, Delhi 2003  
2. Aircraft Material & Process by Titterton 2004  

Reference Books:  
1. Workshop Technology – Vol 1 & 2 by Hajira Chowdhry, Nedia Promoters, Mumbai  

13AE213 AEROELASTICITY  

Credits: 3:0:0  

Objective:  
- To understand the basic concepts of Aeroelasticity  
- To acquire knowledge about the Static and dynamic Aeroelastic phenomena  
- To understand about Aeroelasticity phenomena in Turbomachines  

Outcome:  
- Understanding the Aero-elastic phenomena’s and learning how to predict the Aeroelasticity phenomena’s  
- Knowledge of how to prevent body (i.e Aircrafts, Turbomachines and etc.) from Aeroelastic instability.  

Unit I  
INTRODUCTION AEROELASTIC PHENOMENAE  

Unit II  
STATIC AEROELASTICITY- DIVERGENCE OF A LIFTING SURFACE  
Simple two dimensional idealisations -Strip theory – Integral equation of the second kind – Exact solutions for simple rectangular wings – ‘Semirigid’ assumption and approximate solutions  

Unit III  
STATIC AEROELASTICITY- STEADY STATE AEROELASTIC PROBLEM  

Unit IV  
DYNAMIC AEROELASTICITY- FLUTTER AND BUFFETING  
Unit V
AEROELASTICITY IN TURBOMACHINES

Text books:

Reference Books:

13AE214 ADVANCED SPACE DYNAMICS

Credit 3:0:0

Objective:
- To understand two-body and restricted three-body problem and its modifications

Outcome:
- Knowledge of the trajectory and performance of the space vehicle
- Understanding the advanced design of inter-planetary trajectory

Unit I
TWO-BODY PROBLEM
The motion of the center of mass, relative motion, two-point boundary value problem- application to Lambert's Theorem, some expansions of elliptic motion.

Unit II
RESTRICTED THREE-BODY PROBLEM
Equations of motion, Jacobi integral, Tisserand's criterion for the identification of comets, reduction, regularization.

Unit III
TOTALITY OF SOLUTIONS
Location of equilibrium points, Motion near the collinear and equilateral points, non-linear phenomenon around the equilibrium points.

Unit IV
HAMILTONIAN DYNAMICS
Equations of motion, canonical transformation in the phase space, extended phase space, Examples of Hamiltonian dynamics in the extended phase space, canonical transformation of the restricted three-body problem.

Unit V
MODIFICATIONS OF RESTRICTED THREE-BODY PROBLEM
Three-dimensional restricted three-body problem, elliptic restricted three-body problem, Hill's problem, other modifications.
13AE215 INTRODUCTION TO HYPERSONIC FLOWS

Credits: 4:0:0

Objective:
- To introduce the basics of hypersonic air flow
- To familiarize with the inviscid and the viscous hypersonic flow on an object

Outcome:
- Understanding the hypersonic flow behavior on an object
- Familiarize with the Hypersonic Interaction Parameter, Shock Wave-Boundary layer Interaction

Unit I
INTRODUCTION
Thin shock layer, Entropy layer, Viscous Interaction, High Temperature effects, Low Density Effects

Unit II
INVISCID HYPERSONIC FLOWS

Unit III
HYPERSONIC INVISCID FLOW FIELD
Governing Equations, Mach number independence Principle, Hypersonic Small Disturbance Theory, Blast wave Theory, Exact methods – Method of Characteristics, Hypersonic Blunt Body Problem, Hypersonic Shock wave shapes

Unit IV
VISCOUS FLOWS
Governing Equations – Navier-Stokes equations, Similarity Parameters, Boundary Conditions, Hypersonic Boundary Layer Theory, Self similar Solution – Flat Plate and Stagnation Point, Non-similar Boundary Layer, Local similarity Method, Hypersonic Transition, Turbulent Boundary layer,

Unit V
HYPERSONIC AERODYNAMIC HEATING AND VISCOUS-INVISCID INTERACTION

Text Books:
1. Anderson – Hypersonic and High Temperature Gas dynamics, 2006

Reference Books:
1. Hayes & Probstien – Hypersonic Flow Theory,
13AE216  AIRCRAFT AND ENGINE SYSTEMS

Credits: 4:0:0

Objective:
- To familiarize the importance and the operating principles of aircraft systems
- To familiarize the various flight and ambient conditions for which aircraft systems should be designed
- To familiarize modern trend in designing aircraft systems

Objective:
- Understanding the aircraft systems requirements
- Knowledge of design concepts of the systems for the various aircraft category
- Familiarize with the methods to diagnose the aircraft systems for its performance

Unit I
AIRCRAFT FLIGHT CONTROL SYSTEMS
Introduction and types of aircraft control systems, Conventional system, Hydro-mechanical system, Hydro-electro-mechanical system (fly by wire system), Fly by wire system with electro-hydro-static actuator, High lift devices systems, Smart actuator system

Unit II
AIRCRAFT HYDRAULIC SYSTEMS
Introduction, importance and types of hydraulic systems, Application and design requirements for hydraulic system, Conventional hydraulic systems, Modern hydraulic system, Design features and operating principles of hydraulic system components – pumps, motors, servo valves, accumulators, pressure reducing valve, pressure relief valve

Unit III
AIRCRAFT FUEL SYSTEMS
Introduction to fuel system and its importance, Design requirements and features of sub systems - feed, refueling, transfer, venting. Factors affecting the fuel system, Design features and operating principles of fuel system components- pumps, fuel no air valve, air no fuel valve, fuel gauging, transfer valve, refueling valve

Unit IV
AIRCRAFT AUXILLIARY SYSTEMS
Introduction, operating principle and design requirements of following systems- Environmental control system, Oxygen systems, Fire protection systems, Deicing & anti icing system, Pilot life supporting and ejection system

Unit V
ENGINE SYSTEMS
Introduction, operating principle, design requirements of following systems- Engine secondary power & starting system, Conventional fuel control system (hydro-mechanical fuel control system), Electro-hydro-mechanical fuel control system (FADEC system)

Text Books:

Reference Books:
13AE217 OPERATIONS RESEARCH

Credit: 3: 0: 0

Objective:
- To introduce students various optimization techniques used in industrial practice.
- The subject also aims at imparting knowledge on Quality and Quality Management Systems.

Outcome:
- Model a physical problem into a mathematical model and find optimal solutions for real situations.
- Contribute to the industry’s quality policy in which they are placed.

Unit I:
LINEAR MODELS
The phases of operations research study – Linear programming – Graphical method – Simplex algorithm – Duality – Transportation problems – Assignment problems.

Unit II:
NETWORK MODELS
Network models - Shortest route – Minimal spanning tree – Maximum flow models – Project network – CPM and PERT networks – Critical path scheduling – Sequencing models-n jobs through two machines, n jobs through m machines

Unit III:
INVENTORY MODELS
Inventory models – Economic order quantity models – Techniques in inventory Management – ABC Analysis – formation of ABC graph from the data – Two Bin Methods.

Unit IV:
QUEUING MODELS
Queueing models (No derivation) – Queueing systems and structures – Notation – parameter – Single server and multi server models – Poisson input – Exponential service – Constant rate service – Infinite population – Simulation – Monte Carlo Technique – inventory and queuing application.

Unit V:
DECISION MODELS

Text Books:

Reference Books:
14AE2001 INTRODUCTION TO AEROSPACE ENGINEERING

Credits: 3:0:0

Course Objectives:
- To introduce the basic concepts of aircrafts, rockets, satellites and their applications.
- To provide knowledge about the basic parts and their function and construction details of aerospace vehicles.
- To provide knowledge about the national and international aerospace agencies.

Course Outcome:
- An understanding the nature of aerospace technologies,
- Knowledge in various types of aerospace vehicles, satellites and their applications.

History of aviation, history of spaceflight; Classification of Flight Vehicles; Components of an airplane and their functions; Standard atmosphere; Principles of flight - Lift generation; General types of aircraft construction and structural layout, Fuselage construction, Wing structure, Empennage structure, Landing gears; Honeycomb and Sandwich structure; Principles of Thrust generation; Working Principle of Aircraft engines; Types of Rockets; Satellites – types and applications; Basic Aircraft instruments; Aerospace industries and institutions worldwide

References:

14AE2002 AEROSPACE COMPONENT DRAWING

Credits: 0:0:1

Co-requisites: 14AE2001 Introduction to Aerospace Engineering

Course Objectives:
- To impart understanding about drawing and develop capacity to represent graphically any component of an Aircraft.
- To develop primary knowledge of standard drawing practices.
- To impart an understanding of the orthographic drawing of different parts.

Course Outcome:
- Ability to draw and develop the Aerospace component with the help of picture.
- An Understanding of the standard procedures in developing the component drawing.

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE2003 MATERIALS IN AEROSPACE APPLICATIONS

Credits: 3:0:0

Course Objectives:
- To provide an understanding in various materials used in Aerospace industry.
- To impart the knowledge in various Mechanical behavior of the material and its testing methods.
Course Outcome:
- Knowledge of the mechanical behavior of various Aerospace Material, its properties and heat treatment process.
- Familiarity with the application of metallic, nonmetallic and adhesives in Aerospace Engineering.

Atomic and Crystal Structure and its characterization of the material; Crystal defects – point, line and the surface defects; Mechanical behavior of Aerospace materials; Linear and non-linear elastic properties; Toughness; Modules of resilience; Testing and flaw detection of materials and components; Non-ferrous Materials properties and structural application - Aluminum and its alloys, Copper Alloys; Magnesium and its alloys, Titanium and its alloys; Super Alloys; Ferrous Materials properties and structural application – Steel, Maraging Steels; Non Metallic Materials applications – Wood, fabric, glass, plastics and rubber; Composite materials and applications; Adhesives and Sealants, Anti- corrosion coating materials.

References:
2. Lalit Gupta,” Aircraft General Engineering”, Himalaya Book House, Delhi 2003
5. Lalit Gupta,” Advanced Composite Materials” Himalaya Book House, Delhi, 2006

14AE2004 ELEMENTS OF AVIONICS

Credits: 3:0:0

Course Objectives:
- To impart knowledge about basic concepts of micro-processors and controllers, their significance and functioning.
- To provide understanding of the basic concepts and functioning of the avionic system data bases.

Course Outcome:
- An understanding of and ability to analyze the functioning of the digital systems.
- Exposure to the working of the air data bases and the trends in display technology.
- An understanding of the basic Avionics systems in Civil and Military Aircrafts.

Introduction to Avionics - Role for Avionics in Civil and Military Aircraft systems, Avionic systems, - Civil and Military Electrical Power requirement standards and its comparison. Data Buses - MIL standard and its elements; Avionics System/subsystem and its requirement and design, Various Avionic architecture. Trends in display technology, Alphanumeric displays, character displays etc., MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit

References:

14AE2005 STRENGTH OF AEROSPACE MATERIALS

Credits: 3:1:0

Course Objectives:
- To provide an understanding regarding the concepts of stress and strain, Shear force and Bending moment
- To provide knowledge in the methods of determining the deflections of beams
Course Outcome:
- An understanding of material properties like elasticity, plasticity etc
- Knowledge in various methods of analysis of aerospace structural members and the failure theories of the materials

Stresses and strain due to axial and impact force; Property of elasticity and plasticity; Thermal and Hoop stresses, Strain Energy; Shear force and bending moment for different types of beam in different load conditions; Theory of bending and torsion – simple equation; Strain energy due to bending moment, deformation in circular solid, hollow and composite shafts; stress due to combined bending and Torsion; Deformations and Stresses in Springs; Deflection of beams using double integration method, Macaulay’s method, area moment method; Column buckling - Euler’s and Rankine’s formulae; Principal stresses and their planes - Mohr’s circle of stresses; Theories of Elastic Failure

References:

14AE2006 AERODYNAMICS

Credits: 3:0:0

Pre-requisites: 14CE2003 - Mechanics of Fluid

Course Objectives:
- To impart knowledge of basics of air flow
- To provide details regarding the airfoils, wings and the flow over these

Course Outcome:
- An understanding of the flow behaviour over aircraft wings
- Ability to assess the forces and moments due to flow


References:
4. Rathakrishnan, E, Theoretical Aerodynamics, John Wiley & Sons, 2013
6. Theodore A. Talay, Introduction to the Aerodynamics of Flight, National Aeronautics and Space Administration, 1975
14AE2007 AERODYNAMICS LABORATORY - I

Credits: 0:0:2

Pre-requisites: 14CE2003 - Mechanics of Fluid
Co requisites: 14AE2006 - Aerodynamics

Course Objectives:
- To impart knowledge about various experimental facilities
- To provide the knowledge of different sensors, measurement techniques and their use for conducting the test, acquiring the data and their analysis

Course Outcome:
Ability to
- choose proper experimental facilities
- configure the experiment and conduct the test
- visualize the flow and pressure distribution over 2D and 3D bodies by tuft & smoke methods

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE2008 AERODYNAMICS LABORATORY - II

Credits: 0:0:2

Pre-requisites: 14AE2007 - Aerodynamics Laboratory - I

Course Objectives:
- To provide details of various experimental facilities
- To provide the knowledge of different sensors, measurement techniques and their use for conducting the test, acquiring the data and their analysis

Course Outcome:
- Ability to choose proper experimental facilities
- Ability to configure the experiment and conduct the test
- An understanding of the methods to draw inferences from acquired data

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE2009 CAD LABORATORY

Credits: 0:0:2

Pre-requisites: 14AE2002 - Aerospace Component Drawing

Course Objectives:
- To impart the skills on 2D and 3D modeling using CAD packages.
- To enable the knowledge in modelling different parts of Aircraft and Launch vehicles.

Course Outcome:
- Ability to understand the CAD packages.
- An understanding of the modeling of different components of aircraft
- Familiarity with basic aircraft assembly
The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

**14AE2010 AIRCRAFT INSTRUMENTATION**

**Credits:** 3:0:0

**Pre-requisites:** 14AE2004 - Elements of Avionics

**Course Objectives:**
- To provide the knowledge regarding basic concepts of flight instruments, their significance and operation.
- To impart the information about the concepts of measurements using air data sensor, Gyroscope and engine data.
- To impart the basic concepts regarding Avionics systems and also the necessary knowledge on working of avionics system in aircraft.

**Course Outcome:**
- An understanding of and ability to analyze the instrumentation methods in avionics engineering.
- An understanding of the importance and need for avionics systems.

Instrumentation brief review-Concept of measurement, Errors, Functional elements of an instrument system; Transducers; Civil and Military aircraft cockpits; Classification of aircraft instruments; Air data instruments; Gyroscope and its properties; Principles of accelerometer; Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, fuel flow, engine vibration, monitoring;

**References:**

**14AE2011 INSTRUMENTATION AND AVIONICS LABORATORY**

**Credit:** 0:0:2

**Pre-requisites:** 14AE2004 - Elements of Avionics

**Co-requisites:** 14AE2010 - Aircraft Instrumentation

**Course Objectives:**
- To impart the knowledge about different types of Instruments and control systems
- To train students to measure parameters accurately and their importance in different applications in the field of Avionics

**Course Outcome:**
- Ability to work with the avionics systems on an aircraft
- An Understanding of the design concept of new control systems
- Familiarity with methods of troubleshoot and rectification of faulty instruments.
The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE2012 AIRCRAFT STRUCTURES

Credits: 3:0:0

Pre-requisites: 14AE2005 - Strength of Aerospace Materials

Course Objective:
- To impart the knowledge on the structural behavior of aircraft components under different types of loads
- To provide the understanding in structural design methods for aerospace vehicles

Course Outcome:
- Knowledge in various methods of analysis of aerospace structural members.
- Familiarity with the buckling property of plates and the concepts of shear flow
- Ability to understand the basic structures in Composite materials

Structural materials and stress-strain characteristics: Structural analysis methods- Method of joints, Clapeyron's three Moment Equation, Castigliano's theorem, Maxwell's Reciprocal theorem, Unit load method and Moment Distribution Method; Shear centre of different sections; Unsymmetrical bending; Flexural shear flow in thin walled sections; Bending, shear and torsion of thin-walled members. Bending and buckling of thin plates and stiffened plates. Stress analysis of wing, control surfaces and their structural members, Stress analysis of fuselage and its structural members; Composite Materials- Introduction and its application

References:
2. G Lakshmi Narasaih “Aircraft Structures”, BS Publications.,2010

14AE2013 AIRCRAFT STRUCTURES LABORATORY

Credits: 0:0:2

Pre-requisites: 14AE2005 - Strength of Aerospace Materials
Co-requisites: 14AE2012 - Aircraft Structures

Course Objective:
- To provide the basic knowledge on the testing equipment for various structural components.
- To impart the practical exposure with the measuring equipment and sensors.

Course Outcome:
- Ability to select test equipment for different types of static loading ,
- Ability to conduct tests, analyze results, document and compare with analytical/theoretical results

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.
14AE2014 AIRCRAFT PERFORMANCE

Credits: 3:1:0

Pre-requisites: 14ME2001 - Engineering Mechanics

Course Objectives:
- To impart knowledge about the concepts of Flight performance
- To introduce the various parameters effecting the performance
- To introduce the various theories of propeller analysis and design

Course Outcome:
- Ability to make preliminary performance estimation
- An understanding of various design parameters of propeller
- Ability to assess various aircraft parameters and their effect of performance

Streamlined and Bluff bodies, Aerofoil characteristics, Pressure Distribution around circular cylinder and aerofoils, NACA Nomenclature, Types of Drags; Induced Drag equation: Drag Polar; Equation of Aircraft Motion - Steady Level Flight; Thrust/Power available and required with altitudes; Estimation of Maximum level flight speed; Range and Endurance for reciprocating and turbine engine Aircraft; Climb flight performances; Glide flight; Hodograph; Estimation of take-off and landing distances, High Lift Devices, use of thrust augmentation and reverse thrust; Load Factor; Vertical and Horizontal turn; V-n diagram; Blade element theory, propeller coefficients, Fixed and variable pitch propellers.

References:

14AE2015 AIRCRAFT STABILITY AND CONTROL

Credit: 3:0:0

Pre-requisites: 14ME2001 - Engineering Mechanics

Course Objectives:
- To introduce the concept of Stability and control of Aircraft
- To impart knowledge about various Aircraft motions and related stability
- To introduce the concept of dynamic stability of Aircraft

Course Outcome:
- Ability to perform the dynamic analysis in the stability of aircraft
- An understanding of the requirement of control force and power plant
- An understanding of the motion of unstable aircraft and related modes of instability

Degrees of Freedom of a system; Static Longitudinal Stability – Basic equations of equilibrium; Stability criterion; Wing and tail contribution; Effects of Fuselage and nacelles; Stick Fixed Static Longitudinal Stability; Stick Free Longitudinal Stability – Elevator hinge moment; Neutral point and Static Margin; Stick Force gradients and Stick force per g load, Aerodynamic balancing; Static Lateral Stability – Dihedral Effect, Adverse yaw, Aileron power, Aileron reversal; Static Directional Stability – Weather cocking Effect, Rudder Requirements, One engine In-operative Conditions, Rudder Lock; Dynamic Longitudinal Stability – Equations of motion, stability Derivatives, Routh’s discriminant, Dutch roll and Spiral instability, Auto rotation and Spin.
References:

14AE2016 SPACE DYNAMICS

Credits: 3:0:0

Pre-requisites: 14ME2001 - Engineering Mechanics

Course Objectives:
- To impart the knowledge related to the performance and stability of rockets, solar system and basics of orbital mechanics.
- To impart the knowledge of various factors affecting the satellite orbits and generation of interplanetary trajectories.

Course Outcome:
- Ability to estimate the trajectory and performance of the rockets.
- Ability to use proper reference coordinate system for space vehicle analysis, to compute the orbits of the satellites under perturbing forces and to generate preliminary design of inter-planetary trajectories.

Rocket performance, Thrust equation, Static and dynamic stability of rockets; Solar system, Kepler’s laws, Reference frames, Coordinate Systems, Earth’s atmosphere, The ecliptic, Motion of vernal equinox, Position, velocity and orbital elements, Solution of Kepler’s equation, Orbit Perturbations, Special and General Perturbation methods, Lagrange planetary equations, Single Impulse Maneuvers, Hohmann transfers, Rendezvous opportunities, Sphere of influence, Departure and arrival, Two-dimensional interplanetary trajectories.

References:

14AE2017 AIRCRAFT PROPULSION

Credits: 3:0:0

Pre-requisites: 14ME2014 - Engineering Thermodynamics

Course Objectives:
- To impart knowledge on working principles of Gas Turbine Engine (GTE)
- To impart knowledge on characteristics of GTE modules and its matching
Course Outcome:

- Ability to design GTE for aircraft/helicopter
- Ability to evaluate GTE performance at component and system level


References:

3. Philip P. Walsh and Paul Fletcher, Gas Turbine Performance, Blackwell Publishing company, 2004

14AE2018 PROPULSION LABORATORY

Credits: 0:0:2

Prerequisites: 14ME2014 - Engineering Thermodynamics
Co-requisites: 14AE2017 - Aircraft Propulsion

Course Objective:

- To impart knowledge on basic concepts and operation of various propulsion systems
- To provide practical exposure to the operation of various propulsion systems

Course Outcome:

- Ability to understand the design features of various propulsion systems
- Ability to evaluate the performance of various propulsion systems

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE2019 COMPUTATIONAL FLUID DYNAMICS

Credits: 3:0:0

Prerequisites: 14CE2003 - Mechanics of Fluid

Course Objectives:

- To provide knowledge on governing equations of fluid dynamics.
- To provide an understanding of the solution methodologies of discretised equations, turbulence and combustion models.

Course Outcome:

- Knowledge of performing CFD Analysis.
- Ability to apply the boundary conditions and solve CFD problems using turbulence and combustion models.

References:

14AE2020 CFD LABORATORY

Credits: 0:0:2

Pre-requisites: 14CE2003 - Mechanics of Fluid
Co-requisite: 14AE2019 - Computational Fluid Dynamics

Course Objectives:

- To provide the understanding in the students with the working of CFD codes
- To impart the knowledge on actual setting up of the problem and solution procedure
- To impart the knowledge on deriving aerodynamic quantities from computed data

Course Outcome:

- Knowledge in performing CFD Analysis.
- Ability to apply the boundary conditions and solve CFD problems.
- Ability to solve problems using turbulence and combustion models.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE2021 GAS DYNAMICS

Credits: 3:0:0

Pre-requisites: 14AE2006 - Aerodynamics

Course Objectives:

- To provide information regarding the behavior of compressible fluid flow
- To impart knowledge regarding the difference between subsonic and supersonic flow; estimation of flow over flying vehicles at subsonic and supersonic speeds

Course Outcome:

- Ability to design flying vehicles for transonic and supersonic flights
- Ability to understand the effect of shock wave on aircraft/engine performance
- Ability to assess the flow behavior and consequent loads

References:

14AE2022 ROCKET PROPULSION

Credits: 3:0:0

Pre-requisites: 14ME2014 - Engineering Thermodynamics

Course Objectives:
- To impart knowledge on concepts of Rocket Propulsion
- To impart knowledge on concept of Ramjet and Scramjet engine

Course Outcome:
- Ability to evaluate the performance of propulsion system
- Ability to select and design a suitable rocket propulsion


References:

14AE2023 AIRCRAFT/SPACECRAFT DESIGN PROJECT

Credits: 0:0:2

Pre-requisites: 14AE2006 - Aerodynamics, 14AE2012 - Aircraft Structures, 14AE2014 - Aircraft Performance

Course Objectives:
- To impart knowledge about inputs required for Aircraft design
• To introduce methodology for aerodynamic design of aircraft
• To introduce power plant selection to meet performance requirements
• To introduce the methodology for structural design of aircraft

Course Outcome:
• Ability to design an aircraft/Spacecraft with given configuration
• Estimating the design parameters required for its better performance

Works to be carried out:
1. Comparative study of the different type of the aircrafts / spacecraft and their specifications and performance details.
2. Preliminary weight estimations, selection of main parameters, Power plant selection, In case of Aircraft: Aerofoil selection for Wing, Tail and Control surfaces
3. Preparation of lay out of balance diagram and three view drawings
4. Detailed performance calculation and Stability Estimates, V-n diagram

14AE2024 COMPUTATIONAL STRUCTURAL ANALYSIS LABORATORY

Credit 0:0:2

Pre-requisites: 14AE2012 - Aircraft Structures

Course Objectives:
• To provide the knowledge on various structural analysis software packages.
• To impart the understanding of the stress analysis of different types of structural components

Course Outcome:
• An understanding of the basics Software packages.
• Ability to analyze and design various structural elements using the software.

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE2025 THERMAL ENGINEERING FOR AEROSPACE

Credits: 3:0:0

Pre-requisites: 14ME2014 - Engineering Thermodynamics

Course Objectives:
• To impart knowledge on behavior of compressible fluid flow
• To impart knowledge on effect of transonic and supersonic flow over flying vehicles

Course Outcome:
• Ability to design flying vehicles for transonic and supersonic flights
• Ability to understand the effect of shock wave on aircraft/engine performance

Internal Combustion Engines – Classification, Components and their function, Working and comparison of Two stroke and Four stroke Engines, Fuel Injection system and Lubrication system in SI and CI engines, Air standard cycles and Efficiency, Comparison of cycles, Steam flow through nozzles and Nozzle efficiency, Supersaturated and meta-stable expansion, Classification of steam turbines, compounding - Working principle of reciprocating compressors, Multi-stage air compressor and Rotary compressors, simple Vapour compression refrigeration, Aircraft air conditioning system , Air cycle refrigeration system, Humidity control system
References:

14AE2026 WIND TUNNEL TECHNIQUES

Credits: 3:0:0

Course Objectives:
- To provide knowledge of various types of wind tunnel and test techniques.
- To introduce the basic concepts of measurement of forces and moments on models during the wind tunnel testing.

Course Outcome:
- An understanding of the various types of wind tunnel and test techniques.
- Familiarity with the application of different types of wind tunnel for various test requirements.
- Knowledge in the flow visualization and measurement techniques.


References:

14AE2027 NAVIGATION, GUIDANCE AND CONTROL OF AEROSPACE VEHICLES

Credits: 3:0:0

Pre-requisites: 14AE2010 - Aircraft Instrumentation

Course Objectives:
- To provide the information regarding the concepts of navigation, guidance and control of an aircraft.
- To provide necessary mathematical knowledge required for modeling the guidance and control methods.

Course Outcome:
- To deploy the skills effectively in design of control for aerospace vehicle systems and in understanding the functioning of navigation methods.
- Exposure to various topics such as 6-DOF equations of motions, autopilots and augmentation systems and missile guidance systems.

2014 | Department of Aerospace Engineering
Introduction to navigation systems - Types Different co-ordinate systems - Transformation Techniques; Different types of radio navigation; - Introduction to Inertial Sensors; INS components; Introduction to GPS - system description - basic principles - position and velocity determination.

Introduction to Guidance and control; Need for automatic flight control systems; Displacement Autopilot - Pitch Orientation Control system; Methods of Obtaining Coordination, Yaw Orientation Control system. Introduction to Fly-by-wire flight control systems, Lateral Autopilot; Operating principles and design of guidance laws, homing guidance laws.

References:

14AE2028 EXPERIMENTAL STRESS ANALYSIS

Credits: 3:0:0

Pre-requisites: 14AE2005 - Strength of Aerospace Materials

Course Objectives:
- To impart the knowledge in experimental method of finding the response of the structure to different types of load.

Course Outcome:
- Knowledge of the general aspects of strain measurements
- Ability to understand the principle of operation of different type of strain gauges, circuits


References:

14AE2029 AIR TRAFFIC CONTROL AND AERODROME DETAILS

Credits: 3:0:0

Course Objectives:
- To impart knowledge on the procedures of aerodrome formation and the functioning of air traffic control.
- To provide information regarding the physical characteristics of the aerodrome.
Course Outcome:

- An understanding of the functioning of the air traffic services and its units.
- An understanding of the concepts of radar services and the visual aids for navigation.

Objectives of ATS - Parts of ATC service - Scope and Provision of ATCs, VFR & IFR operations, Classification of ATS air spaces, Altimeter setting procedures, Division of responsibility of control; Area control service, Assignment of cruising levels minimum flight altitude ATS routes and significant points, RNAV and RNP - Vertical, lateral and longitudinal separations based on time / distance, ATC clearances, Flight plans, Position report; Radar service, Basic radar terminology - Identification procedures using primary/ secondary radar, Alerting service, Rules of the air; Aerodrome data - Basic terminology; Instrument runway, Physical characteristics of runway - Markings, Lightings; Visual aids for navigation Wind direction indicator, Landing direction indicator, Aerodrome beacon, Identification beacon – Simple approach lighting system, VASI & PAPI

References:

14AE2030 BASICS OF AEROSPACE ENGINEERING

Credits: 3:0:0

NOTE: This course is offered to other dept/school students

Course Objectives:

- To introduce the basic concepts of aircrafts, rockets, satellites and their application
- To impart knowledge about the basic parts and their function and construction

Course Outcome:

- An understanding the nature of aerospace technologies
- Knowledge in principles of flight, power plants used and fundamentals of structures.

Historical evolution; Developments in aerodynamics, materials, structures and propulsion over the years; Components of an airplane and their functions; Different types of flight vehicles, classifications; Basic instruments for flying; Principles of flight- Evolution of lift, drag and moment; General types of Aircraft construction, Fuselage and Wing Structure; Aerospace materials, metallic and non-metallic materials; Basic ideas about piston, turboprop and jet engines, Basic Propeller theory; Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

References:
5. Course material of Faculty Enablement Program on “Introduction to Aircraft Industry”, conducted by Infosys, Mysore through Campus connect Program.
14AE2031 INTRODUCTION TO NON - DESTRUCTIVE TESTING

Credits: 3:0:0

Course Objectives:
- To provide the knowledge in various processes involved in non-destructive testing.
- To impart knowledge in NDT application in Aerospace maintenance field.

Course Outcomes:
- Knowledge in non – destructive testing, its scope and purpose.
- An understanding of the different NDT processes.


References:

14AE2032 AERO-ELASTICITY

Credits: 3:0:0

Pre-requisites: 14AE2012 - Aircraft Structures, 14AE2015Aircraft Stability and Control

Course Objectives:
- To impart the basic concepts of Aeroelasticity
- To provide knowledge about the Static and dynamic Aeroelastic phenomena

Course Outcome:
- An understanding of the Aero-elastic phenomena
- Ability to predict the Aeroelastic behavior
- Knowledge in preventing body (i.e. Aircrafts) from Aeroelastic instability.


References:

14AE2033 ADVANCED SPACE DYNAMICS

Credits: 3:0:0

Pre-requisites: 14AE2016 - Space Dynamics

Course Objectives:
- To impart the knowledge related to the basics of celestial mechanics, Hamiltonian dynamics and analytical methods.
- To impart the knowledge related to the orbits in restricted three-body problem.

Course Outcome:
- Ability to compute the orbits of satellites with Hamiltonian dynamics and perturbation theory.
- Ability to understand different type of orbits in the restricted three-body problem.

Fundamental principles and definitions, central orbits, the problem of two bodies, Lambert’s theorem, force model, fundamentals of perturbation theory, perturbation in the elements, Lagrange’s and Hamilton's equations, the method of canonical transformations, the general integrals of the problem of n-bodies, the problem of three bodies, restricted three-body problem, periodic and quasi-periodic orbits, perturbations - geometrical considerations, analytical methods.

References:

14AE2034 INTRODUCTION TO HYPersonic FLOWS

Credits: 3:0:0

Pre-requisites: 14AE2021 - Gas Dynamics

Course Objectives:
- To introduce the features of in-viscid hypersonic flows, viscous hypersonic flows and high temperature effects
- To provide knowledge regarding estimation of flow over bodies under hypersonic conditions
Course Outcome:
- Ability to solve problems involving in-viscid and viscous hypersonic flows
- An understanding of high temperature effects in hypersonic aerodynamics.
- An understanding of the design issues for hypersonic wings
- Ability to use computational tools to evaluate hypersonic flows.


References:
4. Ernst Heinrich Hirschel, Basics of Aerothermodynamics, Springer Verlag Berlin, 2005

14AE2035 AIRCRAFT SYSTEMS

Credits: 3:0:0

Pre-requisites: 14CE2003 - Fluid Mechanics

Course Objective:
- To impart knowledge on importance and operating principles of aircraft systems
- To impart knowledge on aircraft environmental and flight conditions

Course Objective:
- Ability to design systems for different category of aircraft
- Ability to diagnose aircraft systems performance

Types of flight control systems and its importance, design features and components. Types of hydraulic systems and its importance, design features, application and components. Fuel system & subsystem design features and its importance and components. Importance and design features of environmental control system, oxygen systems, fire protection systems, deicing & anti icing system, pilot life supporting and Ejection system. Importance, design features and components of Gas Turbine Engine lubrication, fuel and FADEC system. Secondary power and Engine starting system and its design features and operation. Current trends in aircraft systems design.

References:

14AE3001 ADVANCED SOLID MECHANICS

Credits: 3:0:0

Course Objectives:
- To impart an understanding of the basic concepts of stress, strain, displacement and transformations.
- To provide the in-depth knowledge in various stresses in plates, shells, thick circular cylinders and discs.

Course Outcomes:
- Ability to analyze the strength, predict failure and incorporate design considerations in solids.
- Ability to apply and use energy methods to find force, stress and displacement in simple structures.

Principal stresses and strains; Mohr’s circle representation of triaxial stresses and strains; Shear centre, stress and deflection of beams subjected to unsymmetrical bending; Bending of rectangular and circular plates; Contact stresses -Point and line contact; Buckling of columns; Stress concentration in tension and compression members; Stresses in a plate with a circular hole, elliptical hole and small semi circular grooves; Beam on Elastic Foundations and supports

References:

14AE3002 ADVANCED COMPUTATIONAL FLUID DYNAMICS

Credits: 3:0:0

Course Objectives:
- To provide knowledge on governing equations of fluid dynamics.
- To provide an understanding of the solution methodologies of discretised equations, turbulence and combustion models.

Course Outcome:
- Knowledge of performing CFD Analysis.
- Ability to apply the boundary conditions and solve CFD problems using turbulence and combustion models.

Introduction to CFD. Governing equations of fluid flow and heat transfer, Navier Stoke’s equations, conservative, differential and integral form of transport equations. Classifications PDEs, Solution methodology- Direct, Relaxation, TDMA. Turbulence and two equation model. Combustion modeling- SCRS and two step reaction model.

FDM for steady and unsteady convection diffusion problems, ADI technique. Quasi 1-D nozzle flow. Two-D supersonic flow, Prandtl-Meyer expansion. Supersonic flow over a flat plate.

References:

14AE3003 THERMODYNAMICS AND HEAT TRANSFER

Credits: 3:0:0

Course Objectives:
- To impart an understanding of the principles of thermodynamics.
- To provide in-depth knowledge of the principles of heat transfer and its relevance in engineering applications.

Course Outcome:
- Knowledge of thermodynamics laws, principles and their applications.
- Ability to apply heat transfer principles to real-time problems.


References

14AE3004 FLIGHT PERFORMANCE AND DYNAMICS

Credits: 3:0:0

Course Objectives:
- To introduce the parameters effecting the Flight performance.
- To impart knowledge about the concept of Stability and control of Aircraft.
- To introduce with the concept of dynamic stability of Aircraft.

Course Outcome:
- Ability to make preliminary performance estimation.
- Ability to analyse the stability of aircraft using dynamical analysis.
Ability to assess the requirement of control force

Atmospheric Structure and its significance: Performance characteristics of aircraft steady level flight, climb, gliding and turn flight; Basic Propeller Theory; Definition of stability, static stability, longitudinal, directional and lateral; stick free stability: stick fixed stability; Neutral Point; Dynamic Longitudinal Stability – Equations of motion, stability Derivatives, Routh’s discriminant, Dutch roll and Spiral instability, Auto rotation and Spin, Two control airplane; stability criterion and stability diagrams; Analysis of unsteady flight, trajectory optimization, automatic control and guidance.

References:

14AE3005 ORBITAL SPACE DYNAMICS

Credits: 3:0:0

Course Objectives:
- To impart the knowledge in two-body, restricted three-body and n-body problem, Hamiltonian dynamics, canonical transformations, Poincare surface sections.
- To provide necessary knowledge to study the satellite and interplanetary trajectories.

Course outcome:
- Ability to solve the orbital problems related to Earth satellite orbits using Hamiltonians.
- Ability to generate interplanetary orbits in the frame work of restricted three-body problem.

Fundamental principles and definitions, central orbits, problem of two bodies, Kepler’s equation and Lambert’s theorem, force model, fundamentals of perturbation theory, perturbation in the elements, Lagrange’s and Hamilton's equations, the method of canonical transformations, the general integrals of the problem of n-bodies, the problem of three bodies, restricted three-body problem, periodic and quasi-periodic orbits, Poincare surface sections.

References:
14 AE3006 ADVANCED AERODYNAMICS

Credits: 3:0:0

Course Objectives:
- To introduce the basics of air flow
- To familiarize student with the airfoils and wings and the flow over them

Course Outcome:
- An understanding of the flow behavior various body shapes
- Ability to assess the forces and moments due to flow


References:
3. Ernst Heinrich Hirschel, Basics of Aerothermodynamics, Springer Verlag Berlin, 2005
5. Rathakrishnan, E, Theoretical Aerodynamics, John Wiley & Sons, 2013
7. Theodore A. Talay, Introduction to the Aerodynamics of Flight, National Aeronautics and Space Administration, 1975

14AE3007 ADVANCED PROPULSION

Credits: 3:0:0

Pre-requisites: 14AE3003 -Thermodynamics and Heat Transfer

Course Objectives:
- To impart knowledge on working principles, operation and performance of Gas Turbine Engine (GTE), Ramjet, Scramjet and Rocket engines
- To impart knowledge on characteristics of GTE modules and its matching

Course Outcome:
- Ability to design an engine for aerospace application
- Ability to evaluate GTE performance at component and system level


References:
5. Philip P. Walsh and Paul Fletcher, Gas Turbine Performance, Blackwell Publishing company, 2004

14AE3008 AEROSPACE STRUCTURAL ANALYSIS

Credits: 3:0:0

Pre-requisites: 14AE3001 - Advanced Solid Mechanics

Course Objectives:
- To impart the knowledge on the structural behavior of aircraft components under different types of loads
- To provide the understanding in structural design methods for aerospace vehicles

Course Outcome:
- Knowledge in various methods of analysis of aerospace structural members.
- Familiarity with the buckling property of plates and the concepts of shear flow
- Ability to understand the basic structural members of an Aircraft and launch vehicle.

Brief historical review of development of the Aerospace structural systems. Design aspects of Aerospace structures; Structural materials and stress-strain characteristics. Structural analysis methods-analytical and numerical; Virtual work, Energy method in Structural Analysis; Bending, shear and torsion of thin-walled members. Bending and buckling of thin plates and stiffened plates. Stress analysis of wing, control surfaces and their structural members, Stress analysis of fuselage and its structural members, Failure modes. Introduction to FEM.

References:
7. G F Titterton, Aircraft Materials and Processes, Himalayan Books, New Delhi, 1956

14AE3009 ADVANCED AVIONICS

Credits: 3:0:0

Course Objectives:
- To impart the understanding in basic principles, theory and operation of flight instruments and modern avionics systems
- To familiarize the student with the concepts of guidance and control of an aircraft and to provide the necessary mathematical knowledge that are needed in modeling the guidance and control methods.
- To familiarize the student with the advanced concepts of remote sensing and image processing for aerospace applications.

Course Outcomes:
- An understanding of the theory of transmission and reception of radio waves and functioning of radar systems.
• An understanding of autopilots and missile guidance systems and ability to deploy these skills effectively in the design of control of aerospace systems.
• An understanding of vision based navigation and control and modeling physical process.


References:
3. IAP. Avionics Fundamentals, IAP., 1987

14AE3010 ADVANCED COMPUTATIONAL FLUID DYNAMICS LAB

Credits: 0:0:1

Co-requisites: 14AE3002 - Advanced Computational Fluid Dynamics

Course Objective:
• To familiarize with the working of CFD codes
• To familiarize the students with actual setting up of the problem and solution procedure
• To extract the required data, post process and compare with available data

Course Outcome:
• Knowledge in performing CFD Analysis.
• Ability to apply the boundary conditions and solve CFD problems.
• Ability to solve problems using turbulence and combustion models.

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE3011 ADVANCED AERODYNAMICS LAB

Credits: 0:0:2

Co-requisites: 14AE3006 - Advanced Aerodynamics

Course Objectives:
• To introduce various experimental facilities
• To provide the knowledge of different sensors, measurement techniques and their use for conducting the test, acquiring the data and their analysis

Course Outcome:
Ability to
• choose proper experimental facilities
• configure the experiment and conduct the test
• visualize the flow and pressure distribution over 2D and 3D bodies by tuft & smoke methods
The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE3012 STRUCTURAL ANALYSIS LAB

Credits: 0:0:2

Pre-requisites: 14AE3001 - Advanced Solid Mechanics
Co-requisites: 14AE3008 - Aerospace Structural Analysis

Course Objective:
- To provide the basic knowledge on the testing equipment for various structural components.
- To impart the practical exposure with the measuring equipment and sensors.

Course Outcome:
- Ability to select test equipment for different types of static loading.
- Ability to conduct tests, analyze results, document and compare with analytical/theoretical results

The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE3013 AIRCRAFT MODELING LAB

Credits: 0:0:1

Course Objectives:
- To provide the role of Computer Modeling on Aerospace Engineering studies.
- To introduce the components of Computer aided design (CAD), basic concepts of Geometric modeling systems – wireframe, surface and solid modeling systems.
- To develop the modeling skills of student for simple mechanical, hydraulic, thermal and structural systems.

Course Outcome:
- Gaining the hands on experience in latest software packages.
- Knowledge in the design and modeling of aircraft structures.

The faculty conducting the Laboratory will prepare a list of 6 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE3014 AERO PROPULSION LAB

Credits: 0:0:2

Prerequisites: 14AE3003 - Thermodynamics and Heat Transfer

Course Objective:
- To impart knowledge on basic concepts and operation of various propulsion systems
- To provide practical exposure to the operation of various propulsion systems

Course Outcome:
- Ability to understand the design features of various propulsion systems
- Ability to evaluate the performance of various propulsion systems
The faculty conducting the Laboratory will prepare a list of 12 experiments and get the approval of HoD/Director and notify it at the beginning of each semester.

14AE3015 ELEMENTS OF AEROSPACE ENGINEERING

Credits: 3:0:0

Course objectives:
- To introduce the basic concepts of aircrafts, rockets, satellites and their application
- To impart knowledge about basic parts and their function and construction details
- To introduce the orbital mechanics

Course Outcome:
- Understanding the nature of aerospace technologies,
- Knowledge in various types of aerospace vehicles, satellites and their applications


References:

14AE4001 BASIC CELESTIAL MECHANICS

Credits: 4:0:0

Course Objectives:
- To impart the knowledge of the modern celestial mechanics through Hamiltonian dynamics. Lie series.
- To impart the knowledge of interpreting the results of numerical simulations carried out with different methods.

Course Outcome:
- Ability to apply the knowledge of Hamiltonian dynamics, Lie series to various real systems.
- Ability to understand the properties of KAM tori, and be able to detect periodic, quasi-periodic orbits and chaotic zones.

References:

14AE4002 ORBITAL MECHANICS

Credits: 4:0:0

Course Objectives:
• To impart the knowledge of basics of two-body, restricted three-body problem, elliptic restricted three-body problem etc and regular variables.
• To impart the knowledge on solar system, basics of orbital mechanics and various factors affecting the satellite orbits.

Course Outcome:
• Ability to estimate the trajectory and performance and carry out the analysis of the space vehicle with the use of proper reference coordinate system.
• Ability to generate preliminary design of inter-planetary trajectory.

The motion of the centre of mass, relative motion, Lambert's Theorem, some expansions of elliptic motion, Solution of Kepler’s equation.Equations of motion, Jacobi integral, Tisserand's criterion for the identification of comets, reduction, regularization, Numerical integration- Fourth-order Runge-Kutta method. Location of equilibrium points, Motion near the collinear and equilateral points, non-linear phenomenon around the equilibrium points.Three-dimensional restricted three-body problem, elliptic restricted three-body problem, Hill's problem. Levi-Civita transformation, KS transformation, Equations of motion of RTBP in KS variables

References:

14AE4003 HYPERSONIC FLOW THEORY

Credits: 4:0:0

Course Objectives:
• To introduce the features of inviscid hypersonic flows, viscous hypersonic flows and high temperature effects
• To impart knowledge regarding Testing facilities and Instrumentation for Hypersonic flows.
• To provide understanding of the numerical methods for hypersonic flows.

Course Outcome:
Ability to solve in-viscid hypersonic flows problems
Ability to solve problems involving viscous hypersonic flows
An understanding of high temperature effects in hypersonic aerodynamics.
Ability to use computational tools to evaluate hypersonic flows.
Knowledge of recent developments in hypersonic aerodynamics with application to aerospace systems

Characteristic features of hypersonic flow, basic equations boundary conditions for in-viscid flow, shock shapes over bodies, flow over flat plate, flow over a wedge, hypersonic approximations, Prandtl-Meyer flow, axisymmetric flow over a cone, Hypersonic small disturbance theory, applications to flow over a wedge and cone, blast wave analogy, Newtonian impact theory, Busemann centrifugal correction and shock expansion method, tangent wedge methods, introduction to viscous flows, hypersonic boundary layers, and non-equilibrium high enthalpy flow, introduction to high enthalpy impulse test facilities and instrumentation. Introduction to computational fluid mechanics techniques for hypersonic flows and methods of generating experimental data for numerical code validation at hypersonic Mach numbers in hypervelocity facilities.

References:
4. Ernst Heinrich Hirschel, Basics of Aerothermodynamics, Springer Verlag Berlin, 2005

14AE4004 HYPERSONIC AEROTHERMODYNAMICS

Credits 4:0:0

Course Objectives:
- To introduce the features of viscous hypersonic flows and high temperature effects as they apply to hypersonic aerodynamics.
- To provide an understanding of Testing facilities and Instrumentation for Hypersonic flows
- To impart the knowledge regarding Numerical methods for hypersonic flows

Course Outcome:
- Ability to solve problems involving high temperature in-viscid hypersonic flows
- Ability to solve problems involving high temperature viscous hypersonic flows.
- Ability to use computational tools to evaluate hypersonic flows.
- Knowledge of experimental methods and Instrumentation for Hypersonic flows
- Knowledge of recent developments in hypersonic aerodynamics with application to aerospace systems

Introduction to hypersonic aerodynamics, shock waves and basic properties of gases, characteristic features of hypersonic flows, equations of motion equilibrium and non-equilibrium flows, introduction to transport properties of gases, definition and techniques of estimation of aerothermodynamics environments including CFD, ground based test facilities for hypersonic flow field measurements including heat transfer and aerodynamic forces, analysis of stagnation region flow field and pressure distribution over hypersonic flight vehicles. Viscous Inviscid interactions, aerodynamics and design consideration of hypersonic reentry vehicles.

References:
3. Ernst Heinrich Hirschel, Basics of Aerothermodynamics, Springer Verlag Berlin, 2005