AEROSPACE ENGINEERING

Programme Structure

Course Code	Course Title	Lecture (L) Hours Per	Tutorial (T) Hours Per Week	Practical (P) Hours Per	Total Credits
ASE2351	Elements of Aerospace Engineering	3	-	-	3
ASE2451	Elements of Space Engineering	3	-	-	3
ASE2551	Aircraft System	3	-	-	3
ASE2651	Aircraft Stability & Control	3	-	-	3
ASE2751	Aircraft Performance	3	-	-	3
ASE2851	Introduction to Automatic Flight Control	3	-	-	3
	TOTAL				**18**

AEROSPACE ENGINEERING

Syllabus

ELEMENTS OF AEROSPACE ENGINEERING

Course Code: ASE2351 **Credit Units: 03**

Course Objective:
Being a foundation course for aerospace students, its objective is to provide introductory knowledge about some of the topics of aerospace engineering, such as, flight vehicles, principles of flight mechanics, propulsion systems, aerospace structures, aircraft systems, passenger comfort systems, power-actuated systems, etc.

Course Contents:
Module I: Introduction to Aerospace Systems
Development of Flying Machines. Classification of flight vehicles. Introduction to prominent features of design; Airplanes, helicopter and other flying machines along with examples.

Module II: Aircraft Systems
Lifting and non-lifting surfaces. Lift and drag of airfoils, stalling, finite span wing, induced drag. Wing plan-form variations, forward and aft swept wings, high lift devices, use of control surfaces, elementary ideas about stability and control of airplanes.

Module III: Principles of Aerospace Propulsion
Classification of propulsive units and their features; Fixed and variable pitch air screws, piston prop engine, turbo prop engine, turbo jet engines and its variations, ramjet, pulse jet, rockets engines; Solid and liquid propellant engine, the concept of staging of rockets, structural features in each case, Engine starting-systems.

Module IV: Aerospace Vehicle Structure
Importance of strength/weight ratio, introduction to loads on different parts of the vehicle, detailed description of the fuselage, wing and tail surfaces, wing surfaces, wing fuselage jointing methods, different types of under carriages,

Module V: Power Actuated Systems
Hydraulic system: details and various components, selector and sequence, switches, electro-hydro-mechanical system, pneumatic system, fuel systems, etc.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:

- Kermode A.C., “Mechanics of Flight”, Pitman Publication, UK, 1984.
- Kermode A.C., “Aeroplane Structures”, Pitman Publication, UK, 1986.
- Michael J. Kroes and JR Rardon, “Aircraft Basic Science” Tata McGraw-Hill.
- Michael J. Kroes and Thomas W. Wild, “Aircraft Power Plants”.
- John Anderson Jr., “Fundamentals of Aerodynamics”.
- Irewin E. Treager, “Aircraft Gas Turbine Engine Technology”.
- Haughten E.L. and Carpentar P.W., “Aerodynamics for Engineering Students”.

ELEMENTS OF SPACE ENGINEERING

Course Code: ASE2451 **Credit Units: 03**

Course Objective:
The knowledge of concepts of Space Systems is important for understanding the essentials of Aerospace discipline, particularly subsystems such as Rockets and Missiles; Satellite Launch Vehicles; Satellite Systems; Tracking, Telemetry and Tele-command; Control, Guidance and Navigation; Flight and Orbital Mechanics.

Course Contents:
Module I: Introduction to Space Systems
Evolution of Rocketry, Planet/Solar Systems, Space Exploration, Space Applications, Future Trends.

Module II: Elements of Rockets and Satellites
Satellite Launch Vehicles, Missiles, Communication Satellites, Remote Sensing.

Module III: Orbital Mechanics and Mission Design
Motion in Gravitational Field. Orbits, Orbital Elements, Hohmann Transfer. Delta-V Requirements. Orbit Perturbations.

Module IV: Ground Systems
Ground Stations, Link Calculations, Station Keeping, Deep Space Network (DSN), VSATs, GPS, ILS, Auto Pilot and Navigation Systems.

Module V: Space Craft Systems
Space Craft Types, Attitude Determination and Control, Power Systems, Thermal Control, Space Craft Propulsion, Communication Satellites, Remote Sensing Satellites.

Module VI: Launch Vehicles and Missiles
PSLV, GSLV, Re-useable Vehicles, Propellant & Propulsion Systems, Thermal Protection, Control Systems, SAM, IRBM, ICBM.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:
Text:
- Satellite Technology, Principles and Applications, Maini, AK
- Guided Weapons Systems Design, Balakrishnan, R
- Space Systems Engineering, Fortesque, PW
- Getting Started With Amateur Satellites, Gould Smith, G

References:
- Wings of Fire, Abdul Kalam, APJ
- Satellite Communication Systems, Evans
- Space Today, Mohan Sundara Rajan
- Handbook of Satellite Communications, ITU

AIRCRAFT SYSTEMS

Course Code: ASE2551 **Credit Units: 03**

Module I: Flight Control Systems
Primary and secondary flight control,flight control linkage systems,push-pull control rod system,cable and pulley systems,high lift control systems, flight control actuation,linear actuator,mechanical actuator,mechanical screw jack actuator,direct drive actuation,fly-by-wire actuator, electro-hydrostatic actuator, electro-mechanical actuator

Module II: Engine Control Systems
Engine starting, engine indications, engine oil system, fuel flow control, ignition control, air flow control, engine offtakes, control system parameters, input signals, output signals, Reverse Thrust on modern civil aircraft, throttle levers, starting sequence

Module III: Hydraulic and Pneumatic Systems
Hydraulic circuit design, Hydraulic actuation, Hydraulic Fluid, Fluid pressure, Fluid flow rate, Hydraulic piping, Hydraulic Pumps, Hydraulic reservoir, emergency power source, Use of bleed air, Engine bleed air control, Bleed air system indications

Module IV: Environment Control Systems
Need for controlled environment, heat sources, ram air cooling, fuel cooling,engine bleed,bleed flow and temperature control,air cycle refrigeration,humidity control,hypoxia,tolerance

Module V: Gyroscopic Systems
Gyroscope and its properties,gyro horizon,turn and bank indicator, turn coordinator, direct reading magnetic compass,and directional gyroscope.

Module VI: Emergency Systems
Warning systems, Fire detection & suppression,emergency power source, Emergency landing,emergency system testing

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

References:
1. Aircraft systems -Ian Moir and Allan Seabridge
2. Aircraft Systems - David A. Lombardo -

AIRCRAFT STABILITY AND CONTROL

Course Code: ASE2651 **Credit Units: 03**

Course Objective:
This objective of this course is to make the students understand various aspects of stability of an aircraft in flight, both stick fixed and stick free, and how geometric features of control surfaces and their proper angular movements achieve it. Students are also given an analytical understanding of longitudinal, lateral and directional stability and measures that can be taken to control the same.

Course Contents:

Module I: Stick Fixed Static Longitudinal Stability
Introduction to stability of airplane, stick fixed longitudinal stability, effect of power, Neutral point, Centre of gravity limits. In flight measurement of stick fixed neutral point.

Module II: Control Surfaces and Aerodynamic Balancing
Control surface hinge moments, floating and restoring tendencies, different types of tabs used on airplanes. Frise Aileron, Spoiler Controls.

Module III: Stick Free Static Longitudinal Stability
Effect of free elevator on airplane stability, Elevator Control force, stick force gradients, Neutral point, Controls free center of gravity limit. In-flight measurement of stick free neutral point.

Module IV: Maneuvering Flight
Effect of acceleration on airplane balancing, Elevator angle per g, and stick force per g, Maneuver margins.

Module V: Directional Stability and Control
Asymmetric flight, Feather cock stability, contribution of different parts of Airplane, Rudder Fixed and Rudder free static directional stability, rudder lock.

Module VI: Lateral Stability and Control
Dihedral Effect. Contribution of different parts of airplane controls in roll, aileron control power, cross coupling of lateral and directional effects.

Module VI: Dynamic Stability
(a) Longitudinal Dynamic Stability: Simple analysis of short period and phugoid modes, stick-fixed and stick-free.
(b) Lateral and Directional Dynamic Stability: Simple analysis of roll subsidence spiral mode and Dutch roll.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:

- Perkins and Hage, “Airplane Performance Stability and Control”.
- Etkin, “Dynamics of flight”
- Dickinson, “Aircraft Stability and control for Pilots and Engineers”.
- Babister, “Aircraft Stability and Control”.
- Dommasch Serby and Connoly, “Airplane Aerodynamics”.

AIRCRAFT PERFORMANCE

Course Code: ASE2751 **Credit Units: 03**

Course Objective:
In this course, aerospace students will learn the concepts and basic structural analysis of 2-D members in Cartesian and Polar coordinates using various methods. Students will also understand the analysis of torsional loads on bars, shells and walled tubes as well as the analysis of statically indeterminate structures.

Course Contents:
Module I: Introduction to Aerospace Structure
Importance of strength/weight ratio, introduction to loads on different parts of the vehicle, detailed description of the fuselage, wing and tail surfaces, wing surfaces, wing fuselage jointing methods, different types of under carriages,

Module II: Imposed Loads
General considerations, basic flight loading conditions, Aerodynamic loads, inertia loads, Load factors for translational acceleration, load factor diagram.

Module III: Evaluation of Vehicle Material
Mechanical properties, stress- strain curve, fatigue, strength-weight comparison of materials, sandwich construction and composite materials.

Module IV: Structural Analysis Method

Energy Method, strain energy, complimentary energy.The two Castinglino's theorems and application to statically indeterminate system.Unit load method, principle of virtual work and virtual displacement, principle of superposition, reciprocal theorem.

Module V: Structural Analysis of Wing and Fuselage
Analysis of typical semi-monocoque structures, distribution of concentrated loads in webs, loads on fuselage bulkhead, analysis of wing ribs. Shear flow in tapered webs.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:

- S. Timoshanko and J.N., "Theory of Elasticity".
- David J. Perry, "Aircraft Structures", McGraw Hill Book Co. 1949.
- T.H.G. Megson, "Aircraft Structures for Engineering Students", Edward Arnold and Co., 2nd Ed, 1990.
- Richard S. Shevell, "Fundamentals of Flight".
- Darrol stinton, "The anatomy of the Aeroplane
- Pilot's Handbook of Aeronautical Knowledge

INTRODUCTION TO AUTOMATIC FLIGHT CONTROL

Course Code: ASE2851 **Credit Units: 03**

Course Objective:
This course is designed to provide adequate knowledge to analyse one-degree and multi-degree of freedom systems of vibrations using different methods to find out their natural frequencies and frequency / amplitude responses.

Course Contents:

Module I: Introduction
Open Loop and Closed Loop (Feed Back) control systems. Types of feedback control systems. Laplace's transform.

Module II: Feedback Control Systems
Transfer function of linear systems. Impulse response of linear systems, Block diagrams of feed back control systems, Multivariable systems. Block diagram algebra.

Module III: Analysis of Feedback Control Systems
Typical test input signals, Time domain performance characteristics of feedback control systems. Effects of derivative and integral control. Steady State response of feedback control system-steady State error, Frequency response.

Module IV: System Stability
Routh-Hurwitz Criterion, the Root Locus Method.

Module V: Auto-pilots
Longitudinal Auto Pilots: Brief description through Block diagrams and Root Locus of Displacement Auto Pilot. Pitch Orientational Control System. Acceleration control system.

Module VI: Miscellaneous
Fly-By-Wire control system, Instrument Landing System.

Examination Scheme:

Components	A	CT	S/V/Q	HA	EE
Weightage (%)	5	10	8	7	70

CT: Class Test, HA: Home Assignment, S/V/Q: Seminar/Viva/Quiz, EE: End Semester Examination; Att: Attendance

Text & References:

- John H. Blackelock, "Automatic Control of aircraft and Missiles", John Wiley and Sons, 2nd Ed.1990
- Perkins C.D. and Hage R.E., "Airplane Performance Stability and Control", John Wiley and Sons.
- Bernard Etkins, "Dynamics of Flight Stability and Control", John Wiley & Sons, 2/Ed 1989
- Robert C. Nelson, 'Flight Stability and Automatic Control", McGraw Hill Co, 1989.
- Pallet H.J., "Automatic Flight Control", B.S. Professionals Books, Oxford, 3rd Ed, 1987.
- Benjamin C. Kuo, "Automatic Control Systems," Prentice Hall of India, 1992