AE1 - M.Tech Aerospace Engineering								
Sem.	Course No	Course Name	Lecture	Tutorial	Extended Tutorial	Afternoon Lab Session	Time to be spent outside of class	Credits
1	AS5010	Aerodynamics and Aircraft performance	3	0	0	0	6	9
	AS5020	Aerospace Propulsion	3	0	0	0	6	9
	AS5030	Aerospace Structures	4	0	0	0	8	12
	AS5110	Laboratory I	0	0	0	3	0	3
	AS5011	Compressible Fluid flows	3	0	0	0	6	9
	MAE1	Mathematics Elective 1	3	0	0	0	6	9
		Total Credits :	**16**	**0**	**0**	**3**	**32**	**51**
2	AS5040	Flight Mechanics	4	0	0	0	7	11
	AS5120	Laboratory II (Str. Lab)	0	0	0	3	0	3
		Aircraft Design Elective*	2	1	2	3	4	12
	DPE1	Department Elective 1	3	0	0	0	6	9
	DPE2	Department Elective 2	3	0	0	0	6	9
	DPE3	Department Elective 3	3	0	0	0	6	9
	AS5150&	MTech Project Proposal	0	0	0	0	4	**
		Total Credits :	**15**	**1**	**2**	**6**	**33**	**53**
Summer	AS5150#	MTech Project (summer)	**0**	**0**	**0**	**0**	**20**	****
3	AS5150+	MTech Project (III semester)	0	0	0	0	27	**
	AS5100	Mini Project	1	2	1	3	5	12
		Total Credits :	**1**	**2**	**1**	**3**	**32**	**12**
4	AS5150	MTech Project (IV sem)	0	0	0	0	38	89**
		TOTAL CREDITS						**205**

Notes:

1) Credits and grades for MTech Project (AS5150&, AS5150#, AS5150+ and AS5150 together)
2) Students with AE background may take alternate courses in lieu of AS 5010, AS 5020, AS5030, AS5011 and AS5040 with the consent of the department.
3) A minimum of 2 electives to be taken from the list of AS electives or their equivalents. Any other M.Tech. level course may be taken as the third elective with the consent of Faculty Advisor.
4) Aircraft Design Elective * may be one of AS5211 Design of Subsonic aircraft, AS5212 Design of Supersonic aircraft, AS5213 Design of UAVs and MAVs.

Course Contents

AS5010 AERODYNAMICS AND AIRCRAFT PERFORMANCE

Introduction

Aerodynamics: Governing equations for fluid flows; incompressible flow and Bernoulli's equation; stream function and velocity potential; source, sink and doublet; non-lifting flow past a circular cylinder; circulation; lifting flow past a circular cylinder; Kutta-Joukowski theorem; flow past an airfoil: Kutta condition and Kelvin's starting vortex; thin airfoil theory; compressibility correction; finite wings: tip vortices, downwash and induced drag; Prandtl's lifting line theory; propeller theory

Aircraft Performance: Standard atmosphere; parts of an airplane; drag-divergence; area-rule; drag polar; steady flight: climb, range, endurance; accelerated flight; V-n diagram; takeoff and landing

Text Books:

1. "Principles of Ideal Fluid Aerodynamics", Krishnamurty Karamcheti
2. "Aerodynamics" , L. J. Clancy
3. "Aerodynamics, aeronautics, and flight mechanics", B. W. McCormick

Reference Books:

1. "Aerodynamics for Engineering Students", E. L. Houghton, P. W. Carpenter, Steven Collicott & Daniel Valentine
2. "Low Speed Aerodynamics", Joseph Katz and Allen Plotkin
3. "Fundamentals of Aerodynamics", John D. Anderson
4. "Fluid Mechanics", Frank M. White
5. "Incompressible Flow", Ronald L. Panton
6. "Introduction to Flight", John D. Anderson
7. "Aircraft Performance and Design", John D. Anderson

AS5020 AEROSPACE PROPULSION

Classification of airbreathing engines, efficiencies of air breathing engines, engine performance of turbojet, turboprop, turbo shaft, turbofan and ramjet engines, thrust augmentation of turbojets and turbofan engines.

Aerothermodynamics of non-rotating propulsion components such as intakes, combustor and nozzle. Basics of moving components (fans, compressors and turbines).

Thrust equation and specific impulse, efficiencies of non-airbreathing engines vehicle acceleration, drag, gravity losses, multi-staging of rockets. Classification of chemical rockets, brief description of electrical rockets. Performance of solid, liquid and hybrid propellant rockets. Brief description of various components of solid, liquid and hybrid propellant rockets.

Text Books:

1. Understanding Aerospace Chemical Propulsion - H S Mukunda
2. Mechanics and Thermodynamics of Propulsion - Hill and Peterson
3. Rocket Propulsion elements - Sutton G P
4. Elements of Propulsion: Gas Turbines And Rockets - Mattingly J.D

AS5030 AEROSPACE STRUCTURES

Determination of loads acting on major airplane components (wing, fuselage, tails). Analysis of wings. Shear centre. Bending and torsion of closed and open tubes. Multi-cell tubes. Columns and beam-columns. Bending and buckling of plates and sheet stringer combination. Analysis of fuselage.

Text Books:

1) THG Megson, Aircraft Structures for Engineering Students.
2) DJ Peery, Aircraft Structures.

Reference Books:

1) EF Bruhn, Analysis and Design of Flight Vehicle Structures.
2) M.Niu, Airframe Stress Analysis & Sizing.

AS5011 COMPRESSIBLE FLUID FLOWS

Fluid Mechanics: Classification of fluid flow; Eulerian and Lagrangian viewpoints; streamlines, streaklines and pathlines; velocity gradient tensor; governing equations of fluid flow; Cauchy stress; boundary layers; Couette flow.

Compressible Flows: Review of thermodynamics; isentropic flow relations; compressibility, speed of sound and Mach number; 1-D steady flow: adiabatic, frictionless flow with normal shock – Hugoniot curve, Fanno flow, Rayleigh flows; 2-D steady flows: flows with oblique shock, θ-β-M curve, Prandtl-Meyer expansion fans; 1-D unsteady flows: moving shock waves, shock tube; flow through CD nozzles: area-Mach relation, choked flow, underexpanded and over expanded nozzles; linearized subsonic and supersonic flows – Prandtl-Glauert relations.

Text Books:

1. “The Dynamics and Thermodynamics of Compressible Fluid Flow”, A. Shapiro
2. “Incompressible Flow”, Ronald L. Panton

Reference Books:

1. “Modern Compressible Flow”, John D. Anderson
2. “Fundamentals of Compressible Fluid Flow”, Genick Bar-Meir

3. “Gas Dynamics”, M. J. Zuckrow, J. D. Hoffman
4. “Elements of Gas Dynamics”, H.W. Liepmann, A. Roshko
5. “Fluid Mechanics”, Frank M. White

AS 5110 LABORATORY-I

Aerodynamics Experiments

AS5040 FLIGHT MECHANICS

Review of rigid body dynamics: Derivation of full six degree of freedom equations of motion (translational, angular, and kinematic). Various reference axis systems – earth-fixed, body, stability, and wind axes.
Equations of angular motions: Airplane pitch dynamics and longitudinal stability – trim, neutral point, static margin. Treatment of spacecraft attitude dynamics – disturbance torques, spin stabilization.
Overview of satellite attitude determination and control techniques.
Aircraft flight dynamics: Linearization of equations of motion about a steady flight condition.
Aerodynamic derivatives. Aircraft dynamic modes and stability. Introduction to lateral and directional stability.
Basics of orbital mechanics: Two body motion. Motion in elliptic, hyperbolic, and parabolic orbits. Keplerian orbital elements. Orbital maneuvers and transfer orbits.

Text Books:

1. Nelson, R. “Flight stability and automatic control,” McGraw Hill, 2007.
2. Kaplan, M. “Modern spacecraft dynamics and control,” Wiley, 2011.
3. Sinha, N.K. and Ananthkrishnan, N. ‘Elementary Flight Dynamics with an Introduction to Bifurcation and Continuation Methods,’ CRC Press, 2013.

Reference Books:

1. Perkins, C.D. and Hage, R. E. “Airplane performance, stability and control,” John Wiley, 1963.
2.Anderson, J.D. “Introduction to flight,” McGraw Hill, 2011.
3. Cook, M.V. “Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control,” Butterworth-Heinemann, 3rd edition, 2012.
4. Wertz, J.R. “Spacecraft attitude determination and control,” Kluwer, 1978.
5. Sidi, M.J. “Spacecraft dynamics and control,” Cambridge, 1997.
6. Wiesel, W.E. “Spaceflight dynamics,” McGraw Hill, 1997.

AS 5120 LABORATORY II

Structures Experiments

AS5100 MINI-PROJECT

Objectives:
To expose students to a systems approach and to total aerospace vehicle engineering.

Course Contents:
Design/ fabrication of aerospace vehicle systems