DEPARTMENT OF AEROSPACE ENGINEERING, IIT MADRAS

B. Tech. Curriculum

Semester wise credit distribution

I	II	III	IV	V	VI	VII	VIII	Total
28	22	25	24	25	28	18	14	184

SEMESTER I

No	Title	L	T	P	C	Cat
AS1010	Introduction to Aerospace Engineering	2	0	0	2	PMT
CY1002	Chemistry Lab I	0	1	3	3	SCY
GN1100	Life Skills	0	0	2	2	HPF
ID1100	Concepts in Engineering Design	2	0	0	2	BET
MA1010	Calculus I Functions of One Variable	3	1	0	4	SMA
ME1100	Thermodynamics	3	0	0	3	BET
ME1120	Engineering Drawing	3	0	0	3	BES
PH1010	Physics I	3	0	0	3	SPH
PH1030	Physics Lab I	0	0	3	2	SPH
WS1010	Workshop I (Winter)	0	0	6	4	BES
	TOTAL				**28**	

SEMESTER II

No	Title	L	T	P	C	Cat
AM1100	Engineering Mechanics	3	1	0	4	BET
CS1100	Computational Engineering	3	0	0	3	BET
CY1001	Chemistry: Structure, Bonding & Reactivity	3	1	0	4	SCY
MA1020	Calculus II Functions of Several Variables	3	1	0	4	SMA
PH1020	Physics II	3	0	0	3	SPH
PH1040	Physics Laboratory II	0	0	3	2	SPH
WS1020	Workshop II (Summer)	0	0	3	2	BES
	TOTAL				**22**	

SEMESTER III

No	Title	L	T	P	C	Cat
AS1020	Fluid Mechanics	3	1	0	4	PMT
AS2010	Basic Strength of Materials	3	1	0	4	PMT
AS2100	Introduction to Aerospace Lab	0	0	6	4	PML
BT1010	Life Sciences	2	0	0	2	SLS
EE1100	Basic Electrical Engineering	3	0	0	3	BET
ID1200	Ecology and Environment	2	0	0	2	BET
HSE1	Humanities Elective 1	3	0	0	3	HSS
MA 2020	Differential Equations	3	0	0	3	SMA
	TOTAL				**25**	

SEMESTER IV

No	Title	L	T	P	C	Cat
AS2030	Gas Dynamics	3	1	0	4	PMT
AS2050	Aerodynamics	3	1	0	4	PMT
AS2070	Aerospace Structural Mechanics	4	0	0	4	PMT
AS2080	Vibrations	3	1	0	4	PMT
AS2510	Low Speed Lab	0	0	3	2	PML
HSE2	Humanities Elective 2	3	0	0	3	HSS
MA2010	Complex Variables & Transform Techniques	3	0	0	3	SMA
	TOTAL				**24**	

SEMESTER V

No	Title	L	T	P	C	Cat
AS2040	Flight Dynamics I	3	1	0	4	PMT
AS2060	Experimental Aerodynamics	3	0	0	3	PMT
AS2520	Propulsion Lab	0	0	3	2	PML
AS3020	Aerospace Structures	3	1	0	4	PMT
AS3270	Propulsion	4	0	0	4	PMT
AS3510	Aero Lab I	0	0	3	2	PML
MAE	Mathematics Elective	3	0	0	3	SMA
MNS1	Minor Elective 1	3	0	0	3	MNS
	TOTAL				**25**	

SEMESTER VI

No	Title	L	T	P	C	Cat
AS3010	Introduction to Space Technology	4	0	0	4	PMT
AS3050	Flight Dynamics II	3	0	0	3	PMT
AS3500	Industrial Training[Summer]				2	PIT
AS3520	Aero Lab II	0	0	3	2	PML
AS4020	Industrial Lecture	1	0	0	1	PIL
AS5210	Aerodynamic Design (Self Study)	0	0	6	4	PSS
DPE1	Department Elective 1	3	0	0	3	PMT
DPE2	Department Elective 2	3	0	0	3	PMT
DPE3	Department Elective 3	3	0	0	3	PMT
MNS2	Minor Elective 2	3	0	0	3	MNS
	TOTAL				**28**	

SEMESTER VII

No	Title	L	T	P	C	Cat
AS4590	Project I				0	PMP*
DPE4	Department Elective 4	3	0	0	3	PMT
DPE5	Department Elective 5	3	0	0	3	PMT
DPE6	Department Elective 6	3	0	0	3	PMT
FRE1	Free Elective 1	3	0	0	3	
HSE3	Humanities Elective 3	3	0	0	3	HSS
MNS3	Minor Elective 3	3	0	0	3	MNS
	TOTAL				**18**	

SEMESTER VIII

No	Title	L	T	P	C	Cat
AS4600	Project II				9	PMP
HS3050	Professional Ethics	2	0	0	2	HPF
FRE2	Free Elective 2	3	0	0	3	
	TOTAL				**14**	

***** Grade will be assigned at the end of 8th Semester

Notes :

1) If required by the area of B.Tech. project, a maximum of 2 electives relevant to the project may be taken for PMT credit even though they are not Aerospace electives or their equivalents.

2) For B.Tech., project is optional. In lieu of project, a student may take 3 PMT electives including a maximum of two from any other Engineering/Physics/Chemistry department.

3) For B.Tech. (Honours), project is compulsory and carries 12 credits. In addition, a student should take 2 AS electives (6 credits) and 1 Maths elective (3 credits). These students are allowed to take a maximum of 2 additional courses in any semester starting from 5th semester.

SEMESTER I

AS 1010 Introduction to Aerospace Engineering 2 0 0 2

History of aviation and space flight ; Classification of aircraft and space vehicles ; Functions of major components of airplane and space vehicles ; subdivisions of aerospace engineering ; elements of aerodynamics, propulsion, structures, systems, flight mechanics and controls. Indian aerospace activities.

SEMESTER III

AS 1020 Fluid Mechanics 3 1 0 4

Brief history of fluid mechanics, Fluids and their properties, Concepts of viscosity, thermal conductivity, mass diffusivity, compressibility and surface tension, Molecular considerations of the same.

Hydrostatics – center of pressure, center of buoyancy and meta centre, ISA.

Tensor calculus (Cartesian Tensors).

Eulerian and Lagrangian methods of describing fluid motion, streamlines, streack lines and path lines. Kinematics of fluids – translation, rotation and deformation, circulation, Green's Stokes theorems.

Derivation of governing equations for mass, momentum, energy in the differential and integral forms and their specialization for inviscid and potential flow. Equations in non-inertial frames. Bernoulli's equation. One-dimensional flow.

Illustrative examples in various cases.

Laminar flows like Couette flow and Hagen-Poiseuille flow, flow in bearings and boundary layers.

Dimensional analysis

Viscous flow over a flat plate and in pipes – transition, turbulent flow, skin friction and losses in pipes

AS 2010 Basic Strength of Materials 3 1 0 4

Introduction to stress and strain – Hooke's law, stress and strain transformations, principal stresses and strains – Torsion of circular sections – Thin-walled pressure vessels – Bending and shearing stresses in beams of symmetric cross-sections – Deflections of statically determinate beams by various methods – Stresses due to combined loading, theories of failure.

Introduction of theory of elasticity, field equations, Airy's stress – function, two-dimensional problems in Cartesian coordinates, Lame's solution for thick cylinders.

AS 2100 Introduction to Aerospace Lab. 0 0 6 4

Experimental techniques in fluid mechanics like visualization of flow over different bodies and estimation of parameters like lift, drag etc.
Simple experiments to demonstrate material behavior including determination of material constants and material strength. Experiments to determine stresses/displacements under simple loading.
Understanding the flight mechanics and functions of various control surfaces using a flight simulator

SEMESTER IV

AS 2030 Gas Dynamics 3 1 0 4

Introductory concepts of compressible flow, Isentropic one-dimensional flow, Normal shocks – stationary and moving , applications, applications to supersonic wind tunnels, Shock tubes, Supersonic Pitot' probes, oblique shock, reflection, Prandtl – Meyer expansion flow. Fanno flow & Rayleigh flow. Under and over expanded nozzles, Shock expansion method for flow over airfoils.

Brief introduction to the methods of characteristics, Prandtl-Glauert and Goethert rules. Ackeret's supersonic airfoil theory. Small perturbation equations for subsonic, transonic, supersonic and Hypersonic flow. Experimental characteristics of airfoils in compressible flow.

AS 2050 Aerodynamics 3 1 0 4

Vortex motion : Helmholtz laws and Kelvin's theorem, Point vortex, vortex sheet, Biot-Savart law.

Incompressible flow past airfoils. Airfoil nomenclature and characteristics. Kutta condition, starting vortex. Method of singularities and thin airfoil theory. Elements of panel method. Experimental characteristics of airfoils.

Momentum and blade elements of theory of propellers.

Incompressible flow past finite wings. Wing nomenclature. Prandtl's lifting line theory. Induced drag. Effect of geometrical parameter on lift and induced drag. Element of lifting surface theory. Flow past swept and delta wings.

Elements of flow past bodies in incompressible flow.

Lift, drag and moment characteristics of the entire airplane.

AS 2070 Aerospace Structural Mechanics **4 0 0 4**

Buckling: columns (solid, thin-walled), flat sheets (compression, shear, bending, combined) Beam-columns
Laminated Composites: Classification, Constitutive Laws, Introduction to Classical Laminate Theory with Applications
Introduction to Fatigue, S-N Curve, Miner's Rule, Stress Concentration, Introduction to Fracture Mechanics, Modes of Fracture, Fatigue Crack Growth.
Experimental Techniques: Strain Gages & Associated Circuits; 2-D photoelasticity, Calibration, Stress Separation

AS 2080 Vibrations **3 1 0 4**

Systems with single and two degrees of freedom; free, forced vibrations with and without damping – Lagrange's equation – Equations of motion of systems with many degree of freedom – Exact analysis of longitudinal, torsional and lateral vibrations of continuous elastic systems – Approximate methods; Rayleigh, Ritz, Galerkin, etc.

AS 2510 Low Speed Lab **0 0 3 2**

Wind tunnels – similarly considerations – Pressure and velocity measurements – Force and moment measurements – Hot-wire measurements – Experiments designed to cover the above.

SEMESTER V

AS 2040 Flight Dynamics I **3 1 0 4**

Forces and moments acting on a vehicle in flight.

Equations of motion of a rigid flight vehicle.

Various types of drags. Drag polar of vehicles from low speeds to hypersonic speeds.

Review of the variation of thrust / power and SFC with altitude and velocity, for various air breathing engines and rockets.

Performance of airplane in level flight, glide, climb, accelerated flight, turn, maneuvers, take-off and landing. Flight limitations.

Flight-testing : Altitude definitions, Speed definitions, Air Speed, altitude and temperature measurements. Errors and calibration. Measurement of engine power, charts and corrections. Flight determination of drag polar.

AS 2060 Experimental Aerodynamics **3 0 0 3**

Definition of accuracy, precision, resolution etc. Estimation of uncertainty analysis of data. Principles of model testing. Characteristic features, operation and performance of Low Speed, Transonic, Supersonic, Hypersonic and special tunnels. Shock tubes and Shock Tunnels.

Introduction to measurements of pressure, temperature, flow rate and velocity. Measurements of Mach number, pressure, temperature, velocity and flow rate in test facilities. Optical flow visualization, hot-wire anemometer, Laser diagnostics.

AS 2520 Propulsion Laboratory **0 0 3 2**

Experiments in Aerothermodynamics of Propulsion; Calorific value of fuel, propellant burning rate, static testing of rockets etc.

AS 3020 Aerospace Structures **3 1 0 4**

Unsymmetrical bending; bending and shearing stresses/shear flows in beams of solid and thinwalled open sections, shear centre, lumped area-Strain energy, Castigliano's theorems, application to beams, trusses and indeterminate structures-Torsion of single and multicell tubes, Neuber tubes, open sections, restrained warping-Combined bending and torsion, multicell structures

AS 3270 Propulsion **4 0 0 4**

Turbo machinery : Axial compressors and turbines; centrifugal pumps and compressors. Rocket propulsion elements; Complex chemical equilibrium calculations; Chemical rocket thrust chambers and associated systems; non-chemical rockets; combined cycle propulsion concepts.

AS 3510 Aero Lab – 1 **0 0 3 2**

Experiments in structures; unsymmetrical bending of beams, shear centre of open section, composite beams, determination of material constants etc.

Flow through CD nozzle, performance of transonic and supersonic wind tunnels, experiments in transonic tunnel.

SEMESTER VI

AS 3010 Introduction to Space Technology **4 0 0 4**

Space mission types, Environment, Astrodynamics; fundamentals of orbital mechanics (two body motion, circular and escape velocity, motion in elliptic hyperbolic and parabolic orbits); basic orbital maneuvers. Rocket propulsion fundamentals; ascent flight mechanics; launch vehicle selection. Atmospheric entry; entry flight mechanics; entry heating. Attitude determination and controls; basic concepts; review of rotational dynamics; rigid body dynamics; disturbance torques; passive attitude control; active control; attitude determination. Thermal control. Spacecraft power. Telecommunications.

AS 3050 Flight Dynamics II **3 0 0 3**

Basic concepts of stability and control, Static longitudinal, directional and lateral stability and control. Equations of equilibrium and stability – contribution of major components. Stick-fixed stability, control of effectiveness, hinge moment, Tabs, aerodynamic balancing, effects of freeing the stick. Control forces and force gradients. Critical conditions for stability and control. Effect of Maneuvers. Longitudinal dynamic stability; Equations of motion of a disturbed aircraft, stability derivatives, characteristic equation for stick fixed case, modes and stability criterion, effect of freeing the stick. Brief description of lateral and directional dynamic stability – Spiral, divergence and dutch roll. Response, automatic control, autorotation and spin.

Determination of neutral points and maneuver point in flight tests.

AS 3520 Aero Lab.- II **0 0 3 2**

Experiments in supersonic tunnel, flow visualization techniques in high speed flow. Shock tube, hot wire and laser Doppler anemometry.

Experiments such as Euler load by southwell plot, buckling of thin-walled open sections, influence lines, moment indicator, frame analysis etc.

AS 5210 Aerodynamic Design **0 0 6 4**

Introduction to systematic design, Preliminary weight estimation, sizing from a conceptual sketch, airfoil and geometry selection, thrust loading and wing loading selection, initial sizing, configuration layout and special consideration in configuration designs. Propulsion and fuel system integration. Internal Layout, weight and balance. Design of wing, fuselage, control surfaces and landing gear and subsystems, surface controls. Performance, stability and control. Preliminary cost analysis.

Preliminary aerodynamic design of a given set of specifications. Drawing its three views and layout an estimation of its performance and stability characteristics.