



GATE Syllabus

Aerospace Engineering



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AEROSPACE ENGINEERING

Subject Code: AE

Course Structure

Sections/Units	Topics
Section A	Engineering Mathematics
Topics (Core)	
1	Linear Algebra
2	Calculus
3	Differential Equations
Topics (Special)	
1	Fourier Series
2	Laplace Transforms
3	Numerical Methods for Linear and Nonlinear Algebraic Equations
4	Numerical Integration
5	Differentiation
Section B	Flight Mechanics
Topics (Core)	
1	Basics
2	Airplane performance
3	Static stability
Topics (Special)	
1	Dynamic stability
2	Euler Angles

3	Equations of Motion
4	Aerodynamic Forces and Moments
5	Stability & Control Derivatives
6	Decoupling of Longitudinal and Lateral-Directional Dynamics
7	Longitudinal Modes
8	Lateral-Directional Modes
Section C	Space Dynamics
Topics (Core)	
1	Central Force Motion
2	Determination of Trajectory
3	Orbital Period in Simple Cases
Topics (Special)	
1	Orbit Transfer
2	In-plane and Out-of-Plane
Section D	Aerodynamics
Topics (Core)	
1	Basic Fluid Mechanics
2	Airfoils and wings
3	Compressible Flows
Topics (Special)	
1	Elementary Ideas of Viscous Flows Including Boundary Layers
2	Wind Tunnel Testing
3	Measurement and Visualization Techniques
Section E	Structures

Topics (Core)	
1	Strength of Materials
2	Flight Vehicle Structure
3	Structural Dynamics
Topics (Special)	
1	Vibration of Beams
2	Theory of Elasticity
3	Equilibrium and compatibility equations, Airy's stress function
Section F	Propulsion
Topics (Core)	
1	Basics
2	Thermodynamics of Aircraft Engines
3	Axial Compressors
4	Axial Turbines
5	Centrifugal Compressor
6	Rocket Propulsion
No Special Topic	
<p>Note: In each of the following subjects the topics have been divided into two categories – Core Topics and Special Topics. The corresponding sections of the question paper will contain 90% of their questions on Core Topics and the remaining 10% on Special Topics.</p>	

Course Syllabus

Section A: Engineering Mathematics

Core Topics

Unit 1: Linear Algebra

- Vector algebra
- Matrix algebra

- Systems of linear equations
- Rank of a matrix
- Eigenvalues and eigenvectors

Unit 2: Calculus

- Functions of single variable
- Limits
- Continuity and differentiability
- Mean value theorem
- Chain rule
- Partial derivatives
- Maxima and minima
- Gradient
- Divergence and curl
- Directional derivatives
- Integration:
 - Line
 - surface and volume integrals
 - Theorems of Stokes
 - Gauss and Green

Unit 3: Differential Equations

- First order linear and nonlinear differential equations
- Higher order linear ODEs with constant coefficients
- Partial differential equations and separation of variables methods

Section B: Flight Mechanics

Core Topics

Unit 1: Basics

- Atmosphere:
 - Properties
 - Standard atmosphere
- Classification of aircraft
- Airplane (fixed wing aircraft) configuration and various parts

Unit 2: Airplane performance

- Pressure altitude:
 - Equivalent
 - Calibrated
 - Indicated Air Speeds
- Primary flight instruments:
 - Altimeter
 - ASI
 - VSI
 - Turn-bank indicator
 - Drag polar
 - Takeoff and landing
 - Steady climb & descent
 - Absolute and service ceiling
 - Cruise
 - cruise climb
 - Endurance or loiter
 - Load factor
 - Turning flight
 - V-n diagram
- Winds:
 - Head
 - Tail
 - Cross winds

Unit 3: Static stability

- Angle of attack, sideslip
- Roll, pitch & yaw controls
- Longitudinal stick fixed & free stability
- Horizontal tail position and size
- Directional stability
- Vertical tail position and size
- Dihedral stability
- Wing dihedral
- Sweep & position
- Hinge moments, stick forces

Section C: Space Dynamics

Core Topics

- Central force motion
- Determination of trajectory
- Orbital period in simple cases

Section D: Aerodynamics

Core Topics

Unit 1: Basic Fluid Mechanics

- Conservation laws:
 - Mass
 - Momentum (Integral and differential form)
- Potential flow theory:
 - Sources
 - Sinks
 - Doublets
 - Line vortex and their superposition
- Viscosity:
 - Reynold's number

Unit 2: Airfoils and wings

- Airfoil nomenclature
- Aerodynamic coefficients:
 - Lift
 - Drag
 - Moment
- Kutta-Joukowski theorem:
 - Thin airfoil theory
 - Kutta condition
 - Starting vortex
- Finite wing theory
 - Induced drag
- Prandtl lifting line theory
- Critical and drag divergence Mach number

Unit 3: Compressible Flows

- Basic concepts of compressibility
 - Conservation equations
- One dimensional compressible flows
 - Fanno flow
 - Rayleigh flow
- Isentropic flows
 - Normal and oblique shocks
 - Prandtl-Meyer flow
- Flow through nozzles and diffusers

Section E: Structures

Core Topics

- Strength of Materials:
 - States of stress and strain
 - Stress and strain transformation
 - Mohr's Circle. Principal stresses
 - Three-dimensional Hooke's law
 - Plane stress and Strain
- Failure theories:
 - Maximum stress
 - Tresca
 - Von Mises
- Strain energy:
 - Castigliano's principles
 - Analysis of statically determinate and indeterminate trusses and beams
 - Elastic flexural buckling of columns

Unit 2: Flight vehicle structures

- Characteristics of aircraft structures and materials
- Torsion, bending and flexural shear of thin-walled sections
- Loads on aircraft

Unit 3: Structural Dynamics

- Free and forced vibrations of undamped and damped SDOF systems
- Free vibrations of undamped 2-DOF systems

Section F: Propulsion

Core Topics

Unit 1: Basics

- Thermodynamics
- Boundary layers and heat transfer and combustion thermochemistry

Unit 2: Thermodynamics of aircraft engines

- Thrust
- Efficiency and engine performance of turbojet
- Turbo prop
- Turbo shaft
- Turbofan and ramjet engines
- Thrust augmentation of turbojets and turbofan engines
- Aerothermodynamics of non-rotating propulsion components such as:
 - Intakes
 - Combustor
 - Nozzle

Unit 3: Axial compressors

- Angular momentum
- Work and compression
- Characteristic performance of a single axial compressor stage
- Efficiency of the compressor
- Degree of reaction

Unit 4: Axial turbines

- Axial turbine stage efficiency

Unit 5: Centrifugal compressor

- Centrifugal compressor stage dynamics
 - Inducer
 - Impeller
 - Diffuser

Unit 6: Rocket propulsion

- Thrust equation and specific impulse
- Vehicle acceleration
- Drag
- Gravity losses
- Multi-staging of rockets
- Classification of chemical rockets
- Performance of solid and liquid propellant rockets