XE-B	Fluid Mechanics

Section 1: Flow and Fluid Properties

Fluid Properties: Density, viscosity, surface tension, relationship between stress and strain-rate for Newtonian fluids.

Classification of Flows: Viscous versus inviscid flows, incompressible versus compressible flows, internal versus external flows, steady versus unsteady flows, laminar versus turbulent flows, 1-D, 2-D and 3-D flows, Newtonian versus non-Newtonian fluid flow.

Hydrostatics: Buoyancy, manometry, forces on submerged bodies and its stability.

Section 2: Kinematics of Fluid Motion

Eulerian and Lagrangian descriptions of fluid motion. Concept of local, convective and material derivatives. Streamline, streakline, pathline and timeline.

Section 3: Integral Analysis for a Control Volume

Reynolds Transport Theorem (RTT) for conservation of mass, linear and angular momentum.

Section 4: Differential Analysis

Differential equations of mass and momentum for incompressible flows. Inviscid flows - Euler equations and viscous flows - Navier-Stokes equations. Concept of fluid rotation, vorticity, stream function and circulation.

Exact solutions of Navier-Stokes equations for Couette flow and Poiseuille flow, thin film flow.

Section 5: Dimensional Analysis

Concept of geometric, kinematic and dynamic similarity. Buckingham Pi theorem and its applications.

Non-dimensional parameters and their physical significance - Reynolds number, Froude number and Mach number.

Section 6: Internal Flows

Fully developed pipe flow.

Empirical relations for laminar and turbulent flows: friction factor, Darcy-Weisbach relation and Moody's chart. Major and minor losses.

Section 7: Bernoulli's Equation and its Applications, Potential Flows

Bernoulli's Equation: Assumptions and applications.

Flow measurements - Venturi meter, Pitot-static tube and orifice meter.

Elementary Potential Flows: Velocity potential function.

Uniform flow, source, sink and vortex, and their superposition for flow past simple geometries.

Section 8: External Flows

Prandtl Boundary Layer Equations: Concept and assumptions.

Boundary Layer Characteristics: Boundary layer thickness, displacement thickness and momentum thickness.

Qualitative idea of boundary layer separation, streamlined and bluff bodies, and drag and lift forces.