

**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.