**3(3+0)**

 Fundamental governing equations; continuity, momentum, energy; Elements of potential flow theory; Laminar flow; Selected exact solutions; laminar and turbulent boundary layer; Thin shear-layer approximation; Simple shear layers and more complex flows Computational solution

**Detailed Course Content**

Basic Concepts and Fundamentals: Definition and properties of Fluids, Fluid as continuum, Langragian and Eulerian description, Velocity and stress field, Fluid statics, Fluid Kinematics.

Governing Equations of Fluid Motion and Some exact solutions of Navier-Stokes Equations: Reynolds transport theorem, Integral and differential forms of governing equations: mass, momentum and energy conservation equations, Navier-Stokes equations, Euler’s equation, Bernoulli’s Equation, Couette flows, Poiseuille flows, fully developed flows in non-circular cross-sections, Unsteady flows, Creeping flows.

Potential Flows: Revisit of fluid kinematics, Stream and Velocity potential function, Circulation, Irrotational vortex, Basic plane potential flows: Uniform stream; Source and Sink; Vortex flow, Doublet, Superposition of basic plane potential flows, Flow past a circular cylinder, Magnus effect; Kutta-Joukowski lift theorem; Concept of lift and drag.

Laminar Boundary Layers: Boundary layer equations, Boundary layer thickness, Boundary layer on a flat plate, similarity solutions, Integral form of boundary layer equations, Approximate Methods, Flow separation, Entry flow into a duct.

Turbulent Flow: Concept of small-disturbance stability, Orr-Somerfield equation, Inviscid stability theory, Boundary layer stability, Thermal instability, Transition to turbulence. Introduction to turbulent boundary layer, Fluctuations and time-averaging, General equations of turbulent flow, Turbulent boundary layer equation, Flat plate turbulent boundary layer, Turbulent pipe flow, Prandtl mixing hypothesis, Turbulence modeling, Free turbulent flows

Introduction to Computational Fluid Dynamics (CFD): Boundary conditions, Basic discretization Finite difference method, Finite volume method and Finite element method.