

4 <sup>th</sup> Semester	RCH4C004	FLUID FLOW AND FLOW MEASUREMENT	L-T-P 3-0-0	3 CREDITS
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**Module-I: (07 Hrs.)**

Basic concepts, Properties and classification. Types of Fluids. Fluid Statics: Hydrostatic Pressure, Pressure Measurements. Introduction to fluids in motion, Kinematics of Fluid Flow, velocity field stream function. Flow in boundary layers. Its formation & growth in tubes and plates.

**Module-II: (10 Hrs.)**

Basic equations of fluid flow continuity, momentum & Bernoulli's equation. Flow measuring devices: Flow measurement, Orifice meter, Venturi meter, Pitot tube, and Rota meters, brief introduction to non-conventional methods: Lasers Doppler velocimetry, Particle image, velocimetry, Ultrasonic flow meters, Electromagnetic flow meters.

**Module-III: (10 Hrs.)**

Flow of incompressible fluid in pipes, Relation between skin friction & wall shear. Laminar flow in pipes, Hagen-Poiseuille equation, Friction factor, Friction from changes in velocity or direction, Flow of compressible fluids, Basic equations. Flow past immersed bodies, Drag co-efficient. Motion of particles Through fluids. Its mechanics. Terminal velocity.

**Module-IV: (08 Hrs.)**

Macroscopic Balances, derivation of integral balances for mass, energy and momentum, differential balances of fluid flow: derivation of continuity and momentum (Navier-Stokes) equations, applications to plane Couette, plane Poiseuille and pipe flows.

**Module-v: (10Hrs.)**

Dimensional analysis and similitude, Buckingham pi theorem and applications, model analysis Fluid transportation, valves pumps and compressors, Performance analysis of fluid machines. Fluid friction in porous media, flow through packed beds and fluidized beds, movement of solid particles in a fluid flow, lift forces. Basic equations of turbulent flow, turbulent boundary layer equation, flat plate turbulent boundary layer, and turbulent pipe flow.

**Books:**

1. Unit operation of Chemical Engineering, 7th ed. By W.L Mc Cabe, J C Smith, and P Harriott, McGraw-Hill.
2. A Textbook of Fluid Mechanics and Hydraulic Machines, 9<sup>th</sup> ed. by R K Bansal.

**Reference books:**

1. Fluid Mechanics for Chemical Engineers, 3<sup>rd</sup> ed. by Noel de Nevers, McGraw-Hill.
2. Fluid Mechanics: Including Hydraulic Machines by AK Jain.
3. Introduction to Fluid Mechanics and Fluid Machines, 3<sup>rd</sup> ed. By S K Som, G Biswas, and S Chakraborty, McGraw-Hill, 2011

**Web Learning References:**

1. Fluid flow operations by Dr. S. K. Majumdar, Department of Chemical Engineering, IIT Guwahati (Link: <https://nptel.ac.in/courses/103/103/103103147/> )