CEPC2006 FLUID FLOW AND FLOW MEASUREMENT (3-0-0)

Overall course Objective: The objective of course is to teach the students regarding various fluids, pumps, flow types, flow measurement devices and boundary layer. The students will also learn about Navier-Stokes equation, Hagen Poiseuille equation and different equations which would define flow.

Course Outcomes

On completion of the course, the students would have

CO1: The knowledge of fundamental concepts in fluids statics and to use dimensional analysis in the design and interpretation of scale model experiments.

CO2: The ability to solve hydrostatic and fluid flow problems using Newton's laws of motion.

CO3: The ability to analyse frictional flow in pipes and piping networks and to compute the head loss and power requirements for chemical process equipment.

CO4: The ability to select the metering equipment and fluid moving machinery for an appropriate chemical engineering operation.

Course Articulation Matrix

COs	POs											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	1	1	-	-	-	-	-	-	-	-
CO2	3	2	2	2	-	-	-	-	-	-	-	-
CO3	3	1	3	3	2	2	-	-	-	-	-	-
CO4	3	3	3	3	1	2	-	-	-	-	-	-

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,9th ed.by R K Bansal.

Reference books:

1. Fluid Mechanics for Chemical Engineers,3rd ed.by Noel de Nevers, McGraw-Hill.
2. Fluid Mechanics: Including Hydraulic Machines by AK Jain.
3. Introduction to Fluid Mechanics and Fluid Machines, 3rd 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/)