Subject Code: 01CH0201

Subject Name: Fluid Flow Operations

B.Tech. Year - II

Objective: To understand the governing principles of Fluid Transport in Chemical Process systems**.**

Credits Earned: 5 Credits

Course Outcomes: After completion of this course, student will be able to:

1. To create a vision of understanding the momentum transfer process.
2. To analyze fluid flow concepts.
3. To review the practical importance and relevance of fluid flow in process industry.
4. To be able to utilize the technological methods in problem solving in process plant.
5. To build a bridge between theoretical and practical concepts used in industry.
6. To understand the behaviour of fluid phase operations going in an industry.

Pre-requisite of course: Basic concepts of Engineering Mathematics and Physics

Teaching and Examination Scheme

Teaching Scheme (Hours)			Credits	Theory Marks			Tutorial/ Practical Marks		Total Marks
Theory	Tutorial	Practical		ESE (E)	CSE	Internal (I)	Viva (V)	Term work (TW)	
4	0	2	5	50	20	30	25	25	150

Contents:

Unit	Topics	Contact Hours
1	**Dimensional Analysis & Introduction to Fluid Statics** Dimensions & Units, Dimensional Analysis: Buckingham's π theorem. Fluid Definition, Properties of fluids: Density, Viscosity, Kinematic Viscosity, Surface tension, Buoyancy, Capillarity, Vapour Pressure, Effect of Temperature on viscosity, Introduction and Significance of Momentum Transfer in Chemical Engineering, Fluid statics: Pascal's law and Hydrostatic law of equilibrium. Pressure Measurement: Manometers, Differential Manometers.	4
2	**Phenomenon of Fluid FLow** Classification of fluids: incompressible, compressible, Viscoelastic, Types of Fluid Flow: potential flow, Laminar Flow , Turbulent Flow, Concept of Shear stress & shear rate, Newton's law of Viscosity & concept of Velocity gradient, Classification/Rheological properties of fluids: Newtonian and non-Newtonian fluids, Ostwald-de waele equation/Power Law for non-Newtonian fluids, Turbulence, Reynolds number and transition from laminar to turbulent flow, Eddy viscosity, Boundary Layer Flow, laminar and turbulent flow in boundary layers, boundary layer formation in straight tubes, Nikuradse Equation.	8
3	**Kinematics of Fluid Flow** Mass Balance of Flowing Fluid: Equation of Continuity for Compressible & Incompressible flow, Momentum Balance of Flowing Fluid: Navier-Stokes Equation, Euler Equation, Momentum correction factor, Equation for Potential Flow: Bernoulli Equation (with & without friction), Kinetic Energy correction factor, Friction correction factor, types of Friction: Skin friction & Form Friction.	8
4	**Flow of Fluids in Conduits** Shear stress distribution in pipe, Fanning friction factor, Equivalent diameter for flow in non-circular channels, Velocity distribution of Laminar flow in pipes: ratio of local velocity to maximum velocity, Hagen- Poiseuille equation, Friction factor chart, Effect of Roughness on friction factor, Loss due to sudden expansion and contraction of pipe cross section.	6
5	**Fluid Flow through Immersed Bodies & Packed Beds.** Drag force and drag coefficient, Flow through Beds of Solid: Kozeny- carman equation, Burke-Plummer Equation, Motion of a Particle through Fluids: Mechanics of particle motion, Terminal Velocity, Free and Hindered Settling of particles, Motion of spherical particles, Criterion for settling regime. Fluidization- condition for Fluidization, Minimum Fluidization velocity, Types of Fluidization, Applications of Fluidization.	8

6	**Transportation of Fluids** Basics of pipe, tubing, joint and fittings, stuffing boxes, mechanical seals, gate valves and globe valves, plug cocks and ball valves, check valves, Pumps: Classification and selection, blowers and compressors, Characteristic properties of Pumps: developed head, power requirement, suction lift and Cavitation, NPSH, constructional features and working principle of single suction volute centrifugal Pump, characteristic curves of a centrifugal pump, reciprocating pumps.	6
7	**Metering of Fluids** Construction & working principle: Venturi meter, Orifice meter, Rotameters, Pitot tube, Magnetic meters. Expression of Bernoulli equation for venturi meter and orifice meter, flow calculations based on readings of venture meter, orifice meter and pitot tube.	6
	Total Hours	**46**

References:

1. "Unit Operations of Chemical Engineering", McCabe W L, Smith J C, Harriott P, McGraw Hill Publication, 7th edition 2005.
2. “Chemical Engineering” Vol. I – Fluid flow, Heat Transfer and Mass Transfer; Coulson & Richardson’s, Butterworth – Heinemann Publication, 6th Edition.
3. “Fluid Mechanics for Chemical Engineers”, Noel de Nevers, 2nd edition McGraw Hill Publication

Suggested Theory distribution:

The suggested theory distribution as per Bloom’s taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember	Understand	Apply	Analyze	Evaluate	Create
30%	30%	20%	15%	5%	-

List of Experiments:

1. To study and verify Bernoulli's Theorem.
2. To calibrate venturimeter and obtain it's coefficient of Discharge.
3. To calibrate Orifice meter and obtain it's coefficient of Discharge.
4. To study Rotameters and obtain it's coefficient of Discharge.
5. To study Reynolds's experimental apparatus.
6. Calculation of friction loss in pipe using water.
7. To study Notched weirs apparatus and obtain it's Discharge coefficient.

Instructional Method:

a. The course delivery method will depend upon the requirement of content and need of students. The teacher in addition to conventional teaching method by black board, may also use any of tools such as demonstration, role play, Quiz, brainstorming, MOOCs etc.

b. The internal evaluation will be done on the basis of continuous evaluation of students in the laboratory and class-room.

c. Practical examination will be conducted at the end of semester for evaluation of performance of students in laboratory.

d. Students will use supplementary resources such as online videos, NPTEL videos, e-courses, Virtual Laboratory

Online Web Resources:

1. http://nptel.ac.in/courses/112105171/
2. https://ocw.mit.edu/courses/audio-video-courses/#chemical-engineering
3. http://www.msubbu.in/ln/fm/
4. http://www.engineeringtoolbox.com/fluid-mechanics-t_21.html