GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3130502
Semester – III
Subject Name: Fluid Flow Operations

Type of course: Core course

Prerequisite: Elements of Physics

Rationale: This Subject is essential for Chemical engineering to know the effect of pressure and stress of fluid on different bodies. Further, it is useful for students to know the metering devices for different type of fluids.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Fluid static and its application: Properties of fluids, Pressure concept, Hydrostatic equilibrium, decanters like continuous gravity, centrifugal etc. Fluid Flow Phenomena: Velocity fluid, Velocity gradient and rate of shear, Newtonian and Non Newtonian fluids, Viscosity and momentum flux, Reynolds number and its significance, laminar and turbulent flow; Laminar and Turbulent flow in boundary layers, boundary layer formation in straight tubes, boundary separation and wake formation.	12
2	Basic equations of Fluid Flow: Mass velocity; average velocity; potential flow; streamlines, stream tubes, macroscopic momentum balance, momentum correction factor, Equation of continuity, Bernoulli's equation, corrections for fluid friction, pump work in Bernoulli's equations, angular momentum equations.	10
3	Flow of incompressible fluids: in Conduits and Thin Layers: Flow of incompressible fluids in Conduits and Thin Layers in pipes, relation between skin friction and wall shear, friction factor laminar flow in pipes, kinetic energy correction factor and momentum correction factor for laminar flow of Newtonian fluids, Hagen-Poiseuille equation, effect of roughness, friction factor chart, friction factor inflow through channels of non-circular cross section, equivalent diameter, hydraulic radius, friction from changes in velocity or direction, flow through sudden enlargement of cross section, flow through sudden contraction of cross section, effect of fittings and valves, form friction losses in Bernoulli's equations, separation of boundary layers in diverging channel.	12
4	Flow of Compressible fluids: Mach number, continuity equation total energy balance equation, velocity of sound. Introduction of isentropic expansion, adiabatic frictional flow, isothermal frictional flow, velocity in nozzles.	10

	Flow past immersed bodies: Introduction to Drag, drag coefficient, form drag, and stream lining. Dimensional Analysis: Different methods of dimensional analysis applied to fluid flow problems.	
5	Transportation and Metering of fluid: Pipe and tubing, joint and fittings selection of pipe sizes, prevention of leakage around moving parts, stuffing boxes, mechanical seals, valves like Gate, Globe, Plug cocks, Ball, Check valves. Fluid moving machinery: Pumps its characteristics like developed head power requirement suction lift and cavitations; positive displacement pumps like reciprocating, rotary pumps, centrifugal pumps and its theory, characteristic of head capacity relation, pump priming, fans, blowers like positive displacement, centrifugal blowers, compressor efficiency, vacuum pumps, jet ejectors, comparison of devices for moving fluids. Measurement of flowing fluids: Full bore meter like venturimeter, orifice meter, coefficient of discharge of venturimeter, orifice meter, area meters like Rotameter, target meters, vortex-shedding meters, coriolis meters, magnetic meters etc., insertion meters like pitot tubes.	**16**

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
17	**14**	**18**	**7**	**7**	**7**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Reference Books:

"Unit Operations of Chemical Engineering", McCabe W L, Smith J C, Harriott P, Mc Graw Hill Publication, 7th edition 2005.
"Chemical Engineering" Vol. I – Fluid flow, Heat Transfer and Mass Transfer; Coulson & Richardson's, Butterworth – Heinemann Publication, 6 th Edition.
"Fluid Dynamics and Heat Transfer", James G. Knudson and Donald L. Katz, Mc Graw Hill Publication.

Course Outcomes:

Sr. No.	CO statement	Marks % weightage
CO-1	Identify fluid properties and memorize the concepts of pressure.	25
CO-2	Classify different types of fluid and generalize the concepts of boundary layer and its estimation in different flows.	20
CO-3	Apply and demonstrate the basic equations of fluid flow.	25

CO-4	Calculate and examine the flow in compressible and incompressible fluid along dimensional analysis for problems in fluid flow.	10
CO-5	Propose appropriate pipe size, joints, fitting and valve for chemical processes.	10
CO-6	Evaluate and compare the performance of various fluid flowing machinery i.e pumps and compressor and metering devices i.e. flow meters.	10

Suggested list of experiments

10 experiments needs to be performed during the semester.

1. To study and verify Bernoulli's Theorem
2. To calibrate Venturi meter and obtain it's coefficient of discharge.
3 To calibrate an Orifice meter and obtain it's coefficient of discharge.
4. To study a Rotameter and obtain it's coefficient of discharge.
5. To Study Notched Weirs Apparatus and obtain its discharge coefficient.
6. Study of Pressure measurement devices.
7. Pressure drop in various size of circular pipes.
8. Friction factor for various size of pipes.
9. Pressure drop and friction factor measurement in bend, valves and different fittings.
10. Pressure drop in non-circular pipes of different size.
11. To observe Reynolds's number and flow pattern in Reynolds Apparatus.
12. Centrifugal Pump testing and characteristic curves.
13. Reciprocating Pump testing and characteristic curves.
14. Determination of metacentric heights for floating bodies.

Major Equipment:

Bernoulli's experiment, Reynolds experimental set up.