B. Tech. Semester III

Subject Name: Fluid flow operation **Subject Code: BTCH13301**

Type of course: Professional Core Course
Prerequisite: Elements of physics
Rationale: This Subject is essential for Chemical engineering to know the fluid behaviour under 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. Study of pressure drop in various types of pipe fittings, pumps, compressor etc. are important to understand for chemical engineers.

Teaching and Examination Scheme:

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	150
3	0	2	4	60	25	15	30	20	

CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests **CA2:** Sincerity in attending classes/class tests/ timely submissions of assignments/self-learning attitude/solving advanced problems **TEE:** Term End Examination **TEP:** Term End Practical Exam (Performance and viva on practical skills learned in course) **CA3:** Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course

Content:

Sr. No.	Topics	Teaching Hrs.	Module Weightage
1.	Basic concepts of density and pressure in a fluid, ideal and real fluids, Pascal's law, absolute pressure and pressure gauges, basic concepts of surface tension and buoyancy, fluid flow, equation of continuity, Bernoulli's equation, streamlined and turbulent flow, concept of viscosity, Newton's law of viscosity, brief introduction to non-Newtonian behaviour, Fluid static and its application. 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. Equations of Continuity and Motion (Cartesian, cylindrical, and spherical coordinates) in laminar flows and its applications for the calculation of velocity profiles, shear stresses, power, etc. in various engineering applications.	8	18%
2.	Equation of continuity, Bernoulli's equation, corrections for fluid friction, pump work in Bernoulli's equations, angular momentum equations.	6	13%

3.	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.	6	13%
4.	Mach number, velocity of sound. Introduction of isentropic expansion, adiabatic frictional flow, isothermal frictional flow, velocity in nozzles.	2	5%
5.	Introduction to Drag, drag coefficient, form drag, fluidization. Dimensional Analysis: Different methods of dimensional analysis applied to fluid flow problems.	4	9%
6.	Pipe and tubing, joint and fittings selection of pipe sizes, mechanical seals, valves.	3	6%
7.	Pumps its characteristics, cavitations; positive displacement, centrifugal pumps and its theory, centrifugal blowers, compressor efficiency, vacuum pumps, jet ejectors, comparison of devices for moving fluids. Advanced applications for pumps, valves and ejectors.	8	18%
8.	Full bore meter, orifice meter, area meters, target meters, vortex-shedding meters, coriolis meters, Ultrasonic flow meters, magnetic meters etc., insertion meters.	4	9%
9.	Introduction to CFD. Latest technologies and instruments used for flow dynamics in Industries.	4	9%

Suggested Specification table with Marks (Theory/Practical):

% Distribution of Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25	25	25	15	10	00

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

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Text Books:

Sr. No.	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1	Unit Operations of Chemical Engineering	McCabe W L, Smith J C, Harriott P,	Mc Graw Hill Publication	2005	7th edition

2	Chemical Engineering,Vol. I – Fluid flow, Heat Transfer and Mass Transfer;	Coulson & Richardsons	Butterworth Heinemann Publication	1999	6th Edition.
3	Fluid Dynamics and Heat Transfer	James G. Knudson and Donald L. Katz,	Mc Graw Hill Publication	1959	1st edition
4	Transport Phenomena	Bird R.B., Stewart W.E., and Lightfoot, E.N.	John Wiley & Sons	2007	2nd edition
5	Coulson & Richardson's Chemical Engineering: Chemical engineering design	Coulson J.M., Richardson J.F., and Sinnott, R.K.	Butterworth Heinemann Publication	1993	Second Edition
6	Perry's Chemical Engineers' Handbook,	Green D. and Perry R.	Mc Graw Hill Publication	2007	Eighth Edition

Course Outcome:

Sr. No.	CO Statement After learning this subject, students will be able to	Marks % weightage
CO-1	Identify fluid properties and memorize the concepts of pressure.	20
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.	15
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.	15
CO-6	Evaluate and compare the performance of various fluid flowing machinery i.e pumps and compressor and metering devices i.e. flow meters.	20

Mapping with POs:

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3
CO-1	2	1	1	2	1	2	2	3	3	2	3	2	3	2	2
CO-2	2	2	2	2	2	2	2	3	3	3	3	3	3	2	2
CO-3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2
CO-4	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3

CO-5	3	3	3	3	3	3	3	3	3	3	3	3	2	1	1
CO-6	3	3	3	3	3	3	3	3	3	3	3	3	2	3	2
Rationale*	16	15	15	16	15	16	16	18	18	16	18	16	15	13	12

***Rationale:** Fluid flow operation is required to know the fluid behaviour under the effect of pressure and stress of fluid on different bodies for the Chemical Engineer. Further, it is useful for students to know the metering devices for different type of fluids. Study of pressure drop in various types of pipe fittings, pumps, compressor etc. are important to understand for chemical engineers.

LIST OF PRACTICALS: (Minimum 10 performed.)

10 experiments need 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. To observe Reynolds's number and flow pattern in Reynolds Apparatus.
11. Centrifugal Pump testing and characteristic curves.
12. Determination of free and forced vortex formation.

Major Equipment:

1. Bernoulli's Theorem
2. Venturi meter
3. Orifice meter
4. Rotameter
5. Notched Weirs Apparatus
6. Centrifugal Pump
7. Free and forced vortex formation

List of Open Source/learning website:

- https://cosmolearning.org/courses/fluid-mechanics-chemical-engineering/video-lectures/
- http://www.nptelvideos.in/2012/11/fluid-mechanics.html
- http://ce-iitb.vlabs.ac.in/
- http://uorepc-nitk.vlabs.ac.in/#
- https://nptel.ac.in/courses/103/103/103103147/

List of Open Source Software:

- https://openfoam.org/
- https://www.smartdraw.com/process-flow-diagram/process-flow-diagram-software.htm
- https://dwsim.inforside.com.br/new/
- https://www.cocosimulator.org/index_download.html