



# GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering

Level: UG

Branch: Chemical Engineering (Green Technology and Sustainability Engineering)

Subject Code: BE03044021

Subject Name: Fluid Flow Operations

W. E. F. Academic Year:	2024-25
Semester:	3
Category of the Course:	PCC

<b>Prerequisite:</b>	Elements of Physics
<b>Rationale:</b>	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.

## Course Outcome:

After Completion of the Course, Student will able to:

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

## Teaching and Examination Scheme:

Teaching - Learning Scheme (in Hours per Semester)					Total Credits = TH/30	Assessment Pattern and Marks					Total Marks
L	T	P	PBL*	TH		Theory		Tutorial / Practical			
						ESE (E)	PA (M)	PA/ (I)	PBL (I)	ESE (V)	
45	0	30	45	120	04	70	30	20	30	50	200

Where L = Lecture, T= Tutorial, P= Practical, TW/SL = Term-Work / Self-Learning, TH = Total Hours, ESE = End-Semester Examination, PA = Progressive Assessment

\* Problem Based Learning (PBL) aims to accommodate learning beyond syllabus as per clause 9.4 of NBA manual.



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## Course 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. 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.	10



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<b>5</b>	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.	<b>16</b>
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## 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.

## Suggested list of experiments

**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.



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4. To study a Rotameter and obtain its 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

## List Learning Resources Required:

Students can refer to video lectures available on the websites including NPTEL

### • List of suggested activities for Problem Based Learning:

Sl. No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Industry/Research laboratory visit	Visit = 5h, Report preparation = 5h Total = 10h	Based on report submitted. Report should contain observations and calculations based on industry/ lab data.
2.	Technical Video based learning related to the subject	Duration of video = 5h Report preparation = 5h Total = 10h	Report /presentation based on the video learning outcomes.
3.	Assignment writing. Numerical based assignment is preferable.	5 assignments of 2h each. Total = 10h	Based on the assignment submitted.



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4.	Self learning on-line course	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
5.	Complex problem solving	Maximum 2 problem. Study of the problem and solution finding, Total = 10h	Based on the depth of the solution submitted.
6.	Videos on Industrial safety aspects based on subject	Duration of video = 5h Report preparation = 5h Total = 10h	Based on quiz/report submitted
7.	Poster/chart/power point preparation on technical topics	Duration = 6 h	Based on poster/chart preparation and presentation skills
8.	Industrial exposure for 2-3 days to observe and provide tentative solutions on society/environment/health/any other issue	Duration = 15 h for industrial exposure  Problem identification and tentative solution = 10 h Total = 20 h	Based on evaluation of critical problems and solutions
9.	Group Discussion on emerging/trending technical topics based on subject	Duration = 1 h each	Based on performance in group discussion, technical depth, knowledge etc.

### Note:

- All the suggested activity should be related to the subject.
- The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, total number of hours is fixed.
- Rubrics for the evaluation can be prepared by the faculty.
- All records pertaining to the evaluation and assessment of self-learning activities must be properly maintained and preserved at the institute level. These records should be made available to the university upon request.
- Institutes are encouraged to utilize digital platforms, such as Microsoft Teams, for effective recordkeeping and to ensure transparency in the evaluation and assessment of self-learning activities.