GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Bachelor of Engineering
Level: UG
Branch: Civil Engineering
Subject Code: BE04006051
Subject Name: Fluid Mechanics

w. e. f. Academic Year:	2024-25
Semester:	4
Category of the Course:	Basic Science Course

Prerequisite:	Introduction to Basics of Civil Engineering
Rationale:	Fluid Mechanics is a basic engineering subject which helps in solving fluid flow problems in the field of Civil Engineering. Subject deals with basic concepts and principles in hydrostatics, hydro kinematics and hydrodynamics and their application in solving fluid mechanics problems. The students will be able to apply the basic principles of fluid mechanics to solve real life problems also.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level
CO-1	Analyze and apply the fundamental concepts of fluid properties and fluid statics, including pressure distribution, buoyancy, and hydrostatic forces on submerged surfaces.	R, U, A
CO-2	Apply the principles of conservation of mass and energy (Bernoulli's equation), and use the momentum equation to solve problems in fluid dynamics.	U, A
CO-3	Identify various flow measuring devices, such as Venturimeter and Pitot tube, and calculate discharge through orifices, notches, and weirs.	R, N
CO-4	Solve problems related to drag and lift in applications like wind tunnels.	A, E
CO-5	Perform dimensional analysis using Buckingham's π theorem on the different applications of fluid mechanics.	A, N, E

Teaching and Examination Scheme:

Teaching / Learning Scheme (in Hours per semester)					Total Credits	Assessment Pattern and Marks					Total Marks
						Theory		Tutorial / Practical			
L	T	P	PBL*	Total no of hours per semester		ESE (E)	PA / CA (M)	PA/ CA (I)	TW/SL (I)	ESE (V)	
45	0	30	15	90	3	70	30	20	30	50	200

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

Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	Introduction to Fluid Mechanics: Definition of a fluid, classification of fluids (ideal vs. real, Newtonian vs. non-Newtonian), and the continuum hypothesis. Fluid Properties: In-depth study of key properties such as density, specific weight, specific gravity, and specific volume. Viscosity: Understanding dynamic viscosity and kinematic viscosity, and its relation to Newton's law of viscosity. Exploration of the variation of viscosity with temperature. Other Properties: Discussion of surface tension, capillarity, vapor pressure, and compressibility.	4	10
2	**Principles of Fluid Statics:** Fluid Pressure and its measurement: Principles of fluid pressure, including Pascal's law. Differentiation between absolute, gauge, and atmospheric pressure. Study of various devices for measuring pressure, such as manometers (simple and differential) and pressure gauges. Hydrostatic Forces: Analysis of hydrostatic forces on submerged plane and curved surfaces, calculation of centre of pressure. Buoyancy and Flotation: Exploration of Archimedes' principle, the concept of buoyancy, and the stability of floating and submerged bodies. Meta-center and metacentric height, analytical and experimental computation of metacentric height	9	18
3	**Kinematics of Flow:** Visualisation of flow, types of flow, streamline, path line, streak line, principle of conservation of mass, velocity, acceleration, velocity potential and stream function, vorticity, circulation.	6	14
4	**Fluid dynamics:** Control volume approach, Euler’s equation, Bernoulli’s equation and its applications, Reynolds transport theorem, momentum and angular momentum equations and their applications.	6	14

5	**Flow Measuring Devices:** Measurement of discharge- Venturimeter, Orificemeter, Nozzlemeter, Rotameter. Measurement of velocity-Pitot tube. Orifice Classification hydraulic coefficients, Experimental determination of hydraulic coefficients, Small and large orifice. Mouthpiece- classification, External cylindrical mouthpiece, Convergent –divergent mouthpiece, Borda's mouthpiece. Notches and weirs: discharge over rectangular notch and triangular notch, discharge over weirs	8	16
6	**Flow Past Immersed Bodies** Drag and lift, Types of drag, drag on sphere, cylinder, flat plate and Airfoil, Karman vortex street, Effect of drag, Development of lift, Magnus effect, Circulation and lift characteristics of airfoils.	6	14
7	Fundamental dimensions, Physical Quantity and Dimensions, Dimensional Homogeneity Non-Dimensional parameters, Theorem of dimensional analysis, Choice of variables, Determination of Dimensionless parameters. Model Similitude, Physical models geometric, kinematic and dynamic similarity.	6	14

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
15	**20**	**30**	**20**	**10**	**5**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

Reference Book:

1. Engineering Fluid mechanics, K.L. Kumar, 8th Edition S. Chand & Company Ltd.
2. Hydraulics and Fluid Mechanics, P.N. Modi and S.M. Seth, Standard Book House
3. Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill.
4. Fluid Mechanics, A.K. Jain, 4th edition, Khanna Publishers.

5. Fluid mechanics by R .C. Hibbeler, Pearson publication
6. Fluid Mechanics by Victor L. Streeter, E. B. Wylie by, McGraw Hill Publication
7. Fluid Mechanics by Frank M White , McGraw Hill Publication

Open source software and website:

1. http://nptel.ac.in/

Suggested Course Practical/Assignment List: Students should follow the DTE laboratory manual for assignments and practical.

Suggested list of Experiment:

1. Measurement of viscosity
2. Study of pressure measurement devices
3. Hydrostatic force and center of pressure on flat/curved surfaces
4. Stability of Floating body
5. Study Characteristics of Laminar and Turbulent flows (Reynolds experiment)
6. Verification of Bernoulli Theorem
7. Determine Hydraulic coefficients of a small circular orifice.
8. Calibration of flow measuring devices (Venturimeter, Orificemeter, Rectangular and V-notch)
9. Similitude and Model Studies
10. Characterisation of drag and lift forces on the bodies.

- **Activities suggested under Problem Based Learning**

Sr . No.	Name of the activity	No. of hours	Evaluation Criteria
1.	Fluid Properties Scavenger Hunt: Identify and understand various fluid properties in everyday life.	Duration= 5h, Report preparation = 5h Total = 10h	Based on the report submitted. The Report should contain observations and interpretations.
2.	Create a Video Lecture Choose a topic like Bernoulli's equation or buoyancy and flotation and create a short, informative video lecture using screen recording software.	Duration= 5h, Video preparation = 5h Total = 10h	Based on the video/report submitted.
3.	Self-learning on-line courses related to application of fluid mechanics concepts in civil engineering projects.	Minimum duration of the course should be 10h.	Examination based assessment at the end of course. Based on the certificate produced.
4.	Poster/chart/power point presentation on topics related to the applications of fluid mechanics concept.	Duration = 6 h	Based on poster/chart preparation and presentation skills

5.	Group Discussion on emerging/trending technical topics	Duration = 02 h each	Based on performance in group discussion, technical depth, knowledge etc.
6.	Real world case studies-based learning for state-of-the-art/new technology in fluid mechanics	Duration of data collection/study = 5h Report preparation = 5h Total = 10h	Based on in-depth study, technical depth, data collected, fact finding, etc.
7.	Preparation of an experimental set-up	Total = 20 h	Demonstration of prepared set-up
8.	Preparation of working/non-working model related to fluid mechanics	Duration for working model=20 h Duration for non-working model=15 h	Demonstration of the model prepared

Note:
1. All the suggested activities should be related to the subject.
2. The number of hours is suggestive. Faculty can sub-divide the number of hours based on the activity. However, the total number of hours is fixed.
3. For a course, a minimum of 3 to 4 activities shall be conducted. There is no limit to the maximum number of activities. However, any activity shall not be more than 10 hrs.
4. Rubrics for the evaluation can be prepared by the faculty.

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