GUJARAT TECHNOLOGICAL UNIVERSITY

CIVIL ENGINEERING (06)

FUILD MECHANICS

SUBJECT CODE: 2130602

B.E. 3rd Semester

Type of course: APPLIED PHYSICS

Prerequisite: System of units, Laws of motion, Basic idea of force, Concept of centroid

Rationale:

1. To develop a basic understanding about the properties of fluids, their behavior under static and dynamic conditions.
2. To enable the students to apply the basic principles of Fluid Mechanics to solve real life problems

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		PA (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Contents:

Sr No	Contents	Teaching Hrs	Weightage (%)
1	**Module 1:Properties of Fluids** Mass density, specific weight, specific gravity, specific volume, vapour pressure, compressibility, elasticity, surface tension, capillarity; Newton's law of viscosity, classification of fluids, dynamic viscosity, kinematic viscosity, variation of viscosity with temperature; Basic concept applicable to fluid mechanics.	4	10
2	**Module 2: Fluid Statics** *Measurement of Pressure*: Pressure variation in static fluid, PASCAL's law, Units and scale of pressure measurement- Atmospheric pressure, Absolute pressure, Gauge pressure, and Vacuum pressure, Hydrostatic paradox, Piezometer, U-Tube manometer, Single column manometer, U-tube differential manometer, Inverted U-tube differential manometer, micromanometers, Mechanical pressure gauges. *Hydrostatic force on plane and curved surface :* Total pressure and center of pressure, pressure diagram, Total pressure on plane surfaces and curved surfaces depth of center of pressure, Practical applications of Total pressure and Center of pressure. *Buoyancy and Flotation:* Buoyant force, Buoyancy and Center of Buoyancy, Archimedes Principle, Metacentre and Metacentric height, Equilibrium of floating and	12	25

	submerged bodies, Metacentric height evaluation –theorectical and experimental method, Oscillation of floating body *Fluids in Relative Equilibrium:* Static fluid subjected to uniform linear acceleration, Liquid containers subjected to constant horizontal acceleration,Liquid containers subjected to constant vertical acceleration, Liquid containers subjected to constant rotation.		
3	**Module 3:Fluid Kinematics** Fluid flow methods of analysis of fluid motion, Streamlines, Path lines, Streak lines and Stream tubes. Types of fluid flow-Steady and unsteady flow, Uniform and non-uniform flow, Laminar and turbulent flow, Reynolds number, Reynolds experiment, Rotational and Irrotational flow, Subcritical, critical and Supercritical flow, Compressible and Incompressible flow, One, Two and three dimensional flow, Circulation and vorticity, Velocity potential and stream function, flow net, Source, Sink and Doublet.	6	10
4	**Module 4: Fluid Dynamics** Euler's equation, Bernoulli's equation, Energy correction factor	3	10
5	**Module 5: Flow Measuring Devices** Measurement of discharge- Venturimeter, Orificemeter, Nozzlemeter, Rotometer. Measurement of velocity-Pitot tube. Orifice- classification. Flow through reservoir opening i.e. orifice, trajectory of free jet, hydraulic coefficients, Experimental determination of hydraulic coefficients, Small and large orifice, Time of emptying a tank with orifice. Mouthpiece- classification, External cylindrical mouthpiece, Convergent –divergent mouthpiece, Borda's mouthpiece. Notches and weirs-discharge over rectangular notch and triangular notch. Velocity of approach, End Contractions. Cippoletti notch. Time of emptying a tank with notch or weir, Ventilation of weir, Sutro weir.	8	25
6	**Module 6: Flow Immersed Past 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.	4	10
7	**Module 7 Compressible Flow** Basic equations, Mach number, Mach cone, Area-velocity relationship, Propagation of sound wave, Stagnation properties.	5	10

Reference Books:

1. Engineering Fluid mechanics, K.L. Kumar, 8th Edition S. Chand & Company Ltd.
2. Hydraulics and Fluid Mechanics, P.M. 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.

Course Outcomes:

After successful completion of the course the students shall be able to:

1. Describe types of fluid and determine their properties

2. Measure pressure and calculate hydrostatic pressures and forces on flat/curved surfaces
3. Analyze forces on floating and immersed bodies and understand fluids in relative equilibrium
4. Know the basics of fluid kinematics and dynamicsand understand and apply the Bernoulli principle.
5. Calibrate fluid flow measuring devices like venturimeter, orificemeter, notches, orifice, mouthpieces.
6. Understand the concept of drag and lift on various objects.
7. Know the basics of compressible fluid flow.

List of Practicals:

Students will have to perform following experiments in laboratory and prepare the laboratory manual. The students will have to solve atleast five examples and related theory from each topic as an assignment/tutorial.

- Measurement of viscosity (Verification of Stokes law)
- Study of pressure measurement devices
- Hydrostatic force and center of pressure on flat/curved surfaces
- Stability of Floating body
- Study Characteristics of Laminar and Turbulent flows (Reynolds experiment)
- Verification of Bernoulli Theorem
- Determine Hydraulic coefficients of a small circular orifice.
- Calibration of flow measuring devices (Venturimeter, Orificemeter)
- Calibration of Rectangular and V notch.
- Drag on immersed objects.

Design based/open ended problem

1. Measurement of capacity of storage tanks
2. Measurement of viscosity of different fluids
3. Measurement of pressure and discharge in pipe flow
4. Comparison of time of emptying a tank computed theoretically and actually observed (Using mouth pieces, orifices).
5. For the college building/ department determine the pressure head,peizometric head from a water tank at a point of interest in flow system.
6. Measurement of pressure in aninflated tube.
7. Prepare working model for falling sphere viscometer, stability of floating bodies
8. Prepare working models of different types of gates for storing water/liquid in a tank/reservoir.
9. Prepare working models of different types of notches, weirs, and orifice.
10. Estimate the time to empty the water /liquid tank of different shapes with orifice.
11. Estimate drag force on objects (like advertisement display board,) or design of a parachute etc.
12. Any other related problem framed by college faculty.

Major Equipments:

1. Viscometer

2. Piezometers, Manometers, pressure gauges
3. Centre of pressure
4. Floating body
5. Reynolds experimental setup
6. Hydraulic bench with modular attachments for various experiments
7. Open channel with flow and depth measurement setup etc.

List of Open Source Software/learning website:
www.nptel.iitm.ac.in/courses/

Active learning Assignments (AL) : Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.