GUJARAT TECHNOLOGICAL UNIVERSITY

ENVIRONMENTAL SCIENCE AND TECHNOLOGY (35)
ELEMENTS OF FLUID FLOW
SUBJECT CODE: 2153507
B.E. 5thSEMESTER

Type of course: Environmental Science & Technology

Prerequisite: A good fundamental backup of different type of fluids, fluid flow and the characteristics of fluids applicable in environmental science and technology.

Rationale: This subject is intended to make students aware about behavior of different fluids under different conditions. It also provides the knowledge of fluid flow in industrial operation for transportation of fluid along with measurement techniques.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	1	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Topic	Teaching Hours	Module Weightage (%)
1.	**Introduction of Fluids:** Units and Unit Systems, Conversion of Units, Dimensional Analysis, Physical properties of fluids, Rheology of fluids. Newtonian and Non-Newtonian fluid. flow Pressure-density-height relationship, manometers, pressure transducers, pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to linear acceleration and uniform rotation about an axis.	10	20
2.	**Types of fluid flows:** Continuum & free molecular flows. Steady and unsteady, uniform and nonuniform, laminar and turbulent flows, rotational and irrotational flows, compressible and incompressible flows, subsonic, sonic and supersonic flows, sub-critical, critical and supercritical flows, one, two and three dimensional flows, streamlines, continuity equation for 3D and 1D flows, circulation, stream function and velocity potential. Dimensional analysis, Buckingham's Pi theorem, important dimensionless numbers and their Significance.	12	30

3.	**Potential Flow:** source, sink, doublet and half-body. Equation of motion along a streamline and its integration, Bernoulli's equation and its applications- Pitot tube, orifice meter, venturi meter and bend meter, Hot-wire anemometer and LDA, notches and weirs, momentum equation and its application to pipe bends. Similarity Laws: geometric, kinematics and dynamic similarity, undistorted and distorted model studies. Equation of motion for laminar flow through pipes, Stokes' law, transition from laminar to turbulent flow, turbulent flow, types of turbulent flow, isotropic, homogenous turbulence, scale and intensity of turbulence, measurement of turbulence, eddy viscosity, mixing length concept and velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow,minor losses, pipe in series and parallel, power transmission through a pipe, siphon, water hammer, three reservoir problems and pipe networks.	14	30
4.	Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sub-layer, separation and its control, Drag and lift, drag on a sphere, a two dimensional cylinder, and an aerofoil, Magnus effect. Introduction to compressible flow	10	20

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
20	**20**	**20**	**20**	**20**	**-**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and 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.

Course Outcome: After learning this course the students would have:

1) Proper understanding of laminar, transition and turbulent flow.
2) Information about type of potential flow, flow net and continuity equation of fluid flow.
3) Proper understanding of characteristics such as compressibility, incompressibility and boundary layer condition of fluid flow and also quantitative determination of material and power requirement for the process.
4) Knowledge of fluid flow storage, handling and measurement instruments used in industries.

Reference Books:

1) Fox & Donald, "Introduction to Fluid Mechanics" John Wiley &Sons Pvt Ltd,
2) . Cengel & Cimbala, "Fluid Mechanics" TMH, New Delhi.
3) White,F.M. "Fluid Mechanics" TMH, New Delhi.
4) Munsen et al ,"Fundamental of Fluid Mechanics" Wiley Newyork Ltd
5) Garde, R.J., " Fluid Mechanics", SciTech Publications Pvt. Ltd
6) I.H. Shames, "Mechanics of Fluids", McGraw Hill, Int. Student, Education

7) McCabe W L, Smith J C, Harriott P, "Unit Operations of Chemical Engineering", 7th Ed. McGraw Hill, 2005.
8) Fluid mechanics By Dr.D.S.Kumar.

PRACTICALS (ANYFIVE):

1. Verification of Bernoulli's Equation.
2. Frictional pressure drop in a circular pipe
3. Classification of flow based on Reynold's experiment.
4. Equivalent length of pipe fittings.
5. Determination of Hydraulic coefficients of Orifice.
6. Calibration of Rotameter
7. Determination of discharge coefficient of V – notch.
8. Estimation of viscosity of fluid by Stoke's law
9. Characteristics of centrifugal pump.
10. Frictional pressure drop in annular pipe.

Design based Problems (DP)/Open Ended Problem:

- Siltation of small Dam (Case Study)
- Flow study of estuary.(Turbulent flow)
- Salt Intrusion near seashore
- River Modeling
- Transportation of fluid in pipe (Any Industry)
- Stratification case study

Major Equipment:
Rota meter, Orifice Meter, Weir, Notch etc.

ACTIVE LEARNING ASSIGNMENTS: 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.