GUJARAT TECHNOLOGICAL UNIVERSITY

FLUID MECHANICS
SUBJECT CODE: 2141906
B.E. 4th SEMESTER

Type of course: Fundamental

Prerequisite: -- Elements of Mechanical Engineering

Rationale: The course is designed to give fundamental knowledge of fluid, its properties and behavior under various conditions.

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		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No	Content	Total Hrs	% Weightage
1	**Fluids and Their Properties:** Introduction of fluid, fluid classifications, hypothesis of continuum, Shear stress in a moving fluid, molecular structure of material, fluid density, viscosity, causes of viscosity in gases and liquids, surface tension, capillary effect, vapor pressure, cavitation, compressibility and the bulk modulus	3	5
2	**Pressures and Head:** Types of Pressure, Pascal's law of pressure at a point, variation of pressure vertically in a fluid under gravity, equality of pressure at the same level in a static fluid, general equation for the variation of pressure due to gravity from a point to point in a static fluid, pressure and head, the hydrostatic paradox, pressure measurements using Elastic Pressure Transducers, Force Balance Pressure gauge, Electrical Pressure Transducers	5	9
3	**Static Forces on Surface and Buoyancy:** Fluid static, action of fluid pressure on surface, resultant force and center of pressure on a plane surface under uniform pressure, resultant force and center of pressure on a plane surface immersed in a liquid, pressure diagrams, forces on a curved surface due to hydrostatic pressure, buoyancy, equilibrium of floating bodies, stability of a submerged body, stability of floating bodies, determination of the metacentric height, determination of the position of the metacentre relative to the center of buoyancy.	8	14
4	**Motion of Fluid Particles and Streams:** Fluid flow, different types of flow, frames of reference, analyzing	4	7

	fluid flow, motion of a fluid particle, acceleration of a fluid particle, discharge and mean velocity, continuity of flow, continuity equations for 2-D and 3-D flow in Cartesian coordinates of system.		
5	**The Energy Equation and its Application:** Momentum and fluid flow, Momentum equation for 2-D and 3-D flow along a stream line, momentum correction factor, Euler's equation of motion along a stream line, Mechanical energy of a flowing fluid – Bernoulli's theorem, kinetic energy correction factor, pitot tube, determination of volumetric flow rate via pitot tube, changes of pressure in tapering pipe, principle of venturimeter, pipe orifices, theory of small orifices discharging to atmosphere, theory of large orifices, Rotameter, elementary theory of notches and weirs, flow in a curved path	8	15
6	**Two-Dimensional Ideal Fluid Flow:** Rotational and ir-rotational flow, circulation and vorticity, streamlines and the stream functions, velocity potential and potential flow, relation between stream function and velocity potential; flow nets, stream function and velocity potential for uniform flow, vortex flow.	4	7
7	**Dimensional Analysis And Similarities:** Dimension reasoning, dimensional homogeneity, dimensional analysis using Rayleigh's method, Buckingham π-theorem, significance of dimensionless, use of dimensionless numbers in experimental investigation, geometric similarity, dynamic similarity, Kinematic similarity, model testing-Model laws, Undistorted and Distorted models.	5	9
8	**Viscous Flow:** Reynolds number and Reynolds experiment, flow of viscous fluid through circular pipe- Hagen Poiseuille formula, Flow of viscous fluid between two parallel fixed plates, power absorbed in viscous flow through - journal, foot step and collar bearing , movement of piston in dash pot, methods of measurement of viscosity.	6	11
9	**Turbulent Flow:** Expression for coefficient of friction -Darchy Weishbach Equation, Moody diagram resistance of smooth and rough pipes shear stress and velocity distribution in turbulent flow through pipes.	4	7
10	**Flow through pipes**: Major energy losses, Minor energy losses, Hydraulic gradient and total energy lines, Pipes in series and parallel, Equivalent pipes, Siphon, power transmission through pipe, Flow through nozzle at end of pipe, Water hammer in pipes	6	11
11	**Compressible Flow:** Basic equations for one dimensional compression, Pressure wave propagation, sound velocity in fluid, Mach number, Stagnation properties	3	5

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks				
R Level	U Level	A Level	N Level	E Level

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate 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 Books:

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S.K.Kataria & Sons
2. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Publications
3. Fluid Mechanics and Hydraulic Machines by R.K. Rajput, S.Chand & Co.
4. Fluid Mechanics by Frank .M. White, McGraw Hill Publishing Company Ltd.
5. Fundamentals of Fluid Mechanics by Munson, Wiley India Pvt. Ltd
6. Fluid Mechanics by A. K. Mohanty, PHI Learning Pvt. Ltd.
7. Laboratory Manual Hydraulics and Hydraulic Machines by R V Raikar

Course Outcome:

After learning the course the students should be able to:

- Understand the basic concept of fluid mechanics.
- Understand statics, dynamics and various approaches to fluid mechanics.
- Understand fundamentals of flow through pipes
- Understand basics of compressible flow
- Correlate fundamentals of fluid mechanics with various mechanical systems

List of laboratory experiments:

1. To understand pressure measurement procedure and related instruments/devices.
2. To determine metacentric height of floating body.
3. Verification of Bernoulli's theorem.
4. To measure the velocity of flow using Pitot tube.
5. To determine the Coefficient of discharge through different flow meters. (Any two out of Orifice meter, Venturi meter and Nozzle meter.)
6. To determine the Coefficient of discharge through open channel flow over a Notch. (Rectangular or V notch)
7. To determine the different types of flow Patterns by Reynolds's experiment.
8. To determine the Friction factor for the different pipes.
9. To determine the loss coefficients for different pipe fittings.
10. To determine the viscosity of fluid by viscometer (Redwood or Saybolt).

Design based Problems (DP)/Open Ended Problem:

1. Develop a model to measure viscosity of the fluid.
2. Study the behavior of fluid under various conditions using software.
3. Study continuum problems with reference to fluid mechanics**.**

Major Equipment:

1. Pitot Tube
2. Venturimeter apparatus
3. Reynold's apparatus
4. Pressure Measurement apparatus
5. Orifice meter apparatus
6. Pipe fitting apparatus
7. Metacentric height apparatus
8. Open Channel apparatus (Notches)
9. Nozzle Meter
10. Manometer
11. Viscometer
12. Elastic Pressure Transducers, Force Balance Pressure gauge, Electrical Pressure Transducers

List of Open Source Software/learning website:

1. http://nptel.ac.in/
2. www.learnerstv.com
3. http://www.mne.psu.edu/cimbala/Learning/Fluid/fluid.htm
4. http://www.efluids.com/efluids/pages/edu_tools.htm

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.