GUJARAT TECHNOLOGICAL UNIVERSITY

MECHATRONICS ENGINEERING (20)
FLUID MECHANICS & MACHINES
SUBJECT CODE: 2152003
B.E. 5th SEMESTER

Type of course: Engineering Science

Prerequisite: NA

Rationale: This subject deals with Fluid Mechanics and Machines and its applications, which are useful for Mechatronics engineers.

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		
4	0	2	6	70	20	10	20	10	20	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	**Introduction:** Objective of the course, Solids, Liquids and gases, Ideal and real fluids, Continuum, Units and dimensions, Density, Specific gravity, Evaporability and vapour pressure, Viscosity, Surface tension and capillarity effect, Compressibility and Bulk Modulus of Elasticity, Newtonian and non- Newtonian fluids.	6	10 %
2	**Fluid Statics:** Pressure, Pascal's law, Hydrostatic law, Pressure variation for an incompressible fluid, Atmospheric, Gauge, Absolute and negative pressure, Force on a horizontal submerged plane surface, Force on a vertical plane submerged surface, Force on an inclined submerged plane surface, Conditions for floating, Archimedes's principle, Reason for buoyancy and three possibilities, Applications of buoyancy and floatation, Stability of floating bodies, Mathematical treatment and conditions for stability, Metacentre and its application, Metacentric height calculation.	8	20 %
3	**Fluid Kinematics:** Description of fluid flow, Classification of fluid flow, Stream-lines, Path-lines and streak lines, Acceleration of a fluid particle, Motion of fluid particles, Motion of fluid particles along a curve path, Continuity equation, Continuity equation in polar co-ordinates, Rotational flow, Rotation and vorticity, Stream function, Potential function, Circulation.	6	10 %
4	**Fluid Dynamics:** Control volume and control surface, Energy and its forms, Euler's equation along a streamlines, Euler's equation in Cartesian co-ordinates, Bernoulli's theorem, Practical Applications of Bernoulli's equation, Momentum of fluids in motion, Moment of momentum equation.	6	10 %

5	**Boundary Layer Theory and Flow Around Submerged Body:** Boundary layer definitions and characteristics, Laminar and turbulent boundary layer, Total drag due to laminar and turbulent layers, Boundary layer separation and its control, Force exerted by a flowing fluid on a body, Expressions for drag and lift.	**4**	10 %
6	**Laminar and Turbulent Flow in Pipes:** Reynolds number, Relation between shear stress and pressure gradient, Laminar flow in circular pipes - Hagen Poiseuille law, Flow of viscous fluid through an annulus, Loss of head due to Friction in pipe Flow-Darcy Equation, Characteristics of Turbulent Flow, Major and Minor head losses.	**4**	10 %
7	**Pumps:** Pump classification and selection criterion, Pump applications, Centrifugal pumps, Pressure changes in a pump, Velocity vector diagrams and work done, Multistage pump, Net positive suction head, Cavitations in centrifugal pumps, Priming, Classification of reciprocating pumps, Operation of reciprocating pump, Discharge co-efficient, Volumetric efficiency and slip, Work and power input, Indicator diagrams, Air vessels, Centrifugal pumps versus reciprocating pumps. Unit quantities, Specific speed and normal relationships, Performance characteristics of pump.	**8**	20 %
8	**Turbines:** Impulse and reaction turbines, Pelton turbine, Work done and efficiency of a Pelton wheel, Effective head, Available power and efficiency, Francis turbine, Propeller and Kaplan turbines, Draft tube.Unit quantities, Specific speed and normal relationships, Performance characteristics of turbine. Stalling and surging.	**8**	10 %

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
50	**30**	**5**	**10**	**5**	**-**

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.

Reference Books:

1. Fluid Mechanics and Fluid Power Engineering, Kumar D.S, S.K. Kataria & Sons.
2. Fluid Mechanics and Hydraulic Machines, Rajput R. K, S. Chand & Company Ltd.
3. Turbines, Compressors & Fans, S. M Yahya, Tata McGraw Hill.
4. Fluid Mechanics, Yunus A. Cengel, Tata McGraw Hill
5. Fluid Mechanics, Streeter V. L. McGraw Hill International Edition.
6. Fluid Mechanics and Machinery, Agrawal S. K, Tata McGraw Hill.

Course Outcome:

After learning the course the students should be able to:

1. Understand the basic fluid property and law with their application.
2. Acquire knowledge regarding fluid static, kinematic, dynamic and study the different type of flow and boundary layer theory.
3. Understand the working of turbo machine like pump, turbine, compressor and blower.

List of Experiments:

1. Verification of Bernoulli's Theorem.
2. Determination of coefficient of discharge of an orificemeter and a venturimeter.
3. Determination of friction factor for Major and Minor Losses.
4. Effect of Reynold's number on the flow pattern.
5. Impact of jet on vanes.
6. Performance testing of a CF Pump and a reciprocating Pump.
7. Performance testing of Impulse Turbine.
8. Performance testing of Francis Turbine.
9. Performance testing of a CF Blower.
10. Effect of angle of attack on lift and drag force

Design based Problems (DP)/Open Ended Problem: Student may be given a task to exhibit the knowledge of the course studied during the academic year.

Major Equipment:

Sr. No.	**Name of Equipment**
1	Bernoulli's theorem Apparatus.
2	Flow measuring devices (Venturimeter) Apparatus.
3	Flow measuring devices (orifice meter) Apparatus.
4	Determination of minor losses in pipe fittings Apparatus.
5	Determination of major losses in pipe fittings Apparatus.
6	Study of Free and forced vortices Apparatus.
7	Metacentric height of a floating body.
8	Reynolds number Apparatus.
9	Flow through orifice and mouthpiece Apparatus.
10	Impact of jet Apparatus.

List of Open Source Software/learning website:

(1) www.NPTL.com
(2) ANSYS Fluent
(3) Fluent

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.