GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3141906
Semester – IV
Subject Name: Fluid Mechanics and Hydraulics Machines

Type of course: Fundamental

Prerequisite: Nil

Rationale: This course imparts fundamental knowledge regarding fluid, types, properties and basic governing equations in static and moving conditions. The course also provides the basic technical knowledge related to various fluid machines used in the practice.

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)	
4	0	2	5	70	30	30	20	150

Content:

Sr. No.	Course Content	Total Hours
1	**Fluids and Their Properties:** Fluid classifications, hypothesis of continuum, shear stress in a moving fluid, molecular structure of material, density, viscosity, surface tension, capillary effect, vapor pressure, compressibility and the bulk modulus, 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, hydrostatic paradox	8
2	**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 and 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 and floating bodies, determination of the metacentric height, determination of the position of the metacenter relative to the center of buoyancy	8
3	**Motion of Fluid Particles and Streams:** Fluid flow, different types of flow, frames of reference, analyzing 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, rotational and irrotational flow, circulation and vorticity, streamlines and the stream functions, velocity potential and potential flow, relation between stream function and velocity potential, stream function and velocity potential for uniform flow, vortex flow	6
4	**The Energy Equation and its Application:** Momentum and fluid flow, Momentum equation for 2-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, changes of pressure in tapering pipe, principle of venturimeter, orifice, rotameter, theory of notches and weirs	6
5	**Dimensional Analysis and Similarities:** Dimension reasoning, dimensional homogeneity, dimensional analysis using Rayleigh's method, Buckingham π-theorem, use of dimensionless	4

	numbers in experimental investigation, geometric similarity, dynamic similarity, kinematic similarity, model testing, model laws, undistorted and distorted models	
6	**Viscous and Turbulent Flow:** 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, 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	6
7	**Flow through pipes**: Major and minor energy losses, hydraulic gradient and total energy lines, pipes in series and parallel, equivalent pipes, water hammer in pipes	4
8	**Impact of Jet and Hydraulic Turbines:** Force exerted on stationary flat and curved plates held normal, force exerted on moving plate held normal and on a plate when vane is moving in direction of jet, jet striking on curved vane tangentially at one tip and leaving at other end, classification of hydraulic turbines, impulse and reaction turbines, construction, working and analysis of Pelton, Francis and Kaplan turbines, draft tube, governing of the hydraulic turbines, cavitations, performance characteristics	10
9	**Centrifugal Pumps:** Pump classification and selection criterion, velocity vector diagrams, pump losses and efficiencies, net positive suction head, pressure rise in impeller, characteristic curves, priming	6
10	**Hydraulic Machines:** Hydraulic press, hydraulic accumulator, hydraulic intensifier, hydraulic crane, hydraulic jack, hydraulic lift, hydraulic ram, fluid couplings, fluid torque converter and air lift pump	2

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
25	25	25	20	5	0

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 by D.S. Kumar, S. K. Kataria & Sons
2. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Prakashan
3. Fluid Mechanics and Hydraulic Machines by R.K. Rajput, S.Chand & Co.
4. Theory and Applications of Fluid Mechanics by K. Subramanya, McGraw Education
5. Fluid Mechanics by Frank .M. White, McGraw Hill Education
6. Mechanics of Fluids by Shames, McGraw Hill Education

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Course Outcomes:

Students will be able to:

Sr. No.	CO statement	Marks % weightage
CO-1	explain various fluid properties and behavior of fluid in static and dynamic mode.	30
CO-2	make use of dimensional analysis and interpret types of fluid flow.	15
CO-3	analyze theory of impact of jet and apply the same for hydraulic turbine.	20
CO-4	evaluate performance of centrifugal pumps	15

List of Experiments:

1. Verification of Bernoulli's theorem
2. To determine metacentric height by metacentric height apparatus.
3. To measure the velocity of flow using orifice meter and venturimeter.
4. To determine the coefficient of discharge through open channel flow over a notch.
5. To determine the different types of flow patterns by Reynolds' experiment.
6. To determine the friction factor for the different pipes.
7. To determine the loss coefficients for different pipe fittings.
8. To verify Impulse-momentum principle for impact of jet on stationary vane.
9. Performance test on Pelton turbine.
10. Performance test on Kaplan turbine.
11. Performance test on Francis turbine.
12. Performance test on centrifugal pump.

Major Equipment: Flow measuring devices and arrangements, Reynolds' apparatus, metacentric height apparatus, impact of jet apparatus, test rigs of Pelton, Francis and Kaplan turbine, test rigs of centrifugal pump and hydraulic ram

List of Open Source Software/learning website: http://nptel.ac.in/, http://www.nfpa.com/