II Year II Semester	**L**	**T**	**P**	**C**
Code:20ME4004	**3**	**0**	**0**	**3**

FLUID MECHANICS & HYDRAULIC MACHINERY

Course Objectives:

1. The students completing this course are expected to understand the properties of fluids, its kinematic and dynamic behaviour through various laws of fluids like continuity, Euler's, Bernoulli's equations, energy and momentum equations.
2. The student shall be able to understand the theory of boundary layer, the working and performance characteristics of various hydraulic machines like pumps and turbines.

Unit I

Introduction: Definition of fluid, properties of fluids, surface tension, capillarity, vapour pressure. Introduction of flow types. Classification (like Ideal and Real fluids, Newtonian and Non-Newtonian fluids, Internal versus External Flow, Compressible versus Incompressible Flow, Laminar versus Turbulent Flow, Natural versus Forced Flow, Steady versus Unsteady Flow, One-, Two-, and Three-Dimensional Flows, etc.) Variation of properties in static atmosphere. Measurement of pressure (Manometers, Piezometer, U-tubes etc.). Pascal's law. Variation of pressure within a static fluid – equation of hydrostatic pressure distribution, Hydrostatic thrust on plane and curved surfaces, Buoyancy, Stability of submerged and floating bodies (Meta-centers).

UNIT II

Fluid kinematics: Eulerian and Lagrangian description of fluid flow, Velocity and acceleration of fluid particles, Streamline, Streak line and path line, stream tube, Deformation of a fluid element – linear and angular deformation and rotation, Vortex motion-irrotational flow, Pressure and stress tensor, Stream function and velocity potential.

Fluid dynamics: Principle of conservation of mass and momentum, Stokes law of viscosity and Navier-Stokes equations – some exact solutions, Inviscid flow – Euler equation, Derivation of Bernoulli's équation and physical signifiance of diffèrent terms, Applications of Bernoulli's equation. Characteristics of Laminar & Turbulent Flow: Reynolds's experiment, critical Reynolds number. Darcy Weisbach equation, Friction factor, Minor losses – at sudden expansion, contraction, at bends, at valves and fittings, etc.

UNIT III

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles. Dimensional Analysis: Similitude and modelling - Dimensionless numbers

Impact of Jets: Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

UNIT IV

Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design -draft tube- theory functions and efficiency.

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer.

UNIT V

Hydroelectric power stations: Elements of hydroelectric power station-types-concept of pumped storage plants-storage requirements, mass curve (explanation only) estimation of power developed from a given catchment area; heads and efficiencies.

Hydraulic Pumps: Classification, Reciprocating pumps, Discharge, slip, indicator diagrams, Single and Double acting reciprocating pumps. Classification of centrifugal pumps, working, work done - manometric head- losses and efficiencies- specific speed- pumps in series and parallel-performance characteristic curves, cavitation & NPSH.

Text Books:

1. Hydraulics, fluid mechanics and Hydraulic machinery MODI and SETH.
2. Fluid Mechanics and Hydraulic Machines by Rajput.

Reference Books:

1. Fluid Mechanics and Hydraulic Machines/ RK Bansal / Laxmi Publications (P) Ltd.
2. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, Kotaria& Sons.
3. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International.
4. Hydraulic Machines by Banga & Sharma, Khanna Publishers.
5. Fluid Mechanics and Hydraulic Machines by Domkundwar & Domkundwar, Dhanpatrai & Co.

Weblinks/ Online Resources:

- https://nptel.ac.in/courses/112/105/112105183/
- https://nptel.ac.in/courses/112/104/112104118/
- https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/fluid-mechanics/

Course Outcomes:

By the end of the course the student would be able to Learn:

CO1 The basic concepts of fluid properties

CO2 The mechanics of fluids in static and dynamic conditions

CO3 Boundary layer theory, flow separation and dimensional analysis and Hydrodynamic forces of jet on vanes in different positions.

CO4 Working Principles and performance evaluation of hydraulic pump and turbines

CO5 The layout of Hydroelectric Power Plants and functioning of hydraulic Pumps