FLUID MECHANICS AND HYDRAULIC MACHINES

Course Code: 22CE11D1 **L T P C**

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Course Outcomes: At the end of the course the student will be able to

- **CO 1** describe various fluid properties and flow characteristics in the flowing fluid (L2)
- **CO 2** demonstrate the applications of fluid dynamics and determine the various losses occurred in the fluid flow problems (L3)
- **CO 3** determine the required hydro power for a given catchment and measure the hydrostatic forces on plane and curved surfaces (L3)
- **CO 4** classify the functioning of various turbines and perform their hydraulic design (L4)
- **CO 5** analyse the performance of centrifugal pumps under different operating conditions (L4)

UNIT I: **10 Lectures**

FLUID STATICS:

Physical properties of fluids – mass density, specific weight, specific volume, specific gravity, viscosity, surface tension, vapour pressure and their influence on fluid motion. Atmospheric pressure, gauge pressure and vacuum pressure, measurement of pressure – Piezometers, U-tube and differential manometers – mechanical pressure gauges.

FLUID KINEMATICS:

Streamline, path line and streak lines and stream tubes. Classification of flows ideal fluid and real fluid – steady and unsteady flows, uniform and non-uniform flows, laminar and turbulent flows, rotational and irrotational flows, equation of continuity for one- dimensional flows.

Learning outcomes: At the end of this unit, the student will be able to

1. explain the properties of fluids (L2)
2. describe the concepts of pressure measurement of flowing fluids (L2)
3. explain the types of fluid flows (L2)

UNIT-II **10 Lectures**

FLUID DYNAMICS:

Various forces acting on a fluid element- Euler's and Bernoulli's equation for flow along a streamline, momentum equation and its applications for pipe bend problem. Closed conduit flow – Reynolds number, Reynolds experiment – "Darcy –Weisbach" equation – Minor losses in pipes – pipes in series and pipes in parallel – total energy line – hydraulic gradient line, measurement of flow: Pitot tube, venturi meter, orifice meter.

Learning outcomes: At the end of this unit, the student will be able to

1. apply the Bernoulli's equation for fluid flow problems (L3)
2. calculate energy losses in pipe flows (L3)
3. determine discharge of fluid flowing through pipes (L3)

UNIT-III **10 Lectures**

HYDRO-ELECTRIC POWER STATIONS:

Types – concept of pumped storage plants – storage requirements, mass curve, estimation of storage capacity for a uniform demand, estimation of power developed from a given catchment area, heads and efficiencies.

BASICS OF TURBOMACHINERY:

Hydrodynamic force on jets on stationary and moving flat, inclined and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency.

Learning outcomes: At the end of this unit, the student will be able to

1. describe the terminology in Hydro-Electric Power Plants (L2)
2. determine the hydrodynamic force of jets acting on different vanes (L3)
3. calculate efficiency of jets (L3)

UNIT-IV **10 Lectures**

HYDRAULIC TURBINES:

Classification of turbines – Impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine – working principles, work done, efficiencies, hydraulic design.

PERFORMANCE OF HYDRAULIC TURBINES:

Draft tube theory, functions and efficiency, Geometric similarity, unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbines, cavitation, surge tank, water hammer.

Learning outcomes: At the end of this unit, the student will be able to

1. outline the functions of Pelton wheel, Francis turbine and Kaplan turbine (L4)
2. explain the principles of governing of turbines (L2)
3. apply the concepts of unit quantities to compare the performance of turbines (L3)

UNIT-V **10 Lectures**

CENTRIFUGAL PUMPS:

Pump installation details-classification- work done- Manometric head losses and efficiencies-specific speed - multistage pumps-pumps in series and parallel- performance of pumps-Characteristic curves- NPSH -Cavitation.

Learning outcomes: At the end of this unit, the student will be able to

1. describe the working principle of centrifugal pump (L2)
2. calculate the head losses and efficiencies of centrifugal pump (L3)
3. classify single-stage and multi-stage centrifugal pumps (L4)

TEXT BOOKS:

1. A.K.Jain, "*Fluid Mechanics Including Hydraulic Machines*", 8th Edition, Khanna Publishers, New Delhi, 2003.

2. P.N Modi and S.M. Seth, "*Hydraulics and Fluid Mechanics Including Hydraulic Machines*", 14th Edition, Standard Book House, 2002.

REFERENCES:

1. R.K. Rajput, "*A Textbook of Fluid Mechanics and Hydraulic Machines*", S. Chand & Company Ltd, New Delhi, 5th Edition, 2009.
2. Banga and Sharma, "*Hydraulic Machines*", Khanna Publishers, New Delhi, 6th Edition, 1995.
3. D.S. Kumar, "*Fluid Mechanics and Fluid Power Engineering*", S K Kataria and Sons, 2nd Edition, 2010.

WEB REFERENCES:

1. https://nptel.ac.in/courses/105/101/105101082/
2. https://nptel.ac.in/courses/105/103/105103095/
3. https://nptel.ac.in/courses/105/103/105103192/