HYDRAULICS AND HYDRAULIC MACHINERY

Course Code: 22CE1111	L	T	P	C
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Pre requisites: Applied Mechanics, Fluid Mechanics.

Course Outcomes:

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

CO1: Outline the similarities between model and prototype and compute hydrodynamic force exerted by jet on different surfaces (L3)

CO2: Perform the hydraulic design of various turbines and analyze their performance under different operating conditions (L3)

CO3: Determine the performance of centrifugal pumps under different operating conditions (L3)

CO4: Discuss the characteristics of uniform and non-uniform flows in open channels (L2)

CO5: Discuss about the gradually varied surface profiles and hydraulic jump (L2)

UNIT-I **(10 Lectures)**

DIMENSIONAL ANALYSIS & SIMILITUDE:

Dimensional analysis -Rayleigh's method and Buckingham π-theorem study of hydraulic models–Geometric, kinematic and dynamic similarities-dimensionless numbers – model and prototype relations, types of models - distorted and un-distorted models

BASICS OF TURBO MACHINERY:

Hydrodynamic force of jets on stationary and moving flat inclined and curved vanes, jet striking at the centre and tip, velocity triangle sat inlet and outlet, expressions for work done and efficiency

Learning outcomes:

At the end of the unit, the student will be able to

1. explain concept of Dimensional Analysis for various fluid flow problems (L2)
2. explain similarity laws and model testing (L2)
3. compute hydrodynamic force exerted by jet of water on different vanes (L3)
4. calculate efficiency of jets (L3)

UNIT-II **(10 Lectures)**

HYDRAULIC TURBINES:

Layout of a typical Hydropower installation – Heads and efficiencies classification of turbines- Pelton Wheel - Francis turbine- Kaplan turbine, principle of working, working proportions, velocity diagrams, work done and efficiency, hydraulic design. Draft tube –

theory, functions and efficiency. Governing of turbines – water hammer- surge tanks, unit quantities-specific speed - performance characteristics- cavitation.

Learning outcomes:

At the end of the unit, the student will be able to

1. explain the hydraulic design aspects of Pelton wheel (L2)
2. explain the hydraulic design aspects of Francis / Kaplan turbines (L2)
3. calculate the efficiencies of Pelton/Kaplan/Francis turbines (L3)
4. Apply the concept of unit quantities to compare the performance of turbines (L3)

UNIT-III **(10 Lectures)**

CENTRIFUGAL PUMPS:

Pump installation details-classification-work done- Manometric head - losses and efficiencies -multistage pumps-pumps in series and parallel- performance characteristics of pumps- Similarity Relations and Specific speed of Pumps -NPSH -cavitation.

Learning outcomes:

At the end of the unit, the student will be able to

1. explain the principles of centrifugal pump (L2)
2. calculate the head losses and efficiencies of centrifugal pump (L3)
3. distinguish of single-stage & multi-stage centrifugal pumps (L2)

UNIT-IV **(10 Lectures)**

OPEN CHANNEL FLOW - I:

Uniform Flow: Types of flows – Type of channels – Velocity distribution – Energy and momentum correction factors – Chezy's, Manning's and Bazin's formulae for uniform flow – Normal depth - Most economical sections.

Non-uniform Flow: Concept of specific energy - Specific energy curves - critical depth – computation of critical depth – critical, subcritical and super critical flows -Channel transitions.

Learning outcomes:

At the end of the unit, the student will be able to

1. distinguish open and closed channel flows (L2)
2. explain the formulae for computation of uniform flow (L2)
3. discuss about the specific energy (L2)

UNIT-V **(10 Lectures)**

OPEN CHANNEL FLOW - II:

Gradually Varied Flow: Dynamic equation for G.V.F. - Classification of channel bottom slopes - Surface Profiles - Direct step method.

Rapidly Varied Flow: Hydraulic jump - Elements and characteristics of hydraulic jump - Types of hydraulic jump - Location and applications of hydraulic jump - Energy loss in a hydraulic jump.

Learning outcomes:

At the end of the unit, the student will be able to

1. discuss the gradually varied flow concepts (L2)

2. draw the water surface profile for different slope conditions (L2)

3. explain the hydraulic jump (L2)

Text Books:

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

2. K. Subramanya, "Flow in Open Channels", 2nd Edition, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2003.

References:

1. Ven Te Chow, "Open Channel Flow", 2nd Edition, McGraw Hill Book Company, New Delhi, 1998.

2. R. Srivatsava, "Open Channel Flow", 2nd Edition, Oxford publishers, New Delhi,1998.

3. R.K. Rajput, "Fluid Mechanics and Hydraulic Machines", 6th Edition, S Chand & Company Ltd., New Delhi, 2016.

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

Web References:

1. https://nptel.ac.in/courses/105/103/105103096/
2. https://nptel.ac.in/courses/105/106/105106114/
3. https://nptel.ac.in/courses/112/103/112103249/