CIPC2005 FLUID DYNAMICS (3-0-0)

Course Objectives:
The course in Fluid Dynamics aims to provide students with a comprehensive understanding of advanced fluid mechanics principles and their practical applications. It seeks to develop deep knowledge of boundary layer theory, momentum equations, fluid machinery, and complex flow systems. Students will explore theoretical concepts and real-world engineering applications, including analysis of pumps, turbines, open channel flows, and fluid dynamic phenomena. The objective is to equip students with sophisticated analytical skills to understand fluid behavior, computational techniques, and engineering design principles related to fluid systems and their dynamic interactions.

Module-I
Boundary Layer Theory: Introduction, thickness of boundary layer, boundary layer along a long thin plate and its characteristics, boundary layer equations, momentum integralequations of the boundary layer, laminar boundary layer, turbulent boundary layer, laminarsub-layer, boundary layer on rough surfaces, separation of boundary layer, methods ofcontrolling the boundary layer.
Drag and Lift: Introduction, Types of Drag, dimensional analysis of drag and lift, drag on a(sphere, cylinder, flat plate and air foil), effect of free surface on drag, effect ofcompressibility on drag, development of lift on immersed body, induced drag on an air foil,of finite length, polar diagram for lift and drag of an air foil.

Module-II
Momentum equation and its applications: Introduction, impulse momentum equation,momentum correction factor, application of impulse momentum equation, force on a pipebed, jet propulsion (orifice tank, ship), momentum theory of propellers, angular momentumprinciple
Impact of free jets: Introduction, force exerted by fluid jets on (stationary flat plate, movingflat plate, stationary curved vane, moving curved vane), Torque exerted on a wheel withradial curved vane

Module-III
Reciprocating Pump: Introduction, main components, types, work done (single acting anddouble acting),coefficient of discharge, slip, percentage slip and negative slip, effects ofacceleration of piston on velocity and pressure in suction and delivery pipes, indicatordiagram, operating characteristic curves
Centrifugal Pump: Introduction,advantages,component parts,working,types,work done by theimpeller,head,losses and efficiencies,minimum starting speed,loss of head due to reduced orincreased flow,diameter of impeller and pipes,specific speed, characteristic curves, cavitation,priming devices, troubles and remedies
Turbines: Introduction,elements of hydraulic power plant,head and efficiencies of hydraulic turbine, classification.
Pelton wheel: work done and efficiencies,working proportions,design of runner, multiple jetwheel.
Radial flow impulse turbine: reaction turbine, Francis turbine, work done and efficiencies, working proportions, design of runner, draft tube theory, Kaplan turbine, workingproportions. Expression for specific speed in terms of known coefficients for different turbines,performance characteristic curves.

Classification, reaction, impulse, outward flow, inward flow & mixed flow turbines, Francis& Kaplan turbines, Pelton Wheel, Physical description and principle of operation, Governingof turbine.

Module-IV

Uniform flow in open channels: Introduction, types, geometrical properties, velocitydistribution, uniform flow, most economical section, computation of uniform flow, specificenergy and critical depth, specific force, critical flow and its computation, application ofspecific energy to channel transitions

Non-uniform flow in open channel: Introduction, gradually varied flow, classification ofcannel bottom slopes, classification of surface profiles, characteristics of surface profiles,integration of varied flow equations, hydraulic jump, location of hydraulic jump, surges inopen channel

Flow over notches and weirs: Introduction, classification, sharp-crested weir, rectangularweir, triangular weir, trapezoidal weir, broad-crested weir.

Measurement of depth of flow: point gauge, hook gauge, float gauge

Course Outcomes:

1. To adopt the dimensional analysis and study of viscous incompressible flow
2. To understand the boundary layer growth and its application in drag and lift phenomena
3. To study momentum equation and its application in impact of jet
4. To analyse velocity triangles for different pumps and turbine
5. To understand the basics of open channel flow and detail flow profiles

Text and Reference Books:

1. S. K. Som and G. Biswas, Fluid Mechanics and Fluid Machines, Tata. McGraw Hill Publishing Company
2. P. N. Modi and S. M. Seth, Hydraulic and Fluid Mechanics, Standard Book House, New Delhi
3. JagdishLal, Hydraulics and Fluid Mechanics, Tata McGraw Hill
4. R. K. Bansal, Fluid Mechanics and Hyd. Machines, Laxmi publisher, New Delhi
5. K. Subramanya, Fluid Mechanics and Hydraulic Machines, McGraw Hill Education
6. A.K. Jain, Fluid Mechanics, Khanna Publishers
7. SukumarPati, Textbook of Fluid Mechanics and Hydraulic Machines,McGraw Hill Education