AGPC2005 MECHANICS & OPEN CHANNEL HYDRAULICS (3-0-0)

Objective: To enable the students to design efficient water conveyance systems like canals, channels and pipes from places of origin to delivery points by acquiring knowledge on the principles of mechanics of fluids, water measurement and regulation and open channel hydraulic principles.

Module I

Fluids-definitions-classification-properties, dimensions. Fluid pressure– introduction– Measurement of fluid pressure–peizometer tube manometry– types of manometers. Mechanical gauges-Bourdon's tube pressure gauge Diaphragm pressure gauge–Dead weight pressure gauge. Fluid Static force on submerged surfaces–Total force on horizontal, vertical and inclined surfaces. Center of pressure of an inclined immersed surface-Centre of pressure of a composite section. Pressure on a curved surface and its applications. Kinematics of fluid flow– introduction – continuity of fluid flow – Types of flow lines.

Module II

Boundary layer theory- Thickness of Boundary layer, Thickness of Boundary layer in a laminar flow, Thickness of Boundary layer in a turbulent flow, Prandtl's Experiment of Boundary Layer separation. Dynamics of fluid flow – Various forms of energy in fluid flow, frictional loss, general equation. Bernoulli's theorem, Euler's equation of motion. Practical applications of Bernoulli's theorem, Verturimeter, pitot tube, Orifice meter.

Module III

Buoyancy of flotation – metacentric height. Flow through orifices (Measurement of Discharge) – Types of orifices, Jet of water, vena contracta, Hydraulic coefficients, Experimental Method for Hydraulic Coefficients, Discharge through a rectangular orifice. Flow through Orifices (Measurement of Time) – Time of Emptying a square, rectangular or circular tank through an orifice at its bottom, time of emptying a hemispherical tank through an orifice at its bottom. Time of emptying a circular horizontal tank through an orifice at its bottom. Time of emptying a tank of variable cross-section through an orifice. Flow through Mouthpieces – Types of Mouthpieces – Loss of Head of a liquid flowing in a pipe, Discharge through a Mouthpiece. Flow over Notches- Types of notches, Discharge over a Rectangular Notch, Triangular Notch, Stepped Notch. Time of emptying a tank over a Rectangular Notch, Triangular Notch. Flow over weirs – Types of weirs, Discharge over a weir, Francis's formula for Discharge over a Rectangular weir (Effect of End Contractions), Bazin's formula for Discharge over a rectangular weir, velocity of approach, Determination of Velocity of Approach.

Module IV

Flow through simple pipes – Loss of head in pipes, Darcy's formula for loss of Head in pipes, Chezy's formula for loss of head in pipes. Transmission of power through pipes, Time of emptying a tank through a long pipe, Time of flow from one tank into another through a long pipe. Flow through compound pipes – Discharge through a compound pipe (Pipes in series)- Discharge through pipes in parallel, Equivalent size of a pipe, Discharge through branded pipes from one reservoir to another. Dimensional analysis and similitude – Rayleigh's method & Buckingham's pi theorem. Types of similarities, Dimensional analysis, dimensionless numbers, introduction to fluid machinery. Open channel hydraulics-

classification of open channel and definitions. Chezy's formula for discharge through an open channel.

Module V

Bazin's formula for discharge through open channel, Numerical Problems on design through open channel, Kutter's formula for discharge, Problems on design. Manning's formula for discharge through an open channel. Channels of most economical cross sections – Conditions for maximum discharge through a channel of rectangular section, trapezoidal section, circular section. Specific energy concept-Specific energy of a following fluid, specific energy diagram, critical depth, Type of flows, critical velocity. Velocity and Pressure profiles in open channels. Hydraulic jump, Types of Hydraulic Jumps, Depth of Hydraulic Jump, Loss of Head due to Hydraulic Jump.

Course Outcomes :

CO1: Understand the principles of fluid mechanics, including properties, classifications, and pressure measurement techniques.

CO2: Apply boundary layer theory and Bernoulli's theorem to analyze fluid dynamics and practical applications like Venturimeters and Pitot tubes.

CO3: Evaluate discharge, time of emptying tanks, and flow characteristics through orifices, mouthpieces, notches, and weirs.

CO4: Analyze head losses in pipe systems, including single and compound pipes, and design efficient water transmission systems using dimensional analysis.

CO5: Design open channels for maximum efficiency using formulas like Manning's and Kutter's and assess energy transitions such as hydraulic jumps in fluid flow.

TEXT BOOKS:

1. Hydraulics and Fluid Mechanics, Modi P M and Seth S. M. 1973. Standard Book House, Delhi.
2. Open Channel Hydraulics, Chow V T, 1983, McGraw Hill Book Co., New Delhi.