CE321 Hydraulics (3L-0T-0P: 3Cr, 3Hr)

Pre-requisites*: Fluid Mechanics or equivalent course*

Flow through Pipes: Mechanism of turbulence and effect of turbulent flow in pipes. Resistance to flow of fluid in smooth and rough pipes, Loss of head through pipes, Darcy-Weisbach equation, Moody's diagram, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead end pipes, siphon, power transmission through pipes, nozzles. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures, branching of pipes, three reservoir problem.

Introduction to Open Channel Flow: Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section.

Uniform Flow: Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Factors affecting Manning's Roughness Coefficient "n", Most economical section of channel. Computation of Uniform flow, Normal depth.

Non-Uniform Flow: Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity. Gradually Varied Flow- Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.

Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types, applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges.

Impact of Jets: Impact of Jets on flat plates, curved plates, stationary and moving plates.

Hydraulic Machines: Working principle of Pumps and Turbines, Types of Pumps and Turbines and their usability in different scenarios, Specific Speed of Pumps and Turbines.

Computational Fluid Dynamics: Basic equations of fluid dynamics, Navier Stokes Equation, its original and simplified forms, methods of numerical solution, Grid generation, Application of CFD in Civil Engineering problems.

Course Plan

Module No.	Topic	Lectures
Module 1	**Flow through Pipes:** Mechanism of turbulence and effect of turbulent flow in pipes. Resistance to flow of fluid in smooth and rough pipes, Loss of head through pipes, Darcy-Weisbach equation, Moody's diagram, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead end pipes, siphon, power transmission through pipes, nozzles. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures, branching of pipes, three reservoir problem.	6
Module 2	**Impact of Jets:** Impact of Jets on flat plates, curved plates, stationary and moving plates	3
Module 3	**Hydraulic Machines**: Working principle of Pumps and Turbines, Types of Pumps and Turbines and their usability in different scenarios, Specific Speed of Pumps and Turbines	6
Module 4	**Introduction to Open Channel Flow**: Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section	4
Module 5	**Uniform Flow:** Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Factors affecting Manning's Roughness Coefficient "n", Most economical section of channel. Computation of Uniform flow, Normal depth.	6
Module 6	**Non-Uniform Flow:** Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity. Gradually Varied Flow- Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.	8
Module 7	**Hydraulic Jump:** Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types, applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges	4
Module 8	**Computational Fluid Dynamics:** Basic equations of fluid dynamics, Navier Stokes Equation, its original and simplified forms, methods of numerical solution, Grid generation, Application of CFD in Civil Engineering problems	3
	Total Lectures	35

COURSE OUTCOME:

CO 1 Students are introduced to the scientific, mathematical, and engineering principles of pipe flow, hydraulic machines and open channel flow and associated terminologies.

CO 2 Students become able to apply knowledge of mathematical, scientific, and engineering principles to solve real life problems of hydraulics.

CO 3 Students acquire the required knowledge and skill to analyse, design or evaluate components or whole of hydraulic engineering systems.

CO 4 Students become able to assess financial and economic implications of hydraulic design choices based on scientific and engineering principles.

CO-PO LINKAGE

CO	Statement	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO 1	Students are introduced to the scientific, mathematical, and engineering principles of pipe flow, hydraulic machines and open channel flow and associated terminologies	2	1	-	-	-	-	-	-		1	-	1	1	1	2
CO 2	Students become able to apply knowledge of mathematical, scientific, and engineering principles to solve real life problems of hydraulics.	2	3	-	-	-	-	-	-		1	-	1	2	1	2
CO 3	Students acquire the required knowledge and skill to analyse, design or evaluate components or whole of hydraulic engineering systems	3	2	3	-	1	1	-	1	1	1	-	1	2	1	2
CO 4	Students become able to assess financial and economic implications of hydraulic design choices based on scientific and engineering principles	1	1	2	-	1	1	-	2	1	1	-	1	2	1	2
CE321																

Text Books:

1. K.Subramanya, Flow in Open Channels, (Tata McGraw Hill, New Delhi, 2010)
2. P. N. Modi and S. M. Seth, Hydraulics and Fluid Mechanics including Hydraulic Machines (Standard Book House, New Delhi, 19th Edition, 2009).

Reference:

1. M. Hanif Chaudhry, Open Channel Flow, (Springer, 2nd Edition, 2007)
2. K. G. Rangaraju, Flow through Open Channels, (Tata McGraw Hill, New Delhi, 1984)