Advanced Fluid Mechanics

Course Code	Credit Hours
CE-215	2-1

Course Description

This course is designed to give advanced knowledge of fluid statics and fluid dynamics. The aim is to give the perception of the governing principles of pipe flow problems and pipe network design salient features. Further, fluid flow in hydraulic machines, especially roto-dynamic machines is treated in this course. Open Channel flow is also studied in this course. The ideas and concepts are further utilized to be implemented on designing different hydraulic structures and hydraulic machinery.

Text Book:

1. J. F. Douglas, J. A. Swaffield “Fluid Mechanics” Fourth Edition.
2. “A Textbook of Hydraulics, Fluid Mechanics and Hydraulic Machines” by R.S. Khurmi.
3. “Fundamentals of Fluid Mechanics” by Munson, B.R, Young, D.F, and Okiishi, T.H, John Wiley & Sons Inc.
4. E. John Finnemore and Joseph B. Franzini “Fluid Mechanics with Engineering Applications” 10 th Edition.

Reference Book:

1. Streeter, Wylie, Bedford “Fluid Mechanics” Ninth Edition
2. Dr Andrew Sleigh “An Introduction to Fluid Mechanics” May 2001 (School of Civil Engineering, University of Leeds)
3. R E. Featherstone “Civil Engineering Hydraulics” Third Edition

Prerequisites :

CE-251 Fluid Mechanics**.**

Assessment System for Theory

	Without Project (%)	With Project/Complex Engineering Problems (%)
Quizzes	15	10-15
Assignments	10	5-10
Mid Terms	25	25
Project	-	5-10
End Semester Exam	50	45-50

Assessment System for Lab

Lab Work/ Psychomotor Assessment/ Lab Reports	70%
Lab Project/ Open Ended Lab Report/ Assignment/ Quiz	10%
Final Assessment/ Viva	20%

Teaching Plan

Theory:

Week	Topic Covered	Reading Assignment/ Home Work		CLO No	Assessment Methodology
1 - 5	**Hydrodynamics Review**			1	Assignments, Quizzes,MSE , CEP, OEL & ESE
	Ideal and real fluids	Chap 4 (Ref 4)			
	Differential equation of continuity	Chap 4 (Ref 4)	Assignment 1		
	Rotational and irrotational flow	Chap 4 (Ref 4)	Quiz 1		
	Stream function and velocity potential function	Chap 4 (Ref 4)			
	Brief description of flow fields	Chap 4 (Ref 4)			
	Orthogonality of streamlines and equipotential lines	Chap 4 (Ref 4)			
	Flow net and its limitations. Different methods of drawing flow net	Chap 4 (Ref 4)			
	Steady Flow through Pipes				
	Type of flows	Chap 8 (Ref 4)	Assignment 3		
	Laminar and turbulent flow in circular pipes, semi empirical theories of turbulence	Chap 8 (Ref 4)	Quiz 3		
	Type of losses in pipes	Chap 8 (Ref 4)			
•	General equation for friction	Chap 8 (Ref 4)			
•	Velocity profile in circular pipes, pipe roughness	Chap 8 (Ref 4)			
•	Nukuradse's experiments	Chap 8 (Ref 4)			
•	Darcy-Weisbach equation	Chap 8			

			(Ref 4)			
	•	Friction factor, Colebrook & Haaland equations and Moody's diagrams	Chap 8 (Ref 4)			
	•	Minor losses	Chap 8 (Ref 4)			
	•	Pipe flow problems.	Chap 8 (Ref 4)			
	•	Darcy's friction versus fanning friction factor	Chap 8 (Ref 4)			
	•	Branching pipes	Chap 8 (Ref 4)			
6-8	Flow around immersed bodies				1	
		Lift and drag force.	Chap 9 (Ref 4)			
		Boundary layer along smooth flat plate.	Chap 9 (Ref 4)	Assignment 4		
	•	Thickness of boundary layer, shear stresses and velocity distributions	Chap 9 (Ref 4)			
	•	Types of boundary layers (laminar, transitioning, and turbulent)	Chap 9 (Ref 4)			
	•	Friction drag coefficient				
9	**Mid Semester Exam**					
10-11	Impact of Jets				1	
		Impulse momentum principle	Chap 6 (Ref 4)			
		Force of jet on stationary flat and curved plates	Chap 6 (Ref 4)			
		Force of jet on moving flat and curved plates	Chap 6 (Ref 4)			
	•	Forces on plumbing fittings	Chap 6 (Ref 4)		1	
12-13	Water Turbines				2	
		Types of turbines	Chap 16 (Ref 4)	Assignment 6		
		Impulse and reaction turbines	Chap 16 (Ref 4)	Quiz 6		
		Momentum equation applied to turbines.	Chap 16 (Ref 4)			

	Specific speed	Chap 16 (Ref 4)	OEL		
	Turbine characteristic curves	Chap 16 (Ref 4)			
	Cavitation and operation	Chap 16 (Ref 4)			
14	Centrifugal Pumps			2	
	Types	Chap 15 (Ref 4)	CEP (Submission)		
	• Classifications	Chap 15 (Ref 4)			
	• Construction features, operation, and efficiencies	Chap 15 (Ref 4)			
	• Maximum suction lift	Chap 15 (Ref 4)			
	• Specific speed and characteristic curve	Chap 15 (Ref 4)			
15	Reciprocating Pumps			2	
	• Types	Chap 24 (Ref 1)			
	• Construction features	Chap 24 (Ref 1)			
	• Single acting and Double acting Reciprocating pumps	Chap 24 (Ref 1)			
	• Coefficient of discharge and slip of the pump.	Chap 24 (Ref 1)			
	• Sum of heads in single acting reciprocating pumps	Chap 24 (Ref 1)			
16	Introduction to related software	Chap 24 (Ref 1)			
	• TURBNPRO software application	Chap 24 (Ref 1)			
17-18	**End Semester Exam**				

Practical

S No.	Practical	Assessment Methodology	Learning Domain/Taxonomy Level
1	To measure the head loss (hL) in a pipe of uniform diameter (d) and to investigate the critical Reynolds Number, relationship		P4, A3

	between hydraulic gradient and velocity of flow and relationship between friction factor and Reynolds Number.	Lab Manual, Lab Quiz, Lab Rubrics	
2	To verify the 'Impulse Momentum Principle' for a jet of water striking on 90°, 120° & 180°deflectors and to investigate the effect of velocity of flow on impulse force of the jet for various deflectors.		P4, A3
3	To make the study of the 'Pelton Wheel' and 'Turgo Impulse Turbine.		P4, A3
4	To perform experiment on Pelton Wheel and hence to plot its characteristic curves.		P4, A3
5	To make the study of Francis Reaction Turbine.		P4, A3
6	To make the study of Double Stage Centrifugal Pump		P4, A3
7	To perform experiment on "Double Stage Centrifugal Pump" and hence to plot its Characteristic Curves.		P4, A3
8	To perform experiment on the "Double Acting Reciprocal Pump" and to determine co-efficient of discharge and Slip of the Pump.		P4, A3