25UMET302	FLUID MECHANICS AND HYDRAULIC MACHINES	Category	L	T	P	R	Credit	Year of Introduction
		PCC	3	1	0	0	4	2025

Preamble: This course introduces the fundamental principles of fluid mechanics and their simple engineering applications. It also familiarizes students with the working principles and relevance of turbomachines, enabling them to analyze and solve basic engineering problems related to fluid flow and energy conversion.

Prerequisite: ICM104 Introduction to Mechanical Engineering & Civil Engineering

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Apply fundamental fluid properties and fluid statics principles to determine pressure forces, buoyancy and stability	K3 Apply
CO2	Apply principles of fluid kinematics and basic fluid dynamics to analyse fluid flow and flow measurement devices.	K3 Apply
CO3	Analyse internal pipe flow problems, estimate energy losses and apply dimensional analysis and boundary layer concepts.	K4 Analyse
CO4	Explain and apply the working principles and performance parameters of hydraulic turbines and pumps for engineering applications.	K3 Apply

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	-	-	2	-	-	-	-	-	1	2	1
CO2	3	3	1	2	2	-	-	-	-	-	1	2	2
CO3	2	2	3	1	2	-	-	-	-	-	1	3	3
CO4	2	2	3	1	2	-	-	-	-	-	1	3	3
Avg	2.5	1.75	2.33	1.33	2	-	-	-	-	-	1	2.5	2.25

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*	*	-	-	-
CO2	*	*	*	*	*	*	*	-	-
CO3	*	*	*	*	*	*	*	*	-
CO4	*	*	*	*	*	*	*	*	*

WKs Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*	*	*	*	*

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	**40**	**60**	**2.5 hrs**

Continuous Internal Evaluation Pattern:

Attendance : 5 marks
Continuous Assessment Test : 20 marks
Continuous Assessment Assignment /IV report : 15 marks

SYLLABUS

Module 1 (12 hrs)

Properties of fluids: density, specific weight, specific gravity, specific volume. Dynamic and kinematic viscosity, Newton's law of viscosity (applications only). Compressibility and bulk modulus. Surface tension and capillarity. Introduction to fluid mechanics: scope and continuum concept. Pressure concepts: atmospheric, gauge and absolute pressure. Pressure head and measurement using piezometer, simple and differential manometers (basic numericals). Mechanical and electronic pressure measurement device.Fluid statics: pressure–depth relationship. Hydrostatic force on plane and inclined surfaces, centre of pressure (standard problems). Buoyancy and metacentre: stability of immersed and floating bodies (conceptual + simple problems). Stability of floating bodies in practical applications (ships, floating structures).

Module 2 (14 hrs)

Description of fluid motion: Eulerian and Lagrangian approach. Types of flow. Velocity and acceleration in fluid flow (basic expressions). Streamlines, pathlines and streaklines. Stream function and velocity potential (conceptual treatment). Flow net (applications only). Introduction to circulation and vorticity.

Continuity equation (1D incompressible flow), Bernoulli's equation – assumptions, applications and limitations. Extended Bernoulli equation with head loss. Euler's equation (concept only). Flow

measurement: Pitot tube, Venturimeter and Orificemeter (moderate numericals). Rectangular and triangular notches (working principle only). Rotameter and electromagnetic flow meter.

Module 3 (14 hrs)

Laminar and turbulent flow. Reynolds number and significance. Velocity distribution and shear stress in laminar pipe flow. Hagen–Poiseuille equation (applications). Major and minor losses in pipes. Darcy–Weisbach equation and Chezy's equation. Moody's chart – interpretation and use. Hydraulic Gradient Line (HGL) and Total Energy Line (TEL). Pipes in series and parallel. Navier–Stokes equation – physical meaning (no derivation). Dimensional analysis: Buckingham's π theorem (procedure + simple examples). Model analysis and similitude. Boundary layer concept: laminar and turbulent boundary layer. Boundary layer separation (qualitative treatment). Methods of controlling separation.

Module 4 (16 hrs)

Impact of jets on fixed and moving flat plates and curved vanes. Velocity triangles (basic construction only). Applications in impulse turbines. Hydraulic turbines: classification and comparison. Pelton, Francis and Kaplan turbines – working, components, efficiencies (no velocity-triangle numericals). Performance characteristics and selection criteria. Centrifugal pump – construction, working, head, efficiencies, priming and cavitation. Reciprocating pump – working, slip, negative slip and efficiency (simple numericals). Performance characteristics and pump selection. Air vessels and their function.

Students should undergo a related Field/Industrial Visit as part of the course.

Text Books:

1. Çengel, Y. A., & Cimbala, J. M., *Fluid mechanics*. Tata McGraw Hill, 2013.
2. Bansal, R. K., *Fluid mechanics and hydraulic machines*. Laxmi Publications, 2005.
3. Som, S. K., *Introduction to fluid mechanics and fluid machines*. McGraw Hill Education India, 2011.

Reference Books:

1. White, F. M., *Fluid mechanics*. Tata McGraw Hill, 2003.
2. Fisher, & Henly, *Engineering applications of fluid dynamics*. Willford Press, 2023.
3. Rathakrishnan, E., *Fluid mechanics: An introduction* (4th ed.). Prentice Hall India, 2022.
4. Modi, P. N., & Seth, S. M.*, Hydraulics and fluid mechanics including hydraulic machines* (23rd ed.), 2022.

END SEMESTER EXAMINATION – MODEL QUESTION PAPER

Course Code	**25UMET302**
Course Name	**Fluid Mechanics and Hydraulic Machines**
Max. Marks: 60	**Duration: 2.5 Hours**

Part A *(Answer all questions. Each question carries 3 marks)*				
Qn No.	**Question**	**Marks**	**CO**	**BL**
1	Illustrate how viscosity and surface tension influence fluid flow behaviour in practical engineering applications.	3	CO 1	L3
2	Apply the principle of buoyancy to explain the concept of	3	CO 1	

	metacentric height and its role in the stability of floating bodies.			L3
3	Illustrate the application of Bernoulli's equation by explaining the assumptions on which it is based.	3	CO 2	L3
4	Illustrate the differences between a Venturimeter and an Orificemeter with respect to their performance and practical applications.	3	CO 2	L3
5	Analyze the role of the Reynolds number in predicting the nature of flow and its influence on pipe flow behavior.	3	CO 3	L4
6	Examine the Hydraulic Gradient Line (HGL) and the Total Energy Line (TEL), and analyze their roles in representing energy distribution in pipe flow.	3	CO 3	L4
7	Apply the concept of flow direction to classify hydraulic turbines and explain the features of each classification.	3	CO 4	L3
8	Illustrate the purpose of priming and explain why it is essential for the efficient operation of centrifugal pumps.	3	CO 4	L3
Part B (*Answer any one full question from each Module. Each carry 9 marks*)				
Module I				
Qn No.	**Question**	**Marks**	**CO**	**BL**
9.a)	Apply the principles of simple and differential manometers to explain pressure measurement, with the help of neat sketches.	5	CO 1	L3
9.b)	Apply the principles of fluid statics to determine the hydrostatic force acting on a vertical plane surface.	4	CO 1	L3
OR				
10.a)	Illustrate the concepts of buoyancy and stability of floating bodies using neat diagrams and explain their applications.	5	CO 1	L3
10.b)	Apply the concept of metacentric height to assess the stability of a floating body.	4	CO 1	L3
Module II				
Qn No.	**Question**	**Marks**	**CO**	**BL**
11.a)	Apply Bernoulli's equation to determine the discharge through a Venturimeter.	5	CO 2	L3
11.b)	Compare the Eulerian and Lagrangian approaches used to describe fluid motion and explain their engineering applications.	4	CO2	L3
OR				
12.a)	Apply the continuity equation to solve one-dimensional incompressible fluid flow problems.	5	CO 2	L3
12.b)	Illustrate the construction of a Pitot tube and explain its	4	CO2	L3

	working for velocity measurement using a neat sketch.			
Module III				
Qn No.	**Question**	**Marks**	**CO**	**BL**
13. a	Analyse the major and minor losses occurring in pipe flow and explain the factors affecting them.	5	CO 3	L4
13. b	Examine the concept of the boundary layer and analyze the factors responsible for boundary layer separation.	4	CO 3	L4
OR				
14. a	Analyse the flow through pipes connected in series and parallel to estimate the discharge and head loss.	5	CO 3	L4
14. b	Deconstruct a dimensional analysis problem and establish the governing dimensionless groups using Buckingham's π theorem.	4	CO 3	L4
Module IV				
Qn No.	**Question**	**Marks**	**CO**	**BL**
15. a	Relate the construction and working of a centrifugal pump to its performance characteristics.	6	CO 4	L3
15. b	Apply the performance characteristics of hydraulic turbines to select a suitable turbine for a given hydraulic head and discharge.	3	CO 4	L3
OR				
16. a	Relate the construction of Pelton, Francis, and Kaplan turbines to their working principles using neat sketches.	6	CO 4	L3
16. b	Apply the concept of impact of jet on curved vanes to determine the force exerted by the jet.	3	CO 4	L3

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