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BME403

Fourth Semester B.E./B.Tech. Degree Examination, June/July 2025
Fluid Mechanics

Time: 3 hrs. Max. Marks: 100

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M : Marks , L: Bloom's level , C: Course outcomes.

		Module – 1	M	L	C
Q.1	a.	Define the following properties of fluids and mention their SI units: (i) Mass Density (ii) Specific weight (iii) Kinematic viscosity	06	L1	CO1
	b.	Calculate the dynamic viscosity of oil which is used for lubrication between a square plate of size 0.8 m × 0.8 m and an inclined plane with an angle of inclination 30°. The weight of the square plate is 300 N and it slides down the inclined plane with a uniform velocity of 0.3 m/s. The thickness of the oil film is 1.5 mm.	08	L3	CO1
	c.	Calculate the capillary rise in a glass tube of 3.0 mm diameter when immersed vertically in (i) water and (ii) mercury. Take surface tensions for mercury and water as 0.0725 N/m and 0.52 N/m respectively in contact with air. Specific gravity for mercury is given as 13.6.	06	L3	CO1
		OR			
Q.2	a.	Distinguish between (i) Absolute pressure (ii) Gauge pressure (iii) Gauge vacuum (iv) Atmospheric pressure. Indicate their relative position on a chart.	06	L2	CO1
	b.	Derive an expression for the total pressure and the depth of centre of pressure for a inclined surface submerged in water.	08	L3	CO1
	c.	A square plate of 1.5 m side is immersed in water vertically. Find the hydrostatic force on the plate and the depth of centre of pressure from free surface of water. When its upper side is 0.5 m below the free surface of water.	06	L3	CO1
		Module – 2			
Q.3	a.	Define the following : (i) Steady and Unsteady flow (ii) Compressible and Incompressible flow (iii) Laminar and Turbulent flow	06	L2	CO2
	b.	Define the equation of continuity. Obtain an expression for continuity equation for a three-dimensional flow.	08	L3	CO2
	c.	The velocity components in a two-dimensional flow are : $u = 8x^2y - \frac{8}{3}y^3$ and $v = -8xy^2 + \frac{8}{3}x^3$ Show that these velocity component represent a possible case of an irrotational flow.	06	L3	CO2

		OR			
Q.4	**a.**	Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow.	**08**	**L3**	**CO2**
	b.	A fluid of viscosity 0.5 poise and specific gravity 1.20 is flowing through a circular pipe of diameter 100 mm. The maximum shear stress at the pipe wall is given as 147.15 N/m^2. Find (i) The pressure gradient (ii) The average velocity (iii) The Reynolds number of the flow.	**08**	**L3**	**CO2**
	c.	Define Reynolds number. Explain its significance in fluid flow.	**04**	**L2**	**CO2**
		Module – 3			
Q.5	**a.**	Derive Euler's equation of motion along a stream line. Obtain Bernoulli's equation from Euler's equation. Mention the assumptions made.	**08**	**L3**	**CO3**
	b.	Derive the expression for the rate of flow of fluid through a horizontal venturimeter.	**06**	**L3**	**CO3**
	c.	A horizontal venturimeter with inlet diameter 20 cm and throat diameter 10 cm is used to measure the flow of water. The pressure at inlet is 14.715 N/cm^2 and vacuum pressure at the throat is 40 cm of mercury. Find the discharge of water through venturimeter. Take $C_d = 0.98$.	**06**	**L3**	**CO3**
		OR			
Q.6	**a.**	Explain the procedure to find the loss of head due to friction in pipes using (i) Darcy formula and (ii) Chezy's formula.	**06**	**L2**	**CO3**
	b.	Obtain expression for head loss in a sudden expansion in the pipe. List all the assumptions made in the derivation.	**08**	**L3**	**CO3**
	c.	Calculate the rate of flow of water through a pipe of diameter 300 mm. When the difference of pressure head between the two ends of a pipe 400 m apart is 5 m of water. Take value of f = 0.009 in the formula. $h_f = \frac{4 f l V^2}{d \times 2g}$	**06**	**L3**	**CO3**
		Module – 4			
Q.7	**a.**	What do you understand by the terms boundary layer and boundary layer theory?	**04**	**L1**	**CO4**
	b.	Define displacement thickness. Derive an expression for the displacement thickness.	**08**	**L3**	**CO4**
	c.	Oil with a free-stream velocity of 2 m/s flow over a thin plate 2 m wide and 2 m long. Calculate the boundary layer thickness and the shear stress at the trailing end point and determine the total surface resistance of the plate. Take specific gravity as 0.86 and kinematic viscosity as 10^{-5} m^2/s.	**08**	**L3**	**CO4**

OR

Q.8	**a.**	Explain the following terms: (i) Geometric similarity (ii) Kinematic similarity (iii) Dynamic similarity	**06**	**L2**	**CO4**
	b.	State Buckingham's π - theorem. What do you mean by repeating variables?	**06**	**L2**	**CO4**
	c.	The frictional torque 'T' of a disc of diameter 'D' rotating at a speed 'N' in a fluid of viscosity 'μ' and density 'ρ' in a turbulent flow is given by 'T'. Show that $T = D^5N^2\rho\phi\left[\frac{\mu}{\rho ND^2}\right]$	**08**	**L3**	**CO4**
		Module – 5			
Q.9	**a.**	State the Bernoulli's theorem for compressible flow. Derive an expression for Bernoulli's equation when the process is (i) Isothermal (ii) Adiabatic.	**10**	**L3**	**CO5**
	b.	Define Mach number. Explain its importance in compressible fluid flow.	**05**	**L2**	**CO5**
	c.	Find the velocity of bullet fired in standard air if the Mach angle is 30°. Take R = 287.14 J/kg °K, take K for air 1.4. Assume temperature as 15°C.	**05**	**L3**	**CO5**
		OR			
Q.10	**a.**	What is CFD? Mention the advantages and disadvantages of CFD.	**08**	**L1**	**CO5**
	b.	What are the steps involved in solving a CFD problem? Explain.	**06**	**L2**	**CO5**
	c.	An aeroplane is flying at an height of 15 km, where the temperature is – 50°C. The speed of the plane is corresponding to M = 2.0. Assuming K = 1.4 and R = 287 J/kg °K. Find the speed of the plane.	**06**	**L3**	**CO5**

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