U.S.N.										

B.M.S. College of Engineering, Bengaluru-560019

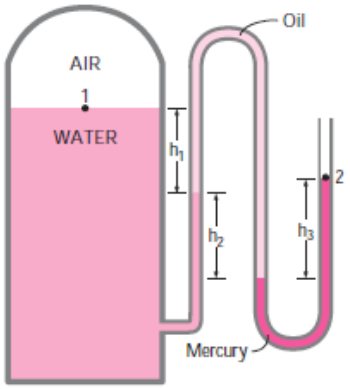
Autonomous Institute Affiliated to VTU

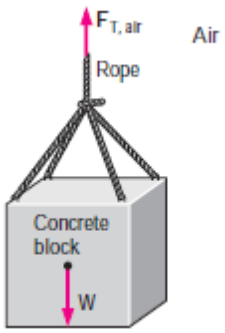
January / February 2025 Semester End Main Examinations

Programme: B.E. **Semester: III**
Branch: Mechanical Engineering **Duration: 3 hrs.**
Course Code: 19ME3DCFME **Max Marks: 100**
Course: Fluid Mechanics

Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
2. Missing data, if any, may be suitably assumed.

Important Note: Completing your answers, compulsorily draw diagonal cross lines on the remaining blank pages. Revealing of identification, appeal to evaluator will be treated as malpractice.

		UNIT - I	*CO*	*PO*	Marks
1	a)	With the help of a sketch explain the variation of shear stress with velocity gradient.	*CO1*	*PO1*	**06**
	b)	The velocity distribution for the flow over a plate is gives by $u = 2y-y^2$, where u is the velocity in m/s at a distance y meters above the plate. Determine the velocity gradient and shear stress at the boundary and 1.5 from it. Take the dynamic viscosity of fluid as 0.9 N-s/m^2.	*CO1*	*PO2*	**08**
	c)	State and prove 'Pascal's law'.	*CO1*	*PO1*	**06**
		OR			
2	a)	Explain briefly the following: (i) Atmospheric pressure, (ii) Gauge pressure, (iii) Vacuum pressure, and (iv) Absolute pressure.	*CO1*	*PO2*	**06**
	b)	With sketch explain working of, (*i*) Piezometer and (*ii*) U-tube manometer.	*CO1*	*PO2*	**06**
	c)	The water in a tank is pressurized by air, and the pressure is measured by a multifluid manometer as shown in Fig. 1. The tank is located on a mountain at an altitude of 1400 m where the atmospheric pressure is 85.6 kPa. Determine the air pressure in the tank if h1 = 0.1 m, h2 = 0.2 m, and h3 = 0.35 m. Take the densities of water, oil, and mercury to be 1000 kg/m^3, 850 kg/m^3, and 13,600 kg/m^3, respectively.  **Figure.1**	*CO1*	*PO2*	**08**

			UNIT - II			
	3	a)	Determine the total pressure and center of pressure for a vertical plane submerged in liquid.	*CO1*	*PO1*	**06**
		b)	A circular plate 1.5 m diameter is submerged in water, with its greatest and least depths below the surface being 2 m and 0.75 m respectively. Determine: (i) The total pressure on one face of the plate, and (ii) The position of the centre of pressure.	*CO1*	*PO2*	**06**
		c)	Define Metacentric height. Prove that Metacentric height is given by MG=BM-GM where, 'MG' is metacentric height, 'BM' is the distance between metacenter and center of buoyancy, 'GM' is the distance between center of buoyancy and centre of gravity.	*CO1*	*PO1*	**08**
			OR			
	4	a)	Derive an expression for the depth of centre of pressure from free surface of liquid of an inclined plane surface submerged in the liquid.	*CO1*	*PO1*	**08**
		b)	A 1 m wide and 1.5 m deep rectangular plane surface lies in water in such a way that its plane makes an angle of 30° with the free water surface. Determine the total pressure and position of centre of pressure when the upper edge is 0.75 m below the free water surface.	*CO1*	*PO2*	**06**
		c)	A crane is used to lower weights into the sea (density =1025 kg/m^3) for an underwater construction project (Fig.2). Determine the tension in the rope of the crane due to a rectangular 0.4m x 0.4m x 3m concrete block (density = 2300 kg/m^3) when it is (i) suspended in the air and (ii) completely immersed in water.  **Figure.2**	*CO1*	*PO2*	**08**
			UNIT - III			
	5	a)	Derive the continuity equation in 3D Cartesian coordinate system.	*CO2*	*PO1*	**08**
		b)	Find the velocity and acceleration at a point (1, 2, 3) after 1 sec for a three-dimensional flow which is given by u = yz + t, v = xz – t, and w = xy m/s.	*CO2*	*PO2*	**08**
		c)	Explain the different methods to describe the fluid motion.	*CO2*	*PO2*	**04**
			OR			
	6	a)	A horizontal venturimeter with inlet diameter 200 mm and throat	*CO2*	*PO2*	**08**

			diameter 100 mm is used to measure the flow of water. The pressure at inlet is 0.18 N/mm^2 and the vacuum pressure at the throat is 280 mm of mercury. Find the rate of flow. The value of C_d may be taken as 0.98.			
		b)	State and prove Bernoulli's equation and also list the assumptions made.	*CO2*	*PO1*	**06**
		c)	Water is flowing through a pipe of 5 cm diameter under a pressure of 29.43 N/cm^2 (gauge) and with mean velocity of 2 m/s. Find the total head or total energy per unit weight of the water at a cross-section, which is 5 m above the datum line.	*CO2*	*PO2*	**06**
			UNIT - IV			
	7	a)	Prove that the maximum velocity in a circular pipe for viscous flow is equal to two times the average velocity of the flow.	*CO2*	*PO1*	**10**
		b)	A horizontal pipe of diameter 500 mm is suddenly contracted to a diameter of 250 mm. The pressure intensities in the large and smaller pipe are given as 13.7 N/cm^2 and 11.7 N/cm^2 respectively. Find the loss of head due to contraction if C_d =0.62. Also determine the rate of flow of water.	*CO2*	*PO2*	**10**
			OR			
	8	a)	Derive force exerted by jet strikes the curved plate at one end tangentially when the plate is symmetrical curved plate.	*CO2*	*PO1*	**08**
		b)	Explain the force exerted by a flowing fluid on a stationary body in terms lift and drag.	*CO2*	*PO2*	**08**
		c)	A prototype automobile has an overall drag coefficient of 0.35. Compute the total drag as it moves at 25 m/s through still air at 25°C. The maximum projected frontal area is 2.50 m^2.	*CO2*	*PO2*	**04**
			UNIT - V			
	9	a)	Discuss the Rayleigh's method of dimensional analysis.	*CO3*	*PO1*	**06**
		b)	List the uses of Dimensional Homogeneity.	*CO3*	*PO1*	**04**
		c)	Using Buckingham's π-theorem, show that the velocity through a circular orifice is given by $V = \sqrt{2gH}\ \phi\left[\frac{D}{H}, \frac{\mu}{\rho VH}\right]$ where, H = Head, D = Diameter of the orifice, μ = Co-efficient of viscosity, ρ = density, and g = Acceleration due to gravity.	*CO3*	*PO2*	**10**
			OR			
	10	a)	Discuss the significance of, i) Reynolds number ii) Mach Number, iii) Weber's number, iv) Euler's number, and v) Knudsen Number	*CO3*	*PO1*	**10**
		b)	Albert Einstein is pondering how to write his equation. He knows that energy E is a function of mass (m) and speed of light (c), but he does not know the functional relationship. Pretend that Albert knows nothing about dimensional analysis, you can help Einstein to come up with his equation.	*CO3*	*PO2*	**10**

****