U.S.N.										

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

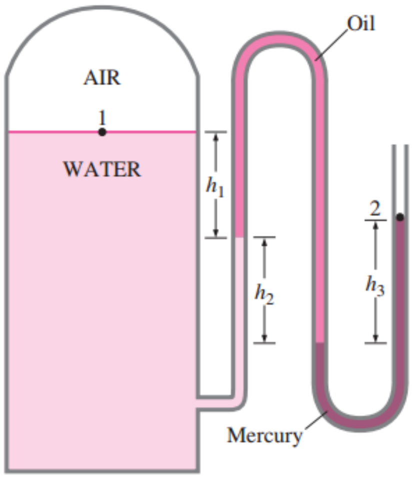
Autonomous Institute Affiliated to VTU

September / October 2023 Semester End Main Examinations

Programme: B.E. | **Semester: IV**
Branch: Mechanical Engineering | **Duration: 3 hrs.**
Course Code: 22ME4PCFME | **Max Marks: 100**
Course: Fluid Mechanics | **Date: 22.09.2023**

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)	Develop an expression for Pascal and hydrostatic law	CO1	PO2	**08**
	b)	The water in a tank is pressurized by air, and the pressure is measured by a multi-fluid 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 h_1= 0.1 m, h_2 = 0.2 m, and h_3 =0.35 m. take the densities of water, oil, and mercury to be 1000 kg/m³, 850 kg/m³, and 13600kg/m³ respectively.  Fig.1	CO1	PO1	**08**
	c)	A solid block of specific gravity 0.9 floats in such a way that, 75 percent of its volume is in water and 25 percent of its volume is in fluid 'X', which is layered above the water. Determine the specific gravity of fluid 'X'	CO1	PO1	**04**
		UNIT - II			
2	a)	Derive an expression for discharge through venturimeter	CO2	PO1	**08**
	b)	The velocity components of an incompressible two dimensional	CO2	PO1	**04**

			velocity field are given by $u = y^2 - x(1+x)$, $v = y(2x+1)$. Show that the flow is irrotational and satisfies conservation of mass.			
		c)	Define the following terms: (i) stream line (ii) streak line (iii) path line (iv) time line	*CO2*	*PO2*	**08**
			UNIT - III			
	3	a)	Derive, the general form of the Reynold's transport theorem	*CO3*	*PO1*	**10**
		b)	A spacecraft with a mass of 12,000 kg is dropping vertically toward a planet at a constant speed of 800 m/s. To slow down the spacecraft, a solid fuel rocket at the bottom of the spacecraft is fired and combustion gases leave the rocket at a constant rate of 80 kg/s and at a velocity of 3000 m/s relative to the spacecraft in the direction of motion of the spacecraft for a period of 5 sec. Disregarding the small changes in the mass of the spacecraft determine, (a) deceleration of the spacecraft during the time the solid fuel rocket is being fired, (b) change in velocity of the spacecraft ,and (c) thrust exerted on the spacecraft.	*CO3*	*PO2*	**10**
			OR			
	4	a)	Derive, Hagen-Poiseuille equation and state the assumptions to be considered.	*CO4*	*PO1*	**10**
		b)	A laminar flow is taking place in a pipe of diameter 200 mm. The maximum velocity is 1.5 m/s. Find the mean velocity and the radius at which this occurs. Also calculate the velocity at 4 cm from the wall of the pipe.	*CO3*	*PO2*	**10**
			UNIT - IV			
	5	a)	By order of magnitude analysis derive the Prandtl's boundary layer equations for a flow over flat plate.	*CO4*	*PO1*	**10**
		b)	A small low-speed wind tunnel is being designed for calibration of hot wires. The air is at 19°C. The test section of the wind tunnel is 30 cm in diameter and 30 cm in length. The flow through the test section must be as uniform as possible. The wind tunnel speed ranges from 1 to 8 m/s, and the design is to be optimized for an air speed of V = 4 m/s through the test section. (a) For the case of nearly uniform flow at 4 m/s at the test section inlet, by how much will the centerline air speed accelerate by the end of the test section? Take $\nu = 1.507 \times 10^{-5}$ m²/s	*CO5*	*PO2*	**10**
			OR			
	6	a)	Define the terms momentum thickness and displacement thickness. Derive their basic expression taking velocity relation (v/U) into account.	*CO3*	*PO1*	**12**
		b)	For a flow over flat plate consider, the local skin friction coefficient, $$C_{f,x} \cong \frac{0.027}{(Re_x)^{1/7}}$$ and the one- seventh power law approximation for the boundary	*CO5*	*PO2*	**08**

			layer profile shape, $$\frac{u}{U} \cong \left(\frac{y}{\delta}\right)^{1/7} \text{ for } y \leq \delta \quad \frac{u}{U} \cong 1 \quad \text{for } y > \delta$$ Using the definition of displacement thickness and momentum thickness [using the Karman's integral equation,] estimate δ, δ^* and θ vary with x.			
			UNIT - V			
	7	a)	Derive on the basis of dimensional analysis suitable parameters to present the thrust developed by a propeller. Assume that thrust P depends upon angular velocity ω, speed of advance V, diameter D, dynamic viscosity μ, mass density ρ, elasticity of fluid medium which can be denoted by the speed of sound in the medium C. Take D, V and ρ as repeating variables	*CO4*	*PO1*	**10**
		b)	Define and explain non-dimensional numbers: (i) Reynolds Number, (ii) Froude Number, (iii) Euler's number (iv)Weber's Number, (v) Mach number Number	*CO3*	*PO2*	**10**

******