U.S.N.										

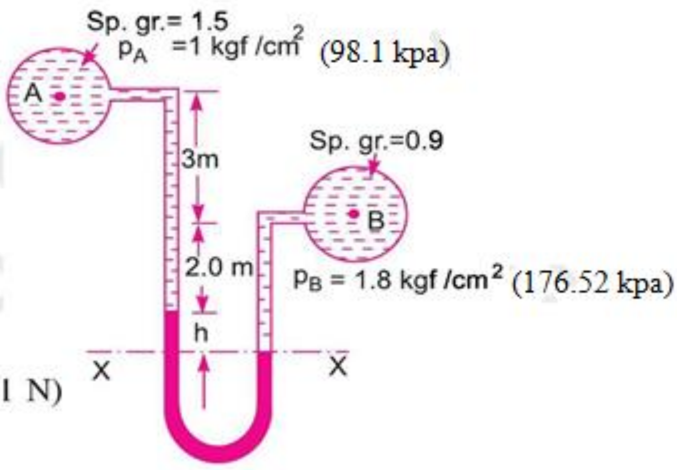
B.M.S. College of Engineering, Bengaluru-560019

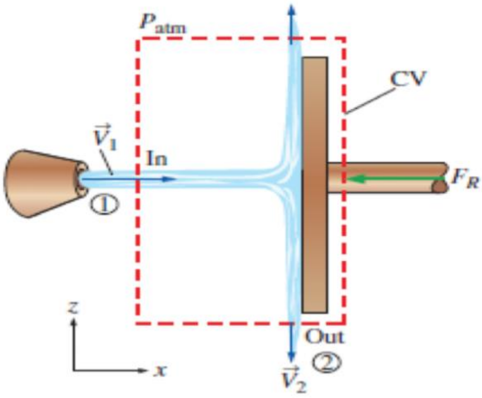
Autonomous Institute Affiliated to VTU

August 2024 Semester End Main Examinations

Programme: B.E. | **Semester: IV**
Branch: Mechanical Engineering | **Duration: 3 hrs.**
Course Code: 23ME4PCFME / 22ME4PCFME | **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.

		UNIT - 1	***CO***	***PO***	**Marks**
1	a)	Discuss the Concept of continuum, explain Newton's law of viscosity.	*CO1*	*PO1*	**05**
	b)	Develop an expression for Pascal's law.	*CO1*	*PO2*	**05**
	c)	A differential manometer is connected at the two points A and B of two pipes as shown in Fig 1. The pipe contains a liquid of sp. gr. = 1.5. while pipe B contains a liquid of sp. gr. = 0.9. The pressure at A and B are (98.1 kPa) and (176.52 kPa) respectively. Find the difference in mercury level in the differential manometer.  Fig. 1	*CO1*	*PO1*	**10**
		UNIT - 2			
2	a)	The velocity of vector in a fluid flow is given as $V = 4x^3\hat{\imath} - 10x^2y\hat{\jmath} + 2t\hat{k}$. Find the velocity and acceleration of a fluid particle at (2,1,3) at time t=1.	*CO3*	*PO1*	**10**
	b)	A horizontal venturi meter with inlet and throat diameter of 300 mm and 150 mm respectively is used to measure the flow of water. The reading of differential monometer connected to the inlet and throat is 200 mm of mercury. Determine the flow rate. Take C_d=0.98.	*CO3*	*PO1*	**10**

			UNIT - 3			
	3	a)	What is Reynolds Transport Theorem (RTT). Deduce an RTT equation for a fixed control volume.			**10**
		b)	An oil of viscosity 0.02 Ns/m^2 is flowing between two stationary plates of 1 m wide maintained 10 mm apart. The velocity in the midway between the plates is 2 m/s. Calculate the pressure gradient, the average velocity, discharge, shear stress at the wall and pressure drop per unit length.	*CO3*	*PO2*	**10**
			OR			
	4	a)	Derive the expression of flow for a viscous fluid between two parallel plates in which one plate is moving and other is fixed (Couette flow).			**10**
		b)	Water is accelerated by a nozzle to an average speed of 20 m/s and strikes a stationary vertical plate at a rate of 10 kg/s with a normal velocity of 20 m/s (as shown in Fig.2). after the strike, the water stream splatters off in all directions in the plane of the plate. Determine the force needed to prevent the plate from moving horizontally due to the water stream.  Fig. 2	*CO3*	*PO2*	**10**
			UNIT - 4			
	5	a)	Derive an expression for momentum integral equation for two-dimensional incompressible laminar boundary layer.	*CO1*	*PO2*	**10**
		b)	A boundary layer develops along the walls of a rectangular wind tunnel. The air is at 20°C and atmospheric pressure. The boundary layer starts upstream of the contraction and grows into the test section (Fig. 3) By the time it reaches the test section, the boundary layer is fully turbulent. The boundary layer profile and its thickness are measured at both the beginning ($x=x_1$) and the end ($x=x_2$) of the bottom wall of the wind tunnel test section. The test section is 1.8 m long and 0.50 m wide (into the page in Fig. 3). The following measurements are made. $\delta_1 = 42\ mm\ \delta_2 = 77\ mm,\ V = 10\ m/s$ (1) At both the locations the boundary layer profile fits better to one eight power law approximation than to the standard one seventh	*CO3*	*PO1*	**10**

power law approximation given by:

$\frac{u}{U} \cong (\frac{y}{\delta})^{1/8}$ for $y \leq \delta$ $\qquad$ $\frac{u}{U} \cong 1$ for $y > \delta$

Estimate the total skin friction drag force F_D acting on the bottom wall of the wind tunnel test section.

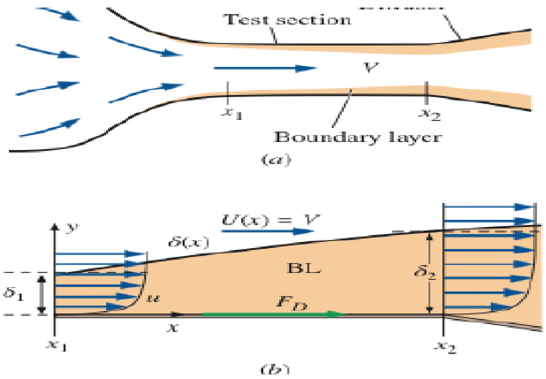


Fig. 3

		OR			
6	a)	Derive an equation for momentum thickness.	*CO1*	*PO1*	**10**
	b)	Water flows over a flat plate at a free stream velocity of 0.15 m/s. There is no pressure gradient and laminar boundary layer is 6 mm thick. Assume a sinusoidal velocity profile [μ=1.02 X 10 $^{-3}$ kg/ms, $\rho = 100\ kg/m^3$] $$\frac{u}{U\infty} = \sin\frac{\pi}{2}(\frac{y}{\delta})$$ For the flow conditions stated above, calculate the local wall shear stress and skin friction coefficient.	*CO1*	*PO4*	**10**
		UNIT - 5			
7	a)	Explain the Geometric Similarity, Kinematic Similarity and Dynamic Similarity that exists between the model and prototype.	*CO4*	*PO1*	**10**
	b)	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' is the head causing flow, D is the diameter of the orifice, μ is the coefficient of viscosity, ρ is the mass density and g is the acceleration due to gravity.	*CO4*	*PO1*	**10**

******