U.S.N. | | | | | | | | | |

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

Autonomous Institute Affiliated to VTU

September / October 2024 Supplementary Examinations

Programme: B.E.   **Semester: IV**
Branch: Mechanical Engineering   **Duration: 3 hrs.**
Course Code: 22ME4PCFME   **Max Marks: 100**
Course: Fluid Mechanics
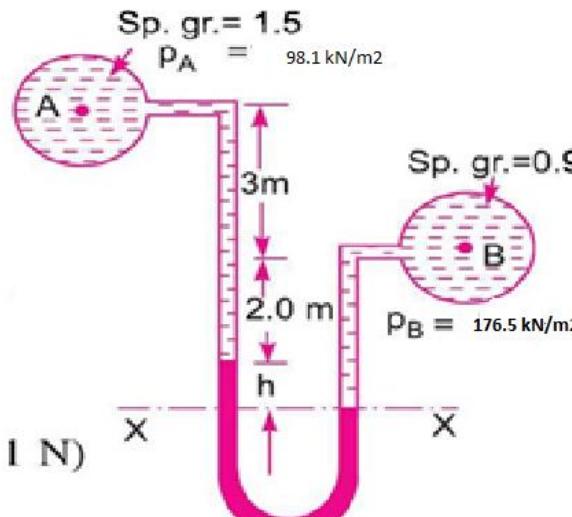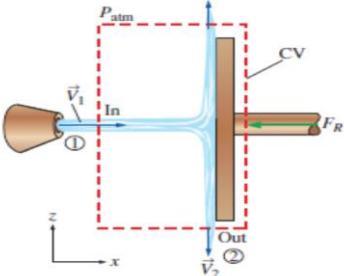
Instructions: 1. Answer any FIVE full questions, choosing one full question from each unit.
                       2. Missing data, if any, may be suitably assumed.

			UNIT - I	*CO*	*PO*	**Marks**
1	a)		Discuss the Concept of continuum, and Newton's law of viscosity.	*CO1*	*PO2*	**10**
	b)		A differential manometer is connected at 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 kN/m^2 and 176.5 kN/m^2 respectively. Find the difference in mercury level in differential manometer.	*CO4*	*PO1*	**10**

Fig. 1

			UNIT - II			
2	a)		List and explain the types of fluid flow.	*CO1*	*PO1*	**10**
	b)		The velocity vector in a fluid flow is given as V=4 x^3i-10x^2 yj+ 2tk. Find the velocity and acceleration of a fluid particle at spatial location (2, 1, 3) at time t=1.	*CO4*	*PO1*	**10**

|			**UNIT - III**			
3	a)		What is Reynolds Transport Theorem (RTT)? Deduce an RTT equation for a fixed control volume.	CO3	PO2	**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	CO4	PO1 PO2	**10**
			OR			
4	a)		Derive the expression for a couette flow of viscous fluid between two parallel plates in which one plate is moving and other is fixed	CO3	PO1	**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.	CO4	PO2	**10**
			UNIT - IV			
5	a)		Derive an equation for momentum and displacement thickness	CO3	PO1	**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). 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). The following measurements are made. $\delta_1 = 4.2\ cm\ \delta_2 = 7.7\ cm\ V = 10\frac{m}{s}$ (1) At both locations the boundary layer profile fits better to a one eight power law approximation than to the standard one seventh power law approximation. $\frac{u}{U} \cong (\frac{y}{\delta})^{1/8}$ for y $\leq\ \delta$ $\quad\quad \frac{u}{U} \cong 1$ for y $>\ \delta$ (2) Estimate the total skin friction drag force F$_D$ acting on the bottom wall of the wind tunnel test section.	CO4	PO2	**10**
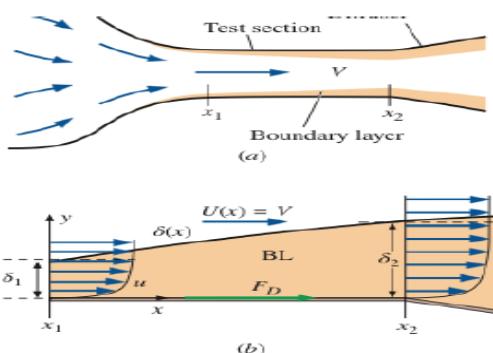
Fig .3

OR

6	a)	Derive an expression for momentum Integral equation for two-dimensional incompressible laminar boundary layer.	CO3	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 [$\mu=1.02 \times 10^{-3}$ 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.	CO4	PO2	**10**

UNIT - V

7	a)	a) Using Buckingham's π theorem, show that the velocity through a circular orifice is given by V = $\sqrt{2gH}\ \phi\ [\frac{D}{H}\ ,\frac{\mu}{\rho VH}]$, where H is the head causing flow, D is the diameter of the orifice, μ is co-efficient of viscosity, ρ is the mass density and g is the acceleration due to gravity.	CO4	PO2	**10**
	b)	Explain the Geometric Similarity, Kinematic Similarity and Dynamic Similarity that exists between the model and prototype.	CO2	PO1	**10**

******