

Birla Institute of Technology and Science, Pilani

Semester I Session: 2023-2024
CHE F212 FLUID MECHANICS
 Mid-semester Test (Closed Book)

Date: 14/10/2023
 Duration: 60 minutes

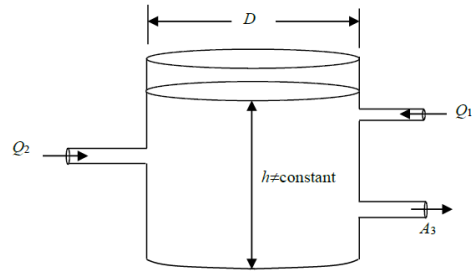
Maximum Marks: 50
 Weightage: 17 %

Q 1

[6+9 =15]

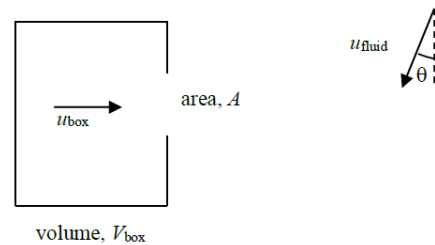
(a)

Water enters a cylindrical tank with diameter D through two pipes at volumetric flow rates of Q_1 and Q_2 and leaves through a pipe with area A_3 , with an average velocity V . The level in the tank, h , does not remain constant. Determine the time rate of change of the level in the tank.



(b)

A box with a hole of area, $A = 0.1 \text{ m}^2$, moves to the right with velocity, $u_{\text{box}} = 0.5 \text{ m/s}$, through an incompressible fluid, as shown in the figure. If the fluid has a velocity of $u_{\text{fluid}} = 2 \text{ m/s}$, which is at an angle, $\theta = 30^\circ$, to the vertical, determine how long it will take to fill the box with fluid. Assume the box volume is $V_{\text{box}} = 0.5 \text{ m}^3$ and is initially empty.



Q 2

[5+ 8 + 7 = 20]

(a)

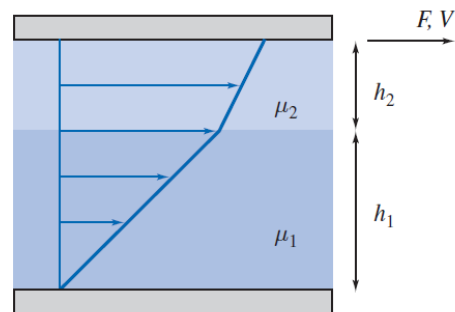
An inclined tube manometer has a well of 20 mm diameter and a 4 mm inner diameter tube. If it is proposed to use a scale graduated accurately in mm to measure the pressure directly, i.e., 1 mm scale division indicates a 1 mm pressure head change, then what would be the angle at which the tube must be inclined with respect to vertical to do this?

(b)

For a 2D flow field, $\vec{V} = u^2 \hat{i} + 2 \hat{j}$, find the equation of streamline passing through the point $(x, y) = (1, 1)$ at time $t = 0$.

(c)

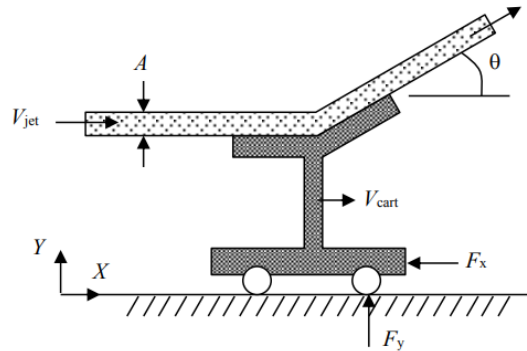
Fluids of viscosities $\mu_1 = 0.2 \text{ Pa}\cdot\text{s}$ and $\mu_2 = 0.3 \text{ Pa}\cdot\text{s}$ are contained between two plates (each plate is 1 m^2 in area). The thicknesses are $h_1 = 0.75 \text{ mm}$ and $h_2 = 0.35 \text{ mm}$, respectively. Find the force F to make the upper plate move at a speed of 1 m/s. What is the fluid velocity at the interface between the two fluids?



Q 3

[15]

A jet of water is deflected by a vane mounted on a cart. The water jet has an area, $A = 0.01 \text{ m}^2$, everywhere and is turned at an angle $\theta = 30^\circ$ with respect to the horizontal. The pressure everywhere within the jet is atmospheric. The incoming jet velocity with respect to the ground (axes XY) is $V_{\text{jet}} = 5 \text{ m/s}$. The cart has a mass of $M = 50 \text{ kg}$. Determine the force components, F_x and F_y , required to hold the cart stationary.



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Semester I Session: 2023-2024

CHE F212 FLUID MECHANICS

Mid-semester Test (Open Book)

Date: 14/10/2023
Duration: 30 minutes

Maximum Marks: 25
Weightage: 8 %

Q 1

[25]

A Newtonian fluid is in laminar flow in a narrow slit formed by two large parallel walls a distance L apart (direction x). One of the walls (left one) is stationary, and one on the right is moving vertically upward with a constant velocity (direction z), v_0 . Obtain the expression for momentum flux and velocity distribution. Also, sketch the qualitative plot of momentum flux and velocity variation with L .