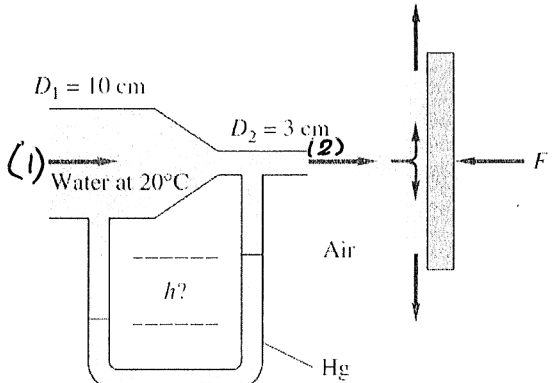
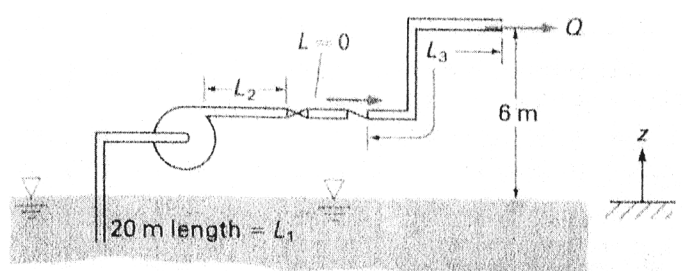


B. E. CHEMICAL ENGINEERING 2nd YEAR 1ST SEMESTER EXAMINATION 2024
 SUBJECT: MECHANICS OF FLUIDS Time: Three hours Full Marks 100

o. of Questions/ CO	Answer all the questions. Assume the missing data (if any)	Marks
1/1	<p>Consider the flow described by the velocity field $V = Bx(1+At)i + Cyj$; $A = 0.5 \text{ s}^{-1}$, $B = C = 1 \text{ s}^{-1}$. Co-ordinates are measured in meters. What are the dimensionality and directionality of flow? Is it steady flow? Derive the equation of stream line passing through the point (1,1,0) at time $t=0$. Plot the streak line formed by the particles passed through the point (1,1,0) during the interval from $t=0$ to $t=5$ s.</p>	(2+1+5+7)
2/2,4	 <p style="text-align: center;">FIG 1</p>	
	<p>Water ($\rho = 1000 \text{ kg/m}^3$, $\mu = 10^{-3} \text{ (kg/ms)}$) flows through a circular nozzle, exits into air as a jet, and strikes a plate, as shown in Fig.1. The force required to hold the plate steady is 70 N . Assuming steady, frictionless, one-dimensional flow, estimate velocities at the (inlet) section (1) and (outlet) section (2) and the manometer reading h.</p>	(10+5)
3/2	<p>Consider a cylindrical pipe of diameter D and length L, filled up with a Bingham plastic fluid (having threshold shear stress τ_0). What is the condition of flow of the Bingham plastic fluid through the pipe under an applied pressure difference of ΔP? Using differential control volume analysis derive an expression for shear stress distribution. Derive an expression for flowrate Q through the pipe.</p>	(4+5+6)
4/4	<p>Draw a schematic of a venturimeter. Why the angle of the diverging section is restricted to less than 7° ?</p> <p>A venturimeter is fitted in a pipe of 30cm diameter inclined at 30° to the horizontal to measure the upward flow rate of a liquid having a specific gravity of 0.8. The ratio of areas of main pipe and throat is 5 and the throat is 1 m from the inlet along its length. The difference in manometer head is 40 mm mercury ($\rho_{Hg} = 13600 \text{ kg/m}^3$). Assume that the discharge coefficient is 0.93. Calculate the flow rate through the venturimeter and the pressure difference between the throat and the entry point of the venturimeter.</p>	(2+3+10)

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No. of Questions/ CO		Marks
5/3	 <p style="text-align: center;">Screwed connections Discharge piping length = 40 m</p> <p style="text-align: center;">$L_2 = 10\text{ m}$ $L_3 = 30\text{ m}$ L_2 and L_3 are equivalent lengths</p> <p style="text-align: right;">FIG 2</p> <p>Water ($\rho=1000\text{ kg/m}^3$, $\mu=1\text{ cP}$) is lifted from the reservoir (as shown in Fig2) by a pump having a head rise of 120 m. The commercial steel piping ($\epsilon/D=0.0018$) has one fully open globe valve and one swing check valve, two 90° elbow in the discharge line, one 90° elbow in the suction line. The pipe inside diameter is 2.5 cm. The Loss coefficients (1 inch pipe) of 90° elbow, fully open globe valve and Swing check valve are 1.5, 8.2 and 2.9, respectively. Calculate the flow rate and fluid velocity through the pipe. Plot the EGL and HGL.</p>	(16+4)
6/3	<p>Consider a vertical packed bed consisting of spherical particles ($\rho_p= 1400\text{ kg/m}^3$) of average diameter 1 mm. The bed is 1 m in diameter by 4 m long. Water ($\rho=1000\text{ kg/m}^3$) is used to fluidize the bed. At the minimum fluidizing condition the void fraction, ϵ of the bed is 0.4. At operating condition the bed height is increased by 1.5 times.</p> <p>Calculate</p> <ol style="list-style-type: none"> (i) The minimum fluidization velocity (ii) The operating flow rate of water (iii) Void fraction of the bed at operating condition (iv) the pressure drop across the bed under such condition, <p>Ergun equation for flow through packed bed having spherical particles is given below:</p> $\frac{(-\Delta P_f)g_c}{L} \frac{D_p}{\rho V_o^2} \frac{\epsilon^3}{(1-\epsilon)} = 150 \frac{(1-\epsilon)}{N_{Rep}} + 1.75; V_o \text{ is the superficial velocity.}$ <p>$N_{Rep} = D_p V_o \rho / \mu$</p>	4x5=20

Moody Diagram

