SCHOOL OF CHEMICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST - I
WINTER SEMESTER 2025-2026

SLOT: D1+TD1

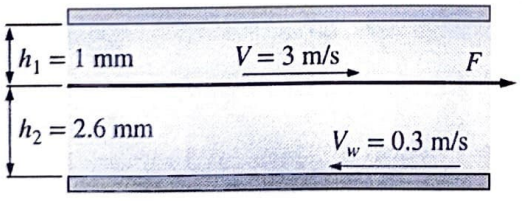
Programme Name & Branch : B.Tech Chemical Engineering
Course Code : BACHE103
Course Name : Momentum Transfer
Faculty Name(s) : Naga Samrat Maruvada V V
Class Number(s) : VL2025260503968
Date of Examination : 30 January 2026
Exam Duration : 90 minutes **Maximum Marks: 50**

General instruction(s):

- **Answer all questions**
- **Course Outcomes:**

CO1. Describe fluid properties, classify fluids, and apply fluid statics principles

CO2. Apply fluid kinematics and dynamics principles to analyze ideal and real flows

Q. No	Question	Marks
1.	The velocity components in a 2D flow are: $u = 8x^2y - \frac{8}{3}y^3, v = -8xy^3 + \frac{8}{3}x^3$. Show that these velocity components represent a possible case of irrotational flow.	10
2.	A thin flat plate with dimensions 30 cm×30 cm moves horizontally at a constant velocity of 3 m/s through a 3.6-mm-thick layer of oil confined between two parallel plates. The lower plate remains stationary, while the upper plate translates in the same direction at 0.3 m/s. The dynamic viscosity of the oil is 0.027 Pa.s. Assuming laminar flow with a linear velocity distribution within each of the two oil films in contact with the moving plate (a) Derive and sketch the velocity profile across the entire fluid domain, and determine the position where the fluid velocity becomes zero relative to a fixed reference frame. (b) Determine the magnitude of the shear force that must be applied to the moving plate to maintain its steady velocity. Fixed wall  Moving wall	10
3.	A hydraulic lift system employs Pascal's principle to elevate a payload mass m_2=2500 kg by applying a control mass m_1=25 kg to the smaller piston with diameter d_1=10 cm. Determine the required diameter d_2 of the larger load-bearing piston to achieve equilibrium, assuming: • Incompressible, ideal hydraulic fluid with negligible leakage • Quasi-static conditions (negligible dynamic effects) • Perfect pressure transmission throughout the system	10

REG.NO.:

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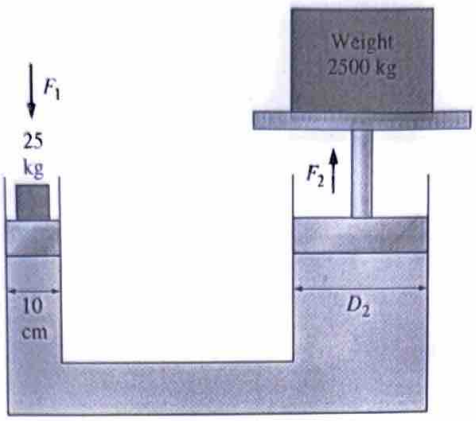
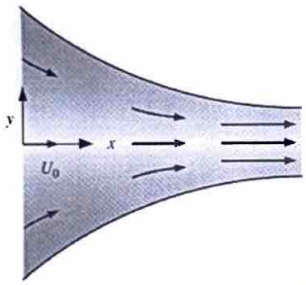
	• Gravitational acceleration • g=9.81 m/s^2. 	
4.	Consider a steady, incompressible, 2D flow through a converging duct. The velocity field through the duct is given as $\bar{v} = (u, v) = (U_0 + bx)\,\bar{i} - by\bar{j}$, where U_0 is the horizontal speed at x=0. Note that this equation ignores the viscous effects along the walls but is a reasonable approximation throughout the majority of the duct. Calculate the material acceleration for fluid passing through the duct. Give the answer as (a) acceleration components a_x and a_y, (b) as acceleration vector $\bar{a}$. 	10
5.	A 30 cm diameter pipe branches into two pipes of diameters 20 cm and 15 cm, respectively. If water is flowing with an average velocity of 2.5 m/s in the 30 cm diameter pipe, find the discharge in this pipe. Also, determine the velocity in a 15 cm pipe if the average velocity in a 20 cm diameter pipe is 2 m/s.	10

Formulae:

Newton's Law of Viscosity: $\tau = -\mu\frac{du}{dy}$

Continuity equation: $\rho v A = \text{constant}$

Velocity potential function: $u = -\frac{\partial\phi}{\partial x}, v = -\frac{\partial\phi}{\partial y}, w = -\frac{\partial\phi}{\partial z}$

Velocity stream function: $u = -\frac{\partial\psi}{\partial y}, v = \frac{\partial\psi}{\partial x}$

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