BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI, PILANI

FIRST SEMESTER 2023– 2024

CE F231 (FLUID MECHANICS) MIDSEMESTER EXAMINATION (CLOSED BOOK)

Duration: **90 mins** **Max Marks**: **60**

Note: Please write the answers in SI units and up to three decimal points with units. Use g=9.81 m/s^2.

Q1. A pressure vessel has an internal volume of 0.6 m^3 at atmospheric pressure. It is desired to test the vessel for 200 bar by pumping water into it. The estimated variation in the change of empty volume of container due to pressurization to 200 bar is 4 percent. Calculate the mass of water to be pumped into the vessel to attain the desired pressure level. Given the bulk modulus of elasticity of water as 2x10^9 N/m^2. **[8]**

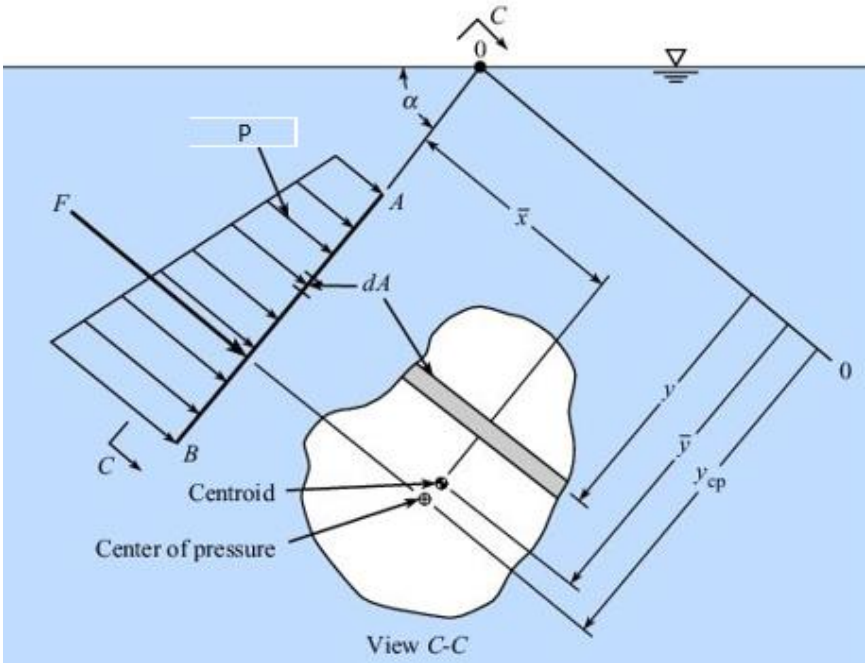
Q2. The space between two 15 cm long concentric cylinders is filled with glycerin (dynamic viscosity is 1.52 Pa.s). Inner and outer cylinder diameters are 7 cm and 8 cm respectively.

a) Determine the torque required to rotate inner cylinder at the rate of 200 rpm if outer cylinder is fixed. Assume the velocity distribution in the gap to be linear.

b) For some repairs work the inner cylinder must be removed. What is the resistance force generated by glycerin if it is pulled out axially upwards (vertically) at 1.2 m/s velocity?

Neglect Buoyancy and weight of the cylinder. **[8]**

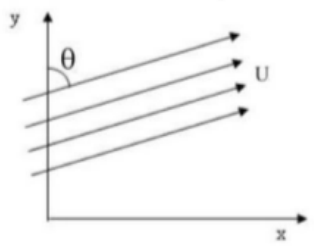
Q3. Derive expression for force and center of pressure on the thin plate shown in figure. Derivation should be according to the coordinate system mentioned in the figure.



[8]

Q4. A cylindrical log of specific gravity 0.35 is 6 m long and 3 m in diameter. To what depth the log will sink in freshwater with its axis being horizontal? **[8]**

Q5a. Uniform flow with velocity U makes an angle θ with the y-axis, as shown in the figure below. Find the velocity Φ.



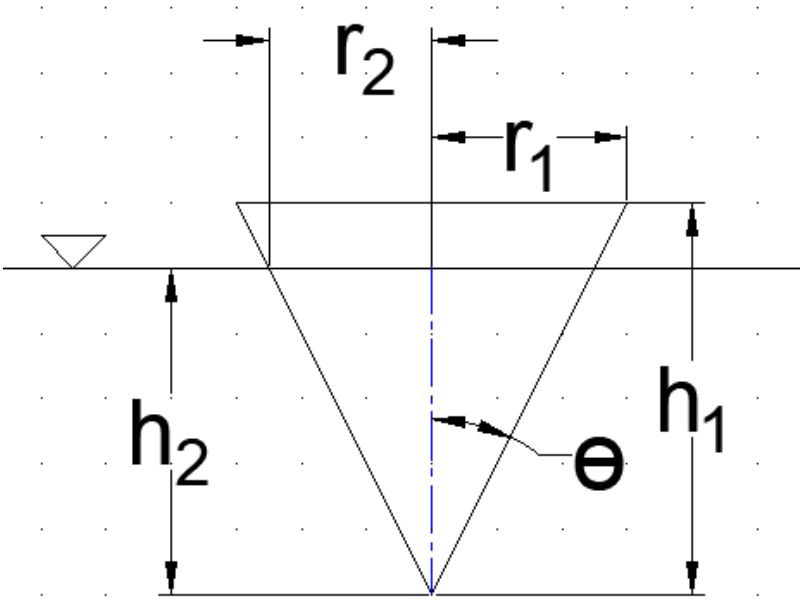
[4]

Q5b. A flow field is given by $u = y^2$; $v = -xy$; $w = 0$. Determine the value of the component of the angular velocity (up to two decimal places) at point (0, -1, 1)? **[4]**

Q5c. In a two-dimensional steady state flow field, in a certain region of the x-y plane, the velocity component in the x-direction is given by $u = x^2$ and the density varies a $\rho = \frac{1}{x}$. Find the expression for velocity in y-direction. **[4]**

Q5d. Elaborate the effect of temperature on the viscosity of liquids and gases with reasoning. **[4]**

Q6. Find the minimum apex angle of a solid cone of specific gravity 0.7 so that it can float in a stable equilibrium in saltwater of density 1025 kg/m^3. The cone axis is vertical with its apex downwards. The center of gravity of cone is on its axis and located at one fourth of the distance from its base.



[12]