CLL110 **Minor Exam** **Max Marks 30**

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Q1. If $\underset{\sim}{v} = x^2 y\, \underset{\sim}{i} - y x^2 \underset{\sim}{j}$, determine the vector $\underset{\sim}{\omega} = \underset{\sim}{\nabla} . (\underset{\sim}{\nabla} \underset{\sim}{v})$. Here $\underset{\sim}{i}$ and $\underset{\sim}{j}$ are the unit vectors in x and y directions in a Cartesian coordinate system. **(5)**

Q2. Velocity of a fluid may be determined using the velocity potential 'ϕ' by the following relation

$$\underset{\sim}{v} = \underset{\sim}{\nabla} \phi$$

If $\phi = \frac{5}{3} x^3 - 5xy^2$, determine the velocity. Does this velocity profile satisfy the equation of continuity for an incompressible fluid? **(5)**

Q3. Water is flowing under laminar conditions through a long tube of diameter 2 cm with an average velocity of 4 m/sec. Further down, this tube is joined by another long tube of diameter 4 cm. Determine the fully developed velocity profile in both tubes. If the viscosity of water is 1 centi -poise, determine the shear stress on the wall for both tubes. You need not show any derivation. **(8)**

Q4. An incompressible Newtonian fluid is flowing down the **inside** of vertical pipe as a **falling film** as shown in Figure 1. Neglect the viscous effects in gas phase and assume that pressure is uniform in the gas phase. Assume that the thickness (δ) of the film is known and constant. Find out the steady state velocity distribution in the film. Write the assumptions/postulates clearly. Also draw sketches of expected velocity and shear stress profiles in the film.

(12)

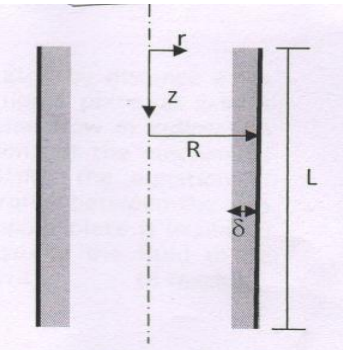

Figure 1: Flow of a film