

B.E. INSTRUMENTATION AND ELECTRONICS ENGINEERING**2ND YEAR 1ST SEMESTER, 2023****APPLIED FLUID MECHANICS****Time: Three Hours****Full Marks:100****Answer question No. 1 (compulsory) and any four questions from the rest****Answer to all parts of a question must be together****Assume any data, if not furnished, consistent with the problem.**

- 1.(a) State Newton's law of viscosity. Draw the rheological curve for different types of fluids. 5
 (b) Give practical examples of the following-
 i) Streakline
 ii) Manometer
 iii) Steady-Uniform flow
 iv) Unsteady-Nonuniform flow
 v) Laminar Flow 5
 (c) The velocity field is given by: $u = V \cos\theta$, $v = V \sin\theta$, and $w = 0$, where V and θ are constants. Find the equation of streamline. 5
 (d) What is a hydraulic gradient line and total energy line? Draw a neat sketch for the same. 5
- 2.(a) What is Bernoulli's theorem? Derive Bernoulli's equation from Euler's equation. What is the significance of Bernoulli's theorem? 2+8+2
 (b) A 25-mm-diameter shaft is pulled through a cylindrical bearing as shown in fig.1. The lubricant that fills the 0.3-mm gap between the shaft and bearing is an oil having a kinematic viscosity of $8.0 \times 10^{-4} \text{ m}^2/\text{s}$ and a specific gravity of 0.91. Determine the force P required to pull the shaft at a velocity of 3m/s. Assume the velocity distribution in the gap is linear. 8

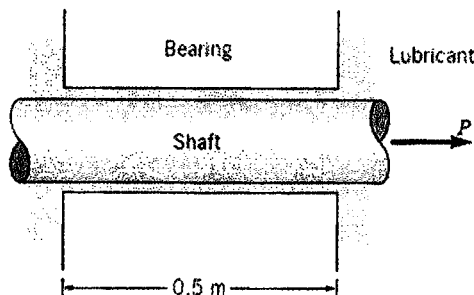


Figure 1

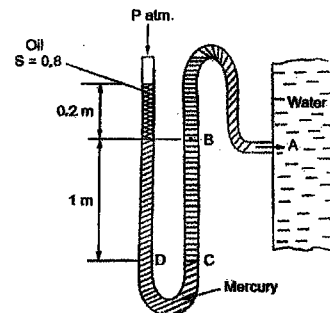


Figure 2

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- 3.(a) Define continuity equation. Derive the continuity equation for steady incompressible flow. 2+8
 (b) The delivery line of a pump is 100mm ID and it delivers water at a height of 12m above entry. The pipe ends in a nozzle of diameter 60mm. The total head at the entry to the pipe is 20m. Determine the flow rate if losses in the pipe is given by $10V_2^2/2g$; where V_2 is the velocity at nozzle outlet. There is no loss in the nozzle. 10
- 4.(a) A vertical venturimeter has an area ratio of 5. It has a throat diameter of 1cm. When oil of sp. gravity 0.8 flows through it, the mercury in the differential gauge indicates the difference in height of 12cm. Find the discharge through the venturimeter. 10
 (b) State and derive Pascal's law of Hydrostatics. What are the limitations of a manometer? 6+4
- 5.(a) What is the variation of pressure with depth? Define: absolute, gauge and vacuum pressure. Write the relation between them with neat sketch. 2+4
 (b) Determine the pressure at A above the atmosphere for the situation shown in fig.2. 7
 (c) Water flows at the rate of $0.015\text{m}^3/\text{s}$ through a 100mm diameter orifice used in a 200mm pipe. What is the difference in pressure head between the upstream section and the vena contracta section? (Take $C_c=0.60$ and $C_v=1.0$) 7
- 6.(a) Derive the expression for a differential manometer with the two vessels at same level. 8
 (b) What is Reynolds number and what is its significance? 4
 (c) What is a notch? Derive an expression for discharge over a trapezoidal notch. 2+6
- 7.(a) Highlight the difference between notch & weir. 4
 (b) Derive Hagen-Poiseuille equation for laminar flow. 7
 (c) A velocity field is given by: $V = 4txi - 2t^2 yj + 4xzk$
 Is the flow field steady or unsteady? Is it 2D or 3D? At the point $(x, y, z) = (-1, +1, 0)$, compute (a) the acceleration vector and (b) any unit vector normal to the acceleration. 4
 (d) The 4-m-diameter circular gate of fig.3 is located in the inclined wall of a large reservoir containing water. The gate is mounted on a shaft along its horizontal diameter, and the water depth is 10 m above the shaft. Determine -
 (a) the magnitude and location of the resultant force exerted on the gate by the water and
 (b) the moment that would have to be applied to the shaft to open the gate. 5

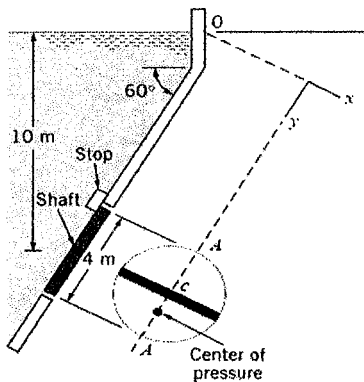


Figure 3