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Final Assessment Test- April 2023

Course: **BMEE204L - Fluid Mechanics and Machines**

Class NBR(s):**1045 / 1046 / 1047 / 1049** Slot: **D2+TD2**

Time: **Three Hours** Max. Marks: **100**

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KEEPING MOBILE PHONE/SMART WATCH, EVEN IN "OFF" POSITION, IS TREATED AS EXAM MALPRACTICE

General Instruction: Moody's chart is allowed.

Answer any TEN Questions

(10 X 10 = 100 Marks)

1. The shaft rests on a 2-mm-thin film of oil having a viscosity of 0.0657 N s / m^2 as shown in fig. 1. If the shaft is rotating at a constant angular velocity of ω = 2 rad/s, determine the torque **T** that must be applied to the shaft to maintain the motion at i) r = 100 mm and *ii)* r = 50 mm. Assume the velocity profile within the oil is linear.

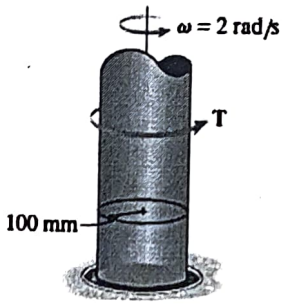

Fig.1

2. The homogeneous mass of 160 kg Gate AB, shown in Fig.2 has 2m width into the paper. It is hinged at A, and is resting on a smooth bottom at B. For what water depth h will the force at point B be zero? The $\rho_{glycerine}$=**1250 kg/m³**and ρ_w = **995 kg/m³** .

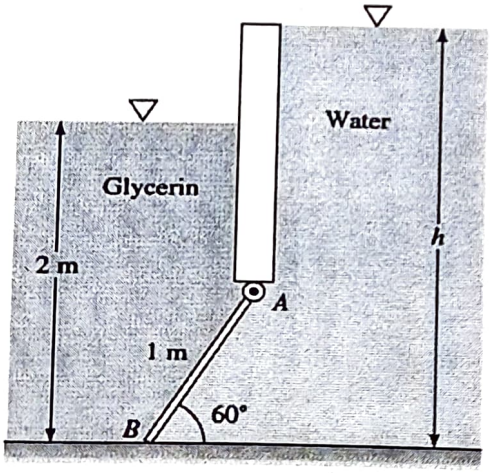

Fig.2

3. In a fluid flow, the velocity components are u = ($2y^2$) m/s and v = (8xy) m/s, where x and y are in meters. Determine the equation of the streamline passing through point (1 m, 2 m).Also, what is the acceleration of a particle at this point? Is the flow steady or unsteady?

4. A venturimeter with a throat diameter of 7.5 cm is installed in a 15 cm diameter pipe. The inlet gauge pressure is 70 kN/m^2 and it is desired that the pressure at any point should not fall below 2.5 m of water absolute. Determine the maximum flow rate of water through the meter. Take C_D = 0.97 and atmospheric pressure as 100 kPa.

5. Oil flows through the 100-mm-diameter pipe with a velocity of 5 m/s. If the pressure in the pipe at A and B is 80 kPa, determine resultant and magnitude of force the flow exerts on the elbow shown in fig 3. The flow occurs in the horizontal plane. Take $\rho_o = 900\ kg/m^3$.

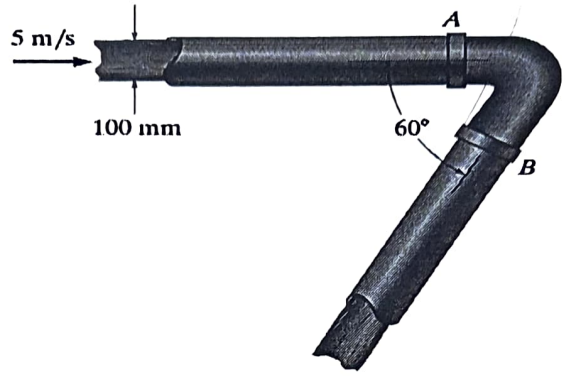

Fig.3

6. A pipeline is to be designed to carry crude oil (SG = 0.93, Kinematic viscosity = 10^{-5} m^2/s) with a discharge of 0.10 m^3/s and a head loss per km of 50 m. What diameter of steel pipe (ϵ = 0.046 mm) is needed? Also determine the power required to maintain the flow.

7. A large artery in a person's body can be approximated by a tube of diameter 9 mm and length 0.35 m. Also assume that blood has a viscosity of approximately 4×10^{-3} N-s/m^2, a specific gravity of 1.0, and that the pressure at the beginning of the artery is equivalent to 120 mm Hg. If the flow were steady (it is not) with V = 0.2 m/s, determine the pressure at the end of the artery if it is oriented (a) Vertically up (flow up) or (b) horizontal.

8. The thrust force, F generated by a propeller is found to depend on the following parameters: diameter D, forward velocity u, density ρ, viscosity μ and rotational speed N. Determine the dimensionless parameters to correlate the phenomenon.

9. A model 1:50 scale of a boat when tested at 1 m/s in water gave a wave resistance of 0 02 N. Determine the velocity of operation of the boat for similarity Also determine the drag force and the power required for cruising the boat.

10. A laminar boundary layer velocity profile is approximated by $u/U = [2 - (y/\delta)](y/\delta)$ for $y \le \delta$ and $u = U$ for $y > \delta$. Use the momentum integral equation to determine the boundary layer thickness, $\delta = \delta(x)$.

11. A Pelton Wheel is to be designed for a head of 60 m when running at 200 rpm. The Pelton Wheel develops 95.6475 kW shaft power. The velocity of the buckets = 0.45 times the velocity of the jet, overall efficiency = 0.85 and co-efficient of velocity is equal to 0.98. Design of Pelton wheel means to find a. diameter of jet (d), b. diameter of wheel (D), c. width and depth of buckets, d. number of buckets on the wheel.

12. A centrifugal pump having outer diameter equal to two times the inner diameter and running at 1000 rpm works against a total head of 40 m. The velocity of flow through the impeller is constant and equal to 2.5 m/s. The vanes are set back at an angle of 40° at outlet. If the outer diameter of the impeller is 500 mm and width at outlet is 50 mm, determine:

(i) Vane angle at inlet,
(ii) Work done by impeller on water per second and
(iii) Manometric efficiency

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