VIT
Vellore Institute of Technology

Final Assessment Test – November 2019

Course: MEE1004 - Fluid Mechanics
Slot: D2+TD2+V6
Class NBR(s): 1830
Max. Marks: 100
Time: Three Hours

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS EXAM MALPRACTICE

Answer any TEN Questions
(10 X 10 = 100 Marks)

1. What is a Newtonian fluid? Is water a Newtonian fluid? How does the dynamic viscosity of liquids and gases varies with temperature?

   If the velocity distribution of a viscous fluid (μ=0.9 Pa.s) over a fixed boundary is given by $u=0.68y-y^2$ in which 'u' is the velocity in m/s at a distance y meters above the boundary surface, determine the shear stress at the surface and at y=0.34 m.

2. A piston having a cross-sectional area of 0.07 m^2 is located in a cylinder containing water as shown in Fig. 1. An open U-tube manometer is connected to the cylinder as shown. For h_1 = 60 mm and h = 100 mm, what is the value of the applied force, P, acting on the piston? The weight of the piston is negligible.

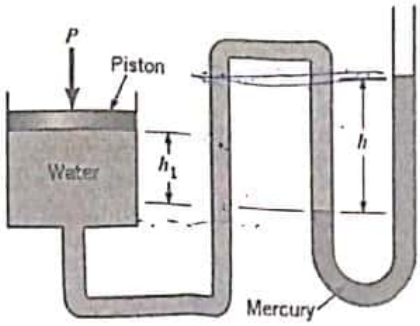

Fig. 1

3. An orifice meter with orifice diameter 10 cm is inserted in a pipe of 20 cm diameter. The pressure gauge fitted upstream and downstream of the orifice meter gives readings of 19.62 N/cm^2 and 9.81 N/cm^2 respectively. Co-efficient of discharge for the meter is given as 0.6. Find the discharge of water through pipe.

4. A compound piping system consists of 1800 m of 50 cm, 1200 m of 40 cm and 600 m of 30 cm diameter pipes of the same material connected in series

   (a) What is the equivalent length of a 40 cm pipe of the same material?
   (b) What is the equivalent size of a pipe 3600 m long?
   (c) If the pipes are in parallel, what is the equivalent length of a 50 cm pipe?

5. Pitot static tube is mounted on an aircraft travelling at a speed 300 kmph against a wind velocity of 20 kmph. If the specific weight of air is 12 N/m^3, determine the pressure difference the instrument will register. Take C_v = 0.98.

6. An oil with ρ = 900 kg/m^3 and μ=0.18 kg/ms flows through 40° inclined pipe. Two sections, section 1 and section 2 are 10 m apart. Assume steady laminar flow. (a) Check whether flow is up or down, (b) Compute head loss due to friction (h_l) between 1 and 2, (c) Compute the discharge, (d) Average velocity and (e) Reynolds number.

   Given following inputs: P_1=350 kPa, Z_1=0.0, P_2=250 kPa, D=6 cm.

7. What is specific energy curve? Draw specific energy curve and derive expressions for critical depth and critical velocity?

8. A liquid spray nozzle is designed to produce a specific size droplet with diameter, d. The droplet size depends on the nozzle diameter, D, nozzle velocity, V, and the liquid properties ρ, μ, σ. From dimensional analysis using Buckingham's method, determine the functional relationship for the dependent diameter ratio of d/D.

9. The drag on a 2 m diameter satellite dish due to an 80 km/hr wind is to be determined through a wind tunnel test using a geometrically similar 0.4 m diameter model dish. Assume standard air for both model and prototype. (a) At what air speed should the model test be run? (b) With all similarity conditions satisfied, the measured drag on the model was determined to be 170N. What is the predicted drag on the prototype dish?

10. Workout the following boundary layer parameters for the velocity distribution prescribed by $\frac{u}{Uo} = (\frac{y}{\delta})^{1/7}$

i) Displacement thickness ii) Momentum thickness iii) Energy thickness. Consider boundary layer thickness as 3 cm and free stream velocity as 12 m/s. Take $\rho = 1.2$ kg/m^3.

11. The diagram fig.2 shows a tank draining into another lower tank through a pipe. Note the velocity and pressure is both zero on the surface on a large tank. Calculate the flow rate using the data given on the diagram.

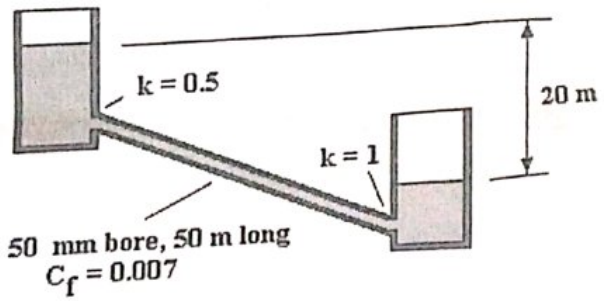

Fig. 2

12. Derive an expression for the depth of centre of pressure from the free surface of liquid of an inclined plane surface submerged in the liquid.