VIT
Vellore Institute of Technology

Final Assessment Test – November 2019

Course: MEE1004 - Fluid Mechanics
Class NBR(s): 1554 / 1804 / 1811 / 2238
Time: Three Hours

Slot: A1+TA1+V1
Max. Marks: 100

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

PART – A (8 X 2 = 16 Marks)

Answer ALL Questions

1. Contrast Bingham plastic and Pseudo plastic. How their shear strain changes with shear stress.
2. State Hydro static law
3. State Bernoulli's theorem, mentioning clearly the assumptions underlying it.
4. List the minor losses in pipe flow.
5. State the laws of fluid friction for turbulent flow stated by William Froude.
6. What is Dimensional Homogeneity?
7. State Reynolds number and Froude number
8. Contrast developing flow and fully developed flow.

PART – B (7 X 12 = 84 Marks)

Answer ALL Questions

9. a) A very large thin plate is centered in a gap of width 0.06 m with different oils of unknown viscosities above and below; one viscosity is twice the other. When the plate is pulled at a velocity of 0.3 m/s, the resulting force on one square meter of plate due to the viscous shear on both sides is 29 N. Assuming a viscous flow and neglecting all end effects, calculate the viscosities of the oils.

OR

9. b) Determine the pressure of the water in pipe A shown in Figure.1, if the gauge pressure of the air in the tank is 13.8 kPa.

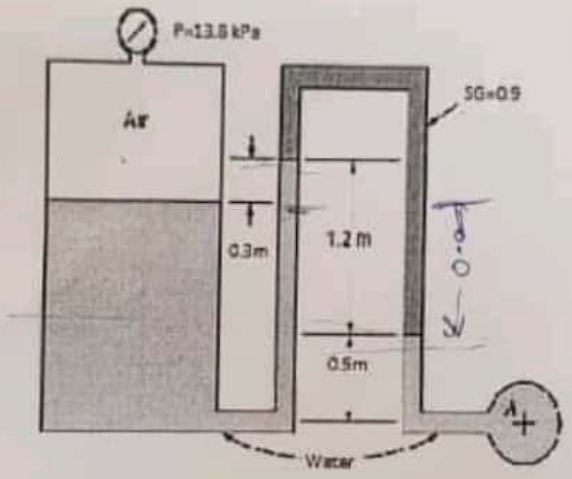


Fig.1

10. a) An open tank has a vertical partition and on one side contains gasoline with a density, $\rho = 700$ kg/m^3 at a depth of 4 m, as shown in Figure.2. A rectangular gate that is 4 m high and 2 m wide and hinged at one end is located in the partition. Water is slowly added to the empty side of the tank. At what depth, h, will the gate start to open?

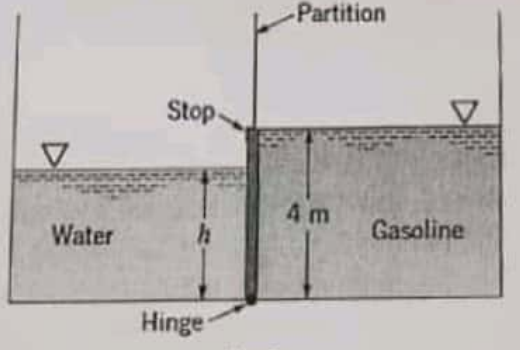
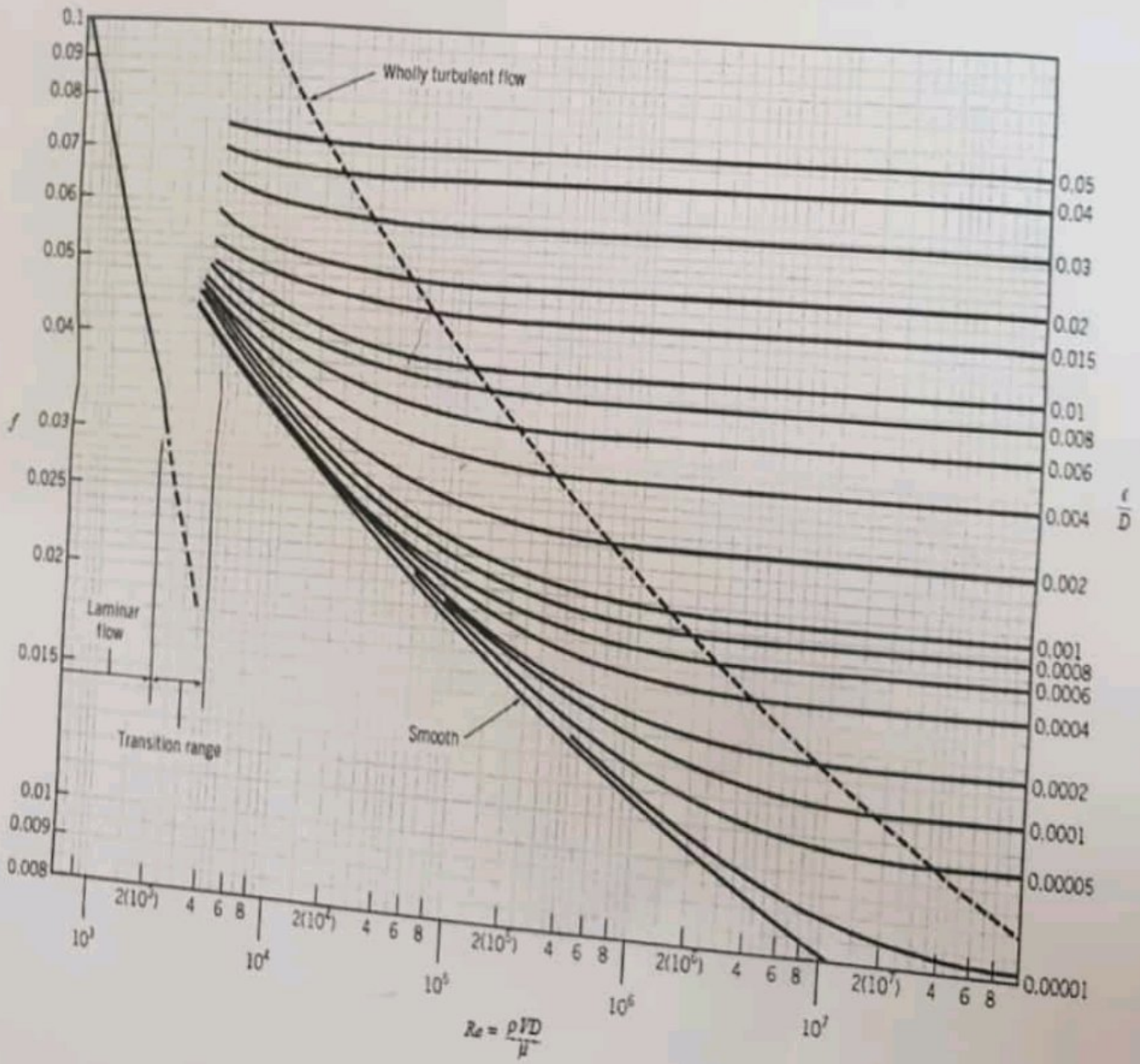


Fig.2

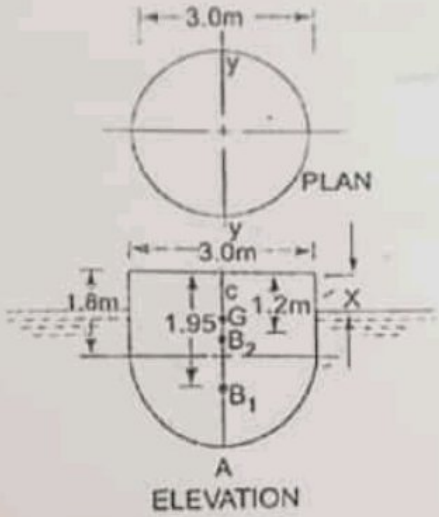
OR

Data Sheet

Pipe	Equivalent Roughness, ε	
	Feet	Millimeters
Riveted steel	0.003–0.03	0.9–9.0
Concrete	0.001–0.01	0.3–3.0
Wood stave	0.0006–0.003	0.18–0.9
Cast iron	0.00085	0.26
Galvanized iron	0.0005	0.15
Commercial steel or wrought iron	0.00015	0.045
Drawn tubing	0.000005	0.0015
Plastic, glass	0.0 (smooth)	0.0 (smooth)



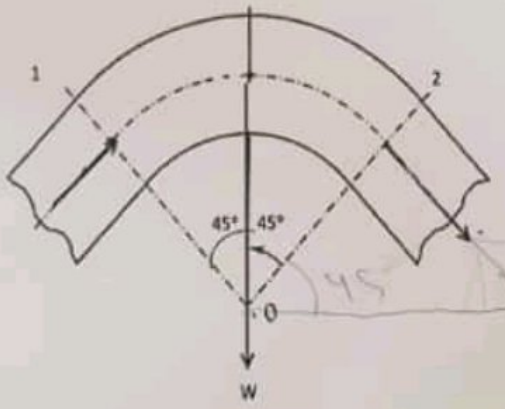
10. b) A body has the cylindrical upper portion of 3 m diameter and 1.8 m deep. The lower portion is a curved one, which displaces a volume of 0.6 m^3 of water. The centre of buoyancy of the curved portion is at a distance of 1.95 m below the top of the cylinder. The centre of gravity of the whole body is 1.20 m below the top of the cylinder. The total displacement of water is 3.9 tonnes. Find the meta-centric height of the body.



11. a) A pipe inclined at 45° to the horizontal converges from 0.2 m diameter to 0.1 m at the top over a length of 2 m. At the lower end the average velocity is 2 m/s. Oil of specific gravity 0.84 flows through the pipe. Determine the pressure difference between the ends, neglecting losses. If a mercury manometer (specific gravity 13.6) is used to measure the pressure, determine the reading of the manometer difference in m of mercury.

OR

11. b) A 0.4 m x 0.3 m vertical bend carries oil of specific gravity 0.85 at the rate of 0.5 m^3/s. The pressure at entry is 118 kN/m^3 at the inlet to the bend. The volume of the bend is 0.1 m^3. Find the magnitude and direction of the force on the bend. Neglect friction and assume both inlet and outlet sections to be on the same horizontal level.



12. a) A pipe line of two sections, the first of 50 mm dia and 15 m length and the second of 75 mm dia and 24 m length connected in series empties a reservoir at the rate of 168 l/min. The entry is sharp edged. The enlargement is sudden. Discharge is to atmosphere. The values of friction factor are 0.0192 and 0.0232 for the pipes. Determine the difference in height between the reservoir level and the discharge point.

OR

12. b) Air under standard conditions flows through a 4 mm diameter drawn tubing with an average velocity of v=50 m/sec. For such conditions the flow would normally be turbulent. However, if precautions are taken to eliminate disturbances to the flow, it may be possible to maintain laminar flow. (i) Determine the pressure drop in a 0.1 m section of the tube if the flow is laminar (ii) Repeat the calculations if the flow is turbulent. Under standard temperature and pressure conditions the density and viscosity are ρ= 1.23 kg/m^3 and $\mu = 1.79 \times 10^{-5}$ $N.s/m^2$. (Refer the Data sheet)

13. a) Determine the maximum discharge through a circular pipe of 2 m diameter with a bed slope of 1/1000. Also determine the depth for maximum velocity and the corresponding discharge Chezy's constant C = 60

OR

13. b) A 3.0 wide rectangular channel carries 2.4 m^3/s discharge at a depth of 0.7 m,
   i) Determine specific energy at 0.7 m depth
   ii) Determine the critical depth
   iii) Is the flow subcritical or supercritical?
   iv) Determine the depth alternate to 0.7 m
   v) If Manning's n is 0.015, determine the critical slope

14. a) The drag force on a sphere submerged in water at 20°C, when moved at 1.5 m/s was measured as 10 N. An enlarged model of 3:1 scale was tested in a pressurised wind tunnel at a pressure of 1.5 MN/m^2 and temperature of 20°C. Determine the velocity for dynamic similarity. Also determine the drag force on the model. Kinematic viscosity of water = 1.006×10^{-6} m^2/s. Dynamic viscosity of air = 18.14×10^{-6} kg/ms. Density of air = 1.22 kg/m^3.

OR

14. b) 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.

15. a) The velocity distribution in the boundary layer is given by $\frac{u}{U} = \frac{3}{2}\frac{y}{\delta} - \frac{1}{2}\frac{y^2}{\delta^2}$ being boundary layer thickness

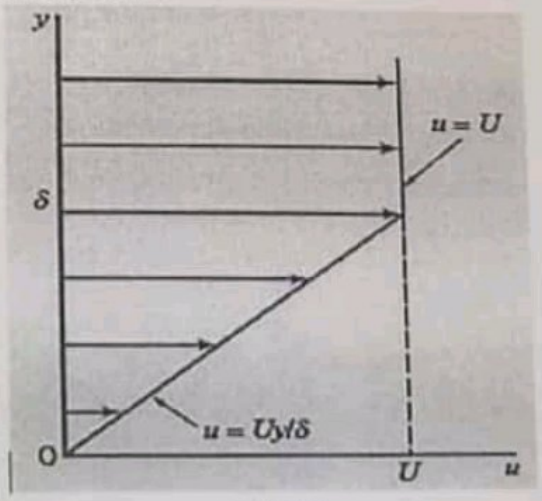
Calculate the following :

i) The ratio of displacement thickness to boundary layer thickness

ii) The ratio of momentum thickness to boundary layer thickness

OR

15. b) Consider the laminar flow of an incompressible fluid past a flat plate at y=0. The boundary layer velocity profile is approximated as $u=Uy/\delta$ for $0 \leq y \leq \delta$ and $u=U$ for $y > \delta$, as shown in fig. Determine the shear stress by using momentum integral equation.



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