EXAMPLE SHEET 1

THEORETICAL PROBLEMS

1. Define the following fluid properties: density, weight density, specific volume, specific gravity, and compressibility of a fluid.
2. Differentiate between (i) liquid and gases, (ii) real fluid and ideal fluid, (iii) Specific weight and specific volume of a fluid.
3. What is the difference between dynamic viscosity and kinematic viscosity? State their units of measurements.
4. Explain the terms: (i) dynamic viscosity, and (ii) kinematic viscosity. Give their dimensions.
5. State Newton's law of viscosity and give examples of its application
6. Define Newtonian and Non-Newtonian fluids.
7. Define surface tension. Show that the capillarity rise of water in a glass tube is given by $h = \frac{4\sigma}{wd}$ All terms retain their usual meaning.
8. Explain the phenomenon of capillarity. Obtain an expression for capillarity rise of liquid
9. State and explain Newton's law of viscosity.
10. Convert 1 kg/s-m dynamic viscosity in poise
11. Why does the viscosity of a gas increase with the increase in temperature while that of a liquid decrease with increase in temperature?
12. How does viscosity of fluid vary with temperature?
13. With a well labelled diagram only, illustrate the variation of shear stress with velocity gradient for at least six (6) types of fluid.

Numerical Problems

14. One litre of crude oil weighs 9.6 N. Calculate its specific weight, density and specific gravity.
15. The velocity distribution for flow over a plate is given by $u = \frac{3}{2}y - y^{3}/_{2}$ where u is the point velocity in metre per second at a distance y metre above the plate. Determine the shear stress at y = 9 cm. Assume dynamic as 8 poise
16. A plate, 0.025 mm distant from a fixed plate, moves a 50 cm/s and requires a force of 1.471 N/m^2 to maintain this speed. Determine the viscosity of the fluid between the two plates in poise.
17. Determine the intensity of shear of an oil having viscosity = 1.2 poise and is used for lubrication in the clearance between a 10 cm diameter shaft and its journal bearing. The clearance is 1.0 mm, and the shaft rotates at 200 r.p.m.

18. Two plates are placed at a distance of 0.15 mm apart. The lower plate is fixed while the upper plate, having surface area 1.0 m^2, is pulled a 0.3 m/s. Find the force and power required to maintain this speed, if the fluid separating them is having a viscosity of 1.5 poise.
19. An oil film of thickness 1.5 mm is used for lubrication between a square plate of size 0.9 m × 0.9 m and an inclined plane having an angle of inclination 20^0. The weight the square is 392.4 N, and it slides down the plane with a uniform velocity of 0.2 m/s. Find the dynamic viscosity of the oil.
20. In a stream of glycerine in motion, the velocity gradient is 0.25 metre per sec per metre at a certain point. The mass density of a fluid is 1268.4 kg per cubic metre, and kinematic viscosity is 6.30×10^{-4} square metre per second. Calculate the shear stress at the point.
21. Find the kinematic viscosity of an oil having density 980 kg/m^2 when the shear stress is 0.25 N/m^2 and velocity gradient 0.3/s
22. Determine the specific gravity of a fluid having a viscosity of 0.07 poise and kinematic viscosity 0.042 stokes.
23. Determine the viscosity of a liquid having kinematic viscosity 6 stokes and specific gravity 2.0
24. If the velocity distribution of a fluid over a plate is given by $u = (3/4)y - y^2$, where u is the velocity in m/sec at a distance of y m above the plate. Determine the shear stress a y =0, 0.1 and 0.2 m. Take μ =6 poise.
25. In question 23, find the distance in metres above the plate, at which the shear stress is zero.
26. The velocity profile of a viscous fluid over a plate is parabolic with vertex 20 cm for the plate, where the velocity is 120 cm/s. Calculate the velocity gradient and shear stress at distances of 0, 5 and 15 cm from the plate, given the viscosity of the fluid = 6 poise.
27. The pressure of a liquid is increased from 60 N/cm^2 to 100 N/cm^2 and volume by 0.2 per cent. Determine the modulus of elasticity.
28. Determine the bulk modulus of elasticity of a fluid which is compressed in a cylinder from a volume of 0.009 m^3 at 70 N/cm^2 pressure to a volume of 0.0085 m^3 at 270 N/cm^2 pressure.
29. The surface tension of water in contact with air at 20 ^{0}C is given as 0.0716 N/m. The pressure inside a droplet of water is to be 0.0147 greater than the outside pressure, calculate the diameter of the droplet of water.
30. Find the surface tension of a soap bubble of 30 mm diameter when the inside pressure is 1.962 N/m^2 above the atmosphere
31. The surface tension of water in contact with air is given as 0.0725 N/m. The pressure outside the droplet of water of diameter 0.02 mm is atmospheric (10.32 N/cm^2). Calculate the pressure within the droplet.