Hydraulics I (CEng2003)

Assignment 1

1. Two horizontal plates are kept 12.5 mm apart and the space between them is filled with oil of dynamic viscosity of 14 poise. If the top plate is moved at a constant velocity of 2.5 m/s, determine the shear stress on the lower plate.
2. When a real fluid flows past a plate held parallel to flow, the velocity distribution near the plate is given by
$$\frac{u}{U} = \frac{3}{2}\left(\frac{y}{\delta}\right) - \frac{1}{2}\left(\frac{y}{\delta}\right)^2$$
Where u=U when y=δ. Determine the shear stress at y=0 and when $y/\delta = 0.50$
3. A circular disc of 0.30 m diameter and weighing 50 N is kept on an inclined surface with a slope of 45^o. The space of 2 mm between disc and inclined surface is filled with oil of dynamic viscosity 1.0 N-s/m^2. What force will be required to pull the disc up the inclined plane at velocity of 0.50 m/s?
4. Express the bulk modulus of elasticity in terms of mass density of the fluid and pressure.
5. Find the increase in the pressure required to reduce the volume of water by 0.8 percent if its bulk modulus of elasticity is 2.075×10^4 N/m^2.
6. Determine the bulk modulus of elasticity of a fluid that has a density increase of 0.002 percent for a pressure increase of 44.540 kN/m^2.
7. A block of dimensions 300 mm x 300 mm x 300 mm and mass 30 kg slides down a plane inclined at 30^o to the horizontal, on which there is a thin film of oil of viscosity 2.3 x 10-3 Ns/m^2. Determine the speed of the block if the film thickness is estimated to be 0.03 mm.
8. A shaft of 100 mm diameter rotates at 120 rad/s in a bearing 150 mm long. If the radial clearance is 0.2 mm and the absolute viscosity of the lubricant is 0.20 kg/ms find the power loss in the bearing.
9. Water is moving through a pipe. The velocity profile at some section is shown in Fig. P9 and is given mathematically as $v = (b/4\mu)(d^2/4 - r^2)$, where v = velocity of water at any position r, b = a constant, μ = viscosity of water, d = pipe diameter, and r = radial distance from centerline. What is the shear stress at the wall of the pipe due to the water? What is the shear stress at a position r = d/4? If the given profile persists a distance L along the pipe, what drag is induced on the pipe by the water in the direction of flow over this distance?

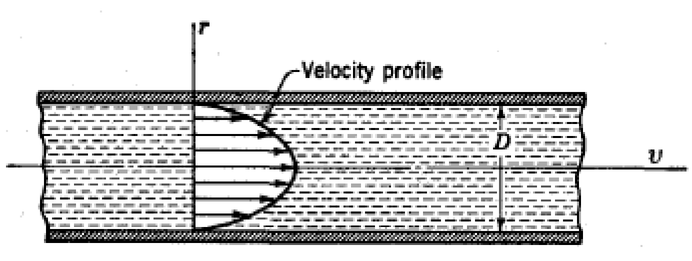

Figure P9