BENHA UNIVERSITY MECH. ENG. DEPT.

SHOUBRA FAC. OF ENG. 2nd YEAR, FLUID DYNAMICS

SHEET [2] 2015

**Internal Incompressible Viscous Flow**

1. Two parallel plates kept 80 mm apart have laminar flow of oil between them with a maximum velocity of 1.5 m/s. Taking dynamic viscosity of oil to be 19.62 **poise**.

Calculate:

* 1. The discharge per meter width,
  2. The shear stress at the plates,
  3. The pressure difference between two points 25 m apart,
  4. The velocity gradient at the plates end, and
  5. The velocity at 20 mm from the plate.

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1. A liquid of viscosity 0.1 N.s/m2 and specific gravity 0.9 is filled between two horizontal plates 10 mm apart. If the upper plate is moving at 2 m/s and the pressure difference between two sections 10 m apart is 9.81 kN/m2, determine:
   1. The velocity distribution,
   2. Discharge per unit width,
   3. The shear stress on the upper and lower plates.

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1. Fluid is in laminar motion between two parallel plates under the action of motion of one the plates and also under the presence of a pressure gradient in such a way that the net forward discharge across any section is zero.
   1. Find out the point where minimum velocity occurs and its magnitude.
   2. Draw the velocity distribution graph across any section.

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1. Laminar flow of a fluid of viscosity 0.9 N.s/m2 and specific gravity 1.26 occurs between a pair of parallel plates of extensive width, inclined at 45o to the horizontal, the plates being 10 mm apart. The upper plate moves with a velocity of 2.0 m/s relative to the lower plate and in a direction opposite to the fluid flow. Pressure gauges mounted at two points 1m vertically apart on the upper plate record second pressures of 250 kN/m2 and 80 kN/m2 respectively. Determine:
   1. The velocity and shear stress distribution between the plates,
   2. The maximum flow velocity, and
   3. The shear stress on the upper plate.

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1. Consider a steady flow of a viscous fluid between two infinitely long, parallel, vertical plates. The distance between them is (h). The velocity variations take place in the x-z plane. The flow is completely independent of (y). The velocity components don’t vary in the z-direction, the wall on the right is moving upwards at constant speed wo. Assume that all pressure gradients are negligible and (gx = gy = 0, and gz = -g).
   * 1. Drive an expression of the velocity distribution.
     2. What is the value of w at the midpoint of the channel?
     3. Develop an expression of wo in terms of g, h, and μ so that there is zero net mass flow across any horizontal plane.

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1. A wide moving belt passes through a container of viscous fluid, the belt moves vertically upwards with a constant velocity *v*o. Because of viscous forces, the belt picks up a film of fluid of thickness h. gravity tends to make the fluid drain down the belt.

Use Navier-Stokes equation to determine an expression for the average velocity of the fluid film as it is dragged up the belt. ***Assume laminar and steady flow.***