Department of Applied Mechanics, IIT Delhi
APL-107 Mechanics of Fluids (2016-2017 I Sem)
Minor Test #2
8 Oct 16 (Sat), 11:00 am - 12:00 noon, Room LH-121
Maximum marks: 20

1. Flow through the converging nozzle in Fig. 1 can be approximated by the one-dimensional velocity distribution:

$$u \approx V_o\left(1+\frac{2x}{L}\right), v \approx 0, w \approx 0$$

(a) Find a general expression for the fluid acceleration in the nozzle.
(b) For the specific case with V_o = 3 m/s and L = 15 cm, compute the acceleration, at the entrance and at the exit. **[4 + 2 + 2 = 8]**

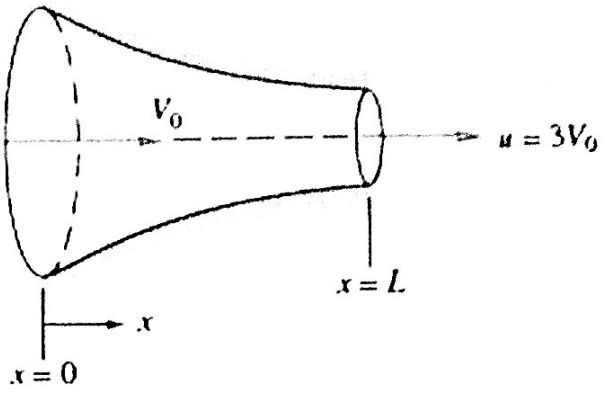

Fig. 1

2. SAE 10 oil (μ = 0.104 kg/m.s, ρ = 870 kg/m^3) flows upwards through the 4.0 cm diameter vertical pipe of Fig. 2. For the mercury (ρ_{Hg} = 13550 kg/m^3) manometer reading h = 42 cm shown (a) calculate the frictional head loss and (b) volume flow rate. Assume laminar pipe flow.
[4 + 3 = 7]

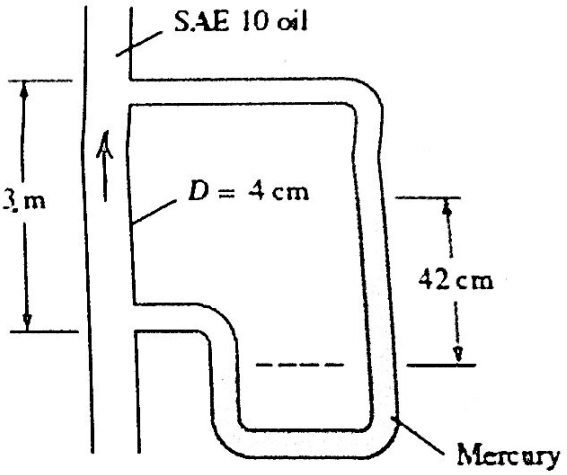

Fig. 2

3. Show that for two-dimensional, steady *creeping flow* where the inertia (or acceleration) can be ignored, the Navier-Stokes equations in terms of the stream function (ψ) reduce to the following equation (neglect body force term)

$$\nabla^4\psi = \frac{\partial^4\psi}{\partial x^4} + 2\frac{\partial^4\psi}{\partial x^2\partial y^2} + \frac{\partial^4\psi}{\partial y^4} = 0$$

[5]