ME202: Fluid Mechanics- 1
Flow through Pipes
Lecture 2

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Exercise problems: Laminar Flow through Pipes

1. Prove that in the case of fully developed laminar flow through a circular pipe, the ratio of the maximum velocity to the mean velocity is 2.
2. The velocity distribution for a fully-developed laminar flow in a pipe is given by

$$u(r) = \left(\frac{\Delta p D^2}{16 \mu L}\right)\left\{1 - \left(\frac{2r}{D}\right)^2\right\}.$$

   Determine the radial distance from the pipe axis at which the velocity equals the average velocity.
3. An oil with density, ρ=900 kg/m^3 and kinematic viscosity, ν=0.0002 m^2/s flows through an inclined pipe of diameter 6 cm as shown in Fig. Q.3. The pressure and elevation are known at sections 1 and 2, 10 m apart. Assuming steady laminar flow, (a) verify that the flow is up, (b) compute h_f between 1 and 2, and compute (c) Q, (d) V and (e) Re. Is the flow really laminar?

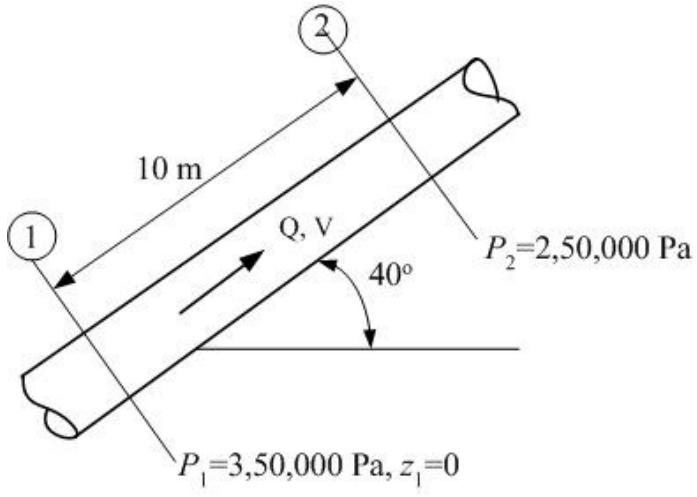

Fig. Q.3

4. The Reynolds number for flow of oil through a 5 cm diameter pipe is 1900. The kinematic viscosity, $\nu=1.02\times10^{-6}$ m2/s. what is the average velocity of flow?
5. The velocity along the center line of the Hagen-Poiseuille flow in a 0.1 m diameter pipe is 2.2 m/s. If the viscosity of the fluid is 0.07 kg/ms and its specific gravity is 0.92, calculate (a) the volumetric flow rate, (b) shear stress of the fluid at the pipe wall.

N.B.: Q.1–Q.3 will be discussed in the class, the rest two are left as assignment.