

HW 1
Biofluid Mechanics
Spring 2014

1. Shear Stress

The velocity distribution for laminar flow between parallel plates is given by

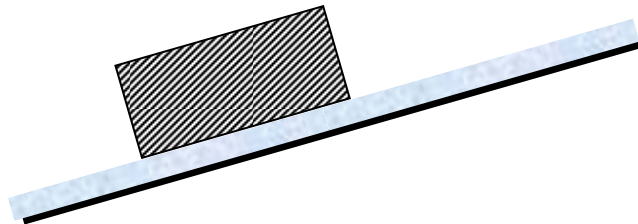
$$\frac{u}{u_{\max}} = 1 - \left(\frac{2y}{h} \right)^2$$

where h is the distance separating the plates and the origin is placed midway between the plates. Consider a flow of water at 15 C, with $u_{\max} = 0.30$ m/sec and $h = 0.50$ mm. Calculate the shear stress on the upper plate and give its direction.

2. Couette Flow: Exact solutions for Planar Unidirectional Flow

Consider the flow of a Newtonian fluid between two infinite, horizontal, parallel plates separated by a distance 'h', where the lower plate is stationary and the upper plate is moving to the right with a velocity V . Start with the Navier-Stokes equations in Cartesian coordinates and obtain a solution for the pressure and velocity of this flow.

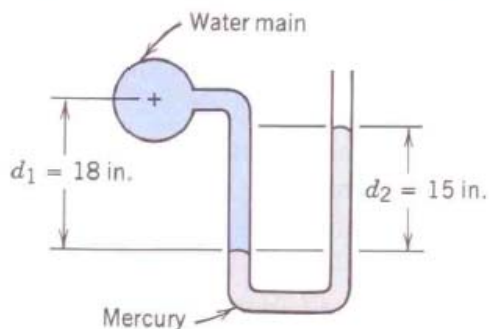
3. Shear Stress



A slab of mass $M = 125$ kg slides down a large smooth plane surface inclined at $\theta = 16^\circ$ from the horizontal and covered with a film of water $h = 0.0250$ mm thick. Estimate the terminal speed of the slab if its dimensions are $L = 515$ mm by $W = 525$ mm.

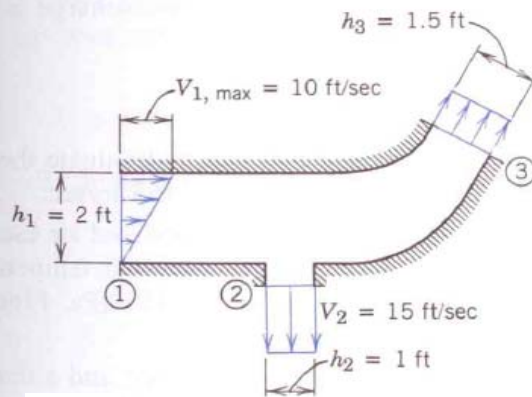
4. Hydrostatics

The pressure in a water main is measured using the dual-fluid manometer shown. Evaluate the gage pressure in the water main.



5. Mass Conservation

- 4 A two-dimensional reducing bend has a linear velocity profile at section ①. The flow is uniform at sections ② and ③. The fluid is incompressible and the flow is steady. Find the magnitude and direction of the uniform velocity at section ③.



6. Mass Conservation

The aorta is the primary vessel that supplies blood to the body. From the aorta, the arteries branch continuously until the blood reaches the capillaries. Given the following,

Aortic Diameter: 2.5cm

Aortic flow velocity: 0.2 m/s

Capillary diameter: 6 microns

Flow velocity in capillaries: 1 mm/s

estimate the total number of capillaries and the cross-sectional area of all the capillaries. Clearly state your assumptions.