

Name: _____

Midterm Exam

CM 3110

October 25, 2007

Please be neat.

Please write on only one side of each piece of paper in your solution.

Significant figures count.

1. (10 points) Does Newton's law of viscosity, shown below written in the $r\theta z$ coordinate system, hold for non-Newtonian fluids such as mayonnaise or molten plastics?

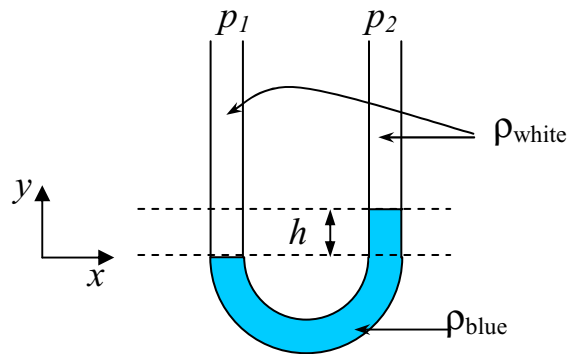
$$\tau_{rz} = -\mu \left(\frac{\partial v_z}{\partial r} \right)$$

ANSWER:

2. (10 points) What is the definition of drag coefficient? Please give your answer in one or two sentences.

ANSWER:

3. (5 points) In the manometer shown, what is the shear stress τ_{yx} ?

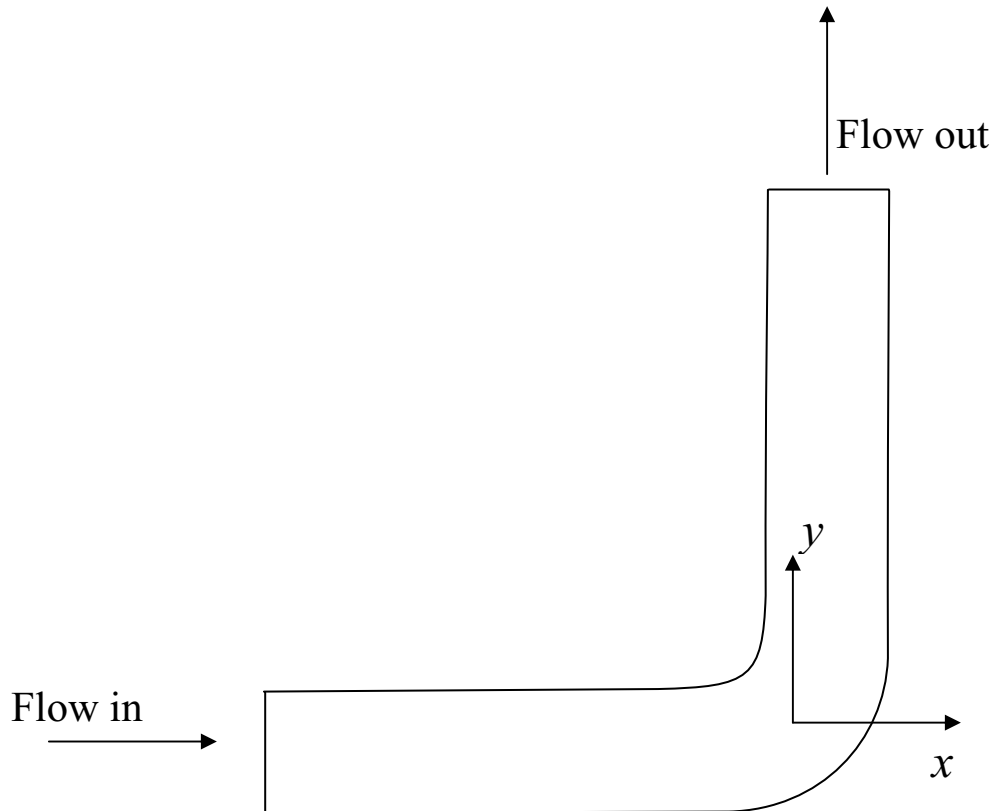


ANSWER:

4. (15 points) In the microscopic momentum balance solution for steady flow in a round tube, what three assumptions lead to the conclusion that $\frac{\partial v_z}{\partial z} = 0$?

ANSWER:

5. (30 points) What is the vector force on the right-angle pipe bend shown below if the flow rate of water (density = $1000. \text{ kg/m}^3$; viscosity = 1.00 mPa s) is $1.84 \text{ gpm} = 1.1609 \times 10^{-4} \text{ m}^3/\text{s}$? The diameter of the pipe is $3.0 \text{ inches} = 0.0762 \text{ m}$ throughout. You may assume that pressure does not change across the bend, and you may omit gravity. Use the coordinate system given. Please box your answer.



(30 points) Glycerin (density = 1258 kg/m^3 , viscosity = 0.951 Pa s) flows in a horizontal pipe of length 5.0 m and diameter $1.0 \text{ in} = 0.0254 \text{ m}$ at a Reynolds number of 5.0×10^2 .

- a) What is the average velocity (m/s) of the glycerin in the tube?
- b) What is the Fanning friction factor in the tube?
- c) What is the pressure-drop (Pa) in the tube over the 5.0 m length?
- d) What is the maximum velocity (m/s) of the glycerin in the tube?