

Name: \_\_\_\_\_.

Box #: \_\_\_\_\_

## Mini-Exam II

CM 3110 8 October 2009

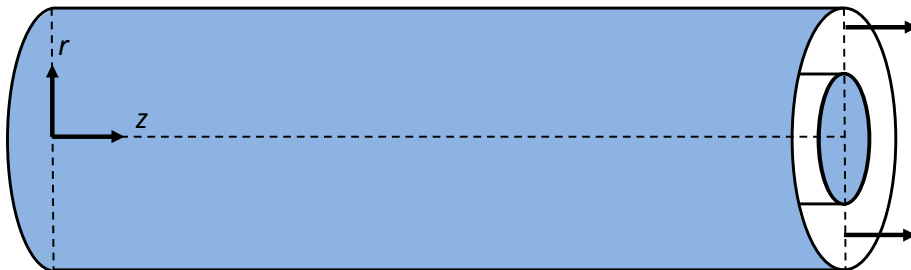
Note:

Significant figures count.

Please box your final answers.

Please be neat.

1. (50 points) For the apparatus shown in the figure below, an incompressible, Newtonian fluid is made to flow under an axial pressure gradient in the gap between two concentric cylinders. The flow is steady, and the inlet pressure is  $P_0$  and the outlet pressure is  $P_L$ . The tube is of length  $L$  and is horizontal. You may neglect gravity. The microscopic mass balance (continuity equation) and the microscopic momentum balance (Navier-Stokes equations) are shown on the next page. For each term in all four equations, cross out the terms that are zero and give a reason for each decision.



Side view:  
steady flow in  
annulus between  
cylinders

2. (50 points) Water (density= $62.25 \text{ lb}_m/\text{ft}^3$ , viscosity= $6.01 \times 10^{-4} \text{ lb}_m/\text{ft s}$ ) flows in an expanding bend whose geometry is shown below. The upstream pressure is  $14.5 \text{ psig}$ . The inlet velocity is  $12.23 \text{ ft/s}$  and the outlet velocity is  $3.61 \text{ ft/s}$ . What is the outlet pressure? You may neglect friction; the flow is turbulent.

