Name _____ Section _____

ES201
Examination I
September 26, 1996

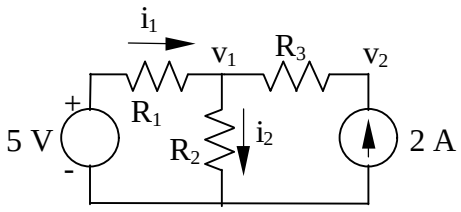
Problem	Score
1	/20
2	/20
3	/30
4	/30
Total	/100

Show all work for credit
AND
Turn in your signed help sheet

Name _____ 20 pts

ES201 Examination I **Problem 1** Sept. 26, 1996

Given the circuit below write the equations necessary to solve for i_1,i_2, v_1 and v_2. DO NOT SOLVE THESE EQUATIONS. Be sure to include some text telling me what you're doing.



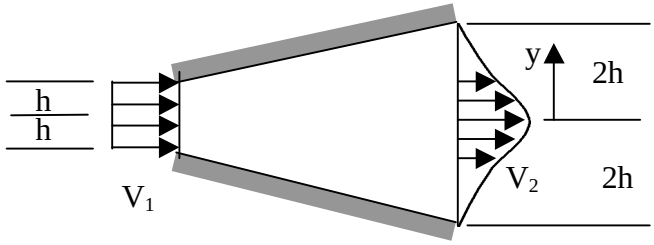
Name _____ 20 pts

ES201 Examination I **Problem 2** Sept. 26, 1996

Liquid mercury enters a diverging channel as shown below. It enters with a one-dimensional velocity profile and exit the channel with the velocity profile shown on the figure. The flow in the channel is steady. Known information about the flow is shown in the figure. The channel is of constant width w (into the paper) and no flow leaks out in this direction. The density of mercury is 13,500 kg/m^3.

a) Determine the mass flow rate of mercury in the channel, in kg/s.
b) Determine the average velocity at the inlet to the channel, in m/s.

h = 0.2 m
V_m = 3 m/s
w = 10 m (width)

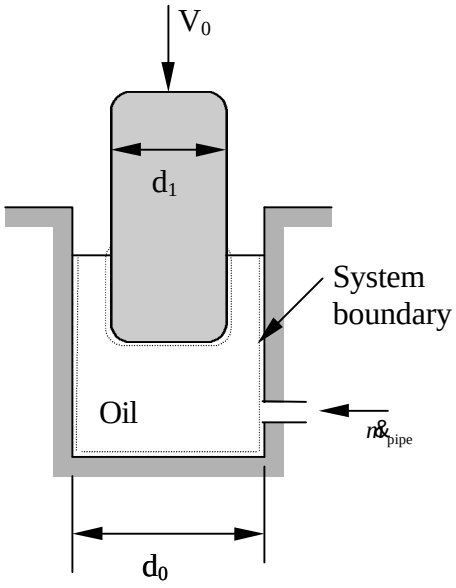


$$V_2 = V_m \cos\left(\frac{p}{4}\frac{y}{h}\right)$$

c) Name _____ 30 pts

ES201 Examination I **Problem 3** Sept. 26, 1996

A vertical, cylindrical tank closed at the bottom is partially filled with an incompressible oil. A cylindrical rod of diameter d_i (less than the tank diameter d_o) is lowered into the liquid at a velocity V_o. In addition, oil is pumped into the tank as shown with a mass flow rate $\dot{m}_{pipe}$. The oil is incompressible and has a density ρ_{oil} (density is uniform and constant).



Develop an equation for the average velocity of the fluid escaping between the rod and the tank walls in terms of the known parameters of the problem. The velocity should be measured relative to the bottom of the tank.

One possible system is shown on the drawing. You may use it or select your own, but be clear about what you are using. FOR MORE THAN A 70% GRADE ON THIS PROBLEM you must clearly show how you modeled the system using the given information, the fundamental laws and basic concepts of this course, and any additional assumptions.

ANALYSIS: (Begin Here)

Name _____ 30 pts

ES201 Examination I **Problem 4** Sept. 26, 1996

An absorption tower operates under steady-state conditions and produces 50 kg/h of an acetone-water solution with an acetone mass fraction of 10%. This solution is produced by scrubbing acetone from an acetone-air mixture by bringing it into contact with a stream of pure water. The acetone-air mixture enters the tower with an acetone mass fraction of 20%. The acetone is not completely removed and the exit acetone-air gas stream has an acetone mass fraction of 3%. All this information is included in the figure below. No chemical reactions occur in the tower.

Determine the required mass flow rates for all streams. Show your work and your reasoning. **DO NOT SOLVE FOR NUMERICAL ANSWERS! Just set up the equations.**