Name ______________________________ Section _______________________

ES205
Examination II
April 20, 2001

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

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

Name ___________________________________ 20 pts

ES205 Examination II **Problem 1** April 20, 2001

A mercury-in-glass thermometer is placed inside a cold room in a frozen-food warehouse to measure the change in air temperature when the door is left open for extended periods of time. In one instance the thermometer reads 1 °C, while the automatic temperature control system for the room indicates that the wall temperature is –10 °C. The convection heat transfer coefficient for the thermometer is estimated at 10 W/(m^2-K) and the emissivity, ε, is 0.9.

Note: $\sigma = 5.67 \times 10^{-8}$ W/(m^2-K^4).

a) Estimate the true air temperature.

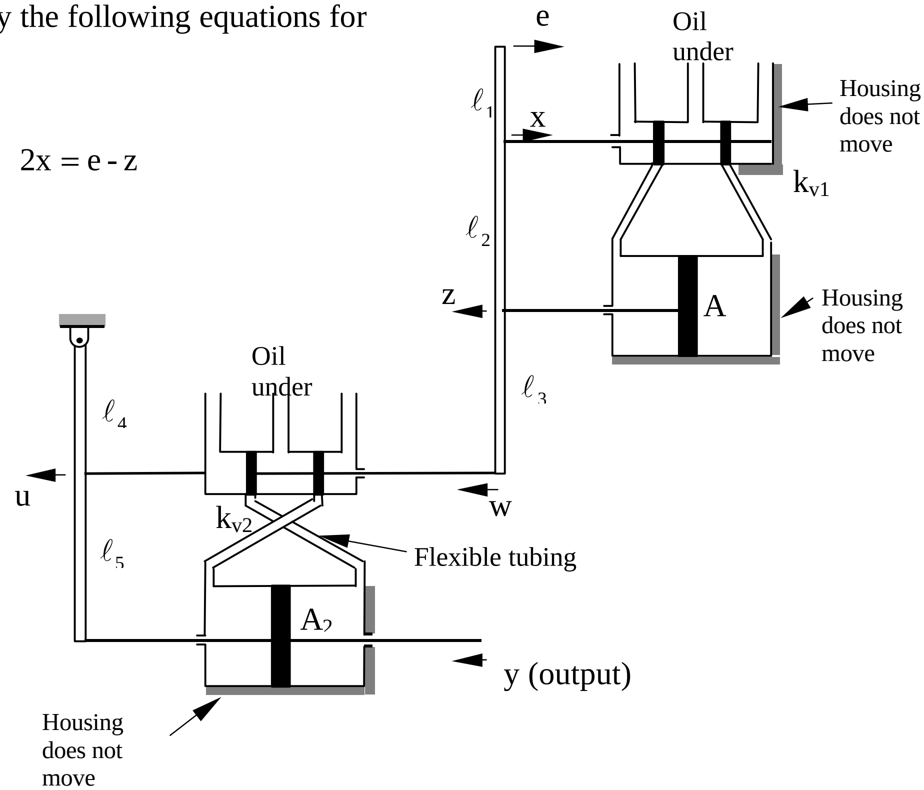
b) How would you suggest to improve the temperature measuring system?

c) Write a differential equation for the temperature of the thermometer (if you are not given any parameters you need, just give them a symbol and tell me what they are) in terms of the temperature of the wall and the temperature of the air.

Name ___________________________________ 20 pts

ES205 Examination II **Problem 2** April 20, 2001

The system shown is governed by the following equations for
$\ell_1 = \ell_2 = \ell_3 = \ell_4 = \ell_5 = \ell$:



1. Input lever: $\dfrac{e - x}{\ell} = \dfrac{e + z}{2\ell} \Rightarrow 2x = e - z$

$$\frac{x + z}{\ell} = \frac{x + w}{2\ell}$$

2. Valve #1: $Q_1 = k_{v1}x$

3. Piston #1: $Q_1 = A_1 \dfrac{dz}{dt}$

4. Valve #2: $Q_2 = k_{v2}(w-u)$

5. Piston #2: $Q_2 = A_2 \dfrac{dy}{dt}$

6. Output lever: $\dfrac{u}{\ell} = \dfrac{y}{2\ell}$

Draw a block diagram for this system where the input is e and the output is y. Hint: Use Eq.1 as shown, that is, solved for x.

Name ___________________________________ 30 pts

ES205 Examination II **Problem 3** April 20, 2001

Crude oil flows through a level section of the Alaskan pipeline at a rate of 1.6 million barrels per day (104 ft^3/s). The galvanized iron pipe inside diameter is 48 in. The maximum allowable pressure in the pipeline is 1200 psi and the minimum pressure required to keep dissolved gasses in solution is 50 psi. The crude oil has a density 1.804 $slug/ft^3$ and a viscosity of μ = 3.5e-4 $lb\text{-}s/ft^2$. A series of pump and efficiency curves are shown below.

For these conditions determine:

a) which pump is being used?

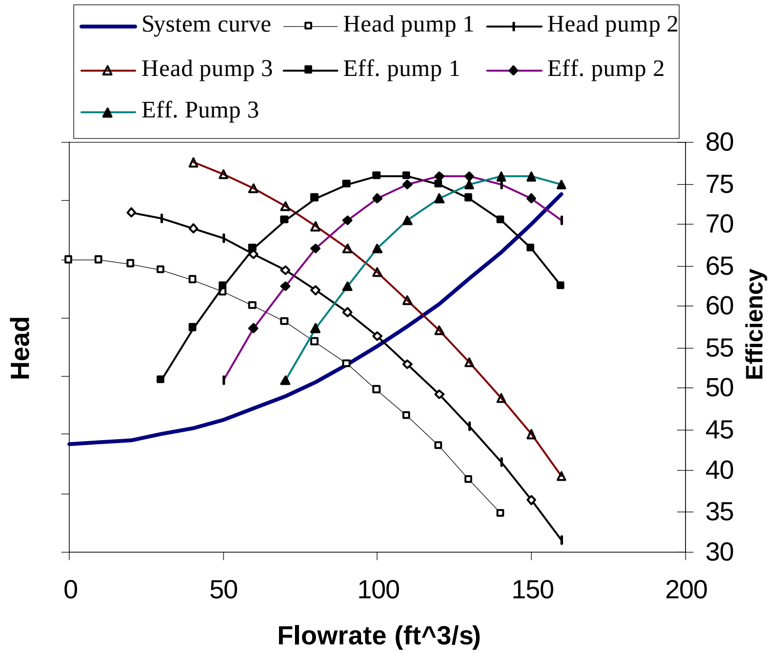
Pump 1 Pump 2 Pump 3

(circle one)

b) What is the maximum possible spacing between pumping stations?

c) What is the power required by each pump in horsepower (1 hp = 550 ft-lb/s).

d) Discuss (in detail) how this problem would change if I had specified the distance between pumps, L, and instead asked you to find the minimum diameter of the pipe.



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ES205 Examination II **Problem 4** April 21, 2000

Consider the liquid level-control system shown below. When the tank is filled to a height H_o the valve is closed. Water is removed by opening the gate at the bottom of the tank. The loss coefficient for the valve in the pipe, K, is a nonlinear function of the amount the value is opened as shown in the figure. Neglect major losses in the pipe. Determine the equations that govern the behavior of this system. Clearly label your equations and keep track of your unknowns.