Name: ______________________________ Section: ____________________

ES 205
Examination II
May 5, 2009

Problem	**Score**
1	/40
2	/40
3	/20
Total	/100

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

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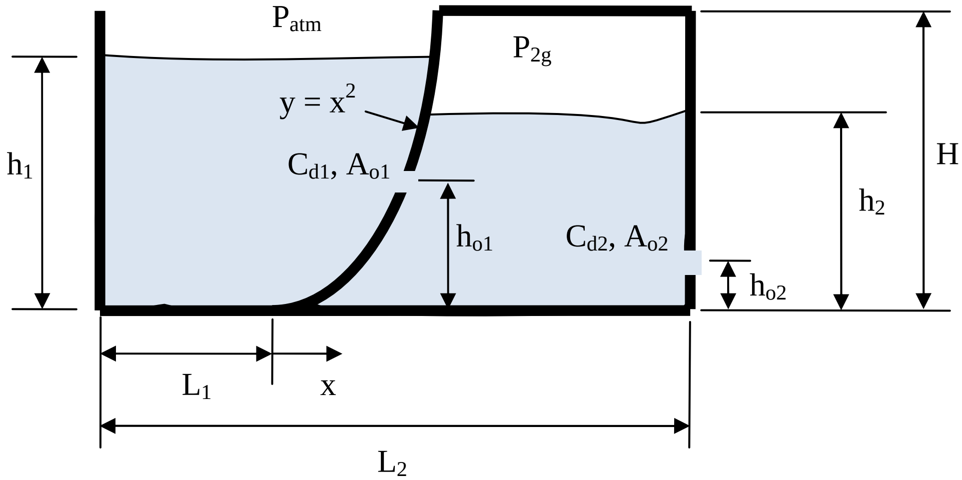
ES 205 Examination II **Problem 1** 40 pts.

Consider the two-chambered tank below. Both tanks have rectangular cross sections with width, w, out of the page. There are two orifices, one between the tanks along the parabolic divider. The other orifice is out of the straight side of the right-hand chamber. Set up the differential equations for the heights of fluid in the two tanks. DO NOT ATTEMPT TO SOLVE THESE EQUATIONS but clearly number you equations and list your unknowns. Assume all the tank dimensions, orifice parameters, and fluid properties are known. Note that P_{2g} is a constant and known gage pressure.



Unknowns:
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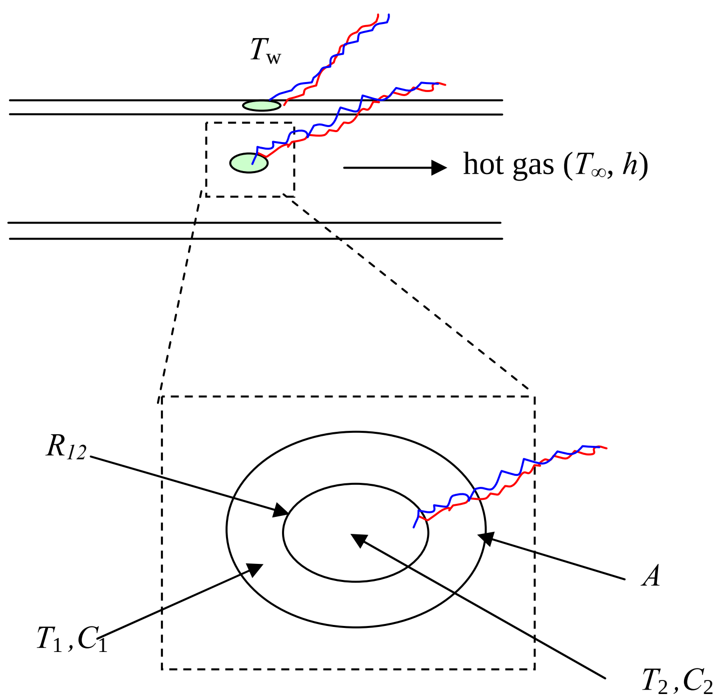
ES 205 Examination II **Problem 2** 40 pts.

Hot gas flows in a duct instrumented with two thermocouples. A shielded thermocouple is placed in the gas stream and consists of two volumes having different thermal capacitances C_1 and C_2. Heat is transferred between the two volumes at a rate given by $\dot{Q} = \Delta T/R_{12}$, where R_{12} represents the thermal resistance of the interface between the two layers and ΔT is the temperature difference between the two volumes. An expanded view of this thermocouple is shown in the dotted lines. The thermocouple mounted in the wall is not sheathed.

(a) Determine the governing differential equations for the temperature T_1 and T_2. Assume T_w, ε, σ, T_∞, h, A, and R_{12} are known.

(b) Assume that at steady state the following is known: The thermocouple embedded in the duct wall indicates a temperature $T_w = 700$ºF. The thermocouple immersed in the center of the hot gas stream has emissivity $\varepsilon = 0.6$, a convection coefficient of 30 btu/(hr·ft^2·F), and indicates a temperature $T_2 = 900$ºF. The Stefan-Boltzman constant in USCS units is $\sigma = 0.1714\times10^{-8}$ btu/(hr·ft^2·R^4). Determine the actual temperature of the gas.



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ES 205 Examination II **Problem 3** 20 pts.

Problem 3.1 (3 pts.)
A second order system has a damping ratio of 0.1, a natural frequency of 4 rad/s and is forced with f(t) = 8 sin8t. Determine the phase difference, in radians, between the input and the steady-state output.

Problem 3.2 (2 pts.)
When calculating the log-incomplete response why do you exclude data past 4 time constants?

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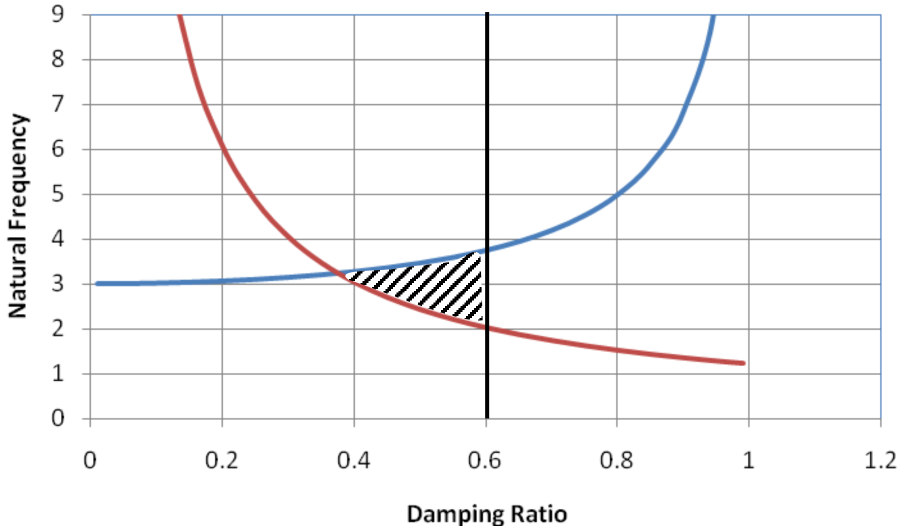
Problem 3.3 (6 pts.)
A design space for a second order system subject to a step input is shown below. Cross hatching shows the acceptable region. Label the curve for

a) Percent overshoot
b) Settling time
c) Peak time



Problem 3.4 (9 pts.)
Determine the performance specifications for Problem 3.3 for percent overshoot, settling time and peak time.