

Name _____ Section _____

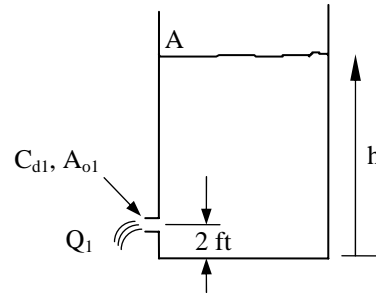
ES205
Examination II
April 30, 2004

Problem	Score
1	/10
2	/15
3	/15
4	/10
5	/25
6	/25
Total	/100

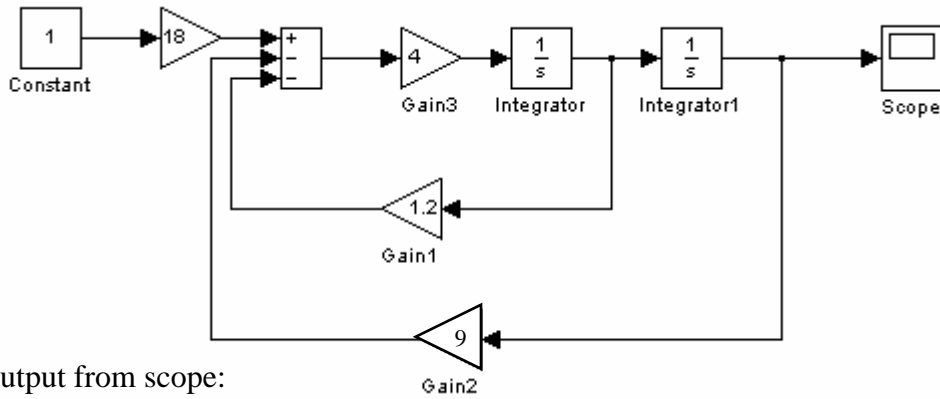
Show all work for credit
AND
Turn in your signed help sheet

The equation of motion for the tank system shown is found to be: $5 \frac{dh}{dt} + 4\sqrt{h-2} = 8$

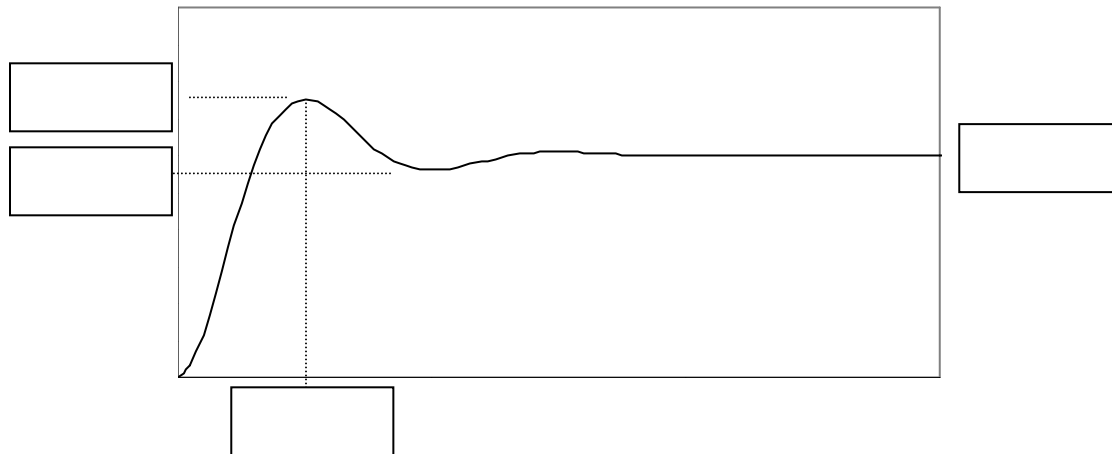
- What is the steady state height of the fluid in the tank?
- If the tank starts empty, draw a Simulink diagram that can be used to determine the height of fluid from the bottom of the tank.



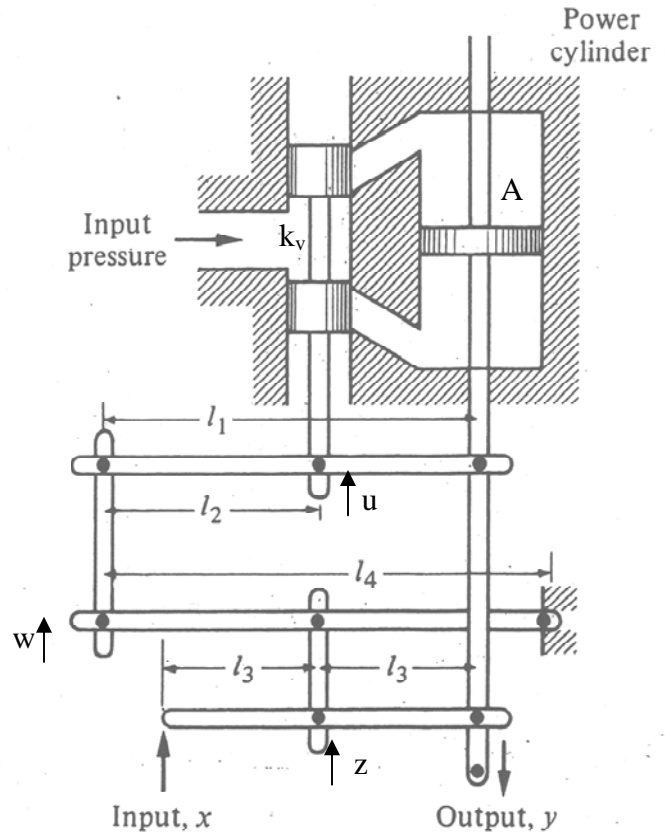
The output of the Simulink model shown below was printed, but unfortunately, the axis were somehow left off. Please fill in the boxes shown to help understand the plot. You may not actually implement this in Simulink! Use the equation of motion this Simulink model represents.



Output from scope:



A valve-controlled hydraulic actuator is shown in the accompanying illustration. Determine the equations necessary to determine an equation of motion relating the input x to the output y . Do not solve the equations, just clearly label them and give me a list of unknowns.



The required performance specifications for a system are:

- Percent overshoot: less than 20%
- Time to first peak: less than 0.4 seconds
- 2% settling time: less than 1 seconds

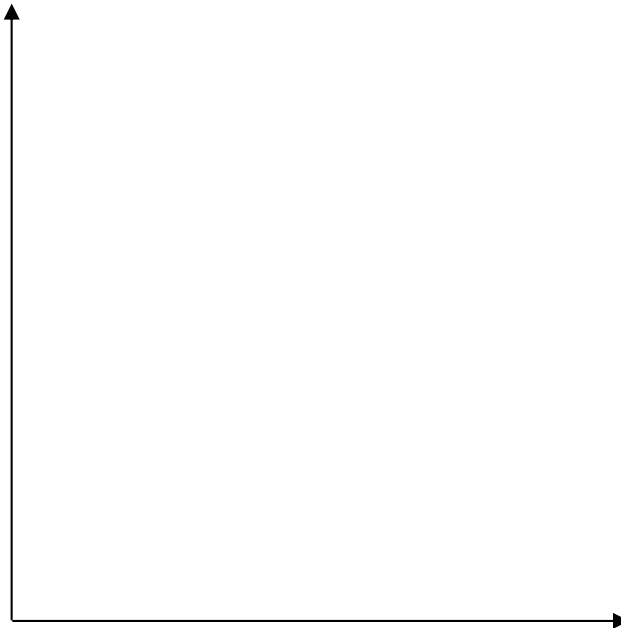
These specification result in the following relationships:

Percent overshoot: $\zeta > 0.45$

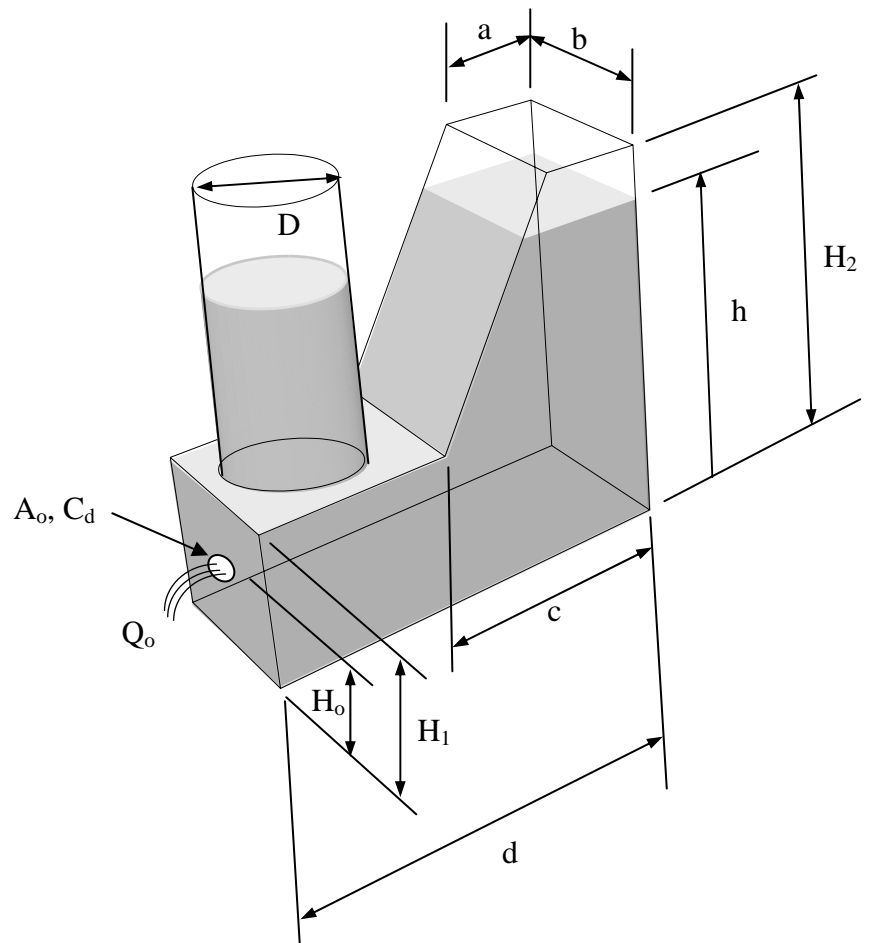
Peak time: $\omega_n > \frac{7.8}{\sqrt{1-\zeta^2}}$

Settling time: $\omega_n > \frac{4}{\zeta}$

Sketch these constraints in a design space. Use the damping ratio ζ as the abscissa and the natural frequency ω_n as the ordinate of the design-space plot.



You have been asked to determine a model for the tank shown below. The model should be valid for the tank completely full to when the water is at the level of the orifice. A list of equations and unknowns is adequate.



The cross section of an oven is shown. When the oven has reached a steady state temperature of $650\text{ }^{\circ}\text{C}$, a small test specimen is placed in it. Determine

- an equation of motion for the temperature for the test specimen
- the time for a small test specimen ($V/A = 0.00075\text{ m}$, $\rho = 7840\text{ kg/m}^3$, $c_p = 0.460\text{ kJ/(kg}\cdot\text{k)}$) to reach a temperature of $600\text{ }^{\circ}\text{C}$ assuming it is placed in the oven at a temperature of $25\text{ }^{\circ}\text{C}$, and the convective heat transfer coefficient is $10\text{ W/(m}^2\cdot\text{K)}$
- the equations necessary to find the steady state temperature of the outside wall of the oven. Do not solve these equations, just clearly derive the equations and give me a list of unknowns. Assume the steel layers are L_{st} thick, the insulation is L_{insul} thick, the thermal conductivities are K_{steel} , and $K_{insulation}$ and the convective heat transfer coefficient between the inside wall and the air is h_{inside} , and the convective heat transfer coefficient on the outside is, $h_{outside}$ and the area of one of the inside wall is A .

