Name ______________________________ Section _______________________

ES205
Examination II
April 23, 1999

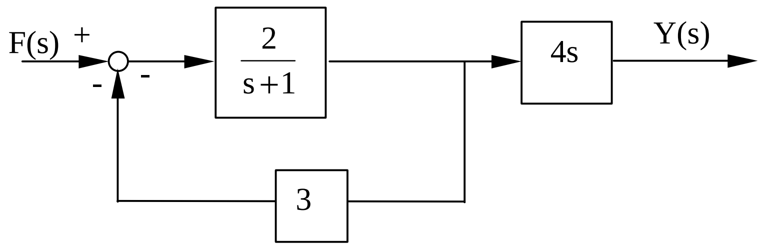
Problem	Score
1	/40
2	/30
3	/30
Total	/100

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

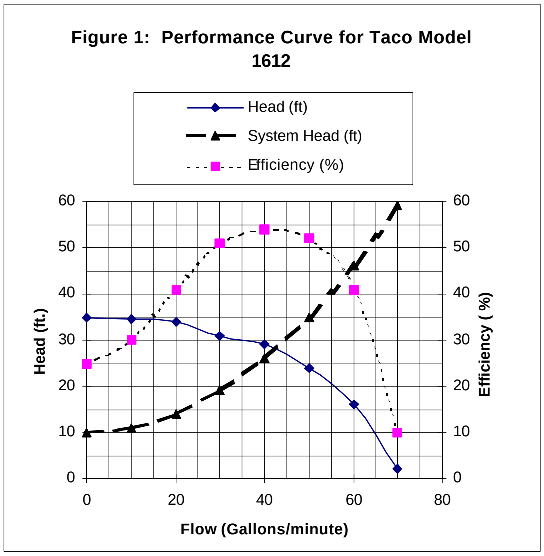
Name ____________________________________ 25 pts

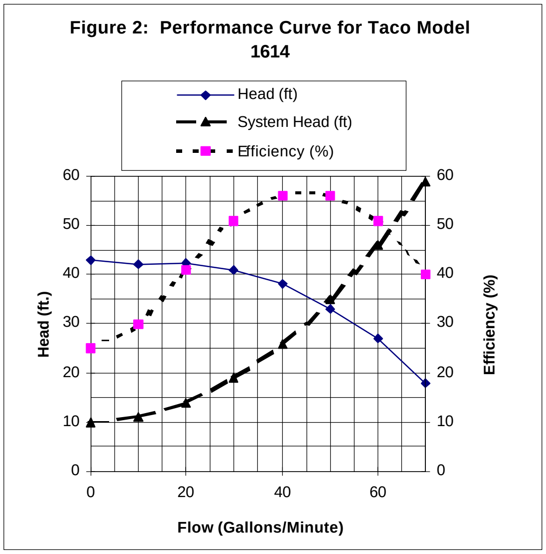
ES205 Examination II **Problem 1** April 23, 1999

1 a) What differential equation is modeled by the block diagram shown below. The input is F and the output is y. (8 pts)

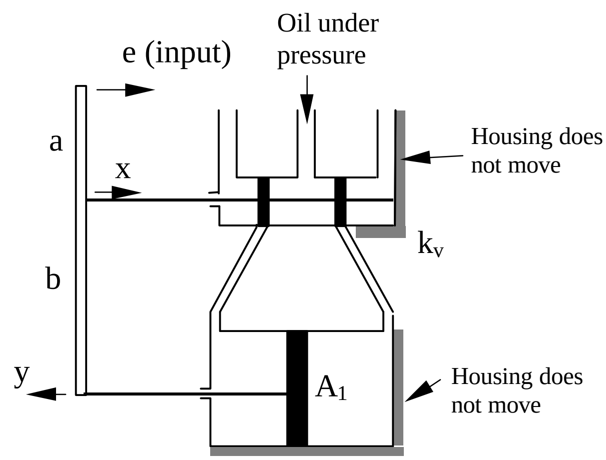


1 b) Examine the two pump curves shown below. The desired system curve has been plotted on each of the pump curves. Which pump would you choose? Justify your choice. What would the system flow rate be for your selection? (6 pts)





1 c) Determine the equations necessary to determine the equation of motion for the hydraulic servomotor shown below. The input is e and the output is y. **Do not find the EOM but number the equations that you would use and generate a list of the unknown variables**. (8 pts)



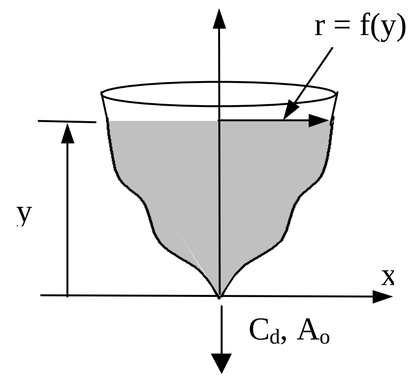
1 d) A cold sphere of copper of diameter d = 0.06 m is suddenly placed in a large hot liquid bath of temperature T_∞. Since the sphere is being heated, the temperature of the sphere, T, rises as a function of time. The following properties of pure copper are given (at 20° C): density ρ = 8954 kg/m^3, specific heat c = 0.3831 kJ/(kg-°C), and thermal conductivity k = 385 W/(m-°C). The surface coefficient of hear transfer is given as h = 25 $W/(m^2$-°C). The properties are weak functions of temperature; i.e., they do not change much as temperature varies.

Is it valid to use a lumped-parameter model? Explain your answer. NOTE: Do not derive the differential equation, just answer whether or not it would be valid to use lumped capacitance. (6 pts)

The volume of a sphere is given by $(4/3)\pi r^3$ the surface area of a sphere is given by $4\pi r^2$.

Problem 1e and 1f)

1e) You have been asked to design a 3-minute timer for a board game. The top half of the timer is shown below where radius of the timer at any y location is given by the function f(y). Determine the differential equation for the height of fluid, y. Assume the time has a circular cross section at every value of y. (8 pts)



1f) If the timer is to drain at a constant rate, -K, so the players can easily determine how much time is remaining, determine the shape of the timer f(y). (4 pts)

Name ___________________________________ 30 pts

ES205 Examination II **Problem 2** April 23, 1999

During a picnic on a hot summer day, all the cold drinks disappeared quickly, and the only available drinks were those at the ambient temperature of 80 °F. In an effort to cool a 12-fluid-oz drink (0.75 lb), which is 5" high and has a diameter of 2.5 in (volume = 0.0142 ft^3, surface area = 0.307 ft^2), a person grabs the can and starts shaking it in the iced water of the chest at 32 °F. The temperature of the can and fluid can be assumed to be uniform at all times, and the heat transfer coefficient between the iced water and the aluminum can is 30 Btu/(hr-ft^2-F). Use the following properties: ρ = 62.3 lbm/ft^3, c_p = 1.0 Btu/(lbm-°F)

Determine:

a) A differential equation for the temperature of the fluid in the can. (20 pts)

b) How long it will take the canned drink to cool to 45 °F. (10 pts)

Name ___________________________________ 30 pts

ES205 Examination II **Problem 3** April 23, 1999

A smooth (ε/D=0) plastic, 10-m-long garden hose with an inside diameter of 20 mm (D = 0.02 m, A = 3.14×10^{-4} m^2) is used to drain a wading pool as shown below. Determine: the flowrate from the pool when the height of water is 0.2 m? Use $K_{entrance} = 0.8$. Use $\nu = 1.12 \times 10^{-6}$ m^2/s.
Hint: Let the first guess for your friction factor be 0.02.