System Analysis in Mechanical & Aerospace Engineering 2009

HW #6. Due 5/07 PM 8:00

1. For the pneumatic system shown in Figure 1, assume that the steady-state values of the air pressure and the displacement of the bellows are $\overline{P}$ and $\overline{X}$, respectively. Assume also that the input pressure is changed from $\overline{P}$ to $\overline{P} + p_i$, where p_i is small. This change will cause the displacement of the bellows to change a small amount x. Assuming that the capacitance of the bellows is C and the resistance of the valve is R, obtain the transfer function relation x and p_i

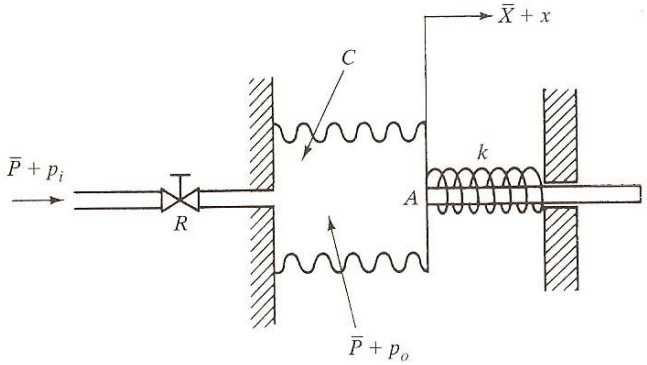

Fig. 1

2. Consider the conical water tank system shown in Figure 2. The flow through the valve is turbulent and is related to the head H by

$$Q = 0.0005\sqrt{H}$$

Where Q is the flow rate measured in m^3/s and H is in meters. Suppose that the head is 2 m at t = 0. What will be the head at t = 60s?

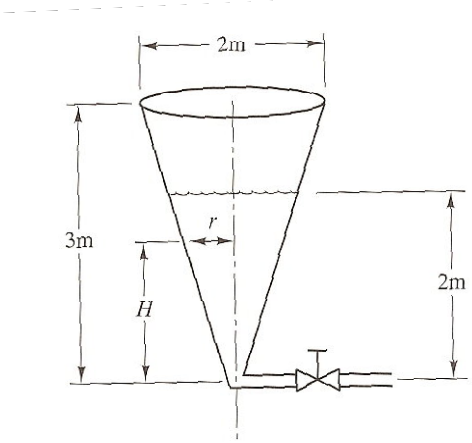

Fig. 2

3. Figure 3. Shows a liquid-level system with a pump input and a drain whose linear resistance is R_2. The inlet from the pump to the tank has a linear resistance R_1. Obtain a linearized model of the liquid height h

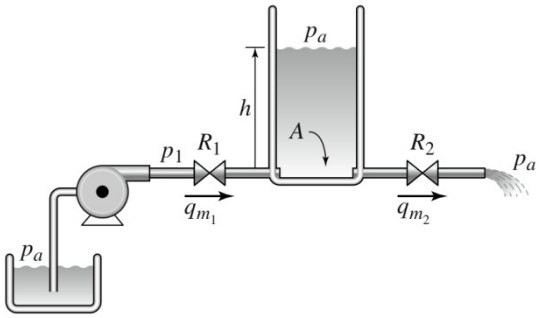

Fig. 3

4. (a) Develop a model of the two liquid heights in the system shown in Figure 4. The inflow rate $q_{mi}(t)$ is a mass flow rate. (b) Using the values $R_1=R$, $R_2=3R$, $A_1=A$, $A_2=4A$, find the transfer function $H_2(s)/Q_{mi}(s)$

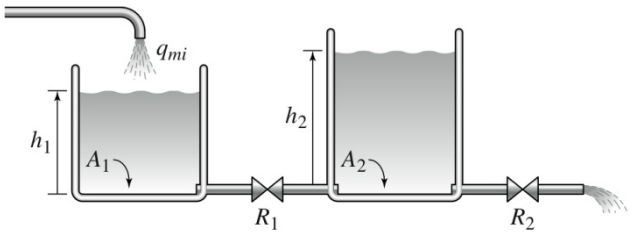

Fig. 4

5. An electric motor is sometimes used to move the spool valve of a hydraulic motor. In Figure 5. The force f is due to and electric motor acting through a rack-and-pinion gear. Develop a model of the system with the load displacement y as the output and the force f as the input. Consider two cases: (a)$m_1 = 0$ and (b)$m_1 \neq 0$

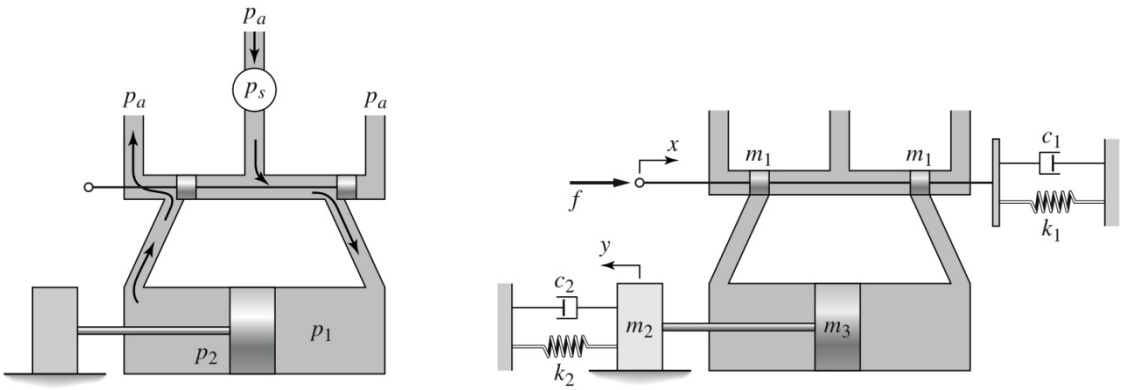

Fig. 5