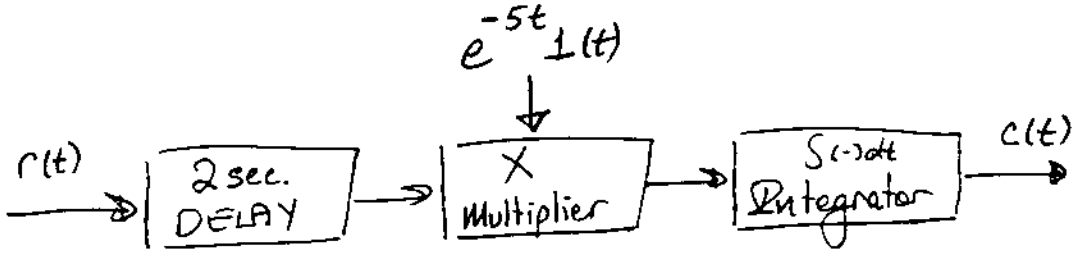
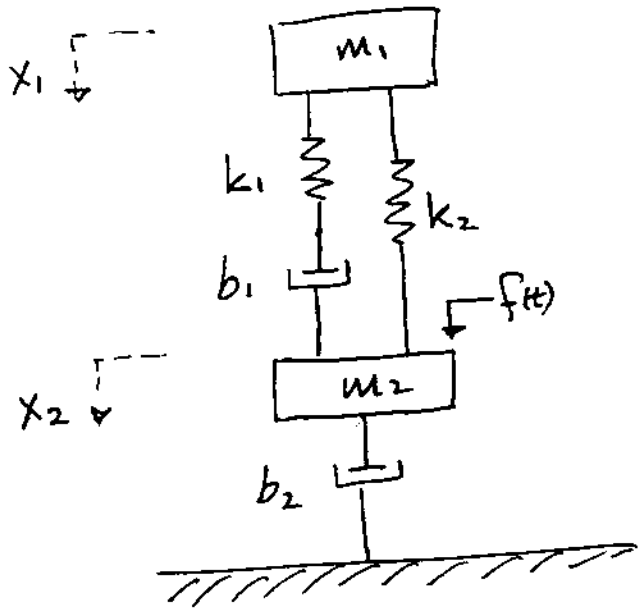
EE 231 **Exam#1** **Feb. 19, 1991**
75 minutes

1. In the following simulation diagram, the Laplace transform of the output is given such that $\mathcal{L}[c(t)] = 2\frac{e^{-2(s+5)}}{s(s+5)}$. Determine the input signal $r(t)$. (20pts)



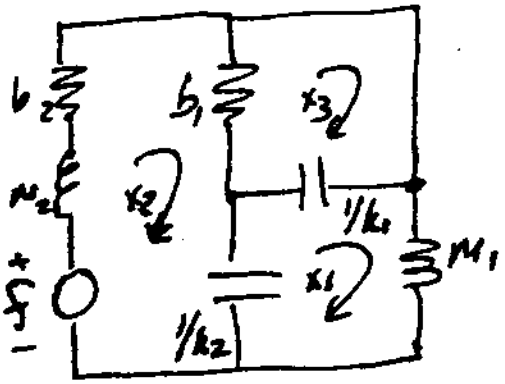
2. For the mechanical system shown below, find the differential equations describing the motion of the masses, and obtain *either* the force-voltage *or* the force-current analog of the system. (20pts)



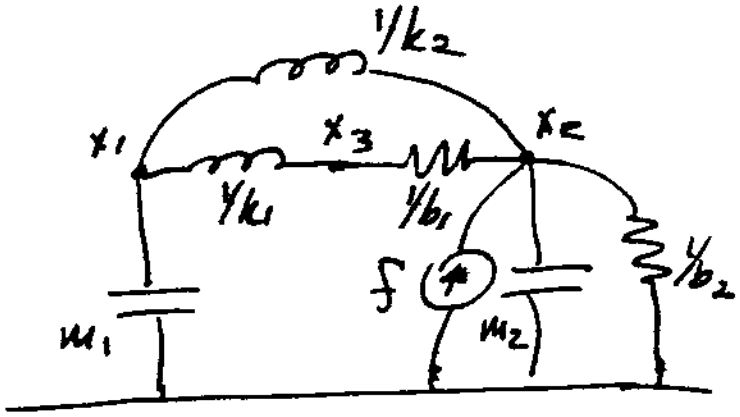
#1 $r(t) = 2\,1(t)$

#2
$$m_1\ddot{x}_1 = -k_1(x_1-x_3) - k_2(x_1-x_2)$$
$$0 = -k_1(x_3-x_1) - b_1(\dot{x}_2-\dot{x}_3)$$
$$m_2\ddot{x}_2 = f - b_2\dot{x}_2 - k_2(x_2-x_1) - b_1(\dot{x}_2-\dot{x}_3)$$

FORCE-VOLTAGE



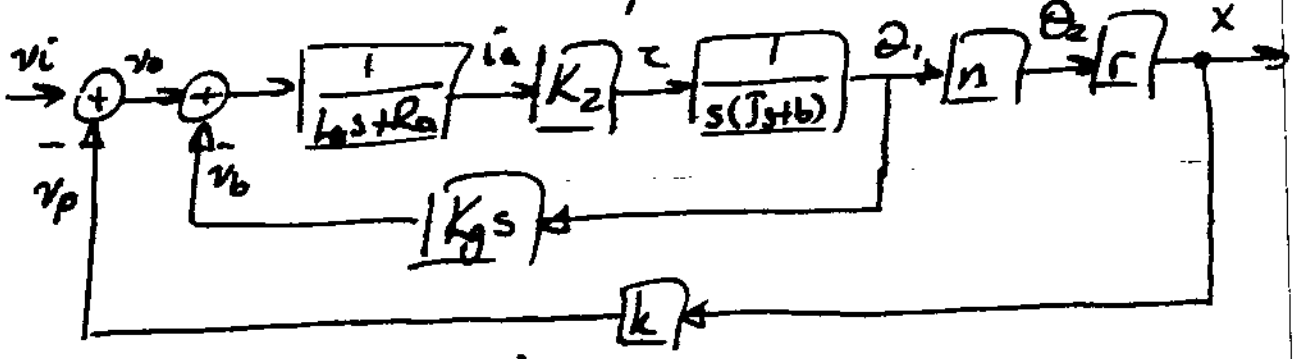
FORCE-CURRENT



#3
$$v_i = v_a + v_p$$
$$v_a = L_a\dot{i}_a + R_a i_a + v_b$$
$$v_b = K_g\dot{\theta}_1$$
$$\tau = K_2 i_a$$

$$\theta_1 = \frac{\tau}{s(Js+b)} \quad \text{where } J = J_m + n^2 J_L, \quad b = b_m + n^2 b_L$$

$$\theta_2 = n\theta_1$$
$$x = r\theta_2$$
$$v_p = kx$$



#4
$$\frac{C(s)}{R(s)} = \frac{G_1(G_2+G_3(1+G_4))}{(1+G_1)(1+G_2)-G_1G_2G_4}$$
$$= \frac{G_1G_2+G_1G_3(1+G_4)}{1+G_1+G_2-G_1G_2G_4+G_1G_2}$$