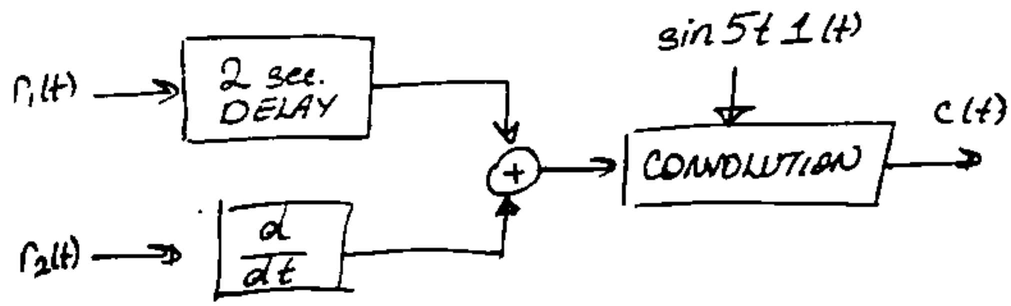
EE 231 | Exam#1 | Oct. 03, 1991

75 minutes

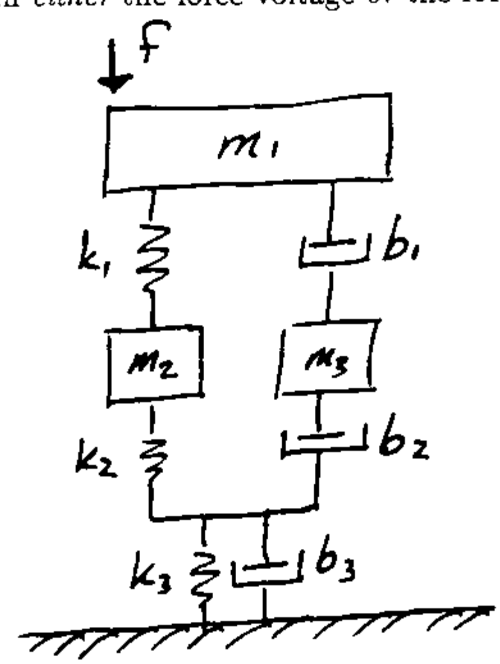
1. In the following simulation diagram, the Laplace transform of the output, $\mathcal{L}[c(t)]$ is given, such that

$$\mathcal{L}[c(t)] = \frac{15e^{-2s}}{s(s^2+25)} + \frac{10s^2}{(s^2+4)(s^2+25)}$$

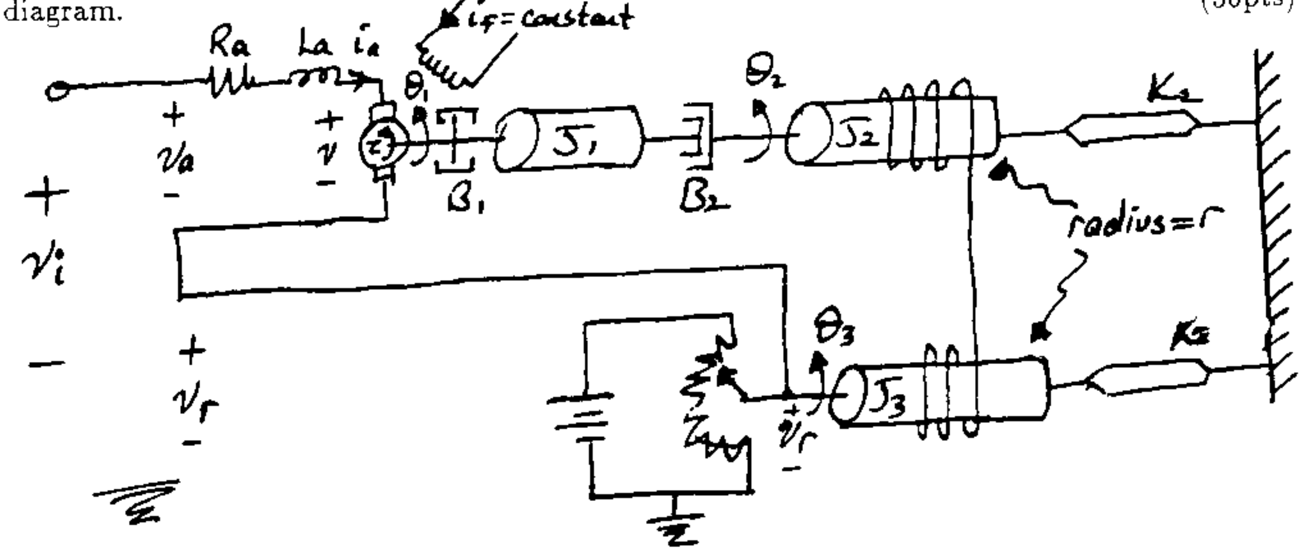
Determine the input signals $r_1(t)$ and $r_2(t)$. (20pts)



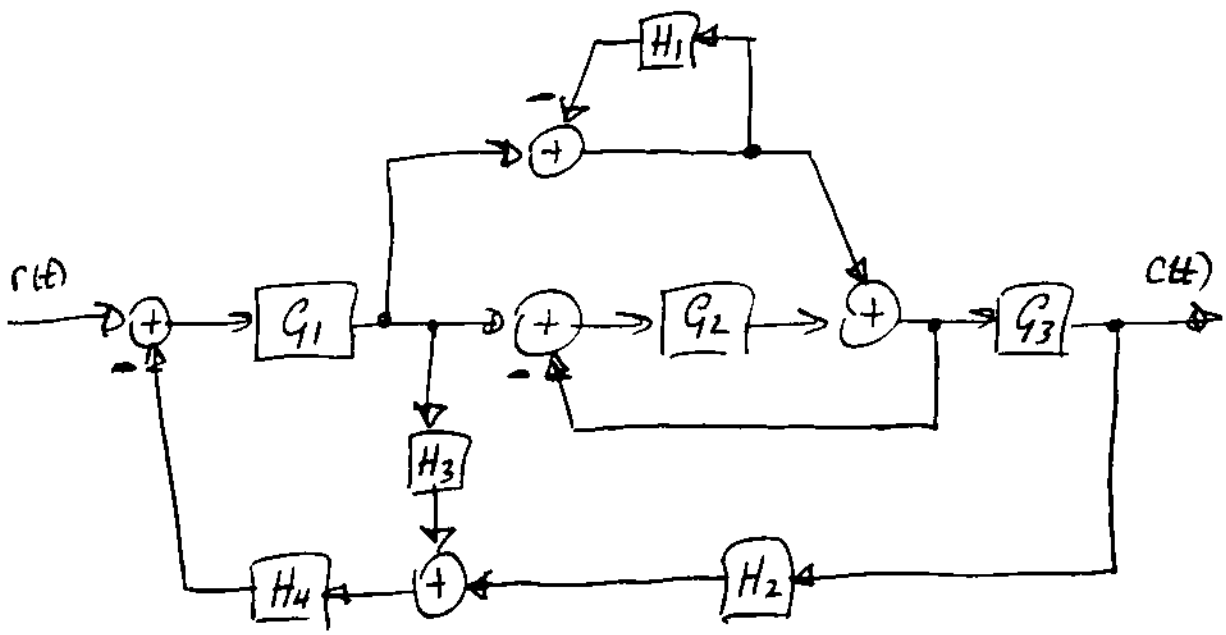
2. For the mechanical system shown below, find the differential equations describing the motion of the masses, and obtain *either* the force-voltage *or* the force-current analog of the system. (20pts)



3. In the following system, a motor is utilized to adjust the angle of a large coil. To sense the angle of the coil, θ_3, the voltage on a special variable resistor, v_r is used, such that $v_r = k_r\theta_3$. Assuming that the input and the output are v_i and θ_3, respectively; obtain a detailed block diagram of the system, and show the variables v_i, v_a, i_a, τ, θ_1, θ_2, θ_3 and v_r on the block diagram. (30pts)



4. For the block diagram given below, determine the transfer function *either* by block diagram reduction, *or* by Mason's formula. Show your work clearly. (30pts)



#1 $r_1(t) = 3\,1(t)$

$r_2(t) = 2\cos 2t\,1(t)$

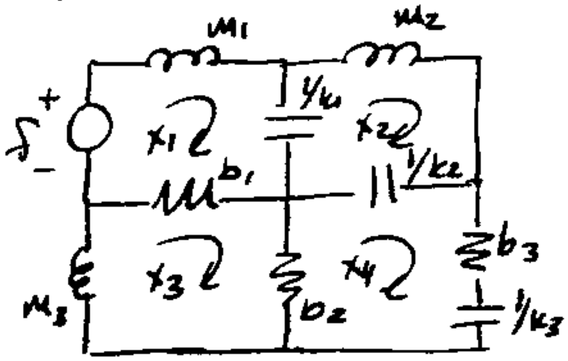
#2 $m_1\ddot{x}_1 = f - b_1(\dot{x}_1 - \dot{x}_3) - k_1(x_1 - x_2)$

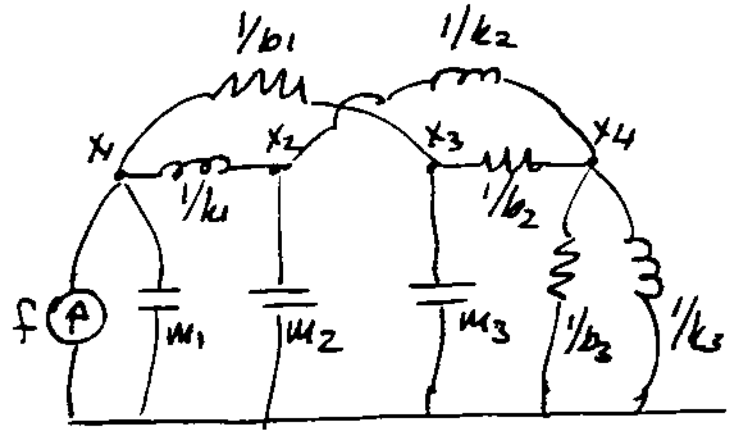
$m_2\ddot{x}_2 = k_1(x_2 - x_1) - k_2(x_2 - x_4)$

$m_3\ddot{x}_3 = -b_1(\dot{x}_3 - \dot{x}_1) - b_2(\dot{x}_3 - \dot{x}_4)$

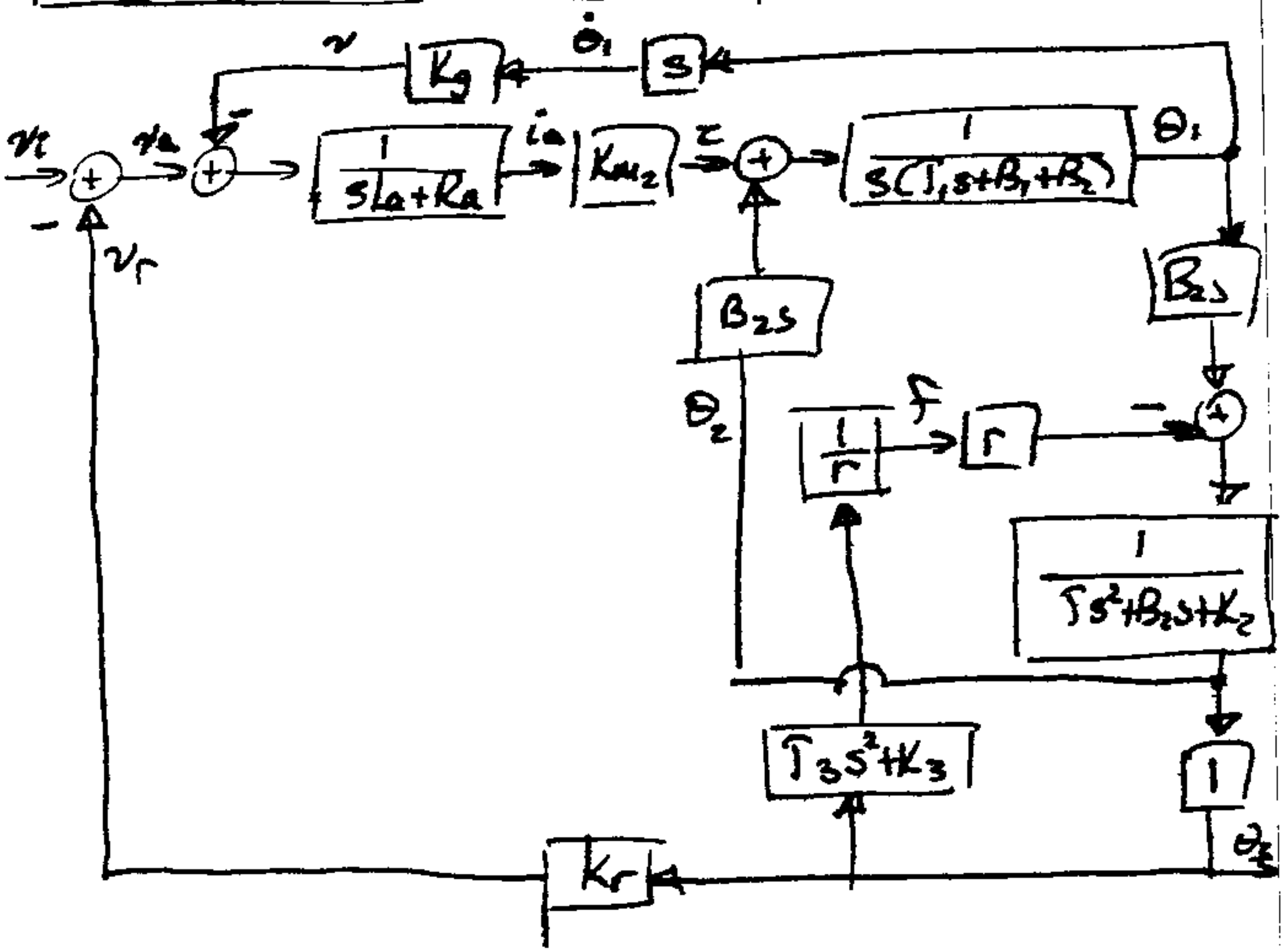
$0 = -b_2(\dot{x}_4 - \dot{x}_3) - b_3\dot{x}_4 - k_2(x_4 - x_2) - k_3 x_4$

force VOLTAGE





#3



#4 $$\frac{C(s)}{R(s)} = \frac{G_1(1+G_2+G_2H_1)G_3}{(1+G_1H_3H_4)(1+H_1)(1+G_2) + G_1(1+G_2+G_2H_1)G_3H_2H_4}$$

$$= \frac{1}{\Delta}\left(G_1G_2G_3(1+H_1) + G_1G_3\right)$$

where $\Delta = 1 + H_1 + G_2 + G_1G_2G_3H_2H_4 + G_1G_3H_2H_4 + G_1H_3H_4 + G_2H_1 + G_1G_2G_3H_1H_2H_4 + G_1H_1H_3H_4 + G_1G_2H_3H_4 + G_1G_2H_1H_3H_4$