EE 231

Exam#1
75 minutes

Feb. 09, 1989

1. For the system given in Figure 1, determine $F_1(s)$, $f_1(t)$ and $F_2(s)$. (25pts.)

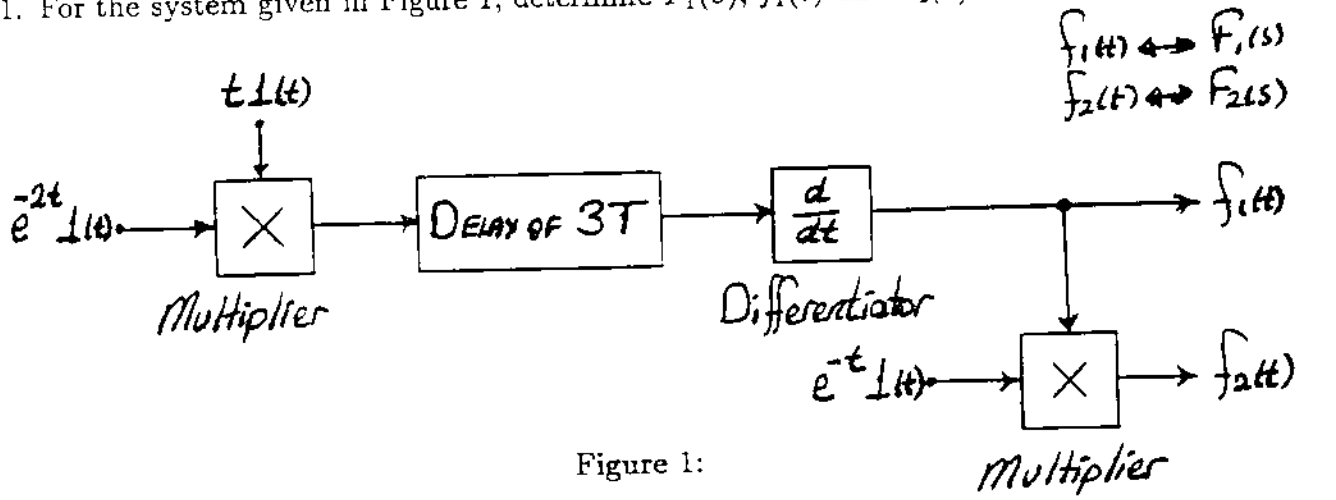

Figure 1:

2. Figure 2 shows a mechanical system. Find the differential equations describing the motion of m_1 and m_2 and force-voltage *or* force-current electric circuit analog of the system. (15pts.)

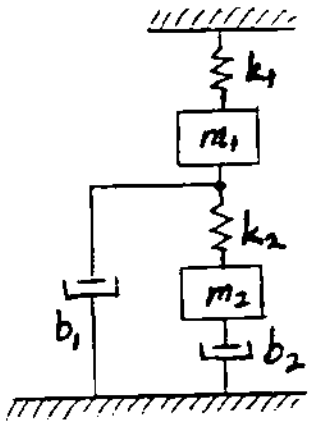

Figure 2:

3. Figure 3 shows a speed control system. The load consists of I, b and an external torque τ_L. The DC tachometer gives an output voltage v_t proportional to the output speed ω. This voltage is subtracted from the reference voltage v_r creating the difference signal v. The signal v is amplified and used to control i_a, so that the motor acquires the desired speed. Write the individual equations describing the system and form a detailed block diagram of the system using these equations. (15pts.)

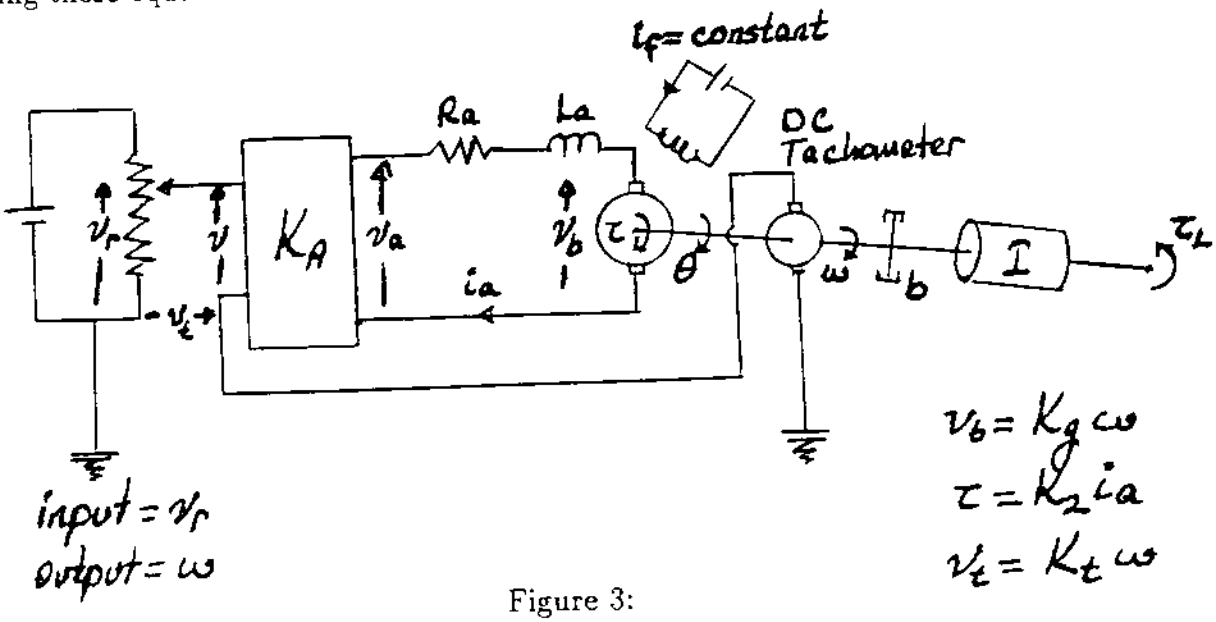

Figure 3:

4. Determine the transfer function of the system in Figure 4 by block diagram reduction. (25pts.)
Note: Solution with signal flow graph will only get 10 pts.

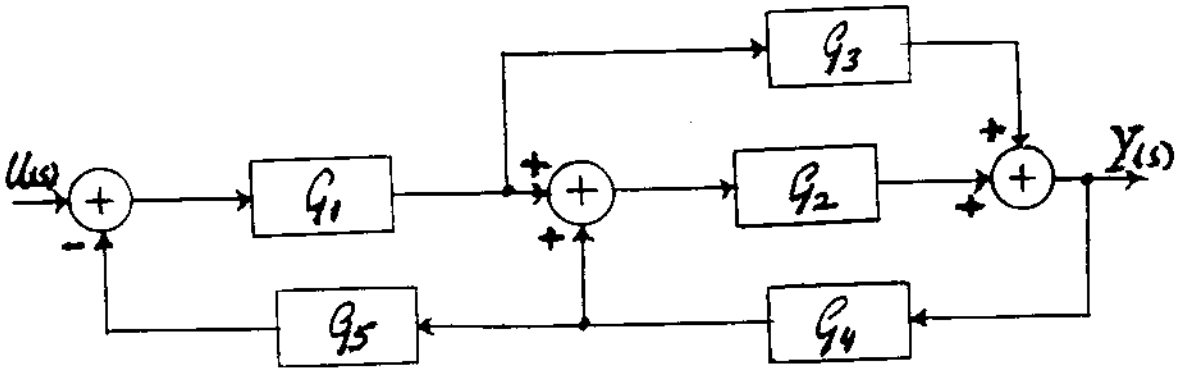

Figure 4:

5. Determine the transfer function $C(s)/R(s)$ for the signal flow graph shown in Figure 5 using Mason's formula. (20pts.)

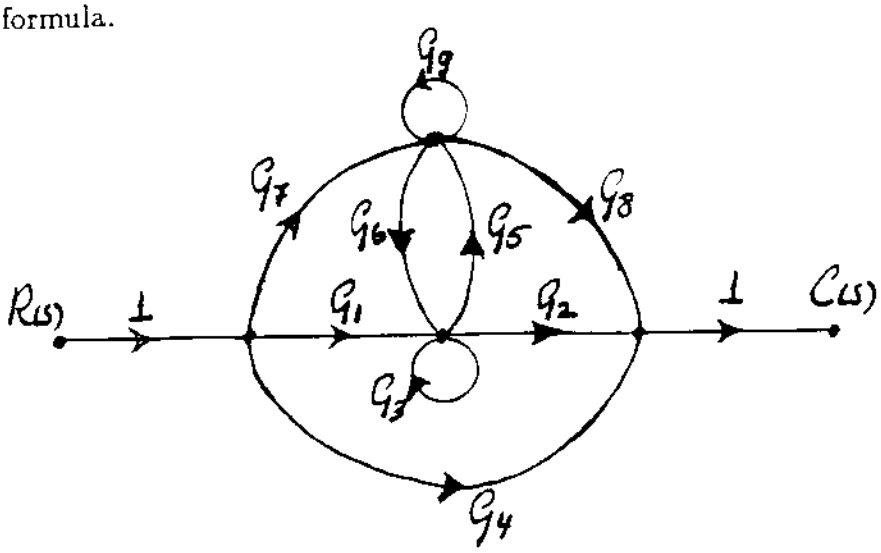

Figure 5:

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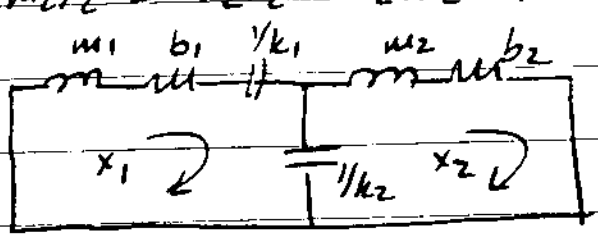
EXAM #1
ANSWERS

#1 $F_1(s) = \dfrac{se^{-3Ts}}{(s+2)^2}$, $f_1(t) = \{1-2(t-3T)\}e^{-2(t-3T)} \quad 1(t-3T)$

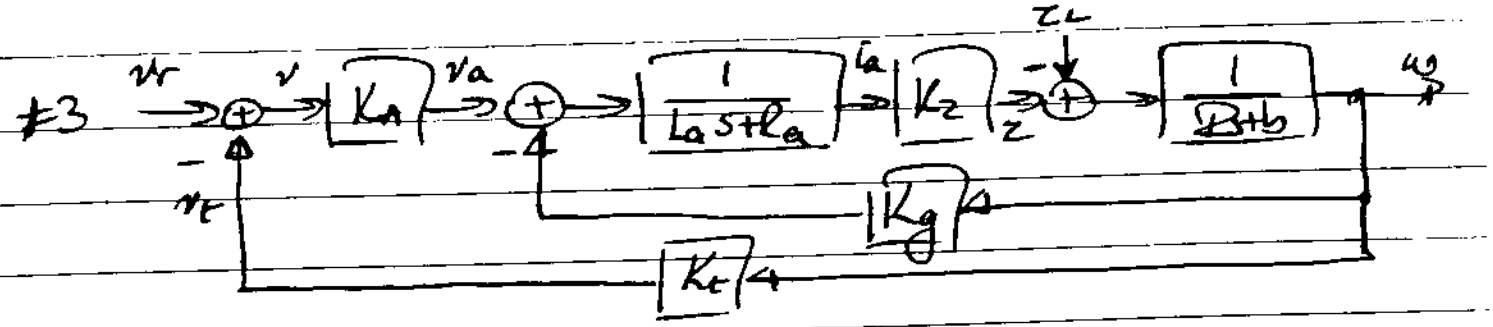
$f_2(s) = \dfrac{(s+1)e^{-3T(s+1)}}{(s+3)^2}$

#2 $m_1\ddot{x}_1 = -b_1\dot{x}_1 - k_1x_1 - k_2(x_1-x_2)$

$m_2\ddot{x}_2 = -b_2\dot{x}_2 - k_2(x_2-x_1)$



#3



#4 $\dfrac{Y(s)}{U(s)} = \dfrac{G_1(G_2+G_3)}{1-G_2G_4+G_1(G_2+G_3)G_4G_5}$

#5 $\dfrac{C(s)}{R(s)} = \dfrac{G_1G_2 - G_1G_2G_9 + G_7G_8 - G_3G_7G_8 + G_4 - G_3G_4 - G_4G_9 - G_9G_5G_6 + G_3G_4G_9 + G_1G_5G_8 + G_2G_6G_7}{1-G_3-G_9-G_5G_6+G_3G_9}$