Test EE3005 2024-25 Sem 1

NAME: ________________________________ **Student Number:** ______________________________

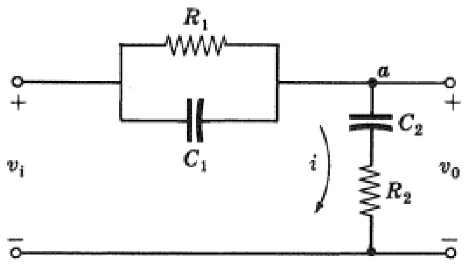
Question 1

Expand the equation below in the form of partial fractions.

$$Y(s) = -\frac{-[s^2 + s - 10]}{s^3 + 3s^2 + 2s}$$

Question 2

Find the transfer function of the lead-lag compensator shown in Fig. Q2 below.



Question 3

Use block diagram reduction technique, find the transfer function $C(s)$ / $R(s)$ of the block diagram shown in Fig. Q3.

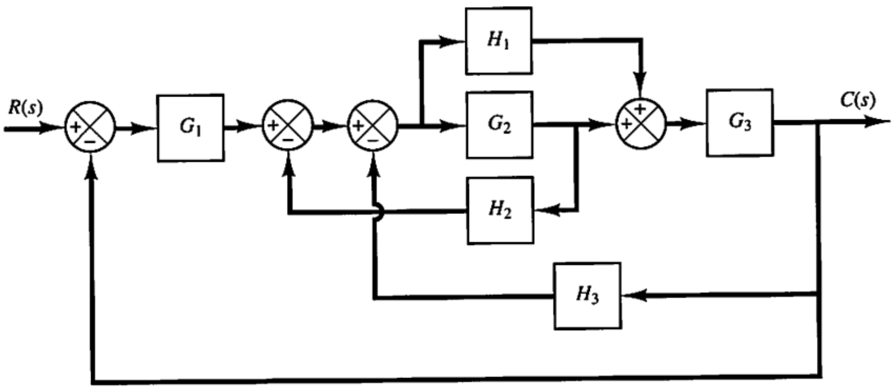


Fig. Q3

Question 4

For the Signal Flow Graph shown in Fig. Q4, find: (a) the input node(s); (b) the output node(s); (c) the path-gain of the forward path(s); and (d) the loop gains of the feedback loop(s).

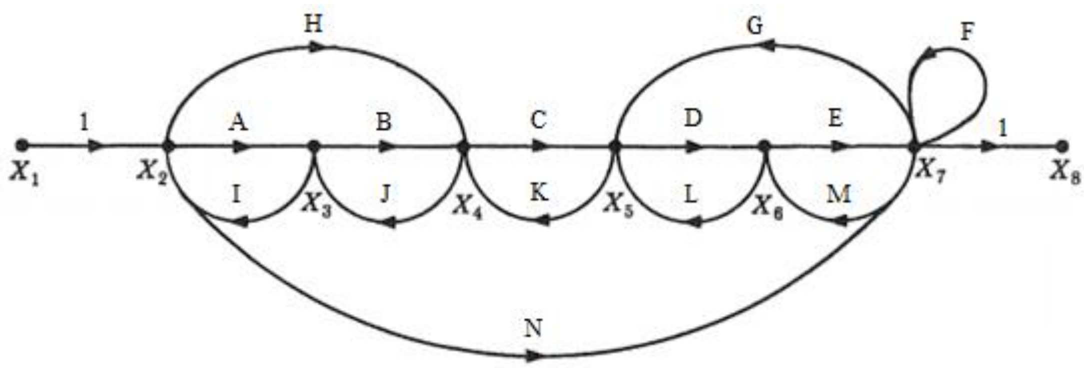


Fig. Q4

QUESTION 1

$Y(s)$ can be written as follow,

$$Y(s)=\frac{-[s^2+s-(10)]}{s(s+1)(s+2)}=\frac{A}{s}+\frac{B}{s+1}+\frac{C}{s+2}$$

Equating the numerator, we have

$$A(s+1)(s+2)+Bs(s+2)+Cs(s+1)=-[s^2+s-(10)]$$

$$if\ s=0,\quad A=\frac{10}{2}$$
$$if\ s=-1,\quad B=-(10)$$
$$if\ s=-2,\quad C=\frac{8}{2}$$

$$Y(s)=\frac{5}{s}-\frac{10}{s+1}+\frac{4}{s+2}$$

QUESTION 2

Method 1

$$Z_1=R_1//\frac{1}{sC_1}\quad \text{and}\ Z_2=\frac{1}{sC_2}+R_2$$

$$Z_1=\frac{R_1}{1+sR_1C_1}\qquad \text{and}\qquad Z_2=\frac{1+sR_2C_2}{sC_2}$$

$$\frac{V_0(s)}{V_i(s)}=\frac{Z_2(s)}{Z_1(s)+Z_2(s)}=\frac{\frac{1+sR_2C_2}{sC_2}}{\frac{R_1}{1+sR_1C_1}+\frac{1+sR_2C_2}{sC_2}}=\frac{\frac{1+sR_2C_2}{sC_2}}{\frac{sR_1C_2+(1+sR_1C_1)(1+sR_2C_2)}{(1+sR_1C_1)sC_2}}$$

$$\therefore\frac{V_0(s)}{V_i(s)}=\frac{(1+sR_1C_1)(1+sR_2C_2)}{sR_1C_2+(1+sR_1C_1)(1+sR_2C_2)}$$

Method 2

Equating currents at the output node a yields

$$\frac{1}{R_1}(v_i-v_0)+C_1\frac{d}{dt}(v_i-v_0)=i$$

The voltage v_0 and the current i are related by

$$\frac{1}{C_2}\int_0^t i\,dt+iR_2=v_0$$

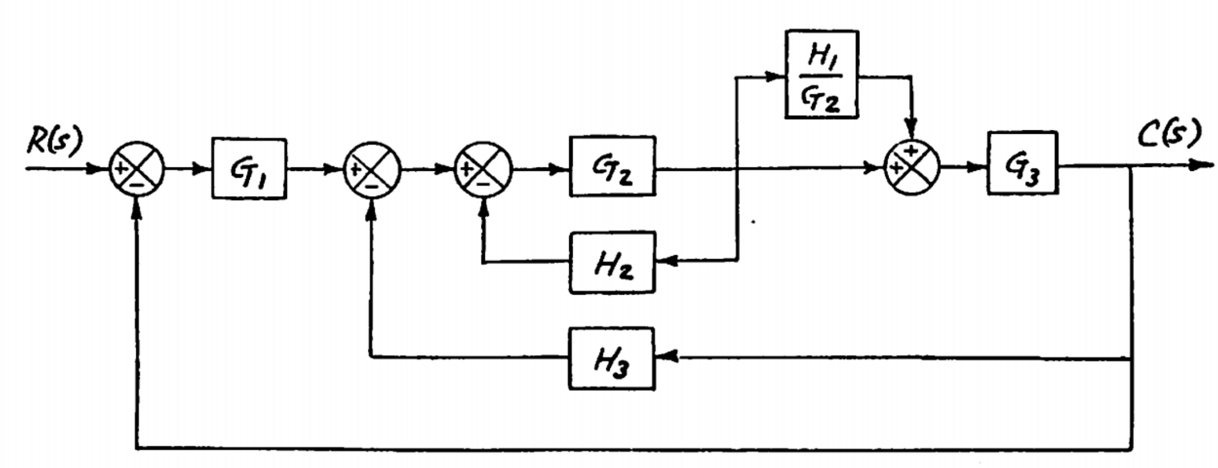
Taking the Laplace Transform of these 2 equations (with zero initial conditions) and eliminating $I(s)$ results in the equation

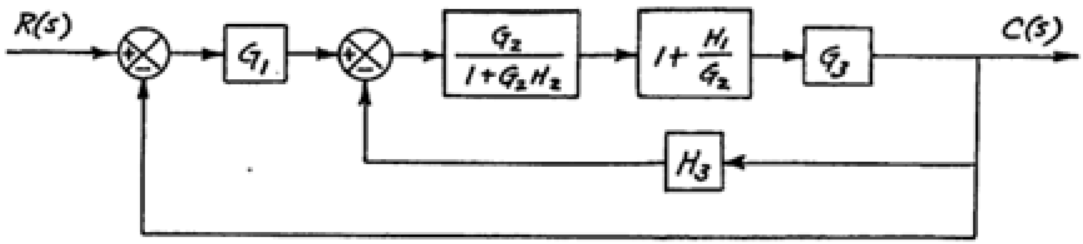
$$\left(\frac{1}{R_1}+C_1s\right)[V_i(s)-V_o(s)]=\frac{V_o(s)}{1/sC_2+R_2}$$

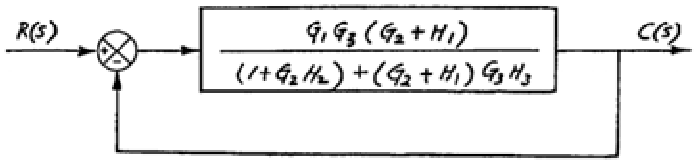
The transfer function of the network is therefore,

$$\therefore\frac{V_0(s)}{V_i(s)}=\frac{\left(s+\frac{1}{R_1C_1}\right)\left(s+\frac{1}{R_2C_2}\right)}{s^2+\left(\frac{1}{R_1C_1}+\frac{1}{R_2C_2}+\frac{1}{R_2C_1}\right)s+\frac{1}{R_1C_1R_2C_2}}$$

QUESTION 3







$$\frac{C(s)}{R(s)} = \frac{G_1G_2G_3 + G_1G_3H_1}{1+G_2H_2+G_2G_3H_3+G_3H_1H_3+G_1G_2G_3+G_1G_3H_1}$$

QUESTION 4

(a) X_1

(b) X_8

(c)

A B C D E   H C D E   N

(d)

A I	B J	C K
D L	E M	F
H J I	D E G	N M L K J I
N G K J I		