SHEKHAWATI INSTITUTE OF ENGINEERING AND TECHNOLOGY, SIKAR (RAJASTHAN)

I[ST] MID TERM EXAMINATION 2018

Subject code & Name: **6EC5A, Control System**

Model Answer Paper

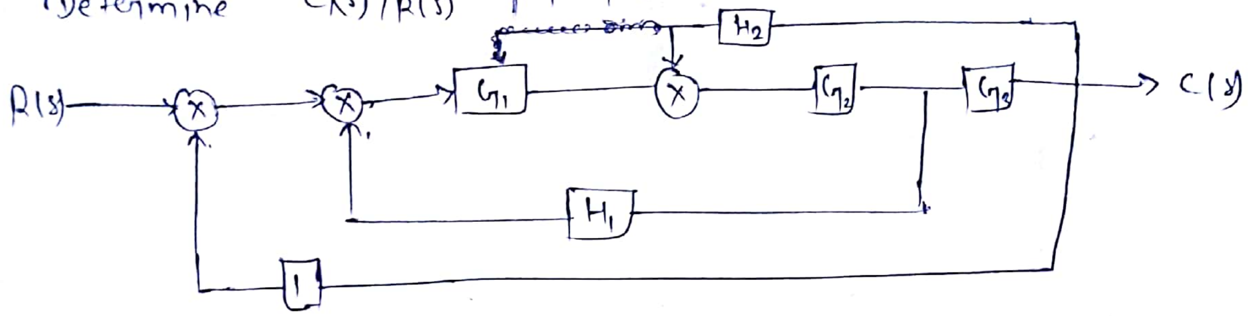
MM: 20

Time: 1.30 Hr

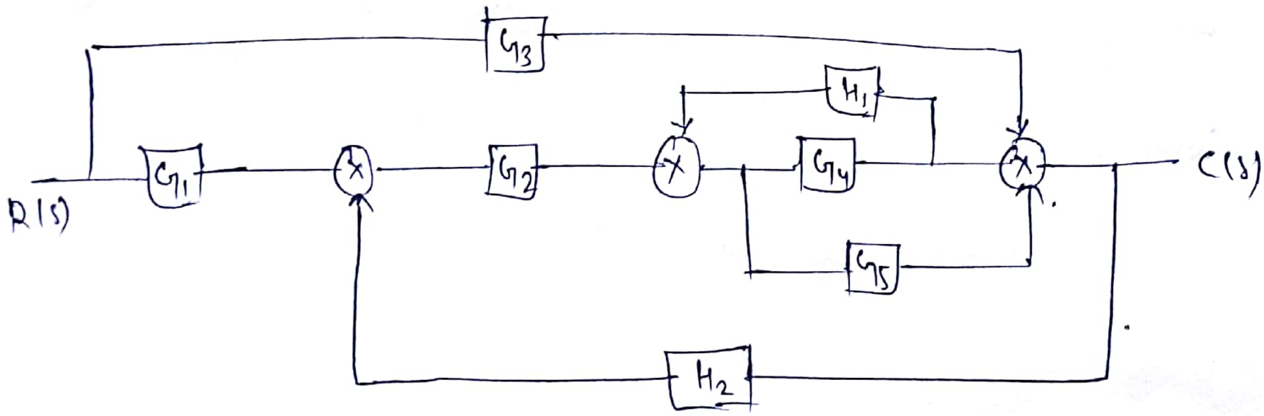
Instructions for Students

1. Use pencil for diagrams.
2. Answers should mark proper S No.
3. Attempt any **Four** questions. All question carry equal marks.

Q.1 Determine C(s)/R(s) for the system shown in fig:



Q.2. obtain the overall Transfer function for a system represented by Block diagram.



Q.3. Find the inverse Z-transform of

$$F(z) = \frac{4z^2 - 2z}{z^3 - 5z^2 + 8z - 4}$$

Q.4 Solve the differential equation

$$x(k+2) - 3x(k-1) + 2x(k) = 4$$

$$x(0) = 0 \qquad x(1) = 1$$

Q.5 The closed loop transfer function of a unity feedback control s/s given below:

$$\frac{C(s)}{R(s)} = \frac{ks+\beta}{s^2+\alpha s+\beta}$$

Determine the steady state error for unit ramp I/p

Q.6. Determine the stability of the s/s having following char. eqn.

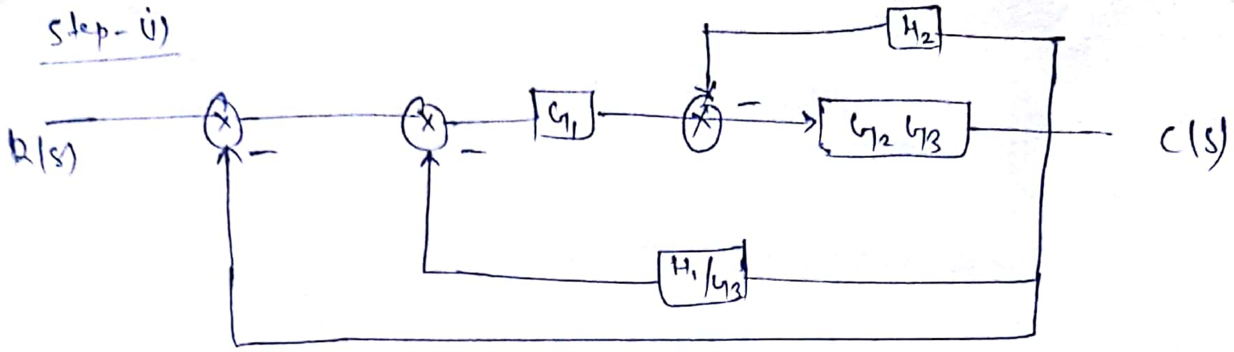
$$F(s) = s^6 + s^5 + 5s^4 + 3s^3 + 2s^2 + 4s - 8 = 0$$

Q.7. Findout position, velocity and acceleration error constant for the following unity feedback s/s

$$G(s) = \frac{50}{(1+0.1s)(1+2s)}$$

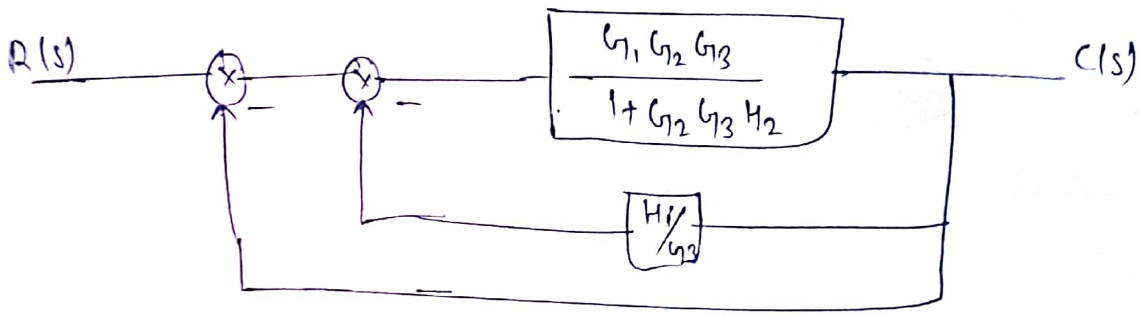
Ans. 1

Step-(i)

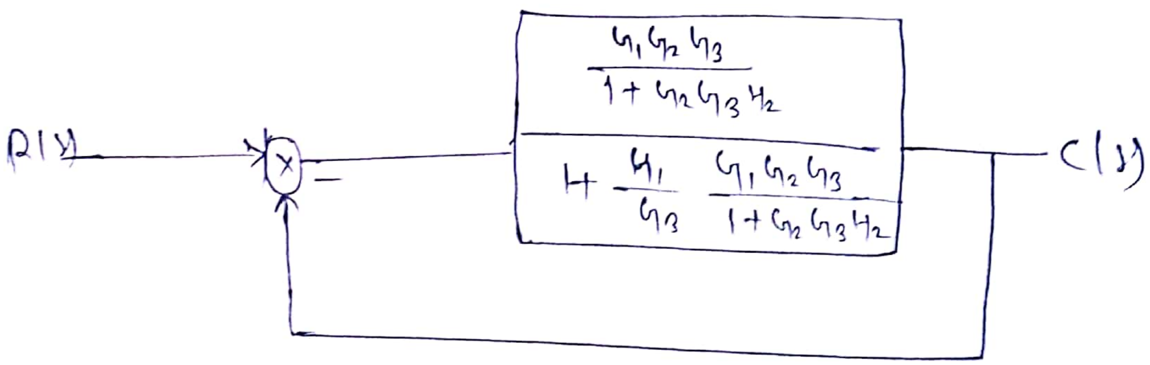


Step (ii)

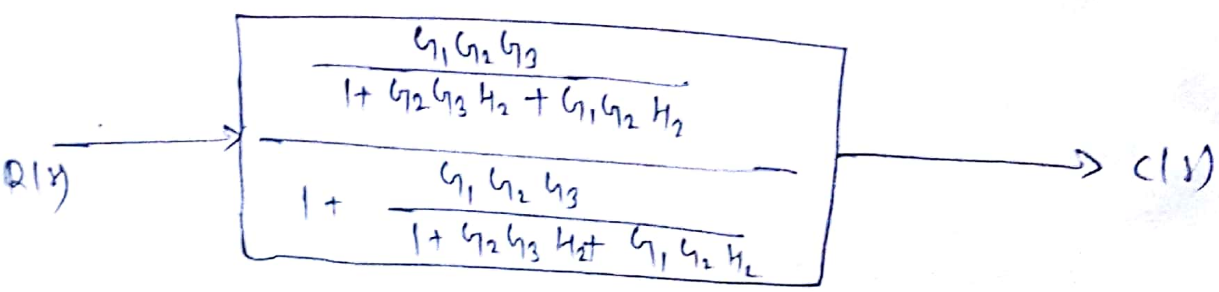
Eliminating the feedback loop H_2 and $G_2 G_3$



Step-(iii) Eliminating Feedback loop.



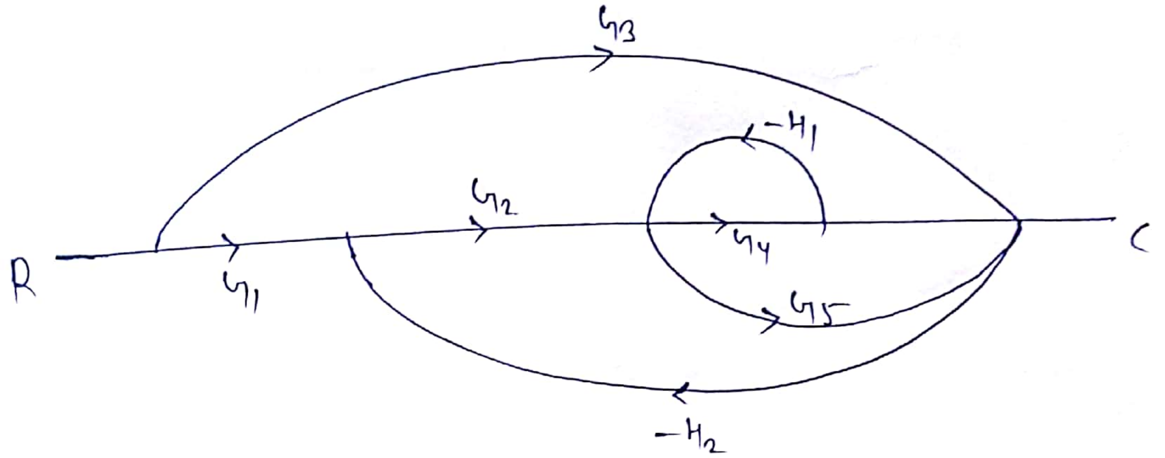
Step-(iv) After simplification and eliminating F/B



$$\frac{C(s)}{R(s)} = \frac{G_1 G_2 G_3}{1 + G_2 G_3 H_2 + G_1 G_2 H_1 + G_1 G_2 G_3}$$

Ans. 2.

Signal flow graph of the given block diagram



Path	Loop	
$P_1 = G_1 G_2 G_4$	$L_1 = -G_2 G_4 H_2$	$\Delta_1 = 1 - 0 \Rightarrow 1$
$P_2 = G_3$	$L_2 = -G_1 G_3 H_2$	$\Delta_2 = 1 - (-G_4 H_1)$
$P_3 = G_1 G_2 G_5$	$L_3 = -G_4 H_1$	$\Delta_3 = 1 - 0 \Rightarrow 1$
~~P_4~~ =		

$$\Delta = 1 - [L_1 + L_2 + L_3] + (L_2 L_3)$$

$$T = \frac{P_1 \Delta_1 + P_2 \Delta_2 + P_3 \Delta_3}{\Delta}$$

$$T = \frac{G_1 G_2 G_4 + G_3 (1 + G_4 H_1) + G_1 G_2 G_5}{1 + G_2 G_4 H_2 + G_1 G_3 H_2 + G_4 H_1 + G_1 G_3 G_4 H_1 H_2}$$

Ans. 3.

$$F(z) = \frac{4z^2 - 2z}{(z-1)(z-2)^2}$$

$$= \left.\frac{4z^2-2z}{(z-2)^2}\right|_{z=1} \frac{1}{(z-1)} + \left.\frac{4z^2-2z}{(z-1)}\right|_{z=2}$$

$$= \frac{1}{(z-2)^2} + \left.\frac{d}{dz}\left(\frac{4z^2-2z}{z-1}\right)\right|_{z=2} \frac{1}{(z-2)}$$

$$= \frac{2}{(z-1)} + \frac{12}{(z-2)^2} + \frac{2}{(z-2)}$$

on taking inverse z-transform

$$f(k) = 2(1)^{k-1} + 6(k-1)(2)^{k-1} + 2(2)^{k-1}.$$

Ans. 4.

$$\left[z^2 x(z) - x(1) - z^2 x(0)\right] - 3\left[z x(z) - z x(0)\right] + 2x(z) = \frac{z}{z-4}$$

$$x(z) = \frac{z^2 x(0) + z\left[x(1) - 3x(0)\right]}{z^2 - 3z + 2} + \frac{z}{(z-4)(z^2-3z+2)}$$

and

$$x(z) = \frac{z}{(z-1)(z-2)} + \frac{z}{(z-1)(z-2)(z-4)}$$

$$x(z) = -\frac{z}{(z-1)} + \frac{z}{(z-2)} + \frac{1}{3}\left(\frac{z}{z-1}\right) - \frac{1}{2}\frac{z}{z-2} + \frac{z}{6(z-4)}$$

Scanned by CamScanner

Ans. 5.

$$\frac{G(s)}{1+G(s)} = \frac{ks+\beta}{s^2+\alpha s+\beta}$$

$$(ks+\beta)(1+G(s)) = G(s)(s^2+\alpha s+\beta)$$

$$G(s) = \frac{ks+\beta}{s^2+s(\alpha-k)}$$

$$\frac{E(s)}{R(s)} = \frac{1}{1+G(s)} = \frac{1}{1+\frac{ks+\beta}{s^2+s(\alpha-k)}}$$

$$E(s) = R(s)\frac{s(s+\alpha+k)}{s^2+s\alpha-sk}$$

$$R(s) = \frac{1}{s^2}$$

$$C_{ss} = \lim_{s\to 0} sE(s) = \lim_{s\to 0} s\cdot\frac{1}{s^2}\cdot\frac{s(s+\alpha-k)}{s^2+s\alpha+\beta}$$

$$C_{ss} = \frac{\alpha-k}{\beta}$$

Ans. 6

s^6	1	5	2	-8
s^5	1	3	-4	0
s^4	2	6	-8	0
s^3	0 (8)	0 (12)	0	0
s^2	3	-8	0	0
s^1	$100/3$	0	0	0
s^0	-8	0	0	0

$$A(s) = 2s^4 + 6s^2 - 8$$

$$\frac{dA(s)}{ds} = 8s^3 + 12s$$

There is one sign change in first column so
The given s/s is astable or unstable.

Ans 7

position error constant (k_p)

$$k_p = \lim_{s\to 0} G(s) \Rightarrow \lim_{s\to 0} \frac{50}{(1+0.1s)(1+2s)} \Rightarrow \underline{\underline{50}}$$

velocity error constant (k_v)

$$k_v = \lim_{s\to 0} sG(s) = \lim_{s\to 0} \frac{s\ 50}{(1+0.1s)(1+2s)} \Rightarrow \underline{0}$$

Acceleration error constant (k_a)

$$k_a = \lim_{s\to 0} s^2G(s) = \lim_{s\to 0} \frac{s^2\ 50}{(1+0.1s)(1+2s)} \Rightarrow \underline{\underline{0}}$$