

**Questions should be —  
WRITTEN IN LEGIBLE HANDWRITING IN BLACK INK.  
SIGNS, SKETCHES OR FIGURES IF ANY BE DRAWN IN NEAT BLACK INK,  
so as to avoid mistakes in the printed question papers.**

Duration ..... 3 ..... Hours.

Total Marks assigned to the paper ..... 80

Q. No.

Solution

Marks

N.B. :

- Q1. a] five points of differentiation [1] mark each  
 b] Derivation [5]  
 c] Derivation [3], diagram [2]  
 d] five factors for selection of voltmeter, 1 mark for each factor.

Q2. a]

$s^6$	1	8	20	16
$s^5$	2	12	16	
$s^4$	2	12	16	
$s^3$	0(8)	0(24)	0	
$s^2$	6	16	0	
$s^1$	2.66	0		
$s^0$	16			

$$A(s) = 2s^4 + 12s^2 + 16s^0$$

$$\therefore 2y^2 + 2y + 16 = 0$$

$$y = -0.5 \pm 2.78i$$

$\therefore$  Marginally stable.

b]

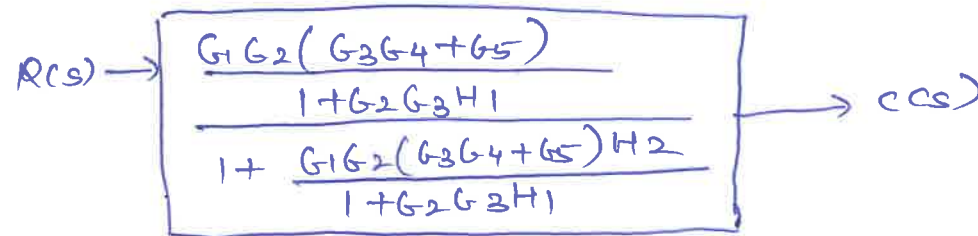
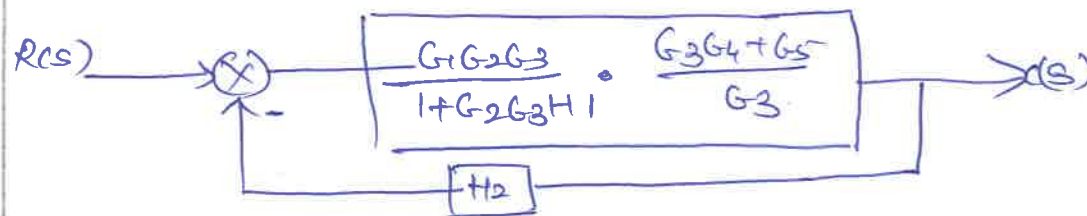
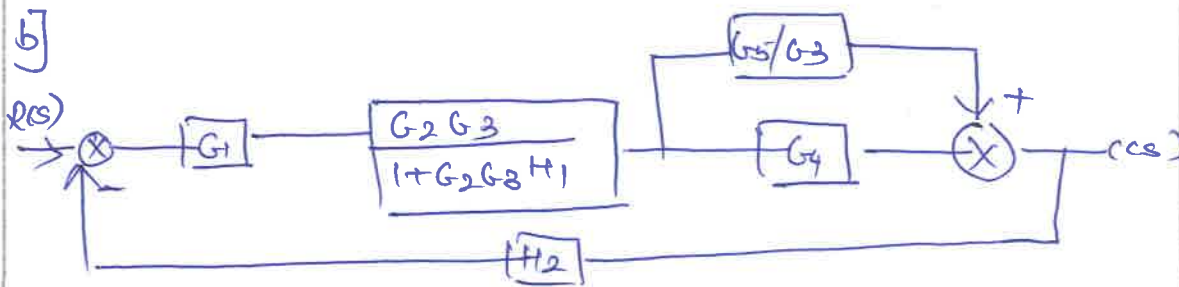
$s^5$	1	0	5
$s^4$	4	10	24
$s^3$	-2.5	-1.25	0
$s^2$	8	24	0
$s^1$	6.25	0	
$s^0$	24		

2 sign changes = 2 roots to  
RHS of 's' plane.

Q. No.

Marks

- Q3. a] function of delay line [4]  
Time base [3], Trigger circuit [3]



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

- Q4. a] Diagram [3] Explanation [7]

b]  $\omega_n^2 = 25$ ,  $2\zeta\omega_n = 6$ ,  $\omega_n = 5$   $\therefore \zeta = 0.6$

Q. No.

$$\theta = \tan^{-1} \left[ \frac{\sqrt{1-\xi^2}}{\xi} \right] = 0.9272 \text{ rad}$$

$$\omega_d = \omega_n \sqrt{1-\xi^2} = 4 \text{ rad/sec}$$

$$T_r = \frac{\pi - \theta}{\omega_d} = 0.5535 \text{ sec}$$

$$T_p = \frac{\pi}{\omega_d} = 0.785 \text{ sec}$$

$$\%m_p = e^{-\frac{\pi \xi}{\sqrt{1-\xi^2}}} \times 100 = 9.48\%$$

$$T_s = \frac{4}{\xi \omega_n} = 1.33 \text{ sec}$$

$$c(t) = 1.5625 e^{-3t} \sin(4t + 0.9272)$$

Q5. a] Lissajous pattern [5], frequency and phase measurement [5]

b]  $P_1 = 0$   $P_{2,3} = -4 \pm 4j$

$$\theta_1 = 60^\circ, \theta_2 = 180^\circ, \theta_3 = 300^\circ, \sigma = -2.667$$

No breakaway point

$$\phi_d = -45^\circ \text{ at } -4 + 4j$$

$$\phi_d = 45^\circ \text{ at } -4 - 4j$$

point of intersection:  $s = \pm \sqrt{32}j$

$$0 < K < 256$$

Entire root locus diagram [4]

[5]

Q. No.

Marks

Q6 a] Calculation [3], Bode plot diag [3], details [1]

$$\omega_{gc} = 4.4 \text{ r/sec}, \quad PM = 4^\circ \quad [3]$$

$$\omega_{pc} = 4.7 \text{ r/sec}, \quad GM = 1.5 \text{ dB}$$

b]  $T_1 = G_1 G_2 G_3$

$$L_1 = -H_3 G_1$$

$$T_2 = G_1 G_2 G_4$$

$$L_2 = -G_1 G_2 H_2$$

$$T_3 = G_1 G_2 G_5$$

$$L_3 = -G_1 G_2 G_3 H_1$$

$$L_4 = -G_1 G_2 G_4 H_1$$

$$L_5 = -G_1 G_2 G_5 H_1$$

[7]

$$\Delta_1 = 1, \quad \Delta_2 = 1, \quad \Delta_3 = 1$$

$$\Delta = 1 - [L_1 + L_2 + L_3 + L_4 + L_5]$$

$$T.F. [3]$$