

3 Hours

Total Marks - 80

- N.B.:-** (1) Question no **ONE** is compulsory.  
 (2) **Attempt** any **THREE** questions out of remaining questions.  
 (3) Assume suitable data if necessary and justify the same.  
 (4) Use graph paper and semilog paper wherever necessary.

Q 1. Answer any **FOUR** from the following questions.

- a. Functionally, how do closed-loop systems differ from open-loop systems? **5**  
 b. Find the transfer function,  $X(s) / F(s)$ , for the system of Figure 1. **5**

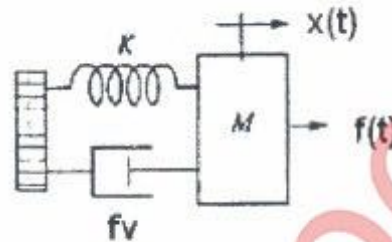


Figure 1 (Q.1 b)

- c. Briefly state and explain the Nyquist criterion. **5**  
 d. How to convert a system represented in state space to transfer function. **5**  
 e. How to determine steady state error characteristics from Bode plot? **5**

Q 2 a) Find the transfer function,  $G(s) = V_L(s)/V(s)$ , for the circuit given in Figure 2. **10**

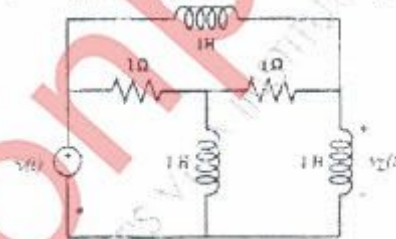


Figure 2 (Q.2 a)

Q 2 b) Reduce the block diagram shown in Figure 3 to a single block representing the transfer function  $T(s) = C(s)/R(s)$ . **10**

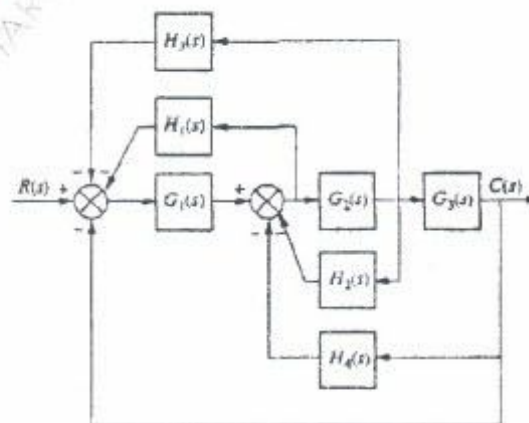


Figure 3 (Q.2 b)

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Q 3 a) Draw a signal-flow graph for the state space following state equation

10

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} r; y = [1 \ 2 \ 0]x$$

Q 3 b) Using Mason's rule, find the transfer function,  $T(s) = C(s)/R(s)$ , for the system represented by Figure 4.

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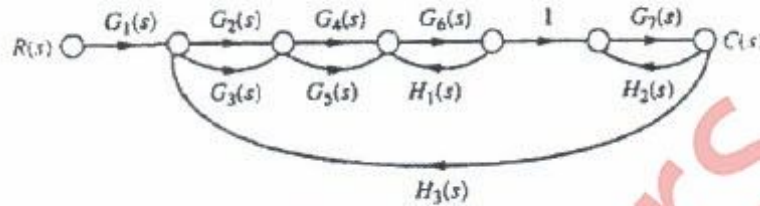


Figure 4 (Q.3 b)

Q 4 a) For the unity feedback system find the steady-state errors for the following test inputs:  $25u(t)$ ,  $31t u(t)$ ,  $47 t^2 u(t)$ .

10

$$G(s) = \frac{450(s+8)(s+12)(s+15)}{s(s+38)(s^2+2s+28)}$$

Q 4 b) Find the number of poles in the left half-plane, the right half-plane, and on the  $j\omega$  axis for the system of Figure 5. Comment on stability.

10

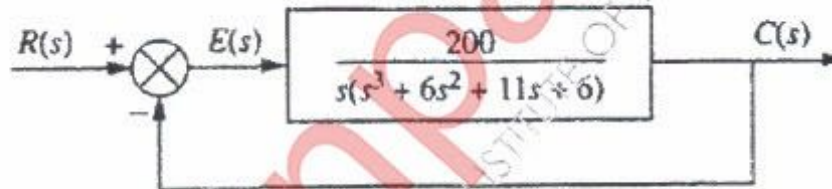


Figure 5 (Q.4 b)

Q 5 a) For each pair of second-order system specifications that follow, find the location of the second-order pair of poles.

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- $\%OS = 12\%$ ;  $T_s = 0.6$  second
- $\%OS = 10\%$ ;  $T_p = 5$  seconds

Q 5 b) Sketch the root locus for the unity feedback system for the transfer function given below

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$$G(s) = \frac{K(s+2)(s+6)}{s^2+8s+25}$$

Q 6 a) Sketch the Nyquist diagram of the unity feedback system of  $G(s) = \frac{(s+2)}{s^2}$

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Q 6 b) Determine gain margin, phase margin, gain crossover frequency and phase crossover frequency for following transfer function

10

$$G(s) = \frac{100(s+2)}{s(s+5)(s+10)}$$