

Time: 3 Hours

Marks: 80

Note:

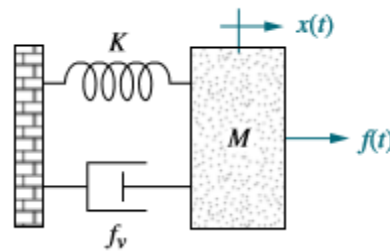
- Question No. 1 is compulsory.
- Answer any **three** from the remaining five questions.
- Assume suitable data if necessary and justify the same.

Q. 1 Answer any FOUR of the following 20

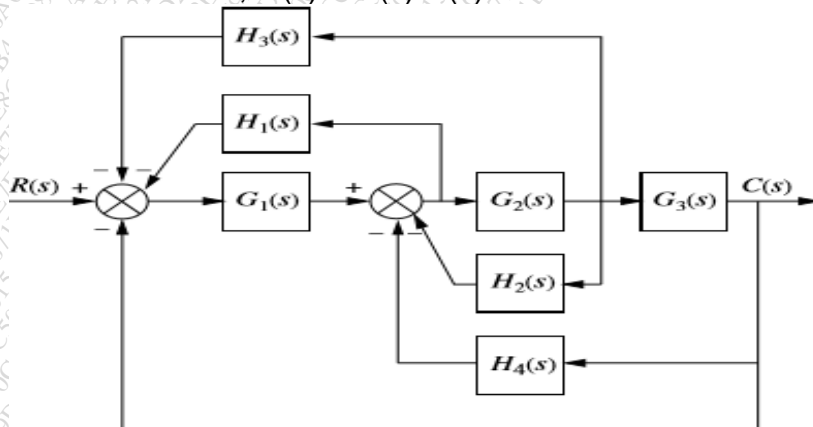
- What is the significance of gain margin and phase margin of a system?
- Define break-away point and break-in point in root locus plot of a system.
- Represent the given system in phase variable form of state space representation. Also draw SFG.

$$G(s) = \frac{s^2 + 35s + 120}{(s + 8)(s + 9)(s + 7)}$$

- Compare open loop and closed loop control systems with the help of suitable example.
- Obtain series electrical analog of the following system.



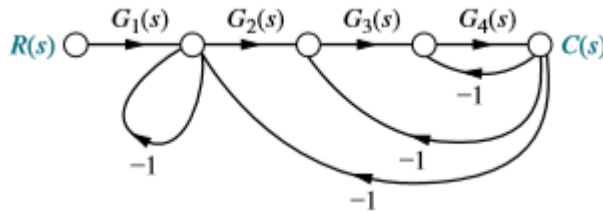
Q.2 a. Reduce the block diagram shown below to a single block representing the transfer function, $G(s) = C(s)/R(s)$ 10



- b. Draw Bode plot for the following unity feedback system, determine $\omega_{gc}, \omega_{pc}, PM, GM$ and comment on the stability of the system. 10

$$G(s) = \frac{(s + 3)}{(s + 2)(s^2 + 2s + 25)}$$

- Q.3 a. Using Mason's rule, find the transfer function, $G(s)=C(s)/R(s)$ for the system represented by 10



- b. Given the system represented in state space as follows: 10

$$\dot{x} = \begin{bmatrix} 1 & -1 & 1 \\ 2 & 1 & 3 \\ -2 & -1 & -3 \end{bmatrix} x + \begin{bmatrix} 7 \\ 1 \\ -2 \end{bmatrix} u$$

$$y = [1 \quad -3 \quad 4]x$$

Convert the system to one where the new state vector, z is

$$z = \begin{bmatrix} 4 & -1 & 0 \\ 2 & 3 & -2 \\ 8 & 5 & 1 \end{bmatrix} x$$

- Q.4 a. For the following unity feedback system, using Routh Hurwitz criteria determine the range of K to ensure stability. What should the value of K for the system response to oscillate, and determine the frequency of oscillation. 10

$$G(s) = \frac{K(s^2 + 1)}{(s + 1)(s + 2)}$$

- b. Obtain Laplace transform solution of the following system. Consider unit step signal as input to the system 10

$$\dot{x} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} x + \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix} u$$

$$y = [1 \quad 0 \quad 0]x$$

- Q.5 a. Derive and explain Nyquist stability criteria. 10

- b. For each pair of second order system specifications that follows, find the location of the second order pair of poles. 10

a. %OS = 15%; $T_s=0.6$ sec

b. %OS = 10%; $T_s=4$ sec

- Q.6 a. A unity feedback system has an open-loop transfer function 10

$$G(s) = \frac{K(s+1)}{s(s-1)}$$

Sketch the root locus and determine the range of K for the system to be stable.

- b. A unity feedback system has the following forward path transfer function: 10

$$G(s) = \frac{1000(s+8)}{(s+7)(s+9)}$$

- Evaluate system type, K_p , K_v and K_a .
- Use answer in (a) to find steady state errors for standard step, ramp and parabolic inputs
- Explain how many integrations in the forward path are required to get zero steady state error for standard step, ramp and parabolic inputs.