Department of Electrical Engineering, MNNIT Allahabad

B.Tech. Electrical Engineering: 4th Semester

Subject: Basic Control System (EE 1402)

End Semester Theory Examination (Even Semester, 2014-15)

Time: 03:00 Hr | Maximum Marks: 60

Note: Attempt all Questions. If any data is missing, assume as per requirement and mention the same.

1(a). Determine the transfer function $\frac{C_1}{R_1}, \frac{C_2}{R_2}, \frac{C_1}{R_2}$ and $\frac{C_2}{R_1}$ from the block diagram as shown in figure 1.

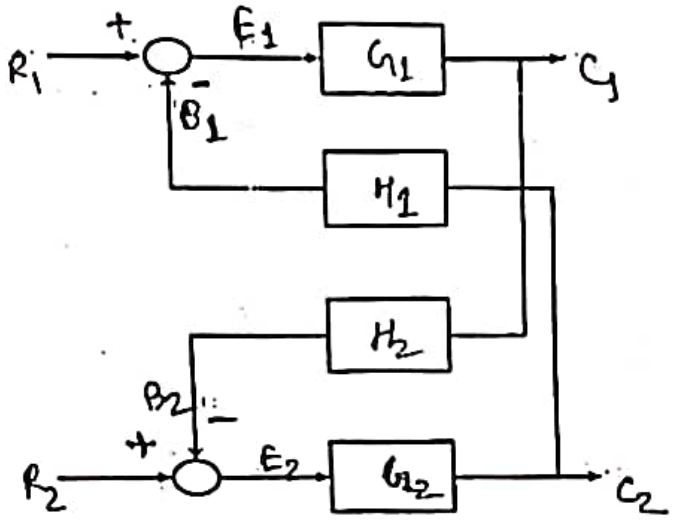

Figure 1 (5)

(b). A system is represented by following equations as below

$$x_2 = a_{12}x_1 + a_{22}x_2 + a_{42}x_4 + a_{52}x_5$$
$$x_3 = a_{23}x_2$$
$$x_4 = a_{34}x_3 + a_{44}x_4$$
$$x_5 = a_{35}x_3 + a_{45}x_4$$

Find the transfer function $\frac{x_5}{x_1}$ with the help of signal flow graph technique. (5)

2 (a). The open loop transfer function of unity feedback system is given by $G(s) = \frac{K}{s(1+sT)}$. Where K and T are forward path gain and time constant. By what factor should the gain K be reduced such that

(i) The peak overshoot of the system to unit step input is reduced to from 75% to 25% and

(ii) The damping ratio increases from 0.1 to 0.6. (6)

(b). Determine the range of values of K of $G(s) = \frac{K}{s(1+s)}$ for unity feedback system so that steady state error $e_{ss} < 0.004$ when $r(t) = 0.2t$ (4)

3(a). The characteristic equation of feedback control system is $s^4 + 20s^3 + 15s^2 + 2s + K = 0$

(i) Determine the range of K for the system to be stable.

(ii) Can the system marginally stable? If so, find the required value of K and frequency of sustain oscillation.

(iii) Also determine the range of K for the system has roots more negative than $s = -1$ to be stable. (5)

(b). Plot the root locus for $G(s)H(s) = \frac{K}{s(s^2 + 6s + 8)}$ then find the value of K

(i) For marginal Stability

(ii) At the breakaway point

(iii) For the damping ratio $\xi = 0.5$ (5)

4. Draw the bode plot on semi-log paper for unity feedback system whose open loop transfer function is given by

$$G(s) = \frac{500}{s(s+1)(s+50)}$$

From the bode plot, determine the following

(i) Gain crossover frequency and phase crossover frequency

(ii) Gain margin and phase margin

(iii) Comment on stability (10)

5. A unity feedback system has open loop transfer function $G(s) = \frac{1}{s(s+1)(2s+1)}$ sketch the Nyquist plot for the system and also calculate the Gain Margin and Phase Margin. (10)

6. Design a lag compensator for a system whose open loop transfer function $G(s) = \frac{K}{s(s+4)(s+5)}$ to meet the following specifications

(i) $\xi = 0.707$

(ii) $K_v \geq 5$

(iii) $\omega_n = 2$ rad/sec (10)