Registration No :

Total Number of Pages : 03

B.Tech

REL5C002

6th Semester Reg / Back Examination: 2024-25

Control System

AERO, CSE, CSEDS, CST, IT, MECH, MMEAM

Time : 3 Hour

Max Marks : 100

Q. Code : S117

Answer Question No.1 (Part-1) which is compulsory, any eight from Part-II and any two from Part-III.

The figures in the right hand margin indicate marks.

Part-I

Q1 Answer the following questions: **(2 x 10)**

a) Compare between open loop and closed loop systems.

b) Define gain margin and phase margin.

c) With suitable diagram differentiate between enclosement and encirclement.

d) Prove that 20 dB / decade is 6 dB / octave.

e) What are the standard test signals employed for time domain studies. Describe their mathematical expression.

f) Draw the pole zero plot for a lead and lag compensator.

g) Determine type and order of the unity feedback system having $G(s)=\dfrac{20}{s(s+2)(s+4)}$

h) Discuss the effect of addition of poles and zeros to a root locus plot.

i) Lists the advantages of generalized error coefficient method over static error constant for computing steady state error.

j) Obtain the characteristic polynomial for the system whose system matrix is given by $A=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}$.

Part-II

Q2 Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve) **(6 × 8)**

a) For a unity feedback system having open loop transfer function $G(s)=\dfrac{25}{s(s+5)}$.

Determine the rise time, settling time and maximum percent overshoot when the closed loop system is subjected to unit step input.

b) A linear time invariant system is characterized by the state equation

$$\dot{X}=\begin{bmatrix}1 & 0\\ 1 & 1\end{bmatrix}X+\begin{bmatrix}0\\ 1\end{bmatrix}u$$

Where u is a unit step function. Compute the solution of these state equations assuming initial condition $X_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$.

c) Obtain the diagonalizing matrix for a system described by

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix} u$$

d) Construct the Routh's array for the following characteristic equation and determine the range of ***k*** for which the system will be stable, unstable and marginally stable.

$$F(s) = s^4 + 25s^3 + 15s^2 + 20s + k$$

e) A unity feedback system is characterized by the open loop transfer function $G(s)H(s) = \dfrac{10}{s(0.5s+1)(0.2s+1)}$. Determine the steady state error for unit step, unit ramp and unit parabolic input.

f) Derive the expression for the time response of a standard second order under damped system to a unit step input. Draw its generalized time response plot and mark the important time domain specifications on it.

g) Test the controllability and observability of the following state space model.

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ -1 & -3 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U \text{ and } Y = [1 \quad 1] X.$$

h) Construct the polar plot of the following system having transfer function

$$G(s)H(s) = \frac{500}{s(s+6)(s+9)}$$

i) What are constant M circles. Show that, the points representing a constant value of the closed loop gain (M) lie on a circle in the G-plane.

j) Draw the bode plot for the following unity feedback system having open loop transfer function, $G(s) = \dfrac{K}{s(0.02s+1)(0.04s+1)}$

k) Determine the stability of the following open loop system using Nyquist stability criterion. $G(s)H(s) = \dfrac{K(s+2)}{(s+1)(s-1)}$

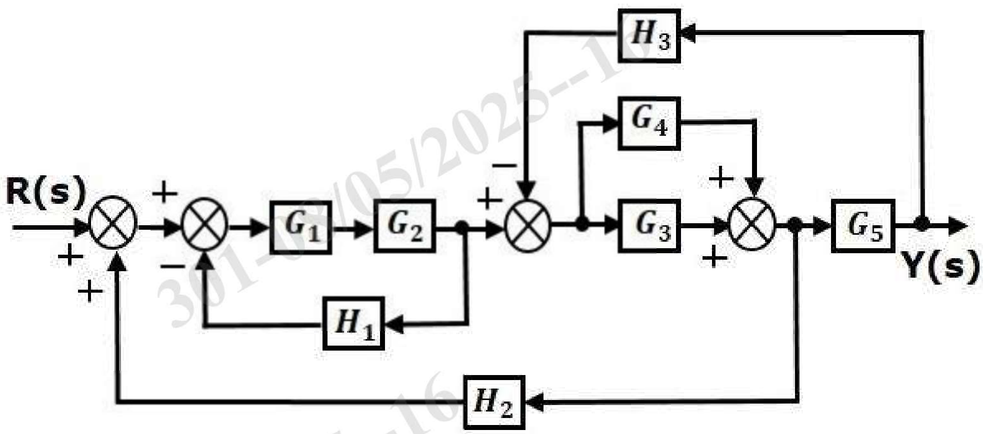
l) Sketch the root locus plot for the following feedback system.

$$G(s)H(s) = \frac{1}{s(s+2)(s^2+2s+10)}$$

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 Determine the overall transfer function of the following block diagram using block diagram reduction techniques. **(16)**



Further, draw the equivalent signal flow graph (SFG) of the above block diagram and obtain the overall transfer function of the SFG using Mason's gain formula.

Q4 What is a lead compensator. Discuss briefly about its generalized transfer function model and design approach. Design a lead compensator for the system with an open-loop transfer function $G(s)=\dfrac{K}{s^2(1+0.1s)}$ for the specifications of acceleration error constant, K_a=10 and phase margin, ϕ_m =30° **(16)**

Q5 Describe the condition for arbitrary pole placement. Also discuss briefly about any one pole placement technique using state feedback. Now using the technique you have discussed, design a state feedback controller to place the eigen values of the following closed loop system at $-2, -1 \pm j1$. $G(s)H(s)=\dfrac{10}{s^3+3s^2+2s}$ **(16)**

Q6 Write short notes on the following: **(16)**

a) Benefits of negative feedback
b) Generalized error coefficients
c) Nichols Chart
d) PID controller Tunning