Faculty of Engineering & Technology
Seventh Semester B.E. (Electrical Engg.) (C.B.S.)
Examination
CONTROL SYSTEM—II

Time—Three Hours] [Maximum Marks—80

INSTRUCTIONS TO CANDIDATES

(1) All questions carry marks as indicated.

(2) Solve Question No. **1 OR** Question No. **2**.

(3) Solve Question No. **3 OR** Question No. **4**.

(4) Solve Question No. **5 OR** Question No. **6**.

(5) Solve Question No. **7 OR** Question No. **8**.

(6) Solve Question No. **9 OR** Question No. **10**.

(7) Solve Question No. **11 OR** Question No. **12**.

(8) Assume suitable data wherever necessary.

1. (a) Derive the transfer functions of a passive R-C lead network. Draw its bode plot. Determine the frequency at which maximum phase lag is obtained. 7

(b) Explain the procedure for the construction of phase trajectories using :

(i) Delta method

(ii) Isocline method. 7

11\. (a) What is sample data control system ? State its advantages and disadvantages. Explain operation of samplers and hold devices. 7

(b) A discrete time system is described by the following equation :

$$y(k + 2) + 3y(k + 1) + 2y(k) = u(k)$$

u(k) is unit step input

$y(k) = 0$ for $k < 0$

$y(0) = 1$

Solve LDE and obtain y(k). 7

OR

12\. (a) Check for the stability of the following characteristic equation :

(i) $f(z) = 2z^5 + 11z^4 + 24z^3 + 24z^2 + 9z + 2 = 0$

(ii) $f(z) = z^4 - 1.7z^3 + 1.04z^2 - 0.268z + 0.024 = 0$

7

Transform this state model into canonical form and then obtain solution for state vector and output. Assume unit step input and initial condition $x(0) = [1\ 0\ 0]^T$. 13

OR

4\. (a) Construct the canonical state model to represent the following transfer function :

$$\frac{C(s)}{R(s)} = \frac{s^2 + 4s + 4}{s^3 + 5s^2 + 4s}.$$ 7

(b) A system represented by the state equation $\dot{x}(t) = A\,x(t)$. The response $x(t) = \begin{bmatrix} 2e^{-2t} \\ e^{-t} \end{bmatrix}$ when $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$ and $x(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$ when $x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$.

Determine system matrix A and state transition matrix. 6

5\. (a) Define controllability and observability. Explain Kalman and Gilbert test for controllability and observability. 7

(b) Find the conditions for b_1, b_2, c_1 and c_2 such that the system is controllable as well as observable. 7

OR

6. (a) Design a state feedback vector to meet the following specifications $\xi = 0.5$ and $\omega_n = 2$. The system is described by

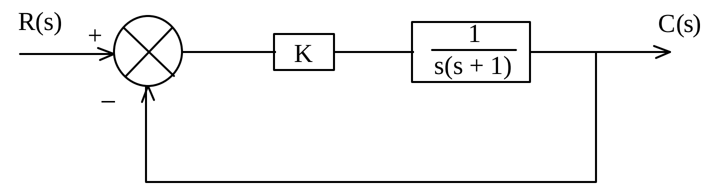
$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & -1 & 1 \\ 0 & -1 & 10 \end{bmatrix} x + \begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix} U.$$ 10

(b) Explain the effect of state feedback on controllability and observability. 4

7. (a) State and prove Parseval's Theorem. 7

(b) For the standard second order underdamped system prove that $ISE = \frac{1}{\omega_n}\left[\xi + \frac{1}{4\xi}\right]$ for fixed value of ω_n and unit step input. Also prove that minimum value of ISE is $1/\omega_n$. 6

OR

8. 

For the system shown in block diagram, determine k and Lagrange multiplier λ such that ISE to unit step input is minimised subject to constraint

$$\frac{1}{2\pi j}\int_{-j\infty}^{j\infty} \frac{C(s)}{R(s)} \frac{C(-s)}{R(-s)} ds \le 2.$$ 13

9. (a) Give comparison between linear and non linear control system. 3

(b) For the non linearity shown, derive describing function and hence obtain describing function for :

(i) Saturation non linearity

(ii) Dead zone non linearity. 10

OR

10. (a) Discuss the following :

(i) Stable system

(ii) Asymptotically stable system

(iii) Globally asymptotically stable system. 6

(b) What is the necessity of compensator in control system ? Explain how the type of compensator is decided for a particular system. 6

OR

2. (a) Transfer function of Lag Network is given by $T.F = \dfrac{(1 + 0.6s)}{(1 + 0.75s)}$. Find the locating of role and zero of compensation, time constant, maximum phase lag and frequency. 7

(b) (i) Lag compensator is used to improve steady state performance of the system. Justify. 6

(ii) Signal to noise ratio is improved by Lag compensator. Justify.

3. A linear time invariant system is described by the following state model

$$X^{\circ} = \begin{bmatrix} -4 & 1 & 0 \\ 0 & -3 & 1 \\ 0 & 0 & -2 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix} U$$

$$Y = [1\ 0\ 0]X$$

(b) Show that the SDCS shown in figure below will be stable for all values of $-1 \le K \le 2.164$ when $aT = 1$, while continuous time system will be always stable for $K > 0$. 7