Q. P. Code: 35998

Duration: 3 Hours **Max. Marks 80**

N.B.

1. **Q.1** is compulsory. Attempt **any three** from the remaining questions.
2. All questions carry equal marks.
3. Figures to the Right indicate full marks.
3. Assume suitable data if necessary

Q.1 Attempt **any four** **20**

a. Obtain the state space representation for following system in diagonal form

$$G(s) = \frac{4}{s^2 + 2s - 3}$$

b. Prove that–'eigen values of the system matrix are invariant under linear transformation'.

c. What is lead compensator? Why it is required?

d. Compute the modal matrix for diagonalization of

$$A = \begin{bmatrix} 1 & 3 \\ 0 & -1 \end{bmatrix}$$

e. Define controllability and observability of the system.

f. For the open loop system

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

Calculate required phase angle contribution by the compensator if desired closed loop poles are $s_d = -0.7 \pm 0.4j$. Which compensator will you suggest?

Q.2 A. Check for the stabilizability and detectability of the system, **10**

$$\begin{aligned} \dot{x} &= \begin{bmatrix} 5 & 1 & 0 \\ 0 & 5 & 0 \\ 0 & 0 & -1 \end{bmatrix} x + \begin{bmatrix} 0 \\ 3 \\ 0 \end{bmatrix} u \\ y &= [1.5 \;\; 0 \;\; 1]\, x \end{aligned}$$

B. Represent the following system into Jordan canonical form **10**

$$G(s) = \frac{0.5s^2 + 2s - 2.5}{s^3 - s^2 - 5s - 3}$$

Q.3 A. Design the series lead compensator using bode plot for the system in Figure 1 to achieve velocity error constant $K_v = 20sec^{-1}$, phase margin $PM \geq 50^0$ and gain margin $GM \geq 10dB$. **10**

B. Draw typical circuit diagram and corresponding transfer function for lag compensator. Write the steps to design lag compensator using root-locus. **10**

Q.4 A. Design the state feedback control for the system **10**

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

to place the poles at $-1, -2.5$.

B. Compute state transition matrix for the system, **10**

$$\dot{x} = \begin{bmatrix} -2 & 0 \\ 0 & 3 \end{bmatrix} x$$

Q.5 A. Obtain the transfer function matrix for the system **10**

$$\begin{aligned} \dot{x} &= \begin{bmatrix} 0 & 1 \\ -1 & -1.6 \end{bmatrix} x + \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix} u \\ y &= \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} x \end{aligned}$$

B. A system is given by **10**

$$\begin{aligned} \dot{x} &= \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \\ y &= [1 \ 0] x \end{aligned}$$

Design the observer that has poles at $-25, -30$.

Q.6 Write short notes on **20**

A. Cohen-coon method for PID controller tuning.

B. Lag-lead compensator.

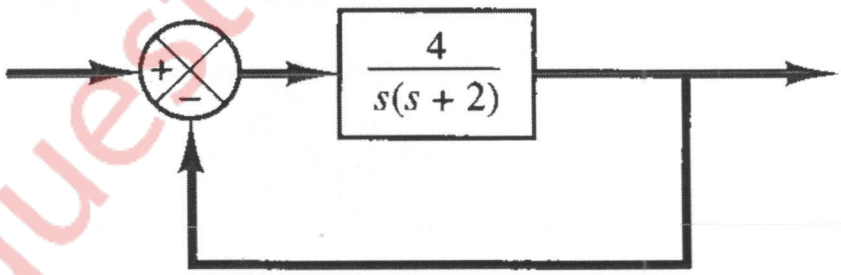

Figure 1: