B.E. / B.Tech. Instrumentation Engineering (Model Curriculum) Semester-V

IN505M / Control1 - Control System Design

P. Pages : 2 **GUG/S/25/14025**

Time : Three Hours * 2 3 6 5 * Max. Marks : 80

Notes : 1. All questions carry marks as indicated.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and Chemical equation should be given wherever necessary.

1. The open loop transfer function is $G(S)=\frac{K}{S(S+2)(S+8)}$ Design a lag compensator such that, Overshoot is 16.4% & ess < 0.16 rad for unit ramp. Input & undamped natural frequency is 16 rad/sec. **16**

OR

2. a) What is compensator in control systems? Explain its purpose. **8**

b) Explain the design procedure for lag compensator to reduce steady state error. **8**

3. a) Draw a Bode plot of the system with open loop transfer function **8**

$$G(S)=\frac{10}{s(1+0.4s)(1+0.1s)}$$

Determine Gain margin, Phase Margin, & comment on stability.

b) Obtain a transfer function of Mechanical type of Lead compensator. **8**

OR

4. a) Draw a Bode plot of the system with open loop transfer function **8**

$$G(S)=\frac{100}{(S+1)(S+2)(S+5)}$$

Determine Gain margin, Phase Margin, $w_{pc,}$ $w_{gc,}$ & comment on stability.

b) Explain the steps required for design of lead compensator. **8**

5. a) Investigate controllability and observability for the system show below, **6**

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

$$y=\begin{bmatrix}1 & 0 & 0\end{bmatrix}x.$$

b) Explain the controllability and drive the condition of controllability. **10**

OR

6. a) Consider a system described by **8**

$\dot{X} = Ax + Bu; \quad y = Cx$

where,

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}, \; B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

Using state feedback control u = -Kx it is desired to have closed-loop poles at s = -2+j4, s = -2 -j4, s = -10. Determine the state feedback matrix K.

b) Consider the system **8**

$$\dot{X} = \begin{bmatrix} 0 & 0 & -2 \\ 0 & 1 & 0 \\ 1 & 0 & 3 \end{bmatrix} x, \; x(0) = \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix}.$$

Evaluate state transition matrix and deduce the time response of a system.

7. a) Enlist the different performance indices? Give the significance of each performance index with suitable example. **8**

b) The open loop transfer function of unity feedback system is given by, **8**

$$G(S)H(S) = \frac{100}{S(S+5)}$$

sketch the polar plot.

OR

8. a) Explain the concept of State space. Also define the terms state, state variables, state vector & state space. **8**

b) Explain Properties of State transmission matrix (STM) with proof. **8**

9. a) Explain phenomena exhibited due to presence of Non-linear elements in a control system. **8**

b) Draw isoclines and mark trajectory slope on same, given that $\frac{dx^2}{dt^2} + 3\frac{dx}{dt} + 4x = 0$ **8**

OR

10. Obrain the describing function for – **16**

i) Ideal relay

ii) Relay with dead zone.

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