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

IN505M - Control System Design

P. Pages : 2 **GUG/W/24/14025**

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

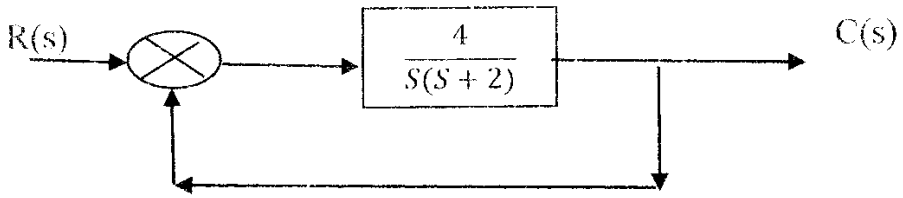
Notes : 1. All questions carry as indicated marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and Chemical equation should be given wherever necessary.

1. a) Explain the effect of adding poles and zeros on the stability and transient response of a control system. **8**

b) Obtain the transfer function of Op-Amp based electronic lag compensator. **8**

OR

2. Consider the system shown below. **16**



Design a lead compensator to satisfy following specifications.

1) Damping factor, $\varepsilon = 0.5$
2) Undamped natural frequency, $W_n = 4$ rad sec
3) Velocity error constant, $k_v = 5\sec^{-1}$.

3. a) Design a lead compensator for a unity feedback system with open loop transfer function **16**

$$G(S) = \frac{K}{S(S+1)\,(S+5)}$$

To satisfy the following specification

i) Velocity error constant $k_v \geq 50$
ii) Phase margin = 40°

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) What is the difference between lead and lag compensator? **8**

5. a) Find the sate transition matrix for system **6**

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

Then find state of system after 500 m sec when $x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$.

b) The plant is given by $x^o = Ax + Bu$ where, **10**

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

The system uses state feedback control $u = -kx$. Consider the desired closed loop poles at $s = -2 + j4, s = -2 - j4, s = -10$. Determine the state feedback gain matrix 'k' by direct substitution method?

OR

6. a) Consider a system gives as $G(S) = \dfrac{s+3}{s^2+3s+2}$ **8**

Obtain state space representation in first companion, second companion and Jordan canonical form?

b) Obtain the state space representation of Armature controlled D.C. motor. **8**

7. a) Write a short note on performance index (PI). Also list its different types. **8**

b) The open loop transfer function of unity feedback system is given by, $G(S)H(S) = \dfrac{20}{S+4}$ **8**

sketch the polar plot.

OR

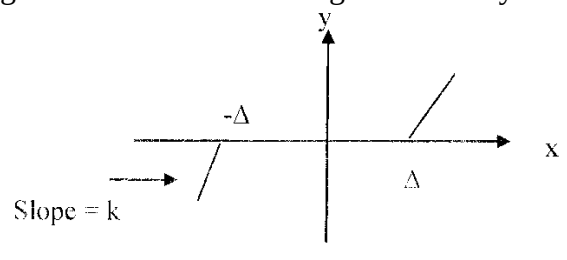
8. Define damping ratio and natural frequency for a second-order system. Evaluate the effect of damping ratio on the Integral of Squared Error (ISE) in a control system. Prove that the minimum value of ISE is inversely proportional to the natural frequency (on) for a unit step input. **16**

9. a) Explain classification of physical non-linearities and give some non-linearities encountered in control systems. **8**

b) Discuss application of isocline method for phase trajectory construction. **8**

OR

10. a) Evaluate the Describing function of the following Nonlinearity. **16**



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