Time: 3 Hours  
Marks: 80

1. Attempt Any Four Questions
2. Question No. 1 is Compulsory
3. Marks to the right indicate full marks
4. Assume suitable data wherever necessary.

Q1. Solve Any Four

a) Draw block diagram and obtain transfer function of a simple closed loop system, with a forward path gain as G(s) and feedback path gain as H(s).

b) In complex “s” plane show pole locations for under damped, critically damped and over damped control systems.

c) What are the effects of feedback on a system?

d) Explain Importance of mathematical modeling.

e) What is state transition matrix? State the properties of state transition matrix.

2a) Determine the transfer function C/R of a control system shown by following block diagram

![Block Diagram]

2b) Draw a Signal flow graph of the system in 2 a) and Obtain overall transfer function using Mason’s Gain Formula

3a) Define Controllability and Observability. Check the Controllability and Observability of the following State Space Model.

\[ \dot{x} = \begin{bmatrix} 2 & 1 \\ 1 & -2 \end{bmatrix} x + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u; \]

\[ y = \begin{bmatrix} 0 & 1 \end{bmatrix} x \]
3b) For the given state variable model, obtain transfer function.

\[
\dot{x} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u;
\]

\[
y = \begin{bmatrix} 1 \\ 0 \end{bmatrix} x
\]

4a) Sketch Bode plot for a system whose open loop transfer function is

\[
G(s) = \frac{0.354 (s + 1)(1 + 0.05 s)}{s(1 + 0.025 s)}.
\]

4b) Sketch root locus for a unity feedback system, whose open loop transfer function is given as

\[
G(s) = \frac{K}{s(s + 2)(s + 4)}.
\]

5a) The open loop transfer function of a unity feedback system is given as

\[
G(s) = \frac{K}{s(s^2 + 4s + 13)}.
\]

Find the range of \( K \) for stability using Routh’s stability criterion.

5b) Write the expression for a unit step response for a general second order system. Hence derive the expression for time to peak overshoot.

6a) A unity feedback system has open loop transfer function as

\[
G(s) = \frac{40 (s + 2)}{s(s + 1)(s + 4)},
\]

Determine i) Type of a system, ii) Static error coefficients and iii) steady state error for ramp input with magnitude of 4.

6b) Write short note on any one of the following:

(i) Advances in Control Systems.
(ii) PID Controller

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