Q1. Attempt any four.

a) Explain open loop & closed loop control systems by giving suitable examples & also highlight their merits & demerits.

b) What are the properties of state transition matrix?

c) What is a compensator? Why is it required?

d) Explain Mason Gains' Formula with its need.

e) Explain the effect of addition of pole and zero to a system.

Q2. A) Find the transfer function $C(s)/R(s)$ of the following system using block diagram technique.

\[ G(s) = \frac{k(s+1)(s+2)}{(s+0.1)(s-1)} \]

Plot the Root Locus and find the gain at which system is critically damped.

Q3. A) Write a note on advances in control system.

Q3. B) Obtain the state variable model of the transfer function –

\[ \frac{Y(s)}{R(s)} = \frac{s + 3}{s^3 + 5s^2 + 8s + 4} \]
Q4. A) Check controllability and observability for the system described by
\[
\begin{align*}
    \dot{x} &= \begin{bmatrix} 0 & 6 & -5 & 0 \\ 1 & 0 & 2 & x+1 \\ 3 & 2 & 4 & 2 \end{bmatrix} u \\
    y &= \begin{bmatrix} 1 & 2 & 3 \end{bmatrix} x
\end{align*}
\]

Q4. B) Determine the stability of the system having characteristic equation
\[
S^5+s^4+2s^3+3s^2+5 = 0
\]

Q5. A) Construct the Bode Plot for the following transfer function. Comment on stability.
\[
G(s) = \frac{K}{(s+3)(s+5)(s^2+2s+2)}
\]

Q5. B) List the performance specifications of Time Response Analysis and derive any four of them.

Q6. Write in short
A) Explain with example Adaptive Control System.
B) Compare PI, PD, PID Controller.
C) Explain the stability of \(s^5+2s^4+2s^3+4s^2+4s+8 = 0\) using Routh Method.
D) Draw polar plot for the transfer function given by
\[
G(s) = \frac{1}{(1+s)(1+4s)}
\]

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