(3 hours)   **[Marks:80]**

NOTE: 1) Question No. 1 is compulsory.
           2) Out of remaining questions, attempt any 3 questions.
           3) In all 4 questions to be attempted.
           4) All questions carry equal marks.
           5) Figures in brackets on the right hand side indicate full marks.
           6) Assume Suitable data if necessary

Q1 Answer any 5
   i)   How do you compare open loop and closed loop system?   4
   ii)   What are position, velocity and acceleration error coefficients?   4
   iii)   What is importance of state space representation?   4
   iv)   Write expression for rise time, peak time, maximum peak overshoot and settling
           time of second order under damped system.   4
   v)   How to find breakaway point in root locus   4
   vi)   How do you define stable system?   4
   vii)   What are properties of state transition matrix?   4

Q2a) Check whether the following systems are stable using Routh's stability criterion   10

   i) $3s^4+10s^3+5s^2+2$

   ii) $s^4+4s^3+6s^2+4s-5$

2b) Find root locus for the transfer function $G(s) = \dfrac{2}{s(s+2)(s+5)}$ 10

3a) Find the state equation and output equation for the transfer function   10
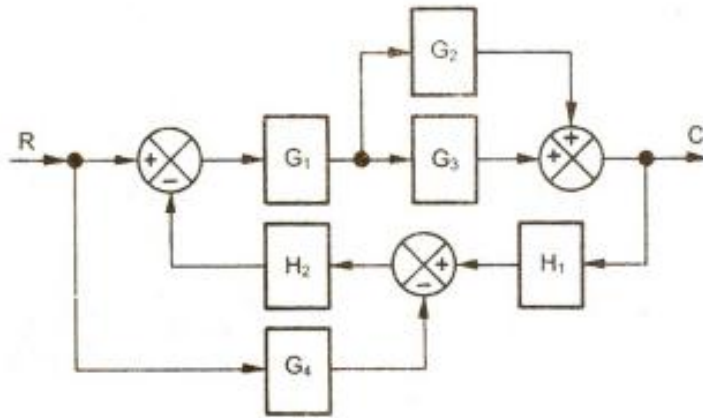
$$G(s) = \frac{2s+1}{s^2+7s+9}$$

3b) Check the controllability and observability of the following system   10

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

$$y = [0 \quad 0 \quad 1] * \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

4a) Reduce the following Block diagram using Block reduction technique   10

4b) Draw Bode plot for the function $G(s) = \dfrac{40(s+2)}{s(s+10)(s+400)}$ and find gain margin and

phase margin

                                                                                                                                    10

5a) Explain signal flow graph representation and its reduction technique using Masons gain
formula

                                                                                                                                    10

5b) Draw polar plots for   10

$i) \dfrac{1}{s+10}$

$ii) \dfrac{1}{s^2}$

$iii) \dfrac{100}{s^3}$

$iv) \dfrac{10}{s}$

6. Write short notes on any 4   20
   i.   Nyquist plots
   ii.   Lead and lag compensator
   iii.   Correlation between time and frequency response
   iv.   Gain and phase margin
   v.   Type and order of system