Register No.: ……………………………… Name: ……………………………………………………………

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIFTH SEMESTER B.TECH. DEGREE EXAMINATION (R,S), DECEMBER 2023
ELECTRONICS AND COMMUNICATION ENGINEERING
(2020 SCHEME)

Course Code : **20ECT307**

Course Name: **Control Systems**

Max. Marks : **100** **Duration: 3 Hours**

PART A

(Answer all questions. Each question carries 3 marks)

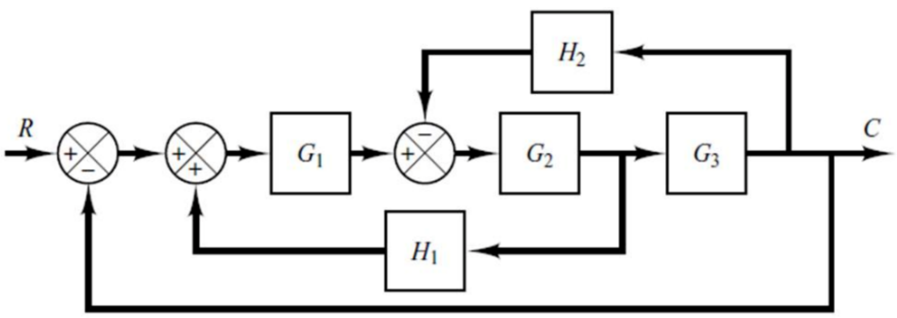
1. With the help of a diagram, define closed loop control system.
2. Draw the signal flow graph for the following set of algebraic equations: x1=ax0+bx1+cx2, x2=dx1+ex3.
3. Derive an expression for rise time of a second order system.
4. For a unity feedback control system, open loop transfer function is $G(s)= \frac{50}{(1+0.1s)(s+10)}$.
   Determine the position, velocity and acceleration error constants.
5. Comment on the significance of location of poles on s-plane for stability with necessary figures.
6. Explain Routh-Hurwitz stability criterion.
7. Define a) Gain cross over frequency b) Phase cross over frequency c) Phase margin.
8. State and explain Nyquist stability criterion.
9. Enumerate the properties of state transition matrix. Write the solution of homogeneous state equation.
10. What are the important features of state space analysis?

PART B

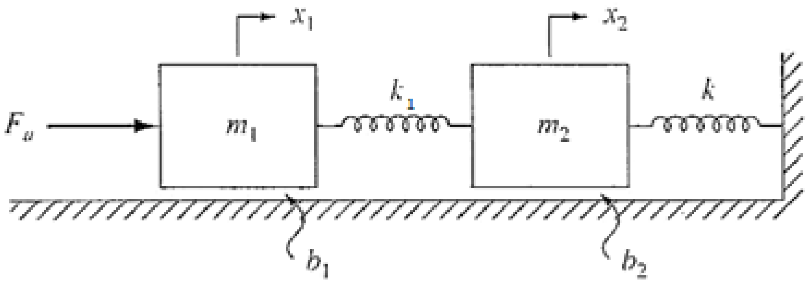
(Answer one full question from each module, each question carries 14 marks)

MODULE I

11. a) Using block diagram reduction method, find the transfer function of the given system. (7)

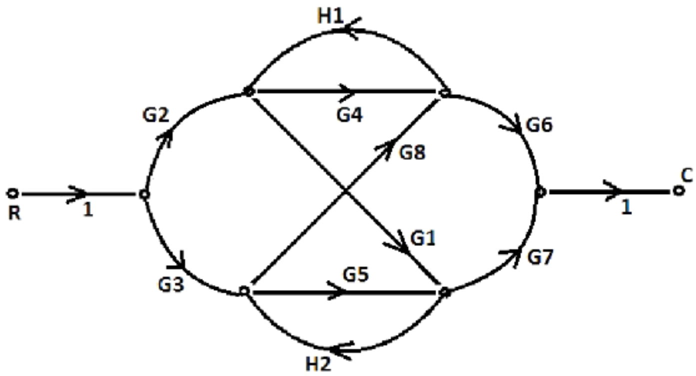


b) Develop the differential equations governing the mechanical system shown below by drawing the free body diagrams. Determine the overall transfer function. (7)



OR

12. a) Using Mason's gain formula, obtain the overall transfer function for the given. (10)



b) Give two examples each for open loop and closed loop systems. (4)

MODULE II

13. a) A unity feedback control system is characterized by an open loop transfer function $G(s) = \frac{K}{s(s+4)}$. Determine the gain K so that the system will have a damping ratio of 0.5 for this value of K. Determine the settling time, peak overshoot, rise time and peak time for a unit step input. (10)

b) Define static error constants. (4)

OR

14. a) Derive an expression for time response of a second order under damped system to step input. (8)

b) Derive an expression for peak time of a second order system. (6)

MODULE III

15. a) With the help of Routh's stability criterion find the stability of the following system represented by the characteristic equation: (8)

$$s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$$

b) Explain the effects of P, PI and PID controllers on the system dynamics. (6)

OR

16. a) Sketch the root locus of the system whose open loop transfer function is (10)

$$G(s)\ H(s) = \frac{K}{s(s+2)(s+4)}$$

b) Define BIBO stability. How the roots of characteristic equation are related to stability? (4)

MODULE IV

17. a) The open loop transfer function of a unity feedback system is $G(s) = \frac{10\ (s+2)}{s(s+5)}$. (8)

Draw the Bode plot and measure the frequency at which the magnitude is 0 db.

b) What is frequency response? Explain the significance of gain margin and phase margin. (6)

OR

18. a) Draw the Nyquist plot for the system whose open loop transfer function is (9)

$G(s)\ H(s) = \frac{K}{s(s+2)(s+10)}$. Determine the range of K for which the closed loop system is stable.

b) Obtain the transfer function of Lag Compensator. Draw pole-zero plot (5)

MODULE V

19. a) Test the given system for controllability: (8)

$$\begin{bmatrix} \dot{x}1 \\ \dot{x}2 \\ \dot{x}3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} u; \qquad y = [1\ \ 0\ \ 0] \begin{bmatrix} x1 \\ x2 \\ x3 \end{bmatrix}$$

b) What is transfer matrix of a system? Derive the equation for transfer matrix. (6)

OR

20. a) Determine the state transition matrix of $\begin{bmatrix} 2 & 0 \\ -1 & 2 \end{bmatrix}$. (7)

b) Obtain the state model from the transfer function: $\frac{Y(s)}{U(s)} = \frac{1}{s^2+s+1}$. (7)

****