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
ROBOTICS AND AUTOMATION
(2020 SCHEME)

Course Code : **20RBT307**

Course Name: **Control Systems**

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

PART A

(Answer all questions. Each question carries 3 marks)

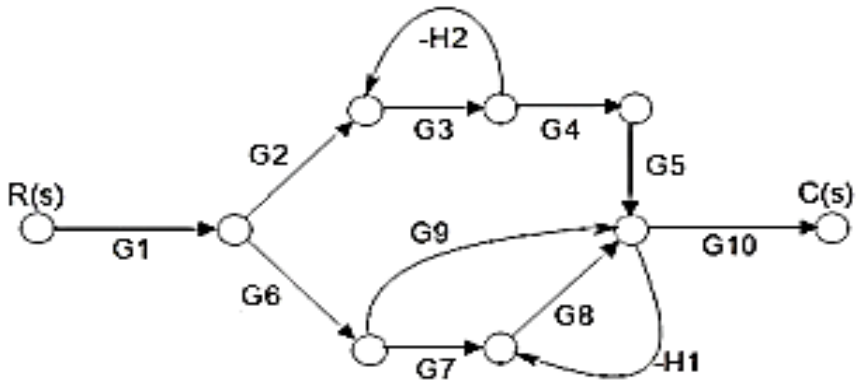
1. With the help of a diagram, define closed loop control system.
2. Describe the functions of an actuator in an automated process? List the classification of actuators.
3. Justify the location of poles influence the stability of a system.
4. Determine the transfer function of a first order RC circuit.
5. Explain how the term offset affects the response of a proportional controller.
6. Define Gain margin and Phase margin.
7. Describe the following terms: i) State ii) State Variable.
8. Explain the concept of controllability and observability.
9. Define the following terms i) Dead zone ii) Saturation.
10. What are the characteristics of non linear system?

PART B

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

MODULE I

11. a)



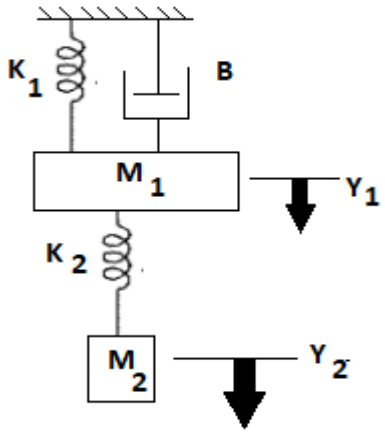
(8)

Determine the overall transfer function of the system using Mason's Gain Formula.

b) With the help of necessary sketches differentiate between an absolute encoder and an incremental encoder (6)

OR

12. a) Determine the transfer function of the following mechanical translational system.



(8)

b) With necessary sketches describe how the speed of a BLDC Motor can be controlled. (6)

MODULE II

13. a) Determine the response of a second order under damped system for unit step input. (8)

b) Derive the expression for steady state error in a closed loop system. (6)

OR

14. a) Determine the response of a second order critically damped system for unit step input. (7)

b) Given the characteristic equation of a system. Using R.H criterion, find the location of roots in s-plane and analyze whether the system is fully stable, unstable or conditionally stable. (7)

$F(s) = S^4 + 2S^3 + 11S^2 + 18S + 18 = 0$

MODULE III

15. a) Explain why controller tuning is essential in real-time systems. (4)

b) Sketch a Bode plot for a system with given transfer function and also determine the value of K for a gain cross over frequency of 5 rad/sec. G(s)= $\frac{Ks^2}{(1+0.2s)(1+0.02s)}$ (10)

OR

16. a) Compare P, PI and PID Controllers. (4)

b) Sketch the root locus of the given system G(s) = Ks/(s+2) (s+4) and also calculate the value of K so that the damping ratio of the closed loop system is 0.5. (10)

MODULE IV

17. a) Determine the transfer function of the following system

$$X' = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} U$$

$$Y = [0 \quad 1 \quad 0]X + [0]U$$

(6)

b) The state model of a system is given by

$$\begin{bmatrix} X_1' \\ X_2' \\ X_3' \end{bmatrix} = \begin{bmatrix} 0 & 0 & 1 \\ -2 & -3 & 0 \\ 0 & 2 & -3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 2 \\ 0 \end{bmatrix} U$$

$$Y = [1 \quad 0 \quad 0] \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix}.$$

(8)

Identify whether the system is controllable and observable.

OR

18. a) The system is described by its transfer function Y(s)/U(s) = 10/s(s+1) (s+2). Determine the state feedback gain matrix K, so that the closed loop poles are located at -2, -1 ± j (10)

b) Explain the advantages of state variable models over transfer function models. (4)

MODULE V

19. a) Explain the classification of nonlinearities in detail with necessary diagrams. (8)

b) A nonlinear system is represented by the state equation $\dot{x}_1 = -x_1 + 0.5x_2$ and $\dot{x}_2 = x_1 + x_1x_2 - x_2^2$. Analyze whether the equilibrium state of the system is stable using first method of Lyapunov. (6)

OR

20. a) Derive the describing function of saturation non linearity. (8)

b) Explain Lyapunov stability theorems. (6)

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