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

SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIFTH SEMESTERB.TECH DEGREE EXAMINATION (S), FEBRUARY 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)

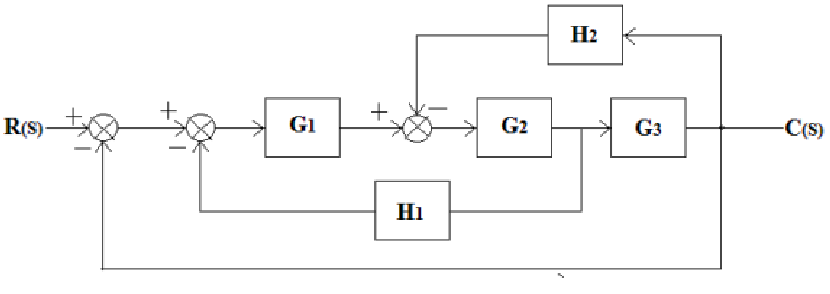
1. Derive the transfer function of a closed loop system with positive feedback.
2. Describe the functions of an actuator in an automated process? List the classification of actuators.
3. Analyze the stability of second order system with positive complex number poles.
4. Derive an expression for steady state error of a unity negative feedback system.
5. Illustrate 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. Illustrate the concept of Controllability and Observability.
9. Illustrate the classification of singular points.
10. Differentiate asymptotic stability and instability.

PART B

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

MODULE I

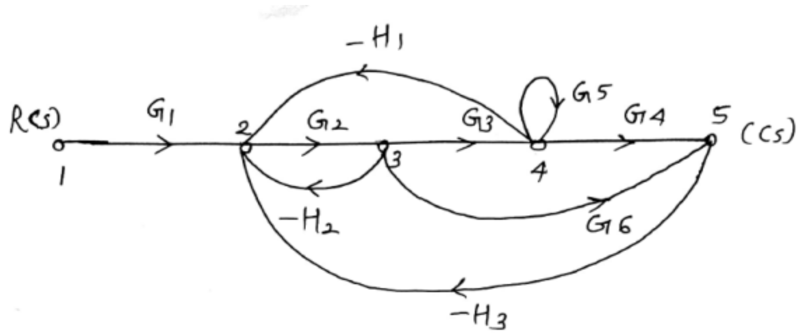
11. a) Determine the transfer function of the given system using block diagram reduction method. (8)



b) Explain how DC motors are used for speed control of quad copters and linear actuation mechanisms. (6)

OR

12. a) Determine overall transfer function for the given system using Mason's gain formula. (8)



b) With the help of necessary sketches compare an absolute encoder with an incremental encoder. (6)

MODULE II

13. a) Determine the Step Response of a Critically Damped Second Order system. (7)

b) Analyze the stability of the system whose characteristic equation is given by $s^5+2s^4+3s^3+6s^2+2s+1=0$. (7)

OR

14. a) Determine the rise time, peak time, settling time and peak overshoot of a second order control system subjected to a unit step input. The damping ratio ξ= 0.5 and undammed natural frequency ω_n =6 rad/sec. (7)

b) Derive an expression for time response of a second order under damped system to step input. (7)

MODULE III

15. a) Sketch the Root Locus and define the Stability of the following system $G(s)H(s)= K/s(s^2+2s+5)$. (10)

b) Describe the concept of Ziegler Nichols Tuning Mechanism. (4)

OR

16. a) Sketch the Bode plot for the following transfer function $G(s) = 75(1+0.2s) /s (s^2+16+100)$ and interpret the stability. (10)

b) Describe the lag compensator with neat sketches. (4)

MODULE IV

17. a) A system is represented by the differential equation y"+3y'+2y = r"+2r'+2r.Calculate a state model in controllable canonical form. Draw the state diagram. (7)

b) Obtain the state model of the system whose transfer function is given as $\frac{10}{s^3 + 4s^2 + 2s + 1}$. (7)

OR

18. a) A feedback system has a closed loop transfer function Y(s) U(s) = 5(s+4) / s(s+1)(s+3). Construct a canonical state model for this system and give block diagram representation of the system and give block diagram representation of the state model (7)

b) Determine State Transition Matrix of the system. (7)

$$\begin{bmatrix} x_1' \\ x_2' \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{Bmatrix} X_1 \\ X_2 \end{Bmatrix}$$

MODULE V

19. a) How the nonlinearities are classified? Explain 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 $\dot{x}_2 = x_1 + x_1 x_2 - x_2^2$. 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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