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SAINTGITS COLLEGE OF ENGINEERING (AUTONOMOUS)

(AFFILIATED TO APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY, THIRUVANANTHAPURAM)

FIFTH SEMESTER B.TECH DEGREE EXAMINATION (S), FEBRUARY 2024
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)

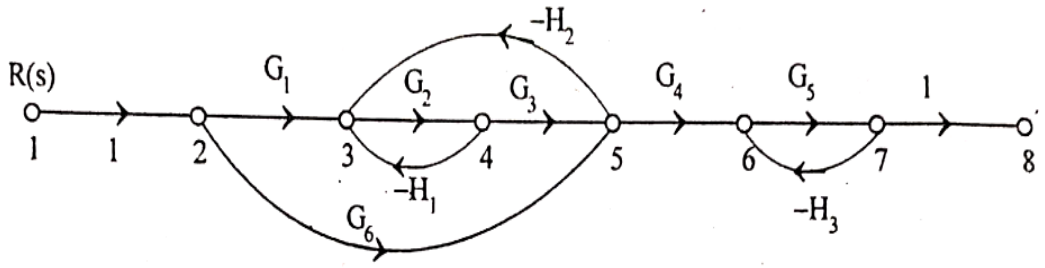
1. Distinguish between open loop system and closed loop system.
2. Explain the advantages of signal flow graph over block diagram representation.
3. Explain the time domain specification in control systems.
4. Define stability of a system based on location of its poles.
5. Explain the necessity of lead compensators.
6. What are two ways to find where the root locus crosses the imaginary axis?
7. Write state model of armature controlled DC motor.
8. Define the following terms a) State variable b) State Space.
9. Derive the describing function of ideal relay nonlinearity.
10. Explain characteristics of non linear systems.

PART B

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

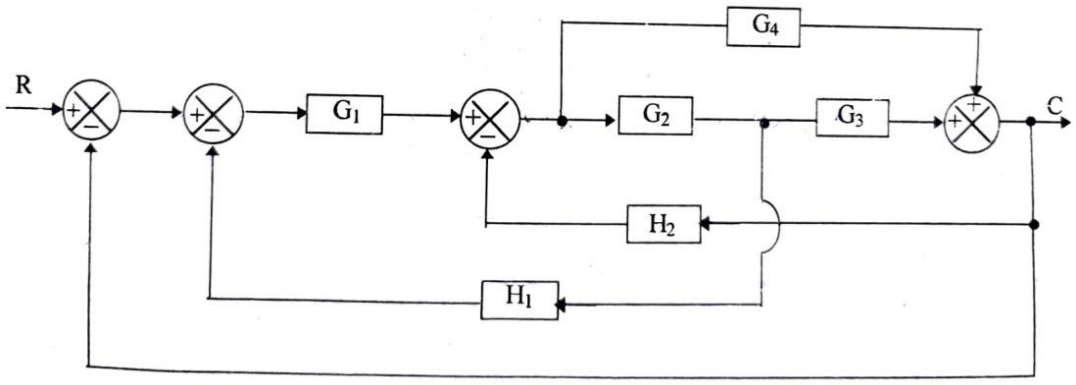
MODULE I

11. a) Describe the working of absolute encoder with sketches. (6)
    b) Find the overall transfer function of the system whose signal flow graph is shown below (8)



OR

12. a) With suitable block diagram explain components of an automatic control system. (6)
    b) Use block diagram reduction techniques to achieve the overall transfer functions for the following systems C(s)/R(s).



(8)

MODULE II

13. a) A system with unity feedback is having an open loop transfer function $\boldsymbol{G(s) = \frac{20}{s^2+14s+50}}$, determine the steady-state error for a step and a ramp input. (6)

b) Derive the step response for under damped second order system. (8)

OR

14. a) Derive the error coefficient and steady state error for a type 1 system applied with unit step and unit ramp input. (7)

b) A system has a characteristic equation $s^5 + s^4 + 2s^3 + s^2 + s + K = 0$. Determine the range of K for stability. (7)

MODULE III

15. a) A unity feedback control system has an open loop transfer function

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

(10)

Draw the root locus and determine the value of K if the damping ratio is 0.707

b) Explain the effect of adding poles and zeros to the nature of root locus. (4)

OR

16. a) Sketch Bode Plot for the system with open loop transfer function $G(s) = \frac{100}{s(s+10)^2}$ From Bode plot, determine GM and PM of the system and assess the stability of the system. (10)

b) Compare the performance characteristics of PI and PD controllers. (4)

MODULE IV

17. a) Determine the diagonal canonical representation of the system with transfer function (7)

$$\boldsymbol{T(s) = \frac{2(s+5)}{(s+2)(s+3)(s+5)}}$$

b) State and prove any three properties of state transition matrix. (7)

OR

18. a) A system is described by following state equation. Find the solution of the state equation (7)

$$\begin{bmatrix} \dot{x_1} \\ \dot{x_2} \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}, \; X[0] = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

b) Define controllability. Explain how can we check the controllability of a system using Kalman's test. (7)

MODULE V

19. a) Describe the Lyapunov's stability criterion and investigate the stability of the following non-linear systems using Lyapunov's method. (8)

a) $\dot{x_1} = -3x_1 + x_2$

b) $\dot{x_2} = -x_1 - x_2 - x_3^2$

b) Explain asymptotic stability and instability. (6)

OR

20. a) With neat sketches explain different types of singular points in detail. (8)

b) Explain the classification of the nonlinearities in detail with necessary diagrams. (6)

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