Reg No.:_______________ Name:___________________________

1100RAT307122102

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree (S, FE) Examination June 2024 (2019 Scheme)

Course Code: RAT 307
Course Name: CONTROL SYSTEMS
(Provide normal graph sheets and semi-log graph sheets)

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks) Marks

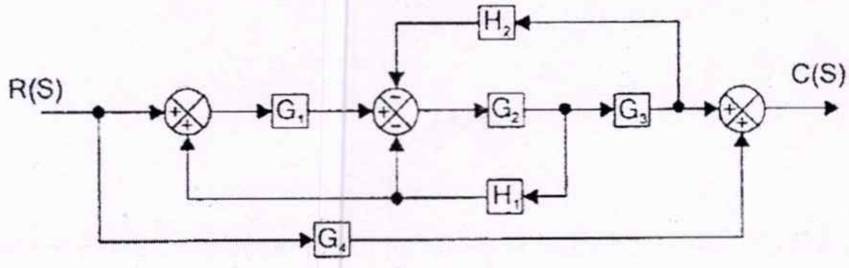
1	Define transfer function with respect to a closed loop system.	(3)
2	Differentiate between hydraulic and electric actuators.	(3)
3	Discuss how the Routh criterion can analyze stability.	(3)
4	Differentiate between transient response and steady-state response of a system.	(3)
5	Illustrate the need for a lead compensator in a control system.	(3)
6	List the frequency domain specifications indicating the performance of the system.	(3)
7	List the limitations of the transfer function approach in control system analysis.	(3)
8	Describe Kalman's method for checking the controllability and observability of a system.	(3)
9	Explain the describing function analysis of non-linear systems.	(3)
10	List the characteristics of non-linear systems.	(3)

PART B

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

Module -1

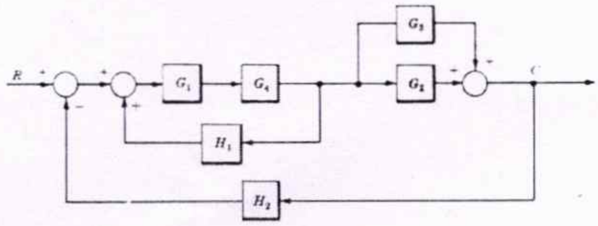
11 a) Reduce the block diagram to obtain the transfer function of the following system (10)



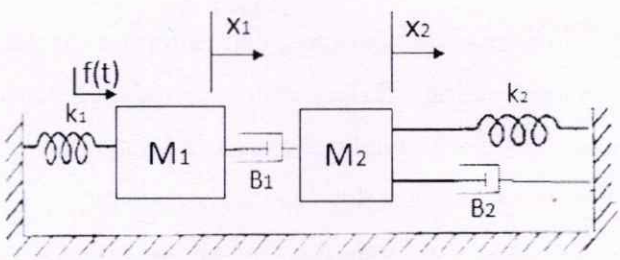
b) Discuss the importance of control systems in robotics. (4)

12 a) Design the signal flow graph for the block diagram shown in the figure and determine the gain C(S)/R(S) using the Masons gain formula. (8)

121



b) Represent the differential equations governing the system and determine the transfer function, $X_2(S)/F(S)$. (6)

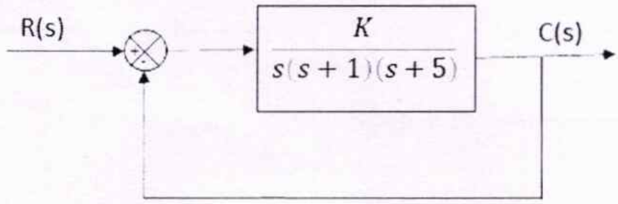


Module -2

13 a) The forward-path transfer function of a unity feedback control system is given by $G(S)=\frac{1000}{(1+0.1s)(1+10s)}$. Determine the static position coefficient and steady-state error values for a unit step input. (6)

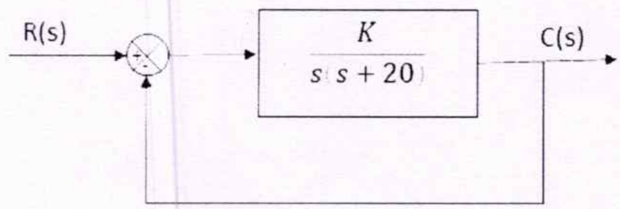
b) Determine the time response of a second-order underdamped control system with a transfer function $\frac{\omega_n^2}{S^2+2\zeta\omega_n s+\omega_n^2}$ subjected to a unit step input. (8)

14 a) Evaluate the value of K for the closed-loop system shown in the figure below to oscillate. Obtain the corresponding oscillating frequencies. (8)



b) A unity feedback system is shown in the figure below. Determine the value of K for the damping ratio is 0.7. Compute the peak time of the output response for a unit step input. (6)

122



Module -3

15 a) Construct the bode plot for the function G(s)H(s)=$\frac{30}{s(1+2s)(1+3s)}$. Determine the phase cross-over frequency. (10)

b) Differentiate between gain margin and phase margin. (4)

16 a) With the help of a root locus diagram, evaluate the stability of a unity feedback control system with forward loop transfer function G(s)=$\frac{K\,(s+1)}{s(s+2)(s+4)}$ (10)

b) Discuss the advantages of frequency domain analysis. (4)

Module -4

17 a) Examine the solution to state equations of time-invariant autonomous systems. Represent the expression for state transition matrix. (6)

b) Given the state-space model $\dot{X}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U(t)$. It is desired to have poles at s= -1 and s= -5. Test whether the condition is realizable. Find the value of feedback gain matrix K. (8)

18 a) Obtain the transfer function of the system with following state model (6)

$$\dot{X}(t) = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U \;\; ; \; Y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} X(t)$$

b) Evaluate the state-space model of the following transfer function using Phase variable approach and controllable canonical form. (8)

$$\frac{Y(s)}{U(s)} = \frac{5}{s^3 + 3s^2 + 6s + 5}$$

Module -5

19 a) With the help of diagrams, illustrate the classification of singular points. (9)

b) Discuss the Lypanauv Second Method for stability analysis. (5)

20 a) Derive the describing function of the Ideal relay. (7)

b) Explain any 3 common physical non-linearities (7)

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123