Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (R,S) Examination November 2025 (2019 Scheme)

Course Code: RAT307

Course Name: CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

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

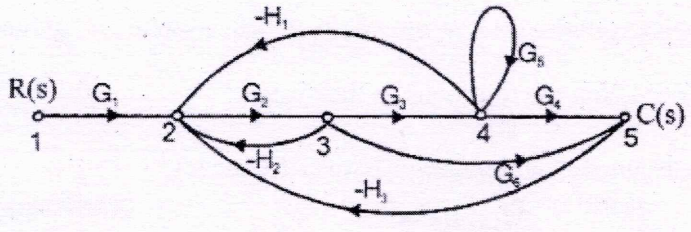
1	Define transfer function. Establish the relationship between transfer function and impulse response of a system.	3
2	Why is a control system essential in robotic systems?	3
3	Obtain the response of first order system for unit step input.	3
4	Compare and contrast type and order of a system.	3
5	Discuss on lead and lag compensators.	3
6	Differentiate between phase margin and gain margin.	3
7	Differentiate between state space approach and transfer function approach	3
8	Define state , state vector, state equation of a system	3
9	Define Singular point. Discuss any one type.	3
10	Comment on stable and unstable limit cycle	3

PART B

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

Module -1

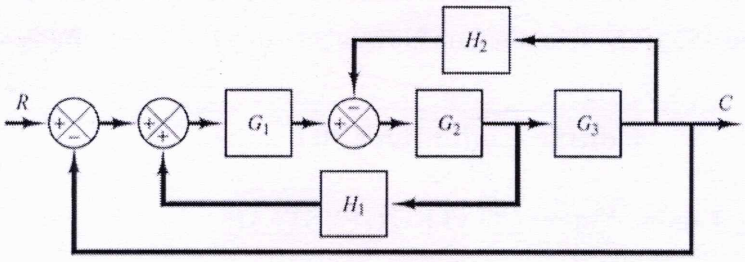
11 a) Using Mason's gain formula find the transfer function of the system shown in figure below. 9



b) Illustrate the importance of Actuators in Robot control system. Discuss various actuators used in Robotic system. 5

12 a) Find the transfer function of the given system using block diagram reduction 9

method.



b) Compare Open loop and Closed loop system with neat diagram. Write any 2 advantages of closed loop control systems. 5

Module -2

13 a) A unity feedback system has the forward transfer function $G(s) = \frac{K(2s+1)}{s(5s+1)(1+s)^2}$. When the input is $r(t) = 1 + 8t$, determine the minimum value of K so that steady state error is less than 0.2. 9

b) Sketch the response of a second order underdamped system. Also define and mark various time domain specifications. 5

14 a) Determine the range of K for stability of unity feedback system whose open loop transfer function is $G(s) = \frac{K}{s(s+1)(s+2)}$ 8

b) Define various static error constants related to a closed loop system. 6

Module -3

15 a) Sketch the Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency to be 5 rad/sec. 10

$$G(s) = \frac{Ks^2}{(1 + 0.2s)(1 + 0.02s)}$$

b) The characteristic equation of a system is given by 4

$$s^3 + 3s^2 + 9s + K = 0$$

Find the values of K for the system to be stable.

16 a) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K(s+9)}{s(s^2+4s+11)}$. Sketch the rootlocus of the system. 10

b) Define gain crossover frequency and phase crossover frequency. 4

Module -4

17 a) Compute the state transition matrix for a system represented by the state equation $\dot{X}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X(t)$ by Laplace transform method. Also compute the solution of the homogeneous equation, assuming the initial state vector , 10

$X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

b) Derive the equation for solution of homogenous state equation. 4

18 a) State equation of a MIMO system is given by 10

$X = AX + Bu$

Where

$$A = \begin{bmatrix} -5 & -2 & 4 \\ 1 & -3 & -2 \\ -2 & -2 & 1 \end{bmatrix} \text{ and } B = \begin{bmatrix} 1 & 1 \\ 1 & -1 \\ 1 & 0 \end{bmatrix}$$

Check whether the system is completely controllable.

b) List the advantages of state space approach compared to transfer function approach. 4

Module -5

19 a) Derive the describing function of a Deadzone non linearity. 10

b) Distinguish between asymptotic stability in large and asymptotic stability in small. 4

20 a) A nonlinear system is represented by the state equation 10

$\dot{x}_1 = -x_1 + 0.5x_2$ and $\dot{x}_2 = x_1 + x_1x_2 - x_2^2$

Check whether the equilibrium state of the system is stable using first method of Lyapunov

b) How can we analyse the existence of limit cycle using describing function analysis. 4

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