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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Fifth Semester B.Tech Degree (Honours) Examination December 2023 (2021 Admission)

Course Code: MRT 395

Course Name: ADVANCED CONTROL SYSTEMS

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks)

		Marks
1	When lag/lead/lag-lead compensation employed?	3
2	Obtain the transfer function of a lead compensator with the help of an electrical network.	3
3	A series RLC circuit is excited by a voltage source, v(t) volts and the output is measured across the resistor. Derive the state model of the electrical system.	3
4	State and prove any three properties of state transition matrix.	3
5	Determine whether the system given below is controllable $\dot{x} = x\begin{bmatrix} -1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 1 \end{bmatrix}\begin{bmatrix} u_1 \\ u_2 \end{bmatrix}$	3
6	Derive pulse transfer function from discrete time state space representation.	3
7	Write any three characteristics of non-linear systems.	3
8	Derive the describing function of ideal relay nonlinearity.	3
9	What is the stability in the sense of lyapunov?	3
10	Explain lyapunov theorem of stability for linear time invariant system.	3

PART B

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

Module -1

11 a) The open loop transfer function of certain unity feedback control system is $G(s)=\frac{K}{S(S+4)(S+8)}$. It is desired to have the phase margin to be atleast 33° and $K_v=30sec^{-1}$. Design a phase lag series compensator — 14

12 a) Consider a unity feedback system with open loop transfer function — 8

		$G(s)=\frac{4}{(s+1)(s+5)}$. Design a PI controller so that the closed loop has a damping ratio of 0.9 and natural frequency of oscillation as2.5 rad/sec.	
	b)	What is the procedure for designing PI controller in frequency domain when the given specifications are desired phase margin and gain cross over frequency.	6

Module -2

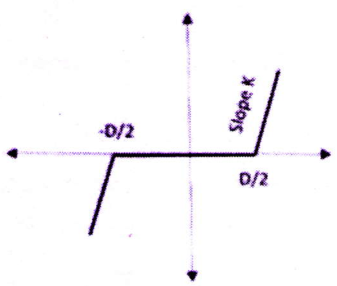
13	a)	Devlop the state model for the system with the transfer function $\frac{Y(s)}{U(s)}=\frac{s^2+2s+3}{s^3+6s^2+11s+6}$	7
	b)	b) Find the state transition matrix using Cayley-Hamilton theorem for the system matrix given below. $A=\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$	7
14	a)	Diagonalise the matrix $A=\begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix}$	14

Module -3

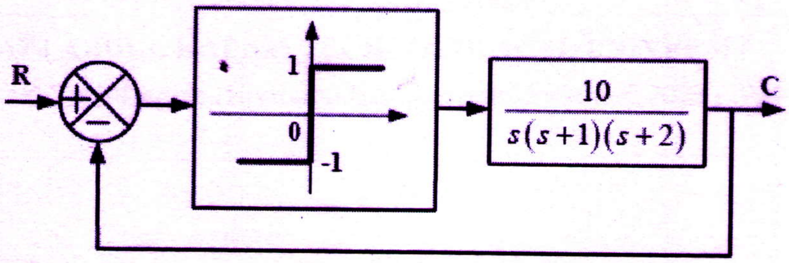
15	a)	Design a feed back controller with state feed back so that the closed loop poles are at -2, -1±j1. $A=\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix}$ $B=\begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix}$	8
	b)	Illustrate the pole placement technique used for control system design	6
16	a)	Find the state space representation of the system described by the difference equation y(k+3)+3y(k+2)+2y(k+1)+y(k)=u(k+2)+u(k+1)+u(k)	10
	b)	Explain Jury's stability test for sampled data control system.	4

Module -4

17	a)	Identify the following non linearity and derive a describing function for the same.	14



18	a)	Determine the frequency and nature of the limit cycle for the unity feed back system given below.	8



b) Define Describing function. Explain how describing function can be used for stability analysis of nonlinear systems. 6

Module -5

19 a) Explain isocline method of constructing phase trajectory. 7

b) Find Lyapunov function hence stability of the system 7

$\dot{x_1} = -x_1 + 2x_2 \qquad \dot{x_2} = -5x_1 - 7x_2$

20 a) What are singular points? Give the classification of singular points 6

b) Compute the Lyapunov function, *V(X)* for which the system given below is asymptotically stable. 8

$$\begin{bmatrix} \dot{x_1} \\ x_2 \end{bmatrix} = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

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