Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: AE405

Course Name: ADVANCED CONTROL THEORY

(Provide normal graph sheets)

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) List the advantages of state space approach compared to transfer function approach. (5)

b) Obtain the state representation of the system represented by the differential equation (10)

$$\frac{d^2y}{dt^2} + 6\frac{dy}{dt} + 8y(t) = r(t)$$

Also draw the state diagram.

2 a) Explain Singular Point, What is its significance. For the given system, determine the singular points. (5)

$\dot{x_1}=x_2$,

$\dot{x_2}=-x_1-x_2-x_1^2$

b) Explain different types of non linearity's (10)

3 a) A second order system is represented by the differential equation $\ddot{e} + 2\zeta\omega_n\dot{e} + \omega_n^2 e = 0$ where $\zeta = 0.25$, $\omega_n = 1$ rad/sec, $e(0) = 2.5$ and $\dot{e}(0) = 0$. Determine the singular point. Construct the phase trajectory using isocline method (10)

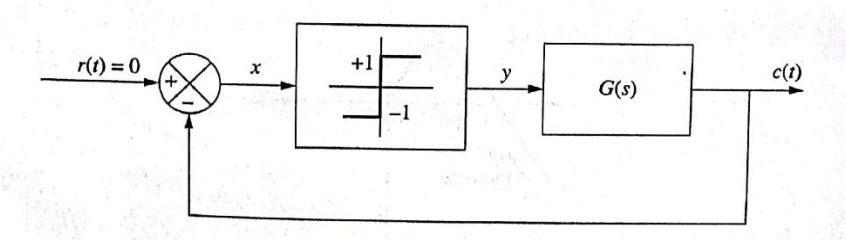
b) Obtain the state transition matrix for the system, $\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$ (5)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive describing function of Ideal relay (5)

b) For the system shown in figure, an ideal relay is connected with a plant having G(s)=1/s(s+1)(s+3). Determine whether the limit cycles excists and if excists,determine the amplitudeand frequency of it. (10)



5 a) Determine the stability of the system described by $\dot{X}$=AX, where A= $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$ by lyapunov theorem and determine a suitable lyapunov function. (10)

b) Explain Sign definiteness in the sense of Lyapnov (5)

6 a) Distinguish between asymptotic stability in large and asymptotic stability in small. (5)

b) Explain stability concept in terms of Describing Function Method with relevant diagrams (10)

PART C

Answer any two full questions, each carries 20 marks.

7 a) A linear system is represented by a state model $\dot{X} = AX + Bu \quad ; y = CX$ (10)

Where $A = \begin{bmatrix} -1 & -1 & 0 \\ 0 & 0 & 1 \\ 0 & -3 & -4 \end{bmatrix}$, $B = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 2 \end{bmatrix}$ and $C = \begin{bmatrix} 1 & 3 & 1 \\ 1 & 2 & 0 \end{bmatrix}$

Check whether the system is completely observable by Kaman's Test.

b) Derive the Pulse transfer function of ZOH (5)

c) Explain mapping between the s plane and the z plane. (5)

8 a) (15)

A continuous time system is described by $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 2 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$

$$y = cx$$

Solve matrix Riccatti equation that results in the control signal that minimises the performance index: $J == \int_0^5 \left[y^T(t) y(t) + u^T(t) u(t) \right] dt$

Solve for $\begin{matrix} c_1 = \begin{bmatrix} 0 & 1 \end{bmatrix} \\ c_2 = \begin{bmatrix} 1 & 0 \end{bmatrix} \end{matrix}$ and compare the results.

b) Explain ROC and its properties based on z transform (5)

9 a) State equation of a MIMO system is given by $\dot{X} = AX + Bu$ (10)

Where $A = \begin{bmatrix} -5 & -2 & 4 \\ 1 & -3 & -2 \\ -2 & -2 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 1 & 1 \\ 1 & -1 \\ 1 & 0 \end{bmatrix}$ Check whether the system is completely controllable

b) Solve the following difference equation by use of z transform method (10)

x(k+2) + 3x(k+1) + 2x(k)=0; x(0)=0 ; x(1)=1

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