Registration No : | | | | | | | | | | |

Total Number of Pages : 02 **B.Tech**

PEI6J002

6th Semester Regular / Back Examination 2018-19

ADVANCED CONTROL SYSTEMS

BRANCH : AEIE, EIE, IEE, IEE

Max Marks : 100

Time : 3 Hours

Q.CODE : F604

Answer Question No.1 (Part-1) which is compulsory, any EIGHT from Part-II and any TWO from Part-III.

The figures in the right hand margin indicate marks.

Part- I

Q1 **Only Short Answer Type Questions (Answer All-10)** **(2 x 10)**

a) Define the Concepts of state and state variables.

b) What is meant by singular points?

c) What is pulse transfer function?

d) If the Eigen values are -1,-1, and -2, find the state transition matrix?

e) What do you understand sample and hold circuit? Draw its circuit diagram.

f) State the duality properties of controllability and observability.

g) Find the Z-transform of $f(t) = e^{-at} \sin \omega t$.

h) The transfer function of certain system is $\frac{Y(s)}{U(s)} = \frac{1}{s^4 + 5s^3 + 7s^2 + 6s + 3}$. Write down the matrix A,B of equivalent state model.

i) State and explain the Cayley Hamilton Theorem.

j) Explain the mapping concept between S-plane and Z-plane.

Part- II

Q2 **Only Focused-Short Answer Type Questions- (Answer Any Eight out of Twelve)** **(6 x 8)**

a) Explain the classification of non-linearities and give the examples for each.

b) States and prove the properties of state transaction matrix.

c) A linear time invariant system is characterized by the homogeneous state equation

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 2 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Determine the solution of homogeneous equation, assuming the initial state vector

$$x_0 = \begin{bmatrix} 1 \\ 0 \end{bmatrix}.$$

d) Obtain the expression for describing functions with diagram.

e) Explain the describing function for relay of non-linearity.

f) Explain the Isocline method for construction of trajectories.

g) Draw the magnitude and phase response (frequency response) of a zero order hold. Derive the required expression.

h) Develop the transfer function representation of MIMO system.

i) What is Eigen value and state its significance?
The state model of linear time invariant system is given by

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & -2 \\ 1 & 0 & -5 \\ 0 & 1 & -9 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix} u$$

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Determine the canonical form of state variable

j) Find the state transition matrix for the following unforced system $\dot{x} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -2 \end{bmatrix}$

k) Find the IZT of $\frac{3z^2 + 2z + 1}{z^2 + 3z + 2}$.

l) Determine the state controllability and observability of the system described by

$$\dot{x} = \begin{bmatrix} -3 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} x + \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 2 & 1 \end{bmatrix} u, y = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} x$$

Part-III

Only Long Answer Type Questions (Answer Any Two out of Four)

Q3 Derive the solutions for both homogeneous and non-homogeneous state equation. **(16)**

Q4 Obtain eigen values, eigen vectors and the state model in canonical form for a system described by $\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix} u(t), y(t) = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x(t)$ **(16)**

Q5 State the properties of ROC. Explain initial and final value theorem of Z-transform. **(16)**
Solve the difference equation $x(k+2) - 3x(k+1) + 2x(k+1) + 2x(k) = 3^k$. The initial conditions are x(0)=0 and x(1)=1.

Q6 The state equation of linear time invariant systems is **(16)**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ -1 & -2 & 1 \\ 3 & 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} -1 \\ 2 \\ 1 \end{bmatrix} u$$

consider the closed loop poles at -1.4±j4 , -5.5 . Design a state feedback controller