Total No. of Questions : 8]

SEAT No. :

**PD4600**

[Total No. of Pages : 2

# [6404]-105
# B.E. (Electrical)
# ADVANCED CONTROL SYSTEM
# (2019 Pattern) (Semester - VII) (403142)

*Time : 2½ Hours]* *[Max. Marks : 70*

***Instructions to the candidates:***

1) ***Solve Q.1 or Q.2, Q.3 or Q.4, Q.5 or Q.6, and Q.7 or Q.8.***
2) ***Figures to the right indicate full marks.***
3) ***Neat diagrams must be drawn wherever necessary.***
4) ***The use of algorithmic tables slide rules, and electronic pocket calculators is allowed.***
5) ***Assume suitable data if necessary.***

***Q1)*** a) Consider the system given below. Compute state transition matrix using Laplace transform method. **[9]**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & -3 \\ 1 & -4 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

b) Explain the various state space representations given below with examples. **[9]**

i) Physical Variable representation

ii) Phase variable representation

iii) Jordon / diagonal canonical form

OR

***Q2)*** a) Find the transfer function of the system given below **[9]**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -5 & -1 \\ 3 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 2 \\ 5 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

b) Define state, state variable, state vector, state equation, and output equation. Draw a state diagram. **[9]**

***P.T.O.***

**Q3)** a) Check the controllability of the state model given below using Kalman's Test **[8]**

$$X = \begin{bmatrix} -1 & 0 & 0 \\ 1 & -2 & 0 \\ 2 & 1 & -3 \end{bmatrix} x + \begin{bmatrix} 10 \\ 1 \\ 0 \end{bmatrix} u$$

b) Explain the concept of state feedback with a proper block diagram. Write down the steps for designing a state feedback controller using a transformation matrix. **[9]**

OR

**Q4)** a) What is observability'? How to investigate the observability of a system using Gilbert's test for. **[8]**

i) Distinct eigenvalues and

ii) Repeated eigenvalues

b) Determine the state observer for the system given below to place the observer poles at $s_1 = -5$ and $s_2 = -5$ by direct substitution technique. **[9]**

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

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

**Q5)** a) State and explain Shannon's Sampling theorem. How to select the sampling period? **[9]**

b) Explain mapping between the s-plane and z-plane. **[9]**

OR

**Q6)** a) Explain the concept of Zero Order Hold and First Order Hold operations. Derive the transfer function of ZOH. **[9]**

b) Explain the block diagram of the digital control system. State the advantages and disadvantages of the digital control system. **[9]**

**Q7)** a) Define adaptive control. Explain any one scheme of adaptive control. **[9]**

b) Explain the various reaching laws of sliding mode control. **[8]**

OR

**Q8)** a) Explain the sliding mode control technique with respect to equivalent control and chattering. **[9]**

b) Define the optimal control problem and write down the steps to solve problem using linear quadratic regulator. **[8]**

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