CLASS: BTECH   SEMESTER : VII
BRANCH: EEE   SESSION : MO//2022

SUBJECT: EE439 APPLIED CONTROL THEORY

TIME: 03 Hours   FULL MARKS: 50

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

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Q.1(a) Define State and state variables of a dynamic system.   [2]
Q.1(b) Derive transfer function of the given state model   [3]

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

Q.1(c) Construct state model for the transfer function given by   [5]

$$G(s) = \frac{(s+3)}{s^3 + 9s^2 + 24s + 20}$$

Q.2(a) A dynamic system has a unique set of state variables. Counter this Statement   [2]
Q.2(b) Obtain the eigen values and eigen vectors for the matrix given by   [3]

$$\begin{bmatrix} 1 & 1 \\ 0 & 2 \end{bmatrix}$$

Q.2(c) Investigate the following system for controllability and observability   **[5]**

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

Q.3(a) Distinguish between physical variables and phase variables used as state variables of the system.   [2]
Q.3(b) Explain the working of Model Reference Adaptive Control System.   [3]
Q.3(c) For the system given below, an observer is to be designed to estimate the state variables. Select the   [5]
        observer gain and write the equations describing the observer dynamics.

$$\dot{x} = \begin{bmatrix} -4 & -4 \\ 1 & -2 \end{bmatrix} x + \begin{bmatrix} 0 \\ 2 \end{bmatrix} u$$
$$y = \begin{bmatrix} 1 & 0 \end{bmatrix} x$$

Observer eigen value should be (-10,-10)

Q.4(a) How can a state transition matrix can obtain from Laplace transform method?   [2]
Q.4(b) Find the Describing function of a relay with a dead zone   [3]
Q.4(c) Discuss the role of performance measure in optimal control.   [5]

Q.5(a) Explain the meaning and physical significance of controllability and observability.   [2]
Q.5(b) Explain the difference in principle and application areas of robust control and   adaptive control.   [3]
Q.5(c) Obtain the linearized model for the nonlinear system given below in the vicinity of the equilibrium   [5]
        point.

$$\dot{x_1} = -\left(\frac{x_1}{x_2}\right) + x_3^2$$

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

$$\dot{x_3} = -3x_3 + x_1$$