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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

FIFTH SEMESTER B.TECH. (INSTRUMENTATION AND CONTROL ENGG.)

END SEMESTER DEGREE EXAMINATIONS, DECEMBER - 2019

SUBJECT: MODERN CONTROL THEORY [ICE 3101]

TIME: 3 HOURS　　　　MAX. MARKS: 50

Instructions to candidates :*Answer ALL questions and missing data may be suitably assumed.*

1A. For the block diagram shown in Fig.Q1A, determine the state variable representation of the system where the output is denoted by y(t) and input is r(t). Also determine the characteristic equation.

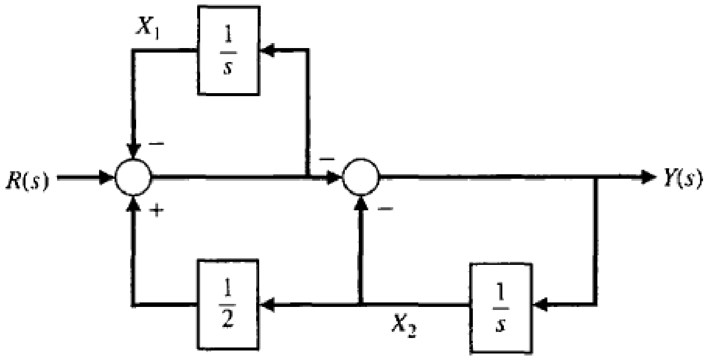

Fig.Q1A

1B. For the system represented by following state model, obtain the state transition matrix. Also applying the property of state transition matrix obtain the $\Phi^{-1}(t)$.

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

1C. What are the advantages and drawbacks of choosing physical variables of the system as state variables?

(5+3+2)

2A. For the system given below,

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

Determine whether the system is completely controllable and observable using Gilbert's test

2B. Using signal flow graph, obtain the state model of the system whose transfer function is given as:

$$\frac{Y(s)}{U(s)} = \frac{10}{s^3 + 4s^2 + 2s + 1}$$

2C. Draw the state diagram of the system described by following state model, in parallel realisation.

$$\dot{x}(t) = \begin{bmatrix} 4 & 0 \\ 0 & 2 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(k); y(k) = [3 \;\; 5]x(t)$$

(5+3+2)

3A For the discrete – time system described by following state – space model, compute the state transition matrix and find output y(k) for an input u(k) = 1; k≥1.

$$x(k+1) = \begin{bmatrix} -3 & 0 \\ 0 & -2 \end{bmatrix} x(k) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u; y(k) = [-1 \;\; 1]x(k)$$

3B A system is described by equation $\dot{x} = Ax + Bu,$ where, $A = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$ $and\ B = I$;the system is controlled using a feedback such that $u = kx$, where $k = \begin{bmatrix} -k & 0 \\ 0 & -2k \end{bmatrix}$. Determine the value of k so that the response of the system is critically damped

3C Briefly explain how control system design is implemented in state – space.

(5+3+2)

4A Obtain the discrete time state space model and pulse transfer function when T=1 sec for the following continuous time system.

$$\frac{Y(s)}{U(s)} = \frac{1}{s(s+2)}$$

4B Draw the block diagram representation of the digital control system and explain each component.

4C Define output controllability and write the conditions to check.

(5+3+2)

5A A discrete time system is represented by the state model,

$$x(k+1) = \begin{bmatrix} 0 & 1 \\ -3 & 4 \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(k); y(k) = [1 \;\; 0]x(k) with x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$$

Determine zero input response and response of the system for $u(k) = cos(k\pi)$.

5B A linear discrete time system has a pulse transfer function $\frac{Y(z)}{R(z)} = \frac{4z^3 - 12z^2 + 12z - 7}{(z-1)^2\,(z-2)}$. Derive the state space model in controllable canonical form and draw the state diagram.

5C Write necessary and sufficient conditions for arbitrary pole placement.

(5+3+2)

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