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EEE052

(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 121856

Roll No.

B. Tech.

(SEM. VIII) THEORY EXAMINATION, 2014-15

ADVANCED CONTROL SYSTEM

Time : **3** Hours]   [Total Marks : **100**

Note : Attempt all questions.

1   Attempt any two parts of the following :   10×2=20
(a)   Consider a system given by following equation :

$$\frac{d^3 y}{dt^3} + 9\frac{d^2 y}{dt^2} + 15\frac{dy}{dt} + 5y = 8u$$

Find the phase-variable form of the state-space representation of the system.

(b)   Consider the state model

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

$x_1(0) = 0$, $x_2(0) = 1$, u = unit step

Compute the STM and find the time response.

121856]   **1**   **[Contd...**

(c) Consider a system described by the differential equation

$$\frac{d^2y}{dt^2} + 5\frac{dy}{dt} + 4y = u$$

Derive the state-space representation of the system and obtain suitable transformation to get the diagonalization.

2 Attempt any two parts of the following :   10×2=20

(a) Examine the observability of the system described by

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

$$y(t) = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$

(b) Given discrete time state equation

$$x[n+1] = Ax[n] + Bu[n]$$

Show that

$$\sum_{i=0}^{n-1} A^{n-i-1} Bu[i] = Z^{-1}\left[(ZI - A)^{-1} B \cup (Z)\right]$$

(c) Solve the difference equation

$$y[n+2] + 3y[n+1] + 2y[n] = u[n]; \quad y[0] = 1$$

$$y[n] = 0 \text{ for } n < 0.$$

3   Attempt any two parts of the following :   10×2=20

(a)   A non-linear system is described by

$$\dot{x}_1 = -3x_1 + x_2$$

$$\dot{x}_2 = x_1 - x_2 - x_2^3$$

Investigate the stability of the system.

(b)   Describe the "Krasovskii's method" of constructing Lyapunov's function for the assessment of the stability of a non-linear system.

(c)   Consider the system described by state-equation

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix} x$$

Detrmine whether the system is stable or not ?

4   Attempt any two parts of the following :   10×2=20

(a)   State principle of optimality. Also derive the necessary condition for the control to be optimal in the sense of minimum value of performance index J.

(b)   A system is described by

$$\dot{x}_1 = x_2$$

$$\dot{x}_2 = u$$

$$y = x_1$$

Obtain the control law which minimizes

$$J = 0.5 \int_0^\infty \left(u^2 + y^2 \right) dt$$

(c)   What is adaptive control ? Differentiate between feedback control and adaptive control. Also describe various schemes of adaptive control.

5   Attempt any two parts of the following :   10×2=20

    (a)   Differentiate 'crisp sets' and 'fuzzy sets'. How a fuzzy inference mechanism infers a set of control actions for the given fuzzy inputs ?

    (b)   Describe the "Infinite-time state-Regular Problem."

    (c)   Discuss the 'Gilbert Test' for complete state controllability by means of suitable examples.

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