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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 :

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

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.

(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.