Roll No. .... Total Pages : 5

306502

December, 2019

B.Tech. (EIC) V SEMESTER

Modern Control System (EI-502)

Time : 3 Hours] [Max. Marks : 75

Instructions :

1. *It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.*
2. *Answer any four questions from Part-B in detail each question contains two parts i.e., (a) and (b): Part (a) is of 8 marks and Part (b) of 7 marks.*
3. *Different sub-parts of a question are to be attempted adjacent to each other.*

PART-A

1. Answer in brief of following :

   (a) What is the meaning of the term canonical in Diagonal canonical form?

   (b) Describe mathematically a LTV system.

(c) Show that state transition matrix

$$\phi(t) = I + At + \frac{1}{2!}A^2t^2 + \frac{1}{3!}A^3t^3 + \ldots\ldots..$$

(d) For the differential equation given below, write the dynamic equations in vector matrix form.

$$2\frac{d^2x(t)}{dt^2} + 4\frac{dx(t)}{dt} + x(t) = 5r(t).$$

(e) Solve $y(k + 2) + 0.5y(k + 1) + 0.2y(k) = u(k)$ where $u(k) = 1$ for $k = 0.1.2\ldots$

(f) Prove that transfer function remains invariant under similarity transformation.

(g) Find out if the given matrix is a state transition matrix

$$\begin{bmatrix} e^{-2t} & te^{-2t} & \frac{t^2e^{-2t}}{2} \\ 0 & e^{-2t} & te^{-2t} \\ 0 & 0 & e^{-2t} \end{bmatrix}$$

(h) Draw signal flow graph of the transfer function

$$\frac{5}{(z+1)(z+2)}.$$

(i) Differentiate between Full order state observer and Reduced order state observer.

PART-B

2. (a) Diagonalize the given system matrix

$$A = \begin{bmatrix} 4 & 1 & -2 \\ 1 & 0 & 2 \\ 1 & -1 & 3 \end{bmatrix}$$

(b) Using trapezoidal rule of integration find the difference equation model for PID controller.

3. (a) Obtain the state model for the following system. Also draw the state diagram.

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

(b) The following facts are known about the linear system

$\dot{X} = AX(t)$ if $X(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$, then $X(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix}$ and

if $X(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$, then $X(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$

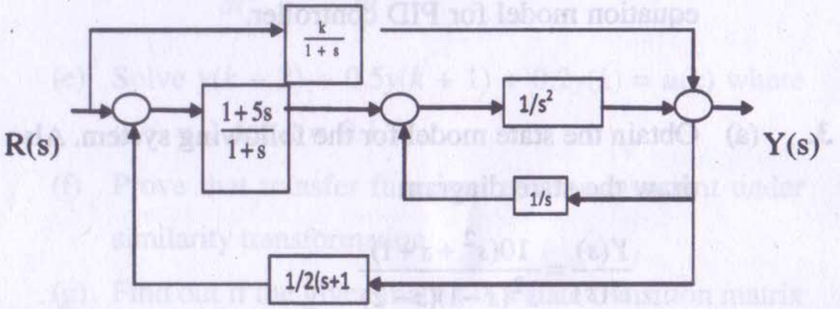
Find e^{At} and hence matrix A.

4. (a) Obtain unit step response $y(k)$ for $K \geq 1$ of the following discrete system assume initial conditions to be zero.

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

and $y(k) = [1 \quad 0]x(k)$

(b) Express the dynamics of the system in state space form.



5. A discrete time regulator system has the plant

$$X(k+1) = \begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix} X(k) + \begin{bmatrix} 4 \\ 3 \end{bmatrix} u(k)$$

$$y(k) = [1 \quad 1]X(k)$$

(a) Design a state feedback control algorithm $u(k) = k\,X(k)$ which places the closed loop characteristic roots at $\pm j\frac{1}{2}$.

(b) Design a state observer which has both the characteristic roots at $z = 0$. Give the relevant observer equation.

6. (a) Draw state model for the system with transfer function

$$\frac{Y(z)}{U(z)} = \frac{50(1+z/5)}{z(1+z/2)(1+z/50)}$$

(b) Comment upon the controllability and observability of the system in Q. 6 (a).

7. For the state variable model

$$\dot{X}(t) = \begin{bmatrix} 0 & 1 \\ -\frac{1}{8} & \frac{3}{4} \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = \begin{bmatrix} -\frac{1}{2} & 1 \end{bmatrix} X(t)$$

(a) Obtain the eigen values and the transfer function.

(b) Comment upon the controllability and observability of the system.
