Total No. of Questions : 10]

SEAT No. :

P3577

[Total No. of Pages : 3

[4959]-1193

B.E. (Instrumentation and Control)

DIGITAL CONTROL

(2012 Course) (Semester - I)

Time : 2.30 Hours] ***[Max. Marks : 70***

Instructions to the candidates:

1) ***Neat diagrams must be drawn wherever necessary.***
2) ***Figures to the right side indicate full marks.***
3) ***Use of Calculator is allowed.***
4) ***Assume suitable data if necessary.***

Q1) a) Obtain mathematical model of zero order Hold. **[6]**

b) Obtain the final value of for the sequence whose Z transform is **[4]**

$$F(z) = \frac{z^2(z-a)}{(z-1)(z-b)(z-c)}$$

What can you conclude concerning the constants b and c if it is known that the limit exists?

OR

Q2) a) Find the equivalent sampled impulse response sequence and the equivalent z-transfer Function for the cascade of the two analog systems with sampled input. **[6]**

$$H_1(s) = \frac{1}{s+2} \text{ and } H_2(s) = \frac{2}{s+4}$$

i) If the systems are directly connected.

ii) If the systems are separated by a sampler.

b) Explain the term impulse sampling. **[4]**

P.T.O.

Q3) a) Determine the stability of closed loop system given in figure 2. **[6]**
(T = 1 sec)

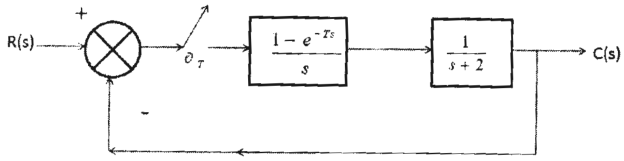

Figure. 2

b) Explain stability regions in S-plane, Z-plane & W-plane with neat sketches. **[4]**

OR

Q4) a) Characteristic equation of system is $z^3 + 0.5z^2 - 1.34z + 0.24 = 0$, Test the stability of system using bilinear transformation & routh array method. **[6]**

b) Explain concept of ringing of poles. **[4]**

Q5) a) Obtain state transition matrix $\psi(k)$ for following discrete time system using Cayley-Hamilton theorem. **[8]**

$$x(k+1) = \begin{bmatrix} 0 & 1 \\ -3 & 4 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

b) Determine Pulse transfer function of system for following system. **[10]**

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -2 & 0 \\ 0 & 0 & -3 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} u(k) \text{ and } y(k) = \begin{bmatrix} -1 & 2 & 1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix} + u(k)$$

OR

Q6) a) Obtain discrete time state model of system for given continuous time system model using sample time T = 1 sec. **[10]**

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

b) Obtain state space representation of following pulse transfer function of system in canonical forms. **[8]**

$$\frac{Y(z)}{U(z)} = \frac{3 - z^{-1} - 3z^{-2}}{1 + \frac{1}{3}z^{-1} - \frac{2}{3}z^{-2}}$$

Q7) a) Find state feedback gain matrix for system such that desired closed loop system exhibit the deadbeat response to any initial condition, **[12]**

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -0.16 & 0.84 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} u(k)$$

b) Explain different types of state estimators. **[4]**

OR

Q8) a) Find state feedback gain matrix for system such that desired closed loop system exhibit deadbeat response. **[12]**

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -0.5 & 0.2 & 1.1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} u(k)$$

b) State the mathematical equations of different methods to compute state feedback gain matrix. **[4]**

Q9) a) Explain the terms : **[4]**

i) Optimal Control

ii) Performance Index

b) Consider the discrete time control system defined by **[12]**

$x(k+1) = 0.1354x(k) + 0.8646u(k),\ x(0) = 1, Q = R = 1, S = 1$

Determine the optimal control Law to minimize the following performance index;

$$J = \frac{1}{2}[x(5)]^2 + \frac{1}{2}\sum_{k=0}^{4}\left[x^2(k) + u^2(k)\right]$$

OR

Q10) Consider following discrete time control system defined by **[16]**

$$x(k+1) = \begin{bmatrix} 0 & 1 \\ -1 & 1 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k) \text{ and } x(0) = \begin{bmatrix} 1 \\ 1 \end{bmatrix}.$$

Determine the optimal control sequence $u(k)$ that will minimizes the following performance index.

$$J_8 = \frac{1}{2}\sum_{k=0}^{7}\left[x^2(k) + u^2(k)\right] \text{ and } Q = \begin{bmatrix} 2 & 0 \\ 0 & 0 \end{bmatrix} \& S = \begin{bmatrix} 0 & 0 \\ 0 & 0.5 \end{bmatrix}, R = 2.$$

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