Total No. of Questions : 10]

SEAT No. :

P2079

[Total No. of Pages : 4

[5059] - 693

B.E. (Instrumentation and Control)

DIGITAL CONTROL

(2012 Pattern)

Time : $2\frac{1}{2}$ 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) Discuss different advantages of Digital control over Analog control. **[6]**

b) Obtain the final value of for the sequence whose Z transform is

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

What can you conclude concerning the constants b and c if it is known that the limit exists? **[4]**

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]**

$$H_1(s)=\frac{1}{s+6} \text{ and } H_2(s)=\frac{10}{s+1}$$

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) State the equations of velocity and position form of digital PID controller. Explain the advantages of velocity form. **[10]**

OR

Q4) Determine stability of system shown with below closed loop transfer function.

Use Jury's stability test. $\frac{Y(z)}{X(z)}=\frac{z^{-3}}{1+0.5z^{-1}-1.34z^{-2}+0.24z^{-3}}$. **[10]**

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

$$x(k+1)=\begin{bmatrix}-4 & 3\\ -6 & 5\end{bmatrix}\begin{bmatrix}x_1(k)\\ x_2(k)\end{bmatrix}$$

b) Determine Pulse transfer function of system for following system, **[8]**

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

OR

Q6) a) Find Eigen Values and Eigen vectors for following state matrix. **[10]**

$$G=\begin{bmatrix}0 & 0 & 1\\ 2 & 0 & 0\\ 8 & 2 & -5\end{bmatrix}$$

b) Obtain state space representation of following pulse transfer function of system in canonical forms. **[6]**

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

Q7) a) A discrete time regulator system has the plant **[12]**

$$x(k+1)=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -4 & -2 & -1\end{bmatrix}x(k)+\begin{bmatrix}0\\0\\1\end{bmatrix}u(k)$$ Design a state feedback controller which will place the closed loop poles at $-\frac{1}{2}\pm j\frac{1}{2},0$.

b) Write the Transformation matrix required if system state model is to be transforming in its standard controllable and observable forms. **[6]**

OR

Q8) a) A discrete time regulator system has the plant **[10]**

$$x(k+1)=\begin{bmatrix}-1 & 1\\ 1 & 2\end{bmatrix}x(k)+\begin{bmatrix}0\\1\end{bmatrix}u(k) \text{ and}$$

$y(k)=[1\ \ 0]x(k)$. Design a full order state observer such that system has closed loop poles at $\mu_1=-5; \mu_2=-5$.

b) Investigate the controllability and observability of system whose state model is; **[8]**

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

Q9) Write short note on: **[16]**

a) Steady State Quadratic Optimal Control.

b) Optimal regulator system based on quadratic performance Index.

OR

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

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

Determine the optimal control law to minimize the performance index. Also determine minimum value of J.

$$J = \frac{1}{2} \sum_{k=0}^{\infty} x^{*}(k) Q x(k) + u^{*}(k) R u(k)$$

$$Q = \begin{bmatrix} 1 & 0 \\ 0 & 0 \end{bmatrix}, R = 1.$$