R09

Code No: C0610

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.TECH I SEMESTER EXAMINATIONS APRIL/MAY-2012
DIGITAL CONTROL SYSTEMS
(DIGITAL SYSTEMS & COMPUTER ELECTRONICS)

Time: 3hours **Max.Marks:60**

Answer any five questions
All questions carry equal marks

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1.a) Explain clearly the advantages and disadvantages of digital control systems.

b) Draw the schematic diagram of basic digital control scheme and explain about each component of it.

c) The input-output relationship of a digital control system is given by the difference equation: y(k + 1) + $\frac{1}{2}y(k) = r(k)$, y(0) = 1. Determine the output sequence y(k), when r(k) is a unit step sequence for k ≥ 0.

2.a) Find the Z-transform of the following:

(i) $F(s) = \frac{1}{s^2(s+1)}$, (ii) f(t) = t sin ωt

b) Find the inverse Z-Transform of the following

(i) F(z) = $\frac{5z}{z^2 + 2z + 2}$, (ii) F(z) = $\frac{5z^4 + 4z^3 + 3z^2 + 2z + 1}{z^4}$.

3. Explain the properties of state transition matrix. For the following pulse transfer function of digital control systems: $\frac{Y(z)}{R(z)} = \frac{z^3 + 2z^2 + z + 2}{z^3 + 3z^2 + 2z + 1}$

Obtain a state space representation for the system and hence obtain the state transition matrix.

4.a) Derive the necessary conditions for the digital control system
X(k + 1) = GX(k) + Hu(k)
Y(k) = CX (k) +DU(k) to be controllable and observable.

b) Examine whether the discrete data system

X(k + 1) = GX(k) + Hu(k) and y(k) = CX(k) where G = $\begin{bmatrix} 0 & 1 \\ -2 & -2 \end{bmatrix}$, H = $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$, C = [1 0]

is (i) State controllable (ii) Output controllable and (iii) Observable.

Contd…..2

5.a) A discrete time system X(k + 1) = AX(k) + Bu(k) has the system matrix A = $\begin{bmatrix} 1 & a \\ 2 & 1/2 \end{bmatrix}$

For what value of **a** is the system stable.

b) Consider the digital system shown in Fig below

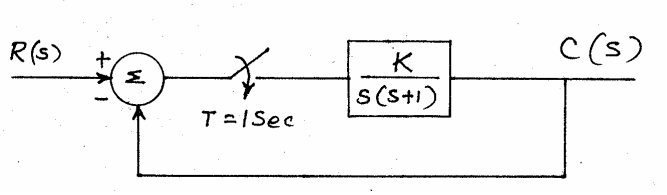

Fig-1

Using Jury's stability test, find the range of values of K for which the system is stable.

6. A block diagram of a digital control system is shown in Fig. Design a digital PID so that the system will meet certain performance specifications such as the ramp-error constant K_v should equal 5, eliminate steady state error and minimize the peak over shoot.

The controlled process is represented by the transfer function $G_P(s) = \dfrac{10}{(s+1)(s+2)}$

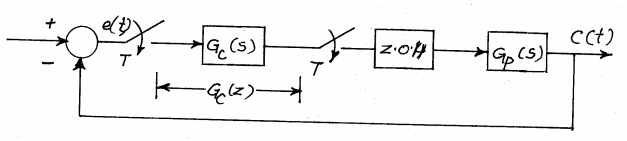

Fig 2

7.a) Consider the single input digital control system

X(k + 1) = AX(k) + Bu(k), where A = $\begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix}$, B = $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$

Determine, the state feed back matrix G such that the state feed back u(k) =-GX(k), places the closed loop system poles at 0.3 ± j0.3.

b) Explain the deadbeat response characteristics. The plant transfer function of a digital control system shown below Fig. is given by $G_p(z) = \dfrac{z^{-2}}{1 - z^{-1} - z^{-2}}$, design a digital controller so that a dead beat performance is obtained when the input is a unit step function.

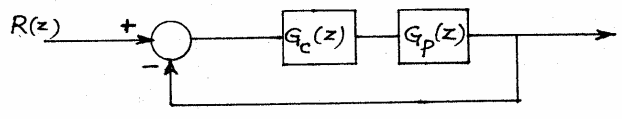

Fig-3

8. Consider the digital process with the state equations described by
X(k + 1) = GX (k) + Hu(k) and y(k) = C X(k)

Where G = $\begin{bmatrix} 0 & 1 \\ -1 & 1 \end{bmatrix}$, $H = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$, $C = \begin{bmatrix} 2 & 0 \end{bmatrix}$.

Design a full order observer which will observe the states $x_1(k)$ and $x_2(k)$ from the output c(k), having dead beat response write the dynamic equation for the observer and draw its state diagram.

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