Code No: C3702 **R09**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
M.Tech I Semester Examinations, April/May-2012
DIGITAL CONTROL SYSTEMS
(CONTROL ENGINEERING)

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

Answer any five questions
All questions carry equal marks
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1.a) With help of suitable circuit explain the principle of operation of sample and hold devises. Derive the transfer function of zero order hold circuit.

b) State and explain the sampling theorem.

2.a) State and prove the following properties/theorems of z-transforms.
i) Shifting theorem
ii) Complex translation theorem
iii) Complex differentiation and Partial differentiation theorem.

b) Find the inverse Z-Transform of the F(z) = $\dfrac{3z^2+2z+1}{(z^2-3z+2)}$

c) Show that $\mathcal{Z}^{-1}\left[\dfrac{z^{-2}}{(1-a\,z^{-1})^2}\right]=\begin{cases}(k-1)a^{k-2} & k=1,2,3..\\ 0 & k\le 0\end{cases}$

3. The block diagram of a digital control system is shown in Figure 1, where $G_p(s)=\dfrac{K(s+1)}{s(s+2)}$.

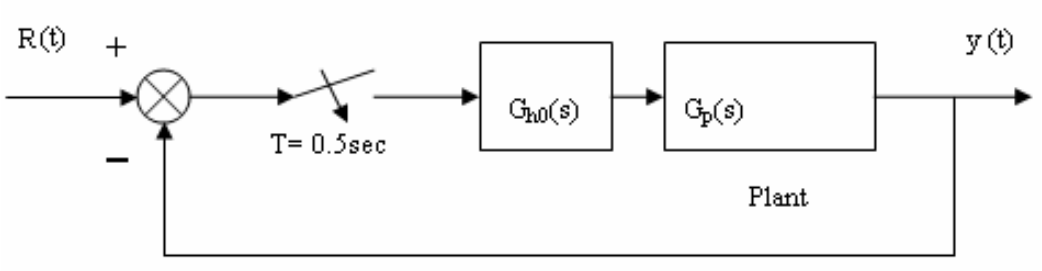

Figure 1

Determine the range of K for the system to be asymptotically stable.

4.a) Determine discrete state variable representations for the transfer functions.

i) $G(z)=\dfrac{2+z^{-1}}{1+z^{-1}}$ ii) $G(z)=\dfrac{5z}{z^2+2z+2}$.

b) Consider the following

$$X(k+1)=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}X(k)+\begin{bmatrix}0\\ 1\end{bmatrix}(-1)^k;\qquad X(0)=\begin{bmatrix}1\\ 1\end{bmatrix}$$

$y(k) = x_1(k)$. Find the y(k) for $k\ge 1$.

Contd.....2

5. The open loop transfer function of a unity feedback digital control system is given as $G(z) = \dfrac{Kz}{(z-1)(z-0.5)}$. Sketch the root loci of the system for $0<K<\infty$. Indicate all important information on the root loci.

6. The open loop pulse transfer function of an uncompensated digital control system is $G_{h0}\, G_p(z) = \dfrac{0.0453(z+0.904)}{(z-0.905)(z-0.819)}$. The sampling period T is equal to 0.1 sec. Find the time response and steady state error of the system to a unit step input.

7.a) With neat block diagram explain the full order observer.

b) Consider the digital process with the state equations described by

$$X(k+1) = \begin{bmatrix} 1.0 & 0.0952 \\ 0 & 0.905 \end{bmatrix} X(k) + \begin{bmatrix} 0.00484 \\ 0.0952 \end{bmatrix} u(k) \qquad y(k) = [1 \quad 0]X(k)$$

Design the first-order observer so as to have a dead beat response.

8.a) Explain the design procedure of digital PID controller.

b) Consider the single input digital control system

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

Determine, the state feed back matrix K such that the state feed back $u(k) = -KX(k)$, places the closed loop system poles at $0.3 \pm j0.3$.

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