Code No: M1025 **R07** **Set No. 1**

IV B.Tech. I Semester Supplementary Examinations, February/March - 2011
DIGITAL CONTROL SYSTEMS
(Electronics & Instrumentation Engineering)

Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
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1. a) What are the merits and demerits of digital control system?
   b) Illustrate the discrete data and digital control system with a step motor control system.

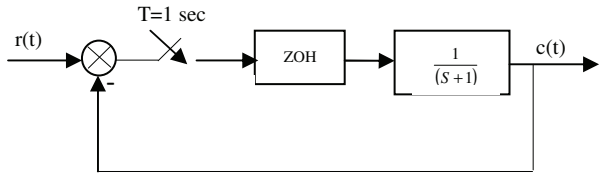
2. a) Define z-transforms. Mention limitations of z-transform.
   b) Obtain the inverse z-transform of the following functions.

   i) $F(z) = 10z + \dfrac{5}{(z-2)(z-0.5)}$

   ii) $F(z) = \dfrac{z(1-e^{-at})}{(z-1)(z-e^{-at})}$

   iii) $F(z) = \dfrac{1}{(z+2)}$

3. a) Explain the procedure for obtaining the pulse transfer function of a closed loop transfer function.
   b) For the sampled data system as shown in below figure, find the response to unit step input.



4. a) Write the state equations and output equation of the following difference equation.

   c(k+3)+5c(k+2)+3c(k+1)+2c(k) = u(k+1)+u(k)

   b) Prove the properties of STM in discrete data system.

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5. Investigate the controllability and observability of the following system.

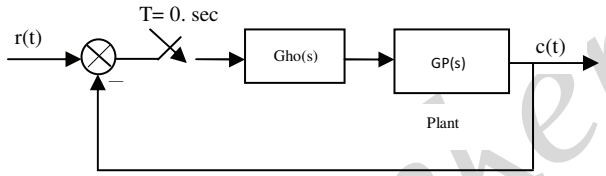
a) $x(k+1)=\begin{bmatrix}-1 & 1\\ 0 & -1\end{bmatrix}x(k)+\begin{bmatrix}0\\ 1\end{bmatrix}u(k), y(k)=\begin{bmatrix}1 & 1\end{bmatrix}x(k)$

b) $x(k+1)=\begin{bmatrix}1 & -2\\ 1 & -1\end{bmatrix}x(k)+\begin{bmatrix}1 & 0\\ 0 & -1\end{bmatrix}u(k), y(k)=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}x(k)$

What can you say about controllability and observability of the state model in part (a) without making any further calculations.

6. The block diagram of a digital control system as shown in below figure, where

$$Gp(s)=\frac{k}{s(s+2)}$$



7. a) Explain the design in the z-plane using the root locus diagram.
b) Discuss the digital PID controllers.

8. Consider the multiple-input digital control system

$x[(k+1)T]=Ax(KT)+Bu(KT)$

$Where\ A=\begin{bmatrix}0 & 1\\ -1 & -2\end{bmatrix}, B=\begin{bmatrix}1 & 0\\ 0 & 1\end{bmatrix}$

The pair [A,B] is controllable. Determine the state feedback matrix 'G' such that the state feedback.

$u(KT)=-Gx(KT)$

Places the closed loop eigen values at z_1=0.1 and z_2=0.2

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1. a) What are the most commonly used digital to analog converters and explain weighted – register 3
   bit converter.
   b) Illustrate the discrete data and digital control system with a simplified single – axis autopilot control system.

2. a) What are the limitations of z-transform?
   b) Find the z transform for the following functions
   i) $F(s) = \frac{2}{s(s^2+1)}$ ii) $F(s) = \frac{2}{s^2+2s+2}$
   c) Find the inverse z – transform for the following functions.
   i) $F(z) = \frac{2z}{(2z-1)^2}$ ii) $F(z) = \frac{z-0.2}{z^2+z+1}$

3. a) Determine the pulse transfer function of the following transfer function.

$$F(s) = \frac{(s+2)}{(s+1)(s+4)}$$

   b) Solve the following difference equation using z-transform method.

$$c(k+2) - 0.1c(k+1) - 0.2c(k) = r(k+1) + r(k)$$
$$Where\ r(k) = u_s(k)\ for\ k = 0,1,2.....,c(0) = 0\ and\ c(1) = 0$$

4. Determine the state model for the following difference equation. Also find its STM
$$y(k+2) + 2y(k+1) + 4y(k) = 3u(k) + 7u(k)$$

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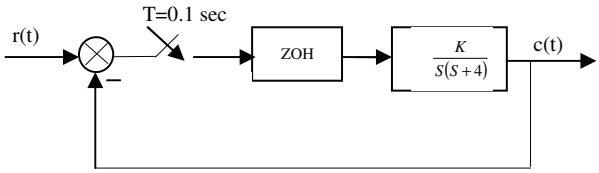
5. a) State and explain the concept of controllability and observability.
   b) Consider a linear discrete – data control system, whose input – output relation is described by the difference equation.

   c(k+2)+3c(k+1)+c(k) = u(k+1)+u(k)

   Test for state controllable and output controllable.

6. Sketch the root loci and find K for asymptotic stability of the following digital control system.



7. Explain the design of digital control systems with digital controllers through bilinear transformation.

8. The dynamic equations of a digital process are given as

$$x(k+1) = Ax(k) + Bu(k), c(k) = Dx(k)$$

$$Where\ A = \begin{bmatrix} 0 & 1 \\ 1 & 0 \end{bmatrix}, B = \begin{bmatrix} 0 \\ 1 \end{bmatrix}, D = \begin{bmatrix} 1 & 1 \end{bmatrix}$$

The State feedback control $u(k) = -G\,x(k), Where\ G = \begin{bmatrix} g_1, g_2 \end{bmatrix}$. Assume that the state variables are un accessible, design a full order state observer so that *x(k)* is observed from *c(k)*. Find the elements of G interns of g_1 and g_2 so that the dynamics of the observer are the same as that of the closed loop digital process.

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Code No. M1025/R07 **Set No.3**

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DIGITAL CONTROL SYSTEMS

(Common to Electronics & Instrumentation Engineering and Electronics &Control Engineering)

Time: 3 hours **Max. Marks: 80**

Answer any FIVE Questions

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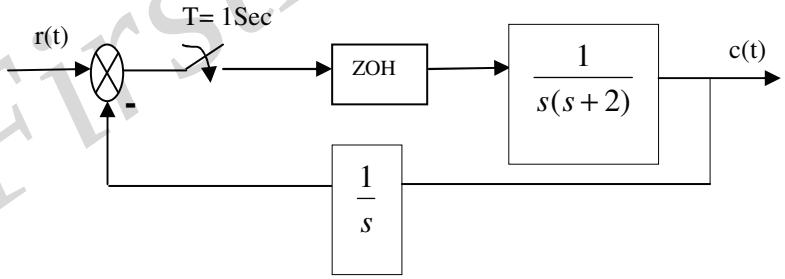
1. a) What are the most commonly used analog to digital conveners and explain successive approximation converter.
   b) Discuss the basic elements of a discrete -data control system.

2. a) State and explain four important Z- transform theorems.
   b) Find the inverse z- transform of the following functions

   $(i)\ F(z) = \dfrac{2z}{z^2 - 1.2z + 0.5}$ $(ii)\ F(z) = \dfrac{z(z+1)}{(z-1)(z^2-z+1)}$

3. For the sampled data system show in below figure, find the response to unit step input



4. Find the state model for the following difference equation .Obtain different canonical forms. Also draw state diagram for each

   c (k+2) + c (k+1) +c(k) =3u(k)

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5. a) Explain controllability ,observability and their tests.
   b) Examine whether the discrete data system

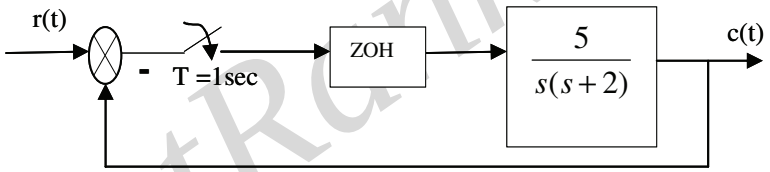
$$x(k+1) = A\,x(k) + B\,u(k)$$

$$y(k) = Cx(k)$$

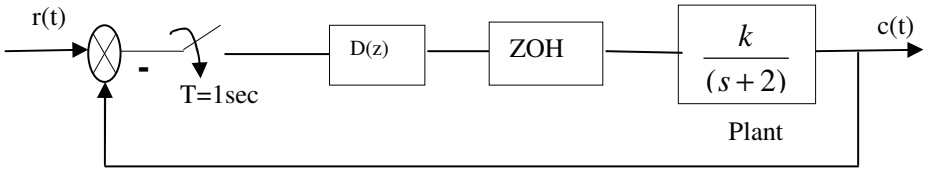
Where $A = \begin{bmatrix} 0 & 2 \\ -1 & 1 \end{bmatrix}$, $B = \begin{bmatrix} -1 \\ 1 \end{bmatrix}$, $C = \begin{bmatrix} 0 & 1 \end{bmatrix}$ is

(i) State controllable
(ii) Output controllable
(iii) Observable

6. Using the bilinear transformation , determine whether the following system is stable



7. Consider the system show in below figure ,design lead compensation $G_c(z)$ in ω - plane for this system to meet the following specifications
   (i) Damping ratio = 0.6
   (ii) Settling time =1.2sec
   (iii) Velocity error constant =3sec^{-1}



8. a) Explain the pole placement design by state feedback with multi input digital control system
   b) Discuss the design of reduced order observer with neat block diagram.

Code No. M1025/R07 **R07** **Set No.4**

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DIGITAL CONTROL SYSTEMS

(Common to Electronics & Instrumentation Engineering and Electronics &Control Engineering)

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*****

1. a) Explain the sample and hold operation with neat circuit diagram and wave form.
   b) Illustrate the discrete data and digital control system with microprocessor - controlled system.

2. a) State and explain modified Z- transforms.
   b) Find the inverse Z- transform using partial fraction expansion for the following function

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

3. a) Explain the mapping between S-plane and Z-plane.
   b) Solve the following difference equation using the Z- transforms method
   $c(k+2)- 1.5c(k+1)+ c(k)= 2u_s(k)$
   Where $c(0)= 0, c(1)=1$

4. Write the state equations and the output equation of the following difference equation $c(k+3) + 5c(k+2)+ 3c(k+1)+ 2ck(k) = u(k)$.Also find the state transition matrix.

5. a) Develop relationship between controllability ,observability and transfer function of discrete –data control system
   b) Examine whether the discrete data system

$$x(k+1) = A\,x(k) + B\,u(k)$$

$$y(k) = C\,x(k)$$

Where $A = \begin{bmatrix} 0 & -2 \\ -1 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 2 & 0 \\ 0 & -1 \end{bmatrix}$, $C = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix}$ is

(i)State controllable and (ii) observable

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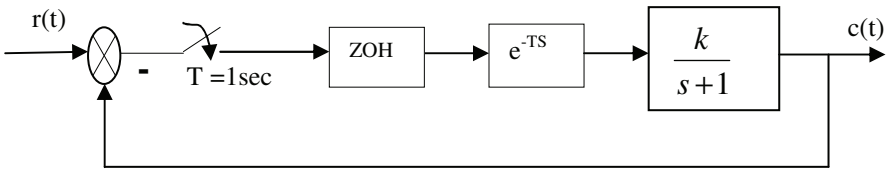
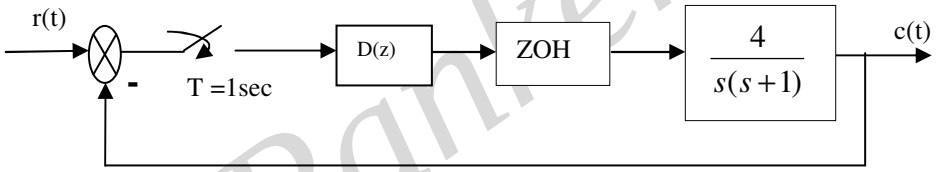
6. Determine the range of "k" for the system show in below figure to be stable.



7. A block diagram of a digital control system is show in below figure. Design a PID D(z) to eliminate the steady error due to a step input and simultaneously realizing A good transient response and the ramp error constant $K_v \leq 3$



8. a) Explain the pole placement design by state feed back with single input digital control system
   b) Discuss the design of full order observer with neat block diagram.