Code No. K0223 **R07** **Set No.1**

IV B.Tech II Semester Supplementary Examinations, July/August, 2012
DIGITAL CONTROL SYSTEMS
(Electrical and Electronics Engineering)

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

Answer any FIVE Questions
All Questions carry equal marks
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1. a) Explain different methods of A/D conversion?
   b) Explain the sample and hold circuits with a neat circuit diagram. [8+8]

2. a) Obtain the inverse z-transform of the following:
   (i) $X(Z) = [Z(Z+2)]/[(Z-1)^2]$
   (ii) $X(Z) = [Z^{-2}]/[(1-Z^{-1})^3]$
   b) Obtain the Z-transform of the following
   (i) $X(S) = \frac{a}{s^2(s+a)}$ (ii) $X(S) = \frac{s}{(s^2-\omega^2)}$ [8+8]

3. a) Explain bounded-input, bounded-output stability.
   b) Solve the following difference equation by the use of Z-transform method.
   $X(K+2) + 3X(K+1) + 2X(K) = 0; with X(0) = 0, X(1) = 1$ [8+8]

4. Consider the discrete control system represented by the transfer function.
   $G(Z) = \frac{Z^{-1}(1+Z^{-1})}{(1+0.5Z^{-1})(1-0.5Z^{-1})}$ Obtain the state space representation in the diagonal form. Also, find its state transition matrix. [16]

5. a) State and explain the Obsevability theorem.
   b) Derive the relation between controllability, obeservabilit and transfer function. [8+8]

6. a) Determine the Z-transform of the following sequence:
   $$f(K) = \begin{cases} 1, K = 0, and, even, \text{int}eger \\ -1, K = odd, \text{int}eger \end{cases}$$
   b) State Z- Transform and obtain the relation between Z-plane and S-plane transformations. [8+8]

7. a) Write short notes on PID controllers
   b) Explain the design procedure of lead-lag compensator in W-plane. [8+8]

8. Explain the reduced order state observer with block diagram. [16]

Code No. K0223 **R07** **Set No.2**

IV B.Tech II Semester Supplementary Examinations, July/August, 2012
DIGITAL CONTROL SYSTEMS
(Electrical and Electronics Engineering)

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

Answer any FIVE Questions
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*****

1. What are the advantages and disadvantages of digital control system over analog control system? With suitable diagram explain any two methods of digital to analog conversion. [6+10]

2. a)Find the Z-Transform of the following

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

   b) State and prove "initial and final "values theorems. [10+6]

3. a) Explain the mapping between S-plain and Z-plain.

   b) Solve the following difference equation

   $X(K)-0.6X(K-1)-0.812X(K-2)+0.67X(K-3)-0.12X(K-4)=Y(K)$

   All the initial conditions are assumed to be zero. [8+8]

4. A discrete system is described by the difference equation

   $Y(K+2)+3Y(K+1)+2Y(K)=r(K)$

   $Y(0)=Y(1)=0, T=1Sec.$

   a) Determine a state variable model for the system. Draw the state diagram.

   b)Find the state transition matrix [8+8]

5. Examine whether the discrete data system given below.

   $X(K+1)=\begin{bmatrix}0 & 1\\ -3 & -4\end{bmatrix}X(K)+\begin{bmatrix}1\\ -1\end{bmatrix}u(K)$

   $Y(K)=\begin{bmatrix}1 & 0\end{bmatrix}X(K)$

   Is (i) State controllable (ii) Output controllable (iii) Observable [6+6+4]

6. a) Solve the following difference equation by the use of Z-transform method

   $X(K+2)+3X(K+1)+2X(K)=0;$ with $X(0)=X(1)=1$.

   b)Explain the mapping between S-plane and Z-plane [10+6]

7. The digital control process of a unity feedback system is described by the transfer function $G_{ho}G_p(Z) = \dfrac{K(Z+0.5)}{(Z-1)(Z-0.5)}$,

   Design a cascade phase –lag controller with the transfer function

   $D(Z) = K_c \dfrac{Z-Z_1}{Z-P_1}$, so that the following design specifications are satisfied.

   (i) $K_V = 6$

   (ii) The dominant roots of the closed loop characteristic equation are approximately at $Y(K)$

   (iii) The maximum overshoot is ≤ 15 present. [16]

8. Consider the digital process with the state equation described by

   $X(K+1) = \begin{bmatrix} 0 & 1 \\ -1 & 1 \end{bmatrix} X(K) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U(K)$ and $Y(K) = \begin{bmatrix} 2 & 0 \end{bmatrix} X(K)$

   Design a full order observer which will observe the states $X_1(K)$ and $X_2(K)$ from the output $Y(K)$, having dead beat response. [16]

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

Answer any FIVE Questions
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*****

1. a) Explain the functions of the following in a digital control system:
   (i) Hold circuit (ii) sampling (iii) Data hold
   b) Describe the following parameters
   (i) Acquisition time (ii) Aperture time and (iii) settling time [8+8]

2. a) Find the inverse Z-transform of the following
   (i) $X(Z) = Z(Z+2)/(Z-1)^2$ (ii) $(2Z^3+Z)/(Z-2)^2(Z-1)$
   b) Explain the procedure for obtaining pulse transfer function of a closed loop transfer function. [10+6]

3. a) Determine the pulse transfer function of two cascaded system, each described by the difference equation. $Y(K) = 0.5Y(K-1) + r(K)$
   b) Explain bounded-input, bounded-output stability [10+6]

4. A discrete – time system is described by the difference equation.
   $Y(K+2) + 5Y(K+1) + 6Y(K) = u(K)$
   $Y(0) = Y(1) = 0; T = 1Sec.$
   Determine a state model in canonical form.
   a) Find the state transition matrix
   b) For input $u(K) = 1, for K \geq 0, Find, Y(K).$ [8+8]

5. Investigate the controllability and observability of the following system.
   $$\begin{bmatrix} X_1(K+1) \\ X_2(K+1) \end{bmatrix} = \begin{bmatrix} 1 & -2 \\ 1 & -1 \end{bmatrix} \begin{bmatrix} X_1(K) \\ X_2(K) \end{bmatrix} + \begin{bmatrix} 1 & -1 \\ 0 & 0 \end{bmatrix} u(K)$$
   $$\begin{bmatrix} Y(K) \\ X(K) \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} X_1(K) \\ X_2(K) \end{bmatrix}$$
   [16]

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6. a) Explain the mapping between S-plane and Z-plane.
   b) Using Jury's stability criterion, find the range of K for which the characteristic equation given below,
   $Z^3 + KZ^2 + 1.5Z - (K+1) = 0$ is representing the closed loop stable system. [8+8]

7. a) Explain the design procedure in the ω-plane of lag compensator.
   b) Explain the design of digital control through deadbeat response method. [8+8]

8. Draw the schematic diagram of full order observer. State the salient steps involved in design of state feedback controller through pole placement. [16]

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DIGITAL CONTROL SYSTEMS
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Answer any FIVE Questions
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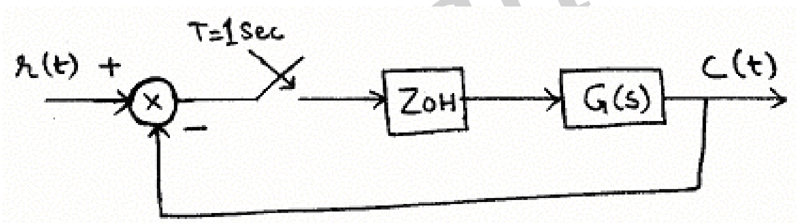
1. a) With a suitable circuit, explain the operation of sampler and hold devices. Also derive the transfer function of zero-order hold.
   b) With help of diagram explain the successive approximation analog to digital converter. [8+8]

2. a)Obtain the Z-transform of
   (i) $f(t) = t^2$ (ii) $f(t) = e^{(-at)} \sin \omega t$
   b) Explain the different properties and theorems of Z-transforms. [8+8]

3. For the sampled data system shown in fig., find the response to unit step input if $G(s) = \dfrac{1}{s+1}$



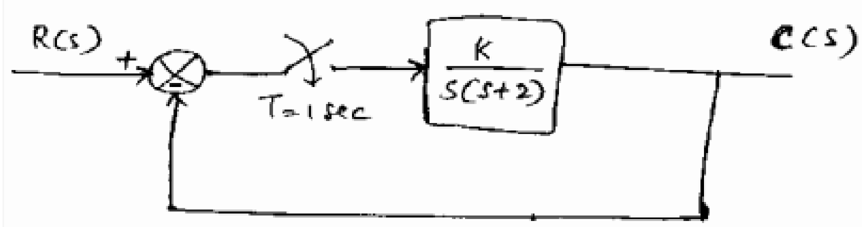
[16]

4. a) Using Z-transform method find the state transition matrix for the digital system is given by. $X(K+1) = \begin{bmatrix} 0 & 1 \\ -3 & -4 \end{bmatrix} X(K)$

   b) Explain the properties of state transition matrix. [10+6]

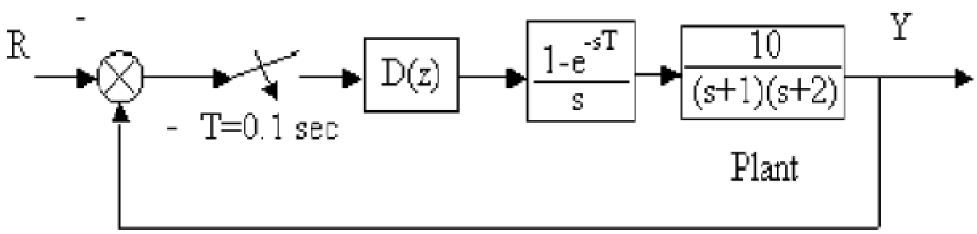
5. a) Derive the necessary condition for digital control system
   $X(K+1) = GX(K) = Hu(K)$
   $Y(K) = CX(K)$ to be output controllable and observable.
   (b) $Y(K) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} X(K)$
   Is (i) output controllable (ii) Observable. [8+8]

6. a) State and explain Jury stability test applied to discrete time controls. Consider the digital system shown in figure.
   b) Find the range of K for the system to be stable using Jury stability test.



[8+8]

7. A block diagram of a digital control system is shown in Figure. Design a PID controller D(Z),to eliminate the steady state error due to a step input and simultaneously realizing a good transient response, and the ramp error constant Kv should be equal 5. [16]



8. Consider the digital process with the state equation described by

$$X(K+1)=\begin{bmatrix}1 & -1\\ -1 & 0\end{bmatrix}X(K)+\begin{bmatrix}1\\ 0\end{bmatrix}U(K) \text{ and } Y(K)=\begin{bmatrix}0 & 2\end{bmatrix}X(K)$$

Design a full order and reduced order observer which will observe the states $X_1(K)$ and $X_2(K)$ from the output $Y(K)$, having dead beat response. [16]