Hall Ticket No: | | | | | | | | | | | Question Paper Code :

ANIL NEERUKONDA INSTITUTE OF TECHNOLOGY & SCIENCES

(AUTONOMOUS)

M.E/M.Tech I-Semester Regular Examinations, November 2015

Digital Control Systems

(Control Systems Engineering)

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

Answer ONE Question from each Unit
All Questions Carry Equal Marks
All parts of the question must be answered in one place only

Note: -
1. **Answer ALL the questions.**
2. **ALL questions carry equal marks.**

1. a. Why digital control so accepted. Draw the block diagram of digital control system, explaining the function of every component. (6 M)

   b. Obtain the solution of the differential equation given by (6 M)

$$x(k+2)-1.5x(k+1)+0.5x(k)=u(k)$$

Where u(k) is unit step function, given initial conditions x(0) =1, x(1) =2.5.

(or)

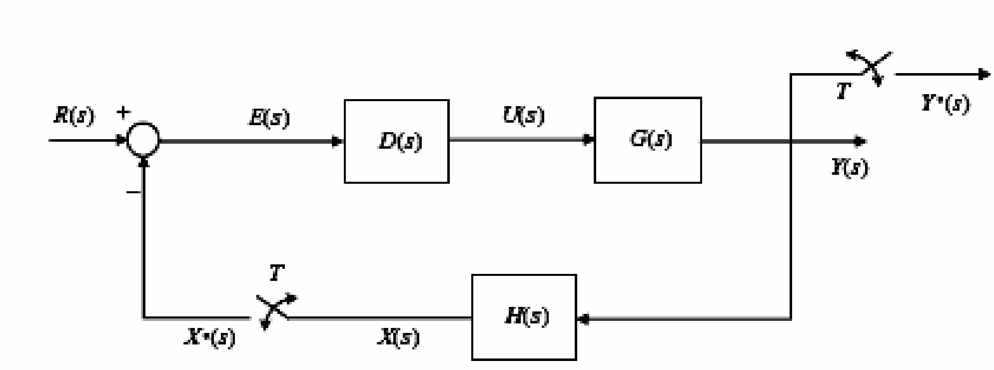
2. a. Explain in detail about limits of sampling rate and how we can reconstruct a signal from its sampled form. (6 M)

   b. Discuss the effects of Z-plane poles and zeros on time response of a system. (6 M)

3. a. Find the modified z-transform for $y(t) = e^{-pt}$, p=4, T=0.2s, delay of 0.5T. (4 M)

   b. Obtain the pulse transfer function of the given system. Given (8 M)

$$D(s)=5\frac{s+1}{s}\left(1-e^{-sT}\right);\ G(s)=5\frac{4}{((s+2)^2+5)}\left(1-e^{-sT}\right),\ H(s)=1$$



(or)

4. a. Obtain the transfer function of Zero order hold device. (6 M)

b. Find the steady-state position error for the digital position control system with unity feedback and with the transfer functions $G_{ZAS}(z) = \frac{K(z+a)}{(z-1)(z-b)}$

$C(z) = \frac{K_c(z-b)}{(z-c)}$ $0 < a, b, c < 1$ (6 M)

1. For a sampled unit step input.
2. For a sampled unit ramp input.

5. a. Using Jury's Stability test, determine the stability of the following systems. (6 M)

(i) $Z^5 - 6Z^4 + 9Z^3 + 12Z^2 - 7Z + 1 = 0$

(ii) $Z^4 - 1.55Z^3 + 0.5Z^2 - 0.5Z + 1 = 0$

b. Determine the maximum value of K for which the unity feedback system (6 M) with the forward transfer function will be stable. Use w-plane for analysis.

G(z)=[K(0.368z+0.264)]/[(z-1)(z-0.368)].

(or)

6. a. Explain in detail about stability of digital contol systems.

b. Explain Bilinear Transformation method of converting an analog system to a digital system . Derive the mapping formula.

7. a. Define Controllability and Observability. Explain whether the discrete data control system (i) state controllable (ii) output controllable (iii) observable (6 M)

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

b. Discretize the state equation with sampling time T= π. (6 M)

$$\frac{dx(t)}{dt}=\begin{bmatrix} 0 & 1 \\ -2 & -2 \end{bmatrix}x(t)+\begin{bmatrix} 1 \\ 1 \end{bmatrix}u(t)$$
$$y(t)=[2 \quad 3]x(t)$$

(or)

8. a. Find the state variable model for the following system represented by the difference equation. Find its eigen values and eigen vectors. (6 M)

$$y(k+3)+7y(k+2)+15y(k+1)+9y(k)=5r(k+1)+3r(k).$$

b. Obtain the state transition matrix of given state equation (6 M)

$$x(k+1)=\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -10 & -11 \end{bmatrix}x(k)+\begin{bmatrix} 0 \\ 0 \\ 10 \end{bmatrix}u(k)$$

9. a. A discrete time regulator system has the plant equation (6 M)

$$X(k+1)=\begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix}X(k)+\begin{bmatrix} 3 \\ 4 \end{bmatrix}U(k)$$
$$Y(k)=[1 \quad 1]X(k)$$

Design a state feedback control system with U (k) =-KX (k) to place the closed loop poles at $\pm j0.5$.

b. Briefly explain the design procedure for a full order observer. (6 M)

(or)

10. a. Explain the '*Separation Principle*' applied to linear systems. (6 M)

b. With an example illustrate the design of a reduced order observer. (6 M)