Code No: **RT42021** **R13** **Set No. 1**

IV B.Tech II Semester Regular/Supplementary Examinations, April/May - 2019

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A (22 Marks)

1. a) Briefly explain the basic components of a digital control system. [4]
   b) What is shifting theorem of z-transforms? [3]
   c) What are the advantages of state space approach compared to conventional approach in system analysis? [4]
   d) What are Primary strips and Complementary Strips? [4]
   e) Explain the need for compensation in digital control systems. [3]
   f) What is pole placement by state feedback? [4]

PART–B (3x16 = 48 Marks)

2. a) Explain the merits and demerits of digital control systems compared to analog control systems. [8]
   b) Derive the transfer function of zero order hold device. [8]

3. a) Obtain the pulse transfer function of the system $G(s) = \frac{1-e^{-Ts}}{s}\left(\frac{1}{s(s+1)}\right)$. [8]
   b) Find the inverse Z-Transform of the following:
   $(i)\ F(z) = \frac{z-4}{(z-1)(z-2)^2}$ (ii) $F(z) = \frac{z^2}{(z-1)(z-0.2)}$. [8]

4. a) Obtain the state transition matrix of the following discrete time systems
   $$X(k+1) = GX(k) + Hu(k)$$
   $$where\ G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}, H = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$ [8]
   b) Consider the following pulse transfer function system:
   $$\frac{Y(z)}{U(z)} = \frac{z^{-1}(1+0.8z^{-1})}{1+1.3z^{-1}+0.4z^{-2}}$$
   Test the state controllability and observability. [8]

5. a) Determine the stability of the following characteristic equation by using suitable tests. $z^4 - 1.7z^3 + 1.04z^2 - 0.268z + 0.024 = 0$. [8]
   b) With an example explain the stability analysis using Modified routh's stability criterion. [8]

6. a) The characteristics equation of a discrete time system is $1 + \frac{Kz(1-e^{-T})}{(z-1)(z-e^{T})} = 0$, Draw the root locus for T=0.5 sec. [8]
   b) Explain the transient response specifications with reference to unit step response of discrete time response. [8]

7. a) Consider the following system

$$X(k+1) = GX(k) + Hu(k)$$

$$where\ G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}, H = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

Determine a state feedback controller K to place the closed loop poles at z=0.5±j0.5. [8]

b) What is the necessary and sufficient condition for arbitrary pole-placement? Prove the sufficiency of the condition. [8]

Code No: **RT42021** **R13** **Set No. 2**

IV B.Tech II Semester Regular/Supplementary Examinations, April/May - 2019

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A (22 Marks)

1. a) What are the disadvantages of digital control systems over analog systems? [4]
   b) Find the inverse Z-transform of $\frac{az}{(z-a)^2}$ [3]
   c) What are the properties of State transition matrix? [4]
   d) Distinguish between Routh's criterion and Modified Routh's stability criterion. [4]
   e) List out the steady state specifications. [3]
   f) How is state feedback controller useful for pole placement? [4]

PART–B (3x16 = 48 Marks)

2. a) Describe any two examples of digital control system. [8]
   b) Explain the Frequency domain characteristics of zero order hold. [8]

3. a) State and explain the following theorems of z-transforms:
   (i) Initial value theorem (ii) Final Value theorem [8]
   b) The pulse transfer function of digital control systems is given by
   $$G(z) = \frac{5z}{z^2 + 3z + 2}$$
   Find the complete solution to a unit step input and assume that, the initial conditions are zero. [8]

4. a) Consider the system defined by
   $$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(k)$$
   $$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$
   Determine the conditions on a,b,c and d for complete state controllability and complete observability. [8]
   b) Obtain the state transition matrix of the following discrete time system:
   $$x(k+1) = Gx(k) + Hu(k)$$
   $$y(k) = Cx(k)$$
   Where
   $$G = \begin{bmatrix} 0 & 1 \\ -2 & -2 \end{bmatrix}, H = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$ [8]

5. a) Explain the mapping between S-plane and Z-plane. [8]
   b) Write down the rules in Jury stability criterion. [8]

6. a) Explain the design procedure for Lag –Lead compensator in ω-plane. [8]
   b) Explain the angle and magnitude conditions for the characteristic equation 1+G(z)H(z)=0 for drawing root locus. [8]

7. a) Derive ‘Ackerman’s formula’ for pole placement. [8]
   b) Consider the following system

$$X(k+1) = GX(k) + Hu(k)$$
$$where\ G = \begin{bmatrix} 1 & 0.2 \\ 0 & 1 \end{bmatrix}, H = \begin{bmatrix} 0.02 \\ 0.2 \end{bmatrix}$$

   Determine a state feedback controller K to place the closed loop poles at z=0.6±j0.4. [8]

Code No: **RT42021** **R13** **Set No. 3**

IV B.Tech II Semester Regular/Supplementary Examinations, April/May - 2019

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B

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PART–A ***(22 Marks)***

1. a) Write down the advantages of digital control systems over analog systems. [4]
   b) Obtain the z-transform of sin ωt. [3]
   c) Explain the concept of observability. [4]
   d) Write the mapping points between S-Plane and Z-plane. [4]
   e) Write the general form of transfer functions for (i) Lead compensator and (ii) Lag compensator. [3]
   f) Draw the block diagram of a closed loop discrete time system that uses state feedback controller for pole placement. [4]

PART–B ***(3x16 = 48 Marks)***

2. a) Draw and explain the general block diagram of discrete data control system. [8]
   b) Explain how a zero order hold helps in data reconstruction. [8]

3. a) Using z-transforms solve the equation given below
   $x(k+2)+3x(k+1)+2x(k)=0, x(0)=0, x(1)=1$ [8]
   b) Explain the procedure for obtaining the pulse transfer function of a closed loop transfer function. [8]

4. a) What is state transition matrix? What are its properties? [6]
   b) Given the following state model of the system
   $$X(k+1)=\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix} X(k)+\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -1 & 1 \end{bmatrix} U(k)$$
   $$Y(k)=\begin{bmatrix} 0 & 1 & -1 \\ 1 & 2 & 1 \end{bmatrix} X(k)$$
   Obtain the state transition matrix. [10]

5. a) Examine the stability of the following characteristic equation using jury stability analysis. $P(Z)=Z^4-1.2Z^3+0.07Z^2+0.3Z-0.08=0$ [8]
   b) Explain stability analysis using bilinear transformation and Routh stability criterion. [8]

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6\. a) Explain the design procedure in the ω - plane of lead compensator. [8]

b) A block diagram of a digital control system is shown in figure, Draw the root locus for sampling period T=0.4 sec.

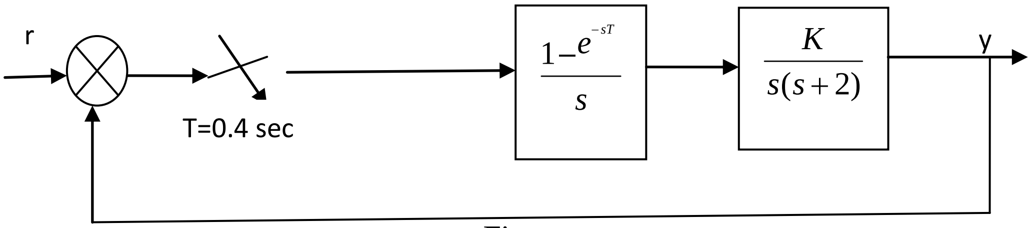

Figure [8]

7\. a) State and prove the necessary condition for arbitrary pole-placement? [8]

b) Consider the following system

$$X(k+1) = GX(k) + Hu(k)$$
$$where\ G = \begin{bmatrix} 1 & 0.2 \\ 0 & 1 \end{bmatrix}, H = \begin{bmatrix} 0.02 \\ 0.2 \end{bmatrix}$$

Determine a state feedback controller K to place the closed loop poles at z=0.4±j0.6. [8]

Code No: **RT42021** **R13** **Set No. 4**

IV B.Tech II Semester Regular/Supplementary Examinations, April/May - 2019

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 hours **Max. Marks: 70**

Question paper consists of Part-A and Part-B
Answer ALL sub questions from Part-A
Answer any THREE questions from Part-B
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PART–A *(22 Marks)*

1. a) What is sampling theorem? What is its importance? [4]
   b) State initial and final value theorems. [4]
   c) Explain the concept of controllability. [3]
   d) Explain the mapping between S-plane and Z-plane. [4]
   e) Write the expressions for static position error constant and steady state error in response to a unit step input in discrete time systems. [4]
   f) Explain 'Ackerman's formula' for pole placement. [3]

PART–B *(3x16 = 48 Marks)*

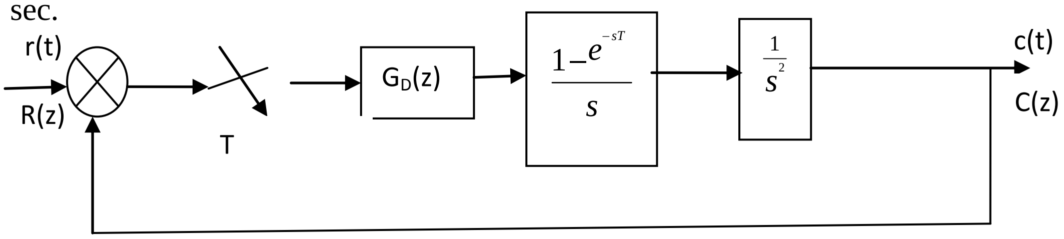
2. a) Explain in detail the process of sampling and reconstruction of signals. [8]
   b) Draw the schematic diagram of basic discrete data control system and explain the same. [8]

3. a) Find inverse z –transform of (i) $\frac{1}{(z+a)^2}$ (ii) $\frac{2}{(2z-1)^2}$ [8]
   b) Explain the procedure for obtaining the pulse transfer function of open loop transfer function. [8]

4. a) Derive an expression to find the state transition matrix of a discrete system. [8]
   b) Obtain the discrete time state and output equations of the following continuous time system. $\dot{X} = AX + bu$; $Y = CX$ where $A = \begin{bmatrix} 0 & 1 \\ 0 & -2 \end{bmatrix}$; $b = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$; $C = [1 \quad 0]$ [8]

5. a) Explain the mapping procedure for the following from s-plane to z-plane
   (i) The constant damping loci (ii) The constant frequency loci [8]
   b) Use the Routh-Hurwitz criterion to find the stable range of K for the closed loop unity feedback system with loop gain $F(z) = \dfrac{K(z-1)}{(z-0.1)(z-0.8)}$. [8]

6. Consider the digital control system shown in figure, where the plant transfer function is $\frac{1}{s^2}$. Design a digital controller in the w-plane such that the phase margin is 50^0 and the gain margin is atleast 10 dB. The sampling period is 0.1 sec.



[16]

Figure

7. a) Explain the step by step procedure of pole placement by state feedback in discrete systems. [8]

   b) Consider the following system

$$X(k+1) = GX(k) + Hu(k)$$
$$where\ G = \begin{bmatrix} 1 & 0.2 \\ 0 & 1 \end{bmatrix}, H = \begin{bmatrix} 0.02 \\ 0.2 \end{bmatrix}$$

   Determine a state feedback controller K to place the closed loop poles at z=0.3±j0.3. [8]