Code No:**R1642021** **R16** **Set No. 1**

IV B.Tech II Semester Regular/Supplementary Examinations, June - 2022

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 FOUR questions from Part-B

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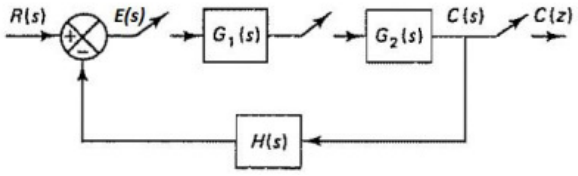
PART–A *(14 Marks)*

1. a) What are the merits of the digital control system? [3]
   b) Define Z- Transform theorems. [2]
   c) Write down the properties of state transition matrix. [2]
   d) Write about the mapping of left half of the s-plane into z-plane. [2]
   e) What is the need of lag-lead compensators? [2]
   f) What are the necessary conditions for state feedback controller. [3]

PART–B *(4x14 = 56 Marks)*

2. a) Derive the expression for transfer function of zero order hold. [7]
   b) With suitable timing diagram explain the following characteristics of a sample and hold device. (i) Acquisition time (ii) Aperture time (iii) Settling time [7]

3. a) Find the z transform of the sequence $f(k) = \left(\frac{1}{2}\right)^k$ for k=0, 1, 2, [7]
   b) Obtain the Pulse transfer function of the given closed loop system [7]



4. a) Derive the expression for state transition matrix ϕ(k) using z-transform method. [7]
   b) Investigate the controllability and observability of the system given below after forming the controllability and observability matrix. [7]

$$x(k+1) = \begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k) \; ; \; y(k) = [1 \quad 0] x(k)$$

5. a) Describe the stability analysis of digital control system using Routh Hurwitz criterion [7]
   b) Consider the following characteristic equation [7]
   $F(z)=z^3 - 1.2z^2 - 0.05z + 0.2 = 0$, verify whether or not any of the roots of the characteristic equation lie outside the unit circle in the z-plane. Use modified Routh's stability criterion.

6. The open loop transfer function of a unity – feedback digital control system is given as $F(z) = \frac{kz}{(z-1)(z-3)}$ Sketch the root loci of the system $0 < K < \infty$. Indicate all important information on the root loci. [14]

7. a) Explain in detail the procedure for state regulator design using pole placement method for a digital control system [7]
   b) Prove Ackermann's formula for the determination of the state feedback gain matrix K. [7]

Code No:**R1642021** **R16** **Set No. 2**

IV B.Tech II Semester Regular/Supplementary Examinations, June - 2022

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 FOUR questions from Part-B

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PART–A *(14 Marks)*

1. a) What is a sample and hold circuit? [2]
   b) What is the property of linearity of z-transforms? [3]
   c) What are the different ways of state space representation? [2]
   d) Write the discrete time state equations of a pulse function. [2]
   e) Write about primary and complimentary strips. [2]
   f) What are the necessary and sufficient conditions in design via pole placement? [3]

PART–B *(4x14 = 56 Marks)*

2. a) With suitable diagrams explain how data reconstruction is done in zero order hold and first order hold. Derive transfer functions for each. [7]
   b) With a block diagram, discuss the basic elements of a discrete -data control system. [7]

3. a) Determine the in usage Z transform of i) $\frac{2Z}{(Z-2)^2}$ and (ii) $\frac{Z}{Z^2-Z-3}$ [7]
   b) Solve the difference equation y(k+2)+0.4 y (k+1) + 0.1 y(k) = u(k) using Z transform. Given y(0)=0; y(1)=0. [7]

4. a) Determine the discrete time state equation and output equation for the continuous time system given: (when T=1sec) $G(s) = \frac{Y(S)}{U(S)} = \frac{1}{s(s+2)}$ [7]
   b) Explain the Concepts of Controllability and observability. [7]

5. a) Determine the stability of the system using Jury's stability test for the characteristic equation $P(z)=z^4-12z^3+0.07z^2+0.3z-0.08=0$ [7]
   b) Explain mapping between the s-Plane and the z-Plane [7]

6. a) Explain the design procedure in the w-plane of lag compensator [7]
   b) List out the transient response specifications and explain in brief. [7]

7. a) Explain the concept of pole placement by state feedback. [7]
   b) Consider the system is given by [7]

$$X(k+1) = \begin{pmatrix} 0 & 1 \\ -0.2 & -1 \end{pmatrix} X(k) + \begin{pmatrix} 0 \\ 1 \end{pmatrix} u(k)$$

Determine the state feedback gains 'K' to place the eigen values at 0.2, 0.3 using Ackermann's formula

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IV B.Tech II Semester Regular/Supplementary Examinations, June - 2022

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 FOUR questions from Part-B

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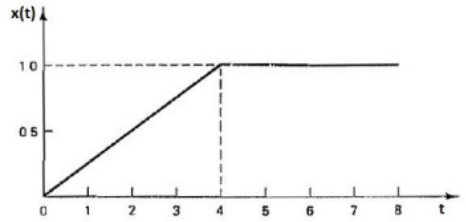
PART–A *(14 Marks)*

1. a) What is a discrete data control system? [2]
   b) Determine the z-transform of sin ωt? [3]
   c) Define the concept of controllability [2]
   d) Give comment on the stability of F(z)= z^2-0.2 =0 by using Jury's stability criterion? [2]
   e) Derive an expression for steady state error for ramp input. [3]
   f) Define the pole placement method. [2]

PART–B *(4x14 = 56 Marks)*

2. a) With suitable block diagram, explain the sample and hold circuit. [7]
   b) Describe the sampling theorem and data reconstruction. [7]

3. a) Find the z-transform of x(t) shown in figure. Assume sampling period T=1s [7]



   b) Find the inverse Z transform of $x(z) = \frac{z^2}{(z-1)(z-0.5)^2}$ [7]

4. a) Write the state space representation of a linear time invariant discrete time control system. Explain various matrices in the representation. [7]
   b) Consider the system $\frac{Y(z)}{U(z)} = \frac{z+2}{z^2-2z+3}$. Determine (i) Controllable canonical form (ii) Observable canonical form (iii) Diagonal form. [7]

5. a) State and explain jury's stability test [7]
   b) Using Rouths stability criterion determine the range of K, for which the characteristic equation $z^3 + kz^2 + 1.5kz - (k + 2) = 0$ is closed loop stable. [7]

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6. a) A unity feedback system is characterized by the open loop transfer function $G_{h0}G(z) = \frac{0.5(z+0.5)}{(z-1)(z-0.3)}$.The sampling period T=0.1 sec, Find steady state errors for following (i) Unit Step (ii) Unit ramp (iii) Unit Parabolic. [7]
   b) State the rules for the construction of root loci of a sampled data control system [7]

7. a) Explain the concept of state feedback controllers? [7]
   b) Consider the system is given by $x(k+1) = \begin{pmatrix} 0 & 1 \\ -1 & -2 \end{pmatrix} x(k) + \begin{pmatrix} 0 \\ 1 \end{pmatrix} u(k)$ [7]
   Obtain the state feedback gains 'K' to place the Eigen values at 0.1, 0.2 using Ackermann's formula

Code No:**R1642021** **R16** **Set No. 4**

IV B.Tech II Semester Regular/Supplementary Examinations, June - 2022

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 FOUR questions from Part-B

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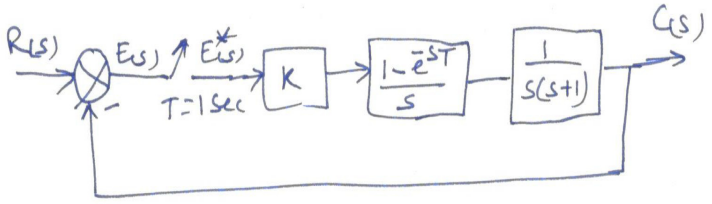
PART–A *(14 Marks)*

1. a) What are the advantages of digital system. [3]
   b) What is the z-transform of te^{-at} ? [2]
   c) Explain the concept of observability [3]
   d) Investigate the mapping from s-plane to z-plane of the constant frequency loci with neat sketch [2]
   e) Derive an expression for steady state error for step input. [2]
   f) What is meant by deadbeat response? [2]

PART–B *(4x14 = 56 Marks)*

2. a) Explain Mathematical modeling of the sampling process. [7]
   b) Describe the frequency domain characteristics of ZOH. [7]

3. a) Determine the pulse transfer function of the closed loop system given below for a sampling time of 1s and open loop gain K=1 [7]



   b) For the analog system $G(s) = \frac{10(s+2)}{s(s+5)}$ with a sampling period of 0.05sec, Determine the impulse response of the system with sampled output and analog input. [7]

4 a) Obtain the Jordan canonical form realization for the following transfer function [7]

$$G(z) = \frac{3z^2 - 4z + 6}{\left(z - \frac{1}{3}\right)^3}$$

   b) What are the various methods of evaluation of state transition matrix? Explain any one method. [7]

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5 a) Discuss the stability analysis of discrete control system using modified Routh stability [7]

b) Use the Routh-Hurwitz criterion to find the stable range of k for the closed loop unity feedback system with loop gain [7]

$$F(z) = \frac{k(z-1)}{(z-0.1)(z-0.8)}$$

6. a) Write about the general rules for constructing Root Loci in the z-Plane [7]

b) Explain the relation between the bilinear transformation and the w plane? [7]

7. a) Describe the Necessary and Sufficient conditions for state feedback controllers. [7]

b) Derive sufficient condition for the design of state feedback controller through pole placement. [7]