Code No: R1932024 **R19** **SET - 1**

III B. Tech II Semester Regular Examinations, June-2022

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
*****

UNIT-I

1. a) State sampling theorem. Explain how an analog signal can be reconstructed. [8M]
   b) Mention various advantages and disadvantages of digital control systems. [7M]

(OR)

2. a) What is the significance of sample and hold circuit? Explain the following parameters for sample and hold: [8M]
   (i) Acquisition time
   (ii) Aperture time
   (iii) Settling time
   (iv) Hold-mode droop
   b) Describe frequency-domain characteristics of a zero-order hold. [7M]

UNIT-II

3. a) State and prove the following theorems of z-transforms: [8M]
   (i) Shifting theorem (ii) Initial-value theorem
   b) Obtain the inverse z-transform of the following: [7M]
   (i) $X(z) = \frac{z^{-3}}{(1-z^{-1})(1-0.2z^{-1})}$ (ii) $X(z) = \frac{z^{-1}(1-z^{-2})}{(1+z^{-2})^2}$

(OR)

4. a) The input and output of a sampled data system is given by the difference equation [8M]
   $$y(k+2) + 3y(k+1) + 4y(k) = r(k)$$
   Determine the pulse transfer function. The initial conditions are y(0) = 0, y(1) = 1.
   b) State and prove differentiation in z-domain property of z-transform. [7M]

UNIT-III

5. a) Explain any one method of evaluation of state transition matrix. [8M]
   b) What is the importance of eigenvalues and state transition matrix? Explain. [7M]

(OR)

6. a) Investigate the controllability and observability of the following system: [8M]

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -4 & -4 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(k)$$

$$\begin{bmatrix} y_1(k) \\ y_2(k) \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

b) Explain the discretization of continuous-time state equations. [7M]

UNIT-IV

7. a) Using Jury's stability criterion, determine the stability of the following discrete-time systems: [8M]
(i) $z^3 + 3.3z^2 + 4z + 0.8 = 0$ (ii) $z^3 - 1.1z^2 - 0.1z + 0.2 = 0$

b) Describe the primary strips and complementary strips. [7M]

(OR)

8. a) Use the Routh-Hurwitz criterion to find the stable range of K for the closed-loop unity feedback system with loop gain [8M]

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

b) Explain the mapping between s-plane and z-plane. [7M]

UNIT-V

9. a) The closed loop transfer function for the digital control system is given as $\frac{C(z)}{R(z)} = \frac{z+0.5}{3(z^2-z+0.5)}$. Find the steady state errors and error constants due to step input. [8M]

b) Write the design procedure of lag compensator in w-plane. [7M]

(OR)

10. a) The open loop transfer function of a unity feedback digital control system is given as $G(z) = \frac{K(z+0.5)(z+0.2)}{(z-1)(z^2-z+0.5)}$ [8M]
Sketch the root loci of the system for $0 < K < \infty$. Indicate all important information on the root loci.

b) List out the steady state specifications. And explain them briefly. [7M]

*****

III B. Tech II Semester Regular Examinations, June-2022

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
*****

UNIT-I

1. a) Explain digital control systems with proper block diagrams. [7M]
   b) Distinguish continuous-time and discrete-time signals with examples. [4M]
   c) Specify various advantages of digital control systems. [4M]

(OR)

2. a) What is the necessity of sample and hold? Sketch the block diagram of sample and hold, and explain its principle of operation. [8M]
   b) Explain the conditions to be satisfied for reconstruction of a continuous-time signal from sampled signal. [7M]

UNIT-II

3. a) State and prove any two theorems of z-transforms. [8M]
   b) Obtain the inverse z-transform of the following in the closed form: [7M]
   (i) $F_1 = \frac{0.368z^2+0.478z+0.154}{z^2(z-1)}$ (ii) $F_2 = \frac{z+2}{z^2(z-2)}$

(OR)

4. a) Given the z-transform X(z) = $\frac{(1-e^{-aT})}{(z-1)(z-e^{-aT})}$, where "a" is constant and "T " is sampling period, determine inverse z transform $x\,(k\,T)$ by the use partial fraction expansion method. [8M]
   b) Obtain the relationship between z- and s-domain. [7M]

UNIT-III

5. a) Obtain the state space representation of discrete time systems using Jordan canonical form. [8M]
   b) Consider the discrete control system represented by the following transfer function: G(z) = $\frac{1+0.8z^{-1}}{1-z^{-1}+0.5z^{-2}}$. Obtain the state representation of the system in the observable canonical form. Also find its state transition matrix. [7M]

(OR)

6. a) Describe the design of reduced order state observer with a neat block diagram. [8M]

   b) Explain the necessary and sufficient conditions for pole placement. [7M]

UNIT-IV

7. a) Discuss the stability analysis of discrete control system using modified Routh stability. [8M]

   b) Explain in detail about primary and complementary strips. [7M]

(OR)

8. a) Construct the Jury stability table for the following characteristic equation P(z) = $a_0 z^4 + a_1 z^3 + a_2 z^2 + a_3 z + a_4$ where $a_0>0$. Write the stability conditions. [8M]

   b) Describe the mapping between s-plane and z-plane. [7M]

UNIT-V

9. a) The open loop transfer function of a unity-feedback digital control system is given as F(z) = $\frac{K(z^2+0.8z+0.5)}{(z-1)(z^2-z+0.2)}$. Sketch the root loci of the system for $0 < K < \infty$. Indicate all important information on the root loci. [8M]

   b) List out the transient response specifications and explain in brief. [7M]

(OR)

10. a) Derive the transfer function of lead compensator. [8M]

    b) Write the expressions for static position error constant and steady state error in response to a unit step input in discrete time systems. [7M]

*****

Code No: R1932024 **R19** **SET - 3**

III B. Tech II Semester Regular Examinations, June-2022

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions **ONE** Question from **Each unit**

All Questions Carry Equal Marks

*****

UNIT-I

1. a) Distinguish analog and digital control systems. [8M]
   b) Illustrate the step motor control discrete data control system. [7M]

(OR)

2. a) Explain frequency domain characteristics of zero order hold circuit. [8M]
   b) Explain how sampling theorem can be used for data reconstruction. [7M]

UNIT-II

3. a) Explain how inverse z-transform can be obtained using partial fraction expansion method. [8M]
   b) Obtain the z-transform of x(t) = t^2e^{-at}, where 'a' is a constant. [7M]

(OR)

4. a) Explain the procedure for obtaining the pulse transfer function of a closed loop transfer function. [8M]
   b) Consider the following pulse transfer function system: [7M]

$$\frac{Y(z)}{U(z)} = \frac{z^{-1}(1+0.8z^{-1})}{1+1.3z^{-1}+0.4z^{-2}}$$

   Test the state controllability and observability.

UNIT-III

5. a) Obtain the state equations of discrete data systems with sample and hold. [8M]
   b) A discrete-time system has state equation [7M]

$$x(k+1) = \begin{bmatrix} 0 & -1 \\ -5 & -3 \end{bmatrix} x(k)$$

   Use Cayley-Hamilton approach to find out its state transition matrix.

(OR)

6. a) Investigate the controllability and observability of the following system. [8M]

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 1 & -1 \\ 2 & 2 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} \mathrm{u(k)}$$

$$\begin{bmatrix} y_1(k) \\ y_2(k) \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

b) State and prove the properties of state transition matrix. [7M]

UNIT-IV

7. a) Determine the stability of characteristic equation by using Jury's stability tests [8M]

$$z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.08 = 0$$

b) Explain the primary strips and complementary strips? [7M]

(OR)

8. a) Explain in detail about modified Routh's stability criterion. [8M]

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) = $\frac{K(z-1)}{(z-0.1)(z-0.8)}$. [7M]

UNIT-V

9. a) Draw lag and lead compensators. Obtain their transfer function. [8M]

b) Recall design procedure of lead compensator in the w-plane. [7M]

(OR)

10. a) Write the expressions for static position error constant and steady state error in response to a unit step input in discrete time systems. [5M]

b) The open loop transfer function of a unity-feedback digital control system is given as F(z) = $\frac{K(z^2+0.8z+0.5)}{(z-1)(z^2-z+0.2)}$ .Sketch the root loci of the system for $0 < K < \infty$. Indicate all important information on the root loci. [10M]

*****

Code No: R1932024 **R19** **SET - 4**

III B. Tech II Semester Regular Examinations, June-2022

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 75

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
*****

UNIT-I

1. a) Explain in detail the process of sampling and reconstruction of signals. [8M]
   b) Explain frequency-domain characteristics of zero order hold circuit. [7M]

(OR)

2. a) Explain in detail the advantages of digital systems. [8M]
   b) Explain the digital controller for a turbine and generator discrete data control systems. [7M]

UNIT-II

3. a) Explain different methods of finding inverse z-transform. [8M]
   b) Illustrate the procedure for obtaining the pulse transfer function of a closed-loop system with a neat block diagram. [7M]

(OR)

4. a) Given the z-transform X(z) = $\frac{(1-e^{-aT})}{(z-1)(z-e^{-aT})}$, where "a" is constant and "T " is sampling period, determine inverse z-transform $x\,(k\,T)$ by the use partial fraction expansion method. [8M]
   b) Obtain the inverse z-transform of the following: [7M]
   (i) X(z)=$\frac{z^{-3}}{(1-z^{-1})(1-0.2z^{-1})}$ and (ii) X(z) = $\frac{z^{-1}(1-z^{-2})}{(1+z^{-2})^2}$

UNIT-III

5. a) Explain concepts of controllability and observability. [8M]
   b) Describe necessary and sufficient conditions of pole placement method. [7M]

(OR)

6. a) What is the necessity of state transition matrix and specify its properties. [8M]
   b) Explain the design of full order state observer with a neat block diagram. [7M]

UNIT-IV

7. a) Explain the mapping between s-plane and z-plane. [8M]

   b) Determine the stability of characteristics equation by using Jury's stability tests $z^3 - 0.2z^2 - 0.25z + 0.05 = 0$. [7M]

(OR)

8. a) Elaborate on modified Routh's stability criterion. [8M]

   b) Write difference between primary strips and complementary strips. [7M]

UNIT-V

9. a) Draw the circuit diagram for lag compensator. Obtain its transfer function. [8M]

   b) Explain the design procedure of lead compensator using root locus technique in the z-plane. [7M]

(OR)

10. a) The closed loop transfer function for the digital control system is given as $\frac{C(z)}{R(z)} = \frac{z+0.5}{3(z^2 - z + 0.5)}$. [8M]

    Find the steady state errors and error constants due to step input.

    b) Derive the transfer function of lead compensator. [7M]

*****