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

IV B.Tech II Semester Regular Examinations, September - 2020

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 meant by impulse sampler? [2]
   b) What is the z-transform of $\sin \omega t$? [2]
   c) Explain the concept of controllability. [2]
   d) Write comment on the stability of $F(z) = z^2 - 0.25 = 0$ by using Jury's stability criterion? [3]
   e) List out the transient response specifications. [2]
   f) Write statement on necessary condition for design of state feedback controller through pole placement? [3]

PART–B *(4x14 = 56 Marks)*

2. a) List out the applications where DCS are used? Explain any one of them in detail. [7]
   b) Explain the frequency domain characteristics of zero order hold with neat schematic. [7]

3. a) The input-output of a sampled data system is described by the difference equation $y(k+2) + 3y(k+1) + 4y(k) = r(k+1) - r(k)$; $y(0) = y(1) = 0$ $r(0) = 0$, Determine pulse transfer function. Also obtain the unit pulse response of the system. [7]
   b) Find the inverse z-transform of $F(z) = \frac{z(z+1)}{(z-1)(z^2-z+1)}$ by using partial fraction expansion method. [7]

4. a) Obtain the inverse of the matrix $(ZI - G)$ $where\ G = \begin{pmatrix} 0.1 & 0.1 & 0 \\ 0.3 & -0.1 & -0.2 \\ 0 & 0 & -0.3 \end{pmatrix}$ also obtain G^k. [7]
   b) Consider the following system
   $$\frac{y(z)}{u(z)} = \frac{z+1}{z^2 + 1.3z + 0.4}$$
   Obtain (i) Controllable canonical form (ii) Observable canonical form (iii) Diagonal form. [7]

5. a) Draw the Jury's table, write its necessary and sufficient conditions. [7]
   b) Consider the following characteristic equation $F(z) = z^3 - 1.3z^2 - 0.08z + 0.24 = 0$, Determine 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. [7]

6. a) Write design procedure in the w-plane. [7]
   b) A unity feedback system is characterized by the open loop transfer function

$$G_{h0}G(z) = \frac{0.2385(z + 0.8760)}{(z - 1)(z - 0.2644)}$$

The sampling period T=0.2 sec, Determine steady state errors for following (i) Unit Step (ii) Unit ramp (iii) Unit Parabolic. [7]

7. a) Derive the Ackermann's formula for state feedback gain matrix. [4]
   b) Consider the system

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

$$G = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -0.12 & -0.01 & 1 \end{bmatrix}; H = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$$

Determine a suitable state feedback gain matrix 'K' such that the system will have the closed loop poles at 0.3, 0.4, 0.6. [10]

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Answer any FOUR questions from Part-B

*****

PART–A *(14 Marks)*

1. a) Write a statement of sampling theorem. [2]
   b) What is the z-transform of te^{-at}? [2]
   c) Explain the concept of observability. [2]
   d) Write about the primary strips and complementary strips with neat schematic. [2]
   e) Derive an expression for steady state error for step input. [3]
   f) Write statement on sufficient condition for design of state feedback controller through pole placement. [3]

PART–B *(4x14 = 56 Marks)*

2. a) Derive the transfer function of zero order hold. [7]
   b) Explain the block diagram representation of the sample and hold devices. [7]

3. For the sampled data system as shown in figure.3 given below, find (i) Pulse transfer function $\frac{Y(z)}{R(z)}$ (ii) Output $y(k)\ for\ r(t) = unit\ step\ (t = 1\ sec)$.

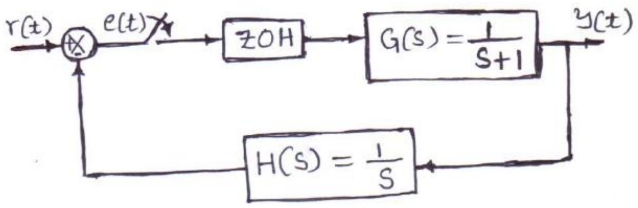

Figure.3 [14]

4. a) Consider the following system $\frac{y(z)}{u(z)} = \frac{z+1}{z^2+z+0.16}$, Obtain (i) Controllable canonical form (ii) Observable canonical form (iii) Diagonal form. [7]
   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. [7]

5. a) Consider the following characteristic equation $z^3 + 2.1z^2 + 1.44z + 0.32 = 0$, Determine whether or not any of the roots of the characteristic equation lie outside the unit circle centered at the origin of the z-plane. [7]
   b) Determine the stability of the following discrete time system
$$\frac{y(z)}{x(z)} = \frac{z^{-3}}{1+0.5z^{-1}-1.34z^{-2}+0.24z^{-3}}$$ [7]

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

   b) The feed forward pulse transfer function is given

$$G(z) = \frac{Kz(1 - e^{-T})}{(z - 1)(z - e^{-T})}$$

   Investigate the effect of the sampling period T on the steady state accuracy of the unit ramp response for the following (i) T=0.5 Sec, K=2 (ii) T=1 Sec, K=2 (iii) T=2 Sec, K=2. Write comment on the above cases. [7]

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

   b) A regulator system has the plant

$$X(k+1) = \begin{pmatrix} 0 & 1 \\ -0.16 & -1 \end{pmatrix} X(k) + \begin{pmatrix} 0 \\ 1 \end{pmatrix} u$$

   Design a full order state observer, the desired eigen values of the observer matrix are -1.8-j2.4, -1.8+j2.4. [7]

Code No: **R1642021** **R16** **Set No. 3**

IV B.Tech II Semester Regular Examinations, September - 2020
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
*****

PART–A *(14 Marks)*

1. a) Write the DCS example of a digital computer controlled rolling mill regulating system. [3]
   b) What is the z-transform of $\cos \omega t$? [2]
   c) Write the diagonal canonical form. [2]
   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 ramp input. [3]
   f) What is the purpose of an observer? [2]

PART–B *(4x14 = 56 Marks)*

2. a) List out the merits of digital systems. [4]
   b) State and explain sampling theorem with neat sketch. [10]

3. a) Solve the difference equation
$$y(k+2) + 3y(k+1) + 2y(k) = r(k);$$
$r(k) = unit\ step, y(0) = 1\ and\ y(1) = 0$ [7]
   b) Obtain the inverse z-transform of $x(z) = \frac{z^{-2}}{(1-z^{-1})^3}$ [7]

4. a) What are the various methods of evaluation of state transition matrix? Explain any one method. [7]
   b) Obtain the state equation and output equation for the system defined by
$$\frac{y(z)}{u(z)} = \frac{z^{-1} + 5z^{-2}}{1 + 4z^{-1} + 3z^{-2}}$$ [7]

5. a) Write about the modified Routh's stability criterion. [7]
   b) Consider the system described by
$$y(k) - 0.6y(k-1) - 0.81y(k-2) + 0.67y(k-3) - 0.12y(k-4) = x(k)$$
Where x(k) is the input and y(k) is the output of the system. Determine the stability of the system by using Jury's stability criterion. [7]

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6. Consider the system as shown in figure.6. Assume that the digital controller is of the integral type.

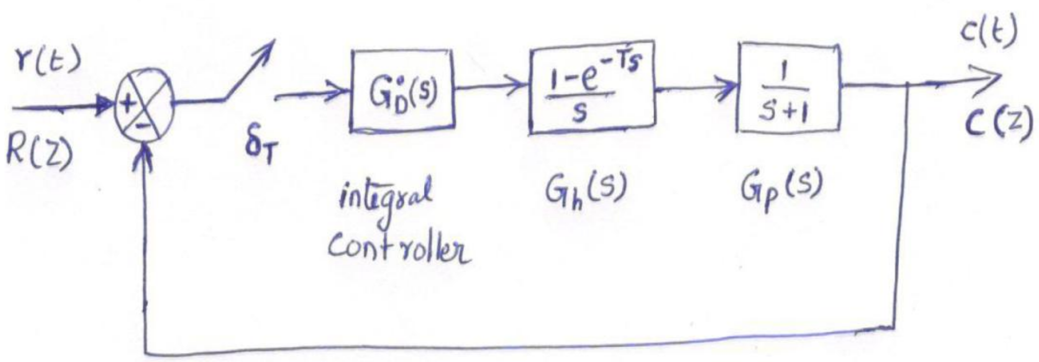

Figure.6

Draw root locus diagram for the system of the sampling period T=0.5. Also determine the critical value of K for T=0.5. Locate the closed loop poles corresponding to K=2 for T=0.5. [14]

7. a) Derive sufficient condition for the design of state feedback controller through pole placement. [4]

b) Consider the system is given by

$$X(k+1) = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -2 & -3 \end{pmatrix}(k) + \begin{pmatrix} 0 \\ 0 \\ 1 \end{pmatrix} u(k)$$

Determine a suitable state feedback gain matrix 'K' to place the eigen values at 0.5, 0.6, 0.7. [10]

Code No: **R1642021**

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Set No. 4

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DIGITAL CONTROL SYSTEMS

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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
*****

PART–A *(14 Marks)*

1. a) Enumerate advantages of digital systems. [2]
   b) Define z-transform and write z transform of unit step function. [2]
   c) Write the Jordan canonical form. [2]
   d) Write comment on the stability of $P(z) = z^2 - 0.25 = 0$ by using modified Routh's stability criterion. [3]
   e) Derive an expression for steady state error for parabolic input. [3]
   f) What is reduced order observer? [2]

PART–B *(4x14 = 56 Marks)*

2. Draw and explain the configuration of the basic digital control systems with neat block diagram. [14]

3. a) State and explain the initial value and final value theorem. [7]
   b) Using the inversion integral method, obtain the inverse z-transform of $x(z) = \frac{10}{(z-1)(z-2)}$; for k=0,1,2,3…….. [7]

4. a) Obtain the state and output equation of discretization of continuous time state equation. [7]
   b) Obtain the state transition matrix of the following discrete time system

$$x(k+1) = Gx(k) + Hu(k)$$
$$y(k) = Cx(k)$$

Where

$$G = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}, H = \begin{bmatrix} 1 \\ 1 \end{bmatrix}, C = \begin{bmatrix} 1 & 0 \end{bmatrix}$$ [7]

5. a) Investigate the mapping between the s-plane and the z-plane with neat schematic. [7]
   b) Consider the discrete time unity feedback control system (T=1 sec) whose open loop pulse transfer function is given by $G(z) = \frac{K(0.3679z + 0.2642)}{(z-0.3679)(z-1)}$. Determine the range of K for stability by use of the Jury's stability test. [7]

|''|''|||''|'''|||'|

6. Consider the digital control system shown in figure.6. Design a digital controller in the w-plane such that the phase margin is 50^0, the gain margin is at least 10 dB, and the static velocity error constant K_v is 2 sce^{-1}. Assume that the sampling period is 0.2 sec.

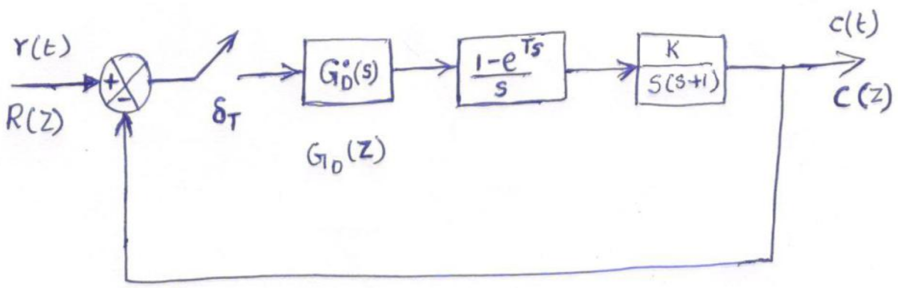

Figure.6

7. a) Explain the full order observer with neat block diagram and also write its error dynamics of the full order state observer. [7]

   b) Consider the system is given by

$$X(k+1) = \begin{pmatrix} 0 & 1 \\ -1 & -2 \end{pmatrix} X(k) + \begin{pmatrix} 0 \\ 1 \end{pmatrix} u(k)$$

   Obtain the state feedback gains 'K' to place the eigen values at 0.1, 0.2 using Ackermann''s formula. [7]