Code No:K0223 **R07** **Set No. 1**

IV B.Tech. II Semester Regular Examinations, April, 2013

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
****

1. a) Explain the examples of data control systems of the following
   i) A step motor control system
   ii) A digital computer controlled rolling mill regulating system
   b) Describe the frequency domain characteristics of the zero order hold.

2. a) Obtain the z-transform of the elementary functions
   i) Unit step function
   ii) Exponential function
   b) Find the z-transform of

$$X(s) = \frac{1}{s(s+1)}$$

3. a) Obtain the solution of the following difference equation in terms of x(0) and x(1)

$$x(k+2) + (a+b)x(k+1) + abx(k) = 0$$

   Where a and b are constants and k=0,1,2……
   b) Explain the mapping between s-plane and z-plane of the following
   i) constant frequency loci
   ii) constant damping ratio loci

4. a) Define
   i) State
   ii) State variable
   iii) State vector & state space
   b) Obtain the pulse transfer function (when the sampling period T=1) of the following continuous time systems.

$$G(s) = \frac{Y(s)}{U(s)} = \frac{1}{s(s+2)}$$

Code No:K0223 **R07** **Set No. 1**

5. a) State the controllability and observability?
   b) Consider the following pulse transfer function
   $\frac{Y(z)}{U(z)} = \frac{z+0.2}{(z+0.8)(z+0.2)}$. Check this system is completely state controllable or not.

6. 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.
   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.

7. a) Discuss the effects of sampling period T on transient response characteristics.
   b) Explain about the PID controllers.

8. a) State the necessary and sufficient condition for state observation.
   b) Consider the double integrator system
   $$X\big((k+1)T\big) = GX(kT) + Hu(kT)$$
   Where $G = \begin{bmatrix} 1 & T \\ 0 & 1 \end{bmatrix}, H = \begin{bmatrix} T^2/2 \\ T \end{bmatrix}$ and T is the sampling period. It is desired that the closed loop poles be located at z=μ_1 and z=μ_2. Assuming that the state feedback control u(kT)=-Kx(kT) is used, determine the state feedback gain matrix K.

Code No:K0223 **R07** **Set No. 2**

IV B.Tech. II Semester Regular Examinations, April, 2013

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
****

1. a) Explain the examples of data control systems of the following
   i) Microprocessor controlled system
   ii) A digital controller for a turbine and generator

   b) Explain the operation of ideal sampler.

2. a) State and prove the final value theorem.

   b) Given the z transform

$$X(z) = \frac{(1 - e^{-aT})}{(z-1)(z - e^{-aT})}$$

   Where a is a constant and T is the sampling period, determine the inverse z transform x(kT) by use of the partial fraction expansion method.

3. a) Investigate how the location of the poles and zeros in the s plane compare with the z plane?

   b) Find the solution of the following difference equation

$$x(k+2) - 1.3x(k+1) + 0.4x(k) = u(k)$$

   Where x(0)=x(1)=0 and x(k)=0 for k<0. For the input function u(k), consider the following two cases $u(k) = \begin{cases} 1, & k = 0,1,2,\dots. \\ 0, & k < 0 \end{cases}$ and $u(0) = 1, u(k) = 0, k \neq 0.$

4. a) Write the canonical forms for discrete time state space equations.

   b) Obtain the state equation and output equation for the system defined by

$$\frac{Y(z)}{U(z)} = \frac{z^{-1} + 5z^{-2}}{1 + 4z^{-1} + 3z^{-2}}$$

Code No:K0223 **R07** **Set No. 2**

5. a) Derive the condition for the complete observability of the discrete time system.
   b) 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.

6. a) Discuss the stability analysis by using bilinear transformation.
   b) Examine the stability of the following characteristic equation.

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

7. a) Write the design procedure of lead-lag compensator in w-plane.
   b) List out the transient response specifications.

8. a) Define
   i) Full order state observer
   ii) Minimum order state observer
   iii) Reduced order observer.

   b) Derive the error dynamics of the full order state observer.

Code No:K0223 **R07** **Set No. 3**

IV B.Tech. II Semester Regular Examinations, April, 2013

DIGITAL CONTROL SYSTEMS

(Electrical and Electronics Engineering)

Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
****

1. a) Enumerate the advantages of digital control systems over analog systems.
   b) Justify the impulse sampler as a modulator with a neat sketch.

2. a) Obtain the z-transform of the elementary functions
   i) Unit ramp function
   ii) polynomial function
   b) Find the z-transform of the cosine function
$$x(t) = \begin{cases} \cos \omega t, & 0 \le t \\ 0, & t < 0 \end{cases}$$

3. a) Derive the expression for pulse transfer function.
   b) Assume that a sampled signal $X^*(s)$ is applied to a system G(s) and the output of G(s) is Y(s) and $y(0^+)=0$. $Y(s)=G(s)X^*(s)$ using the relationship $Y^* = \frac{1}{T}\sum_{k=-\infty}^{\infty} Y(s + j\omega_s k)$ show that $Y^*(s) = G^*(s)X^*(s)$

4. a) Derive the solution of discrete time state equation by using z transform method.
   b) Obtain a state space representation of the following pulse transfer function system in the diagonal canonical form.
$$\frac{Y(z)}{U(z)} = \frac{1 + 6z^{-1} + 8z^{-2}}{1 + 4z^{-1} + 3z^{-2}}$$

5. a) Derive the condition for the complete controllability of the discrete time system.
   b) Write down the necessary and sufficient conditions for complete state controllability and observability for systems S_1 and S_2.

Code No:K0223 **R07** **Set No. 3**

6. a) Discuss the stability analysis by using routh stability criterion.
   b) Consider the following characteristic equation
   $$P(z) = z^3 - 1.3z^2 - 0.08z + 0.24 = 0$$
   Determine whether or not any of the roots of the characteristic equation lie outside the unit circle in the z plane. Use the bilinear transformation and the routh stability criterion.

7. a) Explain the design procedure of lead-lag compensation in frequency domain.
   b) Derive the steady state error conditions for step and ramp input.

8. Explain about the full order observer with neat diagram? Derive the necessary equations.

Code No:K0223 **R07** **Set No. 4**

IV B.Tech. II Semester Regular Examinations, April, 2013
DIGITAL CONTROL SYSTEMS
(Electrical and Electronics Engineering)

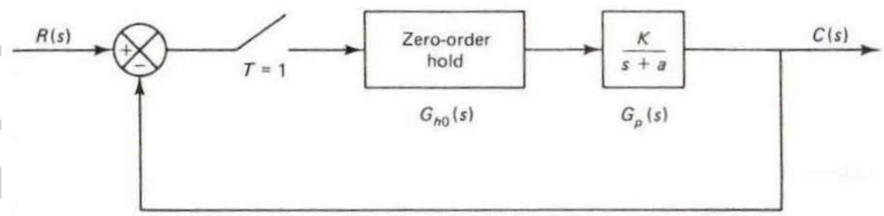
Time: 3 Hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks
****

1. a) Describe the data hold circuits with a neat sketch.
   b) Discuss the types of analog to digital converters? Explain about the successive approximation type.

2. a) Consider the function y(k), which is a sum of functions x(h), where h=0,1,2,…,k such that $y(k) = \sum_{h=0}^{k} x(h), \quad k = 0,1,2,\ldots..$ where y(k)=0 for k<0. Obtain the z transform of y(k).
   b) Obtain the inverse z transform of $X(z) = \frac{z^2}{(z-1)^2(z-e^{-aT})}$ by using the inversion integral method.

3. a) Discuss the primary strip and complementary strips.
   b) Obtain the closed loop pulse transfer function of the system shown in figure.



4. Determine the inverse of the matrix (ZI-G), Where $G = \begin{bmatrix} 0.1 & 0.1 & 0 \\ 0.3 & -0.1 & -0.2 \\ 0 & 0 & -0.3 \end{bmatrix}$, Obtain G^k.

5. Consider the following pulse transfer function system
$$\frac{Y(s)}{U(s)} = \frac{z^{-1}(1 + 0.8z^{-1})}{1 + 1.3z^{-1} + 0.4z^{-2}}$$
Show that the state space representation is state controllable but not observable and vice versa.

Code No:K0223 **R07** **Set No. 4**

6. a) Explain the stability analysis of closed loop systems in the z plane.
   b) Determine the stability of the following discrete time system.

$$\frac{Y(s)}{X(s)} = \frac{z^{-3}}{1 + 0.5z^{-1} - 1.34z^{-2} + 0.24z^{-3}}$$

7. a) Discuss design based on frequency response method.
   b) Describe the lead, lag, lead-lag compensator.

8. a) Derive the ackermann's formula for the determination of the state feedback gain matrix.
   b) Explain the reduced order observer with necessary equations.