Code: 9A13501

1

B.Tech IV Year II Semester (R09) Regular Examinations, March/April 2013

DIGITAL CONTROL SYSTEMS

(Electronics and Instrumentation Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) What are the basic elements of discrete-data control system? Explain each of them.

(b) What are the advantages of discrete data control systems?

2 (a) Find the z-transform of (i) $f(t) = \sin \omega t$. (ii) $f(t) = t\, u_s(t)$.

(b) State and explain the following theorems of z-transform.
(i) Shifting theorem. (ii) Complex translation theorem.

3 Solve the following difference equation using z-transform method:

$$C(K+2) - 0.1\, C(K+1) - 0.2\, C(K) = r(K+1) + r(K).$$

where, $r(K) = u_s(K) for\ K = 0,1,2 \ldots., C(0) = 0\ and\ C(1) = 0.$

4 (a) What is the procedure for discretization of continuous time state space equations? Explain.

(b) State and prove various properties of state transition matrix.

5 Prove that, the system described by the state equation.
$X(K+1) = A \cdot X(K) + BU(K)$ is completely state controllable
iff $S = [B\ \ AB\ \ A^rB..A^{n-1}B]$ is of rank 'n'.

6 Explain the following in detail:

(a) Mapping between S-plane and Z-plane.

(b) Primary strips.

(c) Complementary strips.

7 (a) Explain in detail different time domain specifications of digital control systems.

(b) Explain in detail the steady state error analysis of digital control systems using:
(i) Step function as input. (ii) Ramp function as input.

8 For a multi input digital control system:
$X[(K+1)T] = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} X(KT) + \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} u(KT)$, design the state feedback matrix: 'G' such that the state feedback $u(KT) = -G.X(KT)$, places the closed loop eigen values at $Z_1 = 0.1\ and\ Z_2 = 0.2$.

*****

Code: 9A13501 **2**

B.Tech IV Year II Semester (R09) Regular Examinations, March/April 2013

DIGITAL CONTROL SYSTEMS

(Electronics and Instrumentation Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

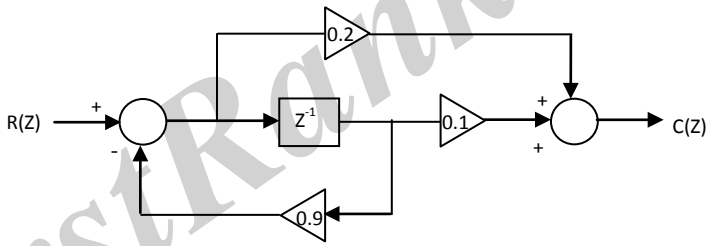
*****

1 With neat sketches explain the operation of various digital to analog converters.

2 Find the solution of the following difference equation using z-transforms. The difference equation is : $y(K+2)+0.4y(K+1)+0.1y(K)=-(0.5)^{K+1}$ with initial conditions: $y(0)=0\ and\ y(1)=0$.

3 (a) Explain in detail the concept of relationship between S-plane and Z-plane.

(b) Find the transfer function $C(Z)/R(Z)$ for the following block diagram.



4 Find state transition matrix Ø(K) for the following:

(a) $X(K+1)=\begin{bmatrix}0 & 1\\ -0.5 & -1\end{bmatrix}X(K)$.

(b) $X(K+1)=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -0.5 & 1.5\end{bmatrix}X(K)$.

5 (a) State and explain the duality property of controllability and observability.

(b) Determine the controllability of the system:

$$X(K+1)=\begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0.04 & -0.53 & 1.4\end{bmatrix}X(K)+\begin{bmatrix}1 & 0\\ -1 & 1\\ 0 & 1\end{bmatrix}u(K)$$

Contd. in Page 2

6 Find the stability of the systems represented by the characteristic equations.

(a) $f(z) = z^3 + 3.3z^2 + 3z + 0.8 = 0$.

(b) $f(z) = z^3 + z^2 + z + 1 = 0$.

Using "Bilinear Transformation" method.

7 Explain in detail the design of digital control systems with digital controllers through "Bilinear Transformation".

8 Explain the design procedure of "Full Order State Observer" for a digital control system.

*****

Code: 9A13501

3

B.Tech IV Year II Semester (R09) Regular Examinations, March/April 2013

DIGITAL CONTROL SYSTEMS

(Electronics and Instrumentation Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 (a) What are the disadvantages of digital control systems over analog control systems? Explain.

(b) With neat circuit explain the operation of sample and hold circuit.

2 State and prove the following theorems of z-transforms.

(a) Initial value theorem.

(b) Final value theorem.

(c) Real convolution theorem.

3 Solve the following difference equation using the z-transform method.

$C(K+2) - 1.5C\ (K+1) + C(K) = 2u_s(K), where, C(0) = 0\ and\ C(1) = 1.$

4 Write the state equations and the output equations of the following difference equations.

(a) $C(K+3) + 5.C(K+2) + 3C(K+1) + 2C(K) = u(K)$

(b) $C(K+4) + 2C(K+2) - C(K+1) + C(K) = 5u(K).$

5 Prove that, the linear digital system described by the state equations.

$X(K+1) = A \cdot X(K) + Bu(K)$

$Y(K) = C \cdot X(K) + Du(K)$ is completely state observable iff,

$\propto = [C^T\ \ A^TC^T\ \ (A^T)^rC^T\ \ldots.(A^T)^{n-1}C^T]$ is of rank 'n'.

6 Explain the procedure to find out stability of discrete data systems using.

(a) Jury's stability test.

(b) Bilinear transformation.

7 Explain in detail the properties of root loci in the z-plane.

8 For a single input digital control system.

$X(K+1) = \begin{bmatrix} 0 & 1 \\ -1 & 2 \end{bmatrix} X(K) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(K)$, find the state feedback matrix "G" such that the eigen values of (A-BG) are at '0' and '0.3'.

*****

Code: 9A13501

4

B.Tech IV Year II Semester (R09) Regular Examinations, March/April 2013

DIGITAL CONTROL SYSTEMS

(Electronics and Instrumentation Engineering)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

*****

1 What is the role of analog to digital converter in digital control systems? Explain various types of analog to digital converters.

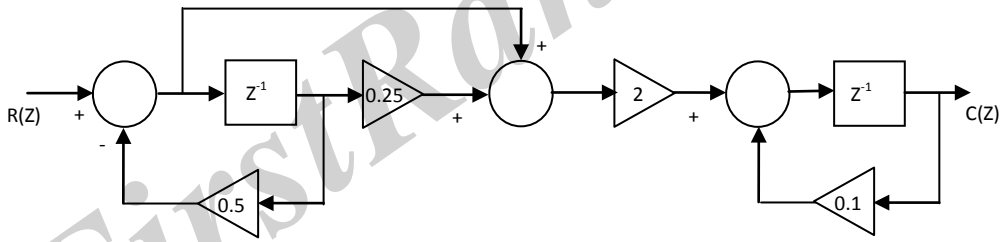
2 (a) Find the z-transform of the functions:

(i) $F(S) = \frac{2(s+1)}{s(s+5)}$ (ii) $F(S) = \frac{10}{s(s^2+s+2)}$

(b) Find the inverse z-transform of the function $F(z) = \frac{z(z+1)}{(z-1)(z^2-z+1)}$

3 (a) Explain in detail the concept of pulse transfer function.

(b) Find the transfer function $^{C(Z)}/_{R(Z)}$ for the following block diagram.



4 The state equation of a linear system is:

$\dot{X}(t) = \begin{bmatrix} -1 & 2 \\ -1 & 0 \end{bmatrix} X(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$, with $u(t) = u(KT) =$ constant for $KT \leq t < (K+1)T$.

The system is discretized, resulting the following discrete data state equation: $X[(K+1)^T] = \emptyset(T) \cdot X(KT) + \theta(T)u(KT)$. Then, find the matrices: $\emptyset(T) and\ \theta(T)$.

5 Find the controllability and observability of the system.

$X(K+1) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} X(K) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(K)$.

$Y(K) = [1 \quad 2]X(K)$.

Contd. in Page 2

6 Find the stability of the following systems represented by the characteristic equation.

(a) $F(z) = z^3 - 1.25z^2 - 1.375z - 0.25 = 0$.

(b) $F(z) = z^3 + 3.3z^2 + 4z + 0.8 = 0$.

(c) $F(z) = z^4 - 2z^3 + z^2 - 2z + 1 = 0$, using "Jury's stability test".

7 What is meant by "Digital PID controller"? Explain in detail the digital PID controller design using different rectangular integration schemes.

8 Explain the design procedure of "Reduced Order Observer" for a digital control system.

*****