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Paper Code : PE-EE 601A Digital control system

UPID : 006642

Time Allotted : 3 Hours *Full Marks :70*

The Figures in the margin indicate full marks.
Candidate are required to give their answers in their own words as far as practicable

Group-A (Very Short Answer Type Question)

1. Answer *any ten* of the following : [1 x 10 = 10]

(I) If Z{x(k)}=1/z then find Z{x(n-k)}.

(II) The order of the controllability matrix is equal to the number of inputs of the system. Hence the system is controllable -True or False?

(III) The constant frequency loci in z plane is a straight parallel to real axis - True or false?

(IV) What is the discrete ramp error constant for type 0 system?

(V) What is regulation problem?

(VI) Mention three types of sampling techniques.

(VII) If Z{x(k)} = 1/z then find find Z{a^kx(k)}.

(VIII) Right side of the s-plane maps into outside of the unit circle in z-plane - True or False?

(IX) The state equation of a digital control system is expressed as
x(k+1)=Ax(k)+Bu(k)
What is the state transition matrix $\Phi(N)$?

(X) A second order system is said to be completely observable if the rank of the observability matrix is ____.

(XI) The constant damping ratio loci for damping ratio zero coincides with imaginary axis in z plane -True or False?

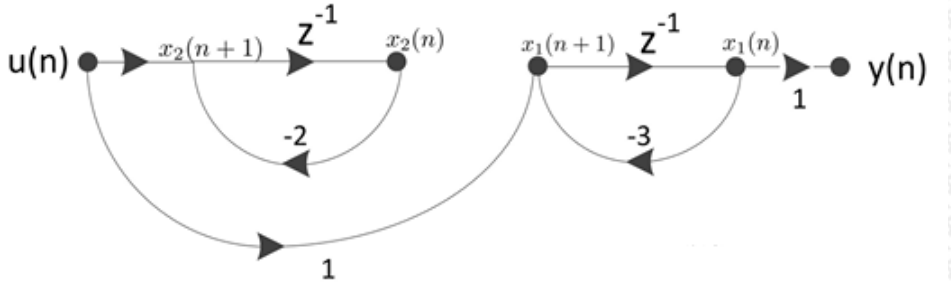
(XII) What is the discrete parabolic error constant for type-1 system?

Group-B (Short Answer Type Question)

Answer *any three* of the following : [5 x 3 = 15]

2. Draw and explain constant frequency loci in Z plane. [5]

3. Determine the state observability of the system bellow [5]



4. State and prove final value theorem in Z transform. [5]

5. The system matrix of a discrete data control system is given following. Find state transition matrix. [5]

$$F = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix}$$

6. Draw and explain Primary strips and Complementary Strips in s-plane. [5]

Group-C (Long Answer Type Question)

Answer *any three* of the following : [15 x 3 = 45]

7. (a) Explain how feedback gain matrix can be designed in discrete data control system by converting state model into controllable canonical form. [7]

(b) Find out the state feedback gain matrix K for the following system by converting the system into controllable canonical form such that the closed loop poles are located at 0.5 and 0.6. [8]

$$\mathbf{x}(k+1) = \begin{bmatrix} -1 & -1 \\ 0 & -2 \end{bmatrix} \mathbf{x}(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

8. (a) State and explain Nyquist–Shannon sampling theorem. [7]

   (b) Define the following for sample and hold circuit. [8]
   Acquisition Time, Aperture Time, Hold Mode Settling Time, Hold Step.

9. (a) Find out the inverse Z transform of the following [5]

$$F(z) = \frac{2z^2 + z}{z^2 - 1.5z + 0.5}$$

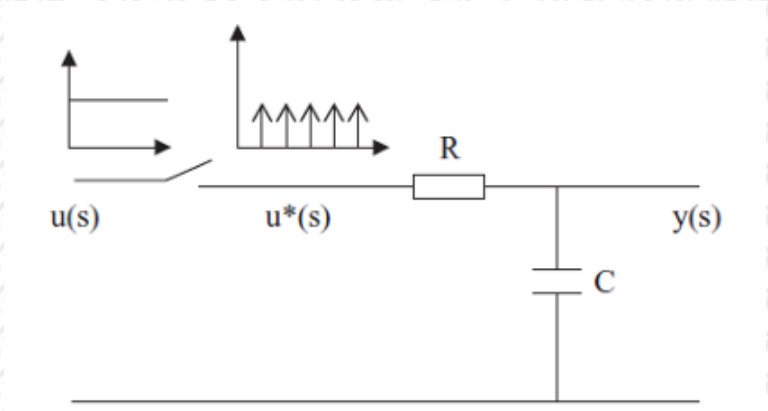
   (b) Find out the inverse Z transform of the following [5]

$$H(z) = \frac{(1-2z^{-1})}{1-\frac{5}{6}z^{-1}+\frac{1}{6}z^{-2}}, \qquad |z| > \frac{1}{2}$$

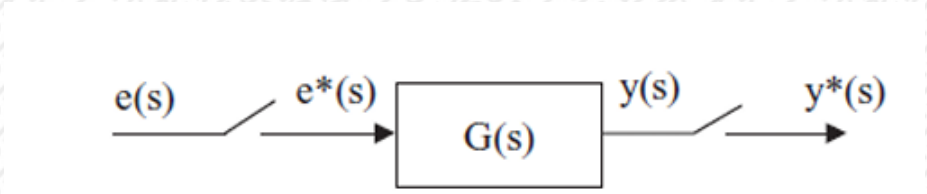
   (c) Find out the inverse Z transform of the following [5]

$$X(z) = \frac{1}{(3-z)(2-z)}, \quad \text{ROC} \quad |z| < 2.$$

10. (a) Consider the following system R = 1 ohm C = 1 F and sampling time is 1s. [10]
    Find out the output response.



   (b) Figure shows an open-loop sampled data system. Derive an expression for the z-transform of the output of the system. [5]



11. The following block diagram showing a digital positioning system. Represent the system in state variable form [15]