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Total No. of Pages : 03

Total No. of Questions : 08

M.Tech. (Power Engg.) (Sem.-1)

DIGITAL CONTROL SYSTEMS

Subject Code : PEE-504

Paper ID : [E0484]

Time : 3 Hrs.

Max. Marks : 100

INSTRUCTIONS TO CANDIDATES :

1. Attempt any FIVE questions out of EIGHT questions.
2. Each question carries TWENTY marks.

1. With the help of a block diagram explain the working of basic digital control system. Define the basic types of discrete time signals.

2. Show that

$$1. \quad Z \left[\sum_{h=0}^k x(h) \right] = \frac{1}{1-z^{-1}} X(z) \quad \text{and} \quad Z \left[\sum_{h=0}^{k-1} x(h) \right] = \frac{z^{-1}}{1-z^{-1}} X(z)$$

$$2. \quad \sum_{k=0}^{\infty} x(k) = \lim_{z \rightarrow 1} X(z).$$

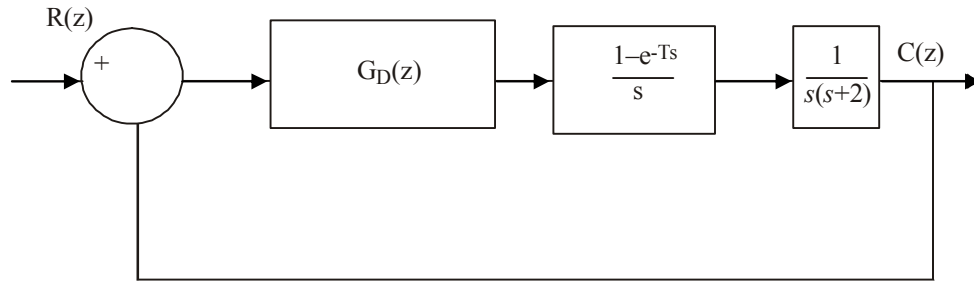
$$3. \quad Z \left[\sum_{h=i}^k x(h) \right] = \frac{1}{1-z^{-1}} \left[X(z) - \sum_{h=0}^{i-1} x(h) z^{-h} \right], \quad \text{where } 1 \leq i \leq k-1.$$

3. Consider the discrete time unity feedback control system (with sampling period 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 gain K for stability by use of the jury stability test.

4. Design a digital controller for the system shown below. Use bode diagram approach in the w plane. The design specifications are that the phase margin be 55° , and gain margin be at least 10db and the static velocity error constant be 5 sec^{-1} . The sampling period is specified as 0.1 sec or $T = 0.1$.

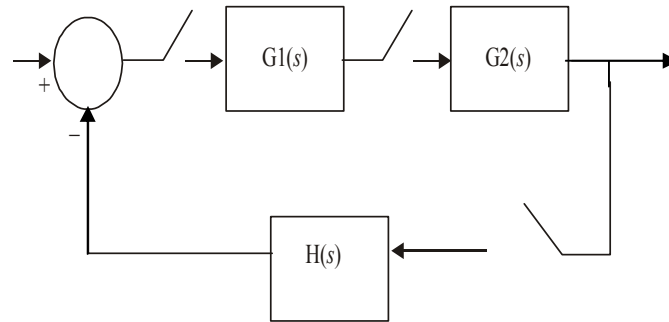


5. Obtain the state space representation of the following pulse transfer function

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

Also obtain the initial values of state variables in terms of $y(0)$, $y(1)$ and $y(2)$.

6. For the system given below in fig.2 obtain the expressions for,
- Static position error constant
 - Static velocity error constant
 - Static acceleration error constant



7. Consider the system defined by the equation $\dot{x} = Ax + Bu$ where,

$$A = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix} \text{ and } B = \begin{bmatrix} 1 \\ 1 \end{bmatrix}$$

Design a state feedback control via pole placement where the desired poles of the closed loop system are at origin.

Investigate the controllability and observability of the system given below

$$\dot{x} = \begin{bmatrix} 0 & 1 & -1 \\ -1 & -1 & 1 \\ -1 & -1 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \\ 0 \end{bmatrix} u$$
$$y = [1 \ 0 \ 1]$$

8. Consider the system defined by,

$$G(z) = \frac{z+1}{z^2+z+0.16}$$

Obtain state space representations for this system in the following forms:

- a. Controllable canonical form
- b. Observable canonical form
- c. Diagonal canonical form