Roll No. 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. $Z\left[\sum_{h=0}^{k} x(h)\right] = \frac{1}{1-z^{-1}} X(z)$ and $Z\left[\sum_{h=0}^{k-1} x(h)\right] = \frac{z^{-1}}{1-z^{-1}} X(z)$

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

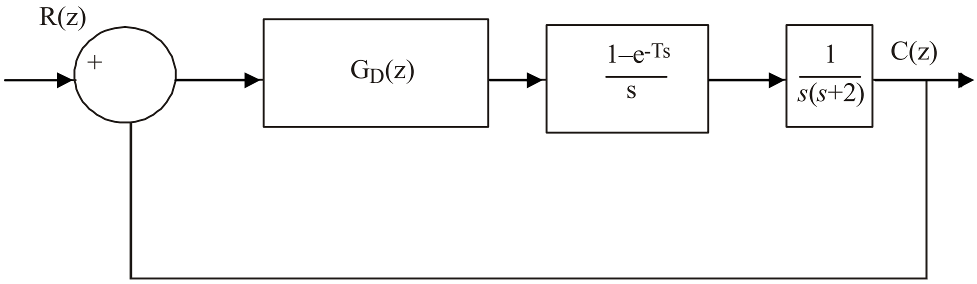
   3. $Z\left[\sum_{h=i}^{k} x(h)\right] = \frac{1}{1-z^{-1}}\left[X(z) - \sum_{h=0}^{i-1} x(h) z^{-h}\right]$, where $1 \le i \le k-1$.

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

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

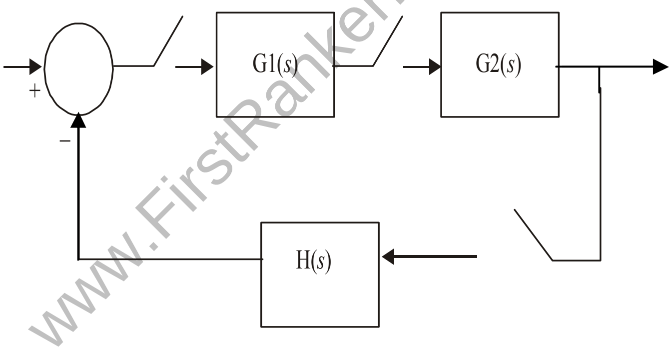
Also obtain the initial values of state variables in terms of y(0), y(l) and y(2).

6. For the system given below in fig.2 obtain the expressions for,

   a. Static position error constant

   b. Static velocity error constant

   c. 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 beiow

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

$$y = [1 \quad 0 \quad 1]$$

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