

M.E. First Semester (Electrical (Electronics & Power) Engg.) (New - CGS)  
**13313 : Digital Control System : 1 EEPME 1**

P. Pages : 3

AU - 3408

Time : Three Hours



Max. Marks : 80

- Notes : 1. Due credit will be given to neatness and adequate dimensions.  
 2. Assume suitable data wherever necessary.  
 3. Illustrate your answer necessary with the help of neat sketches.

**SECTION - A**

1. a) Find z-transform of :- 8  
 i) Sampled sinusoids.  
 ii) Sampled ramp function.  
 iii) Sampled exponential function  
 v) Unit step sequence
- b)  $x(z) = \frac{2z^3 + z}{(z-2)^2 (z-1)}$  : 5  
 obtain Inverse z-transform.

**OR**

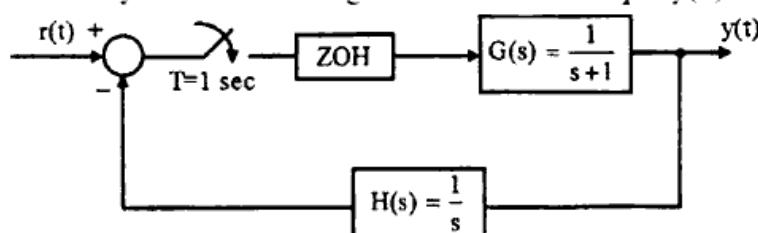
2. a)  $x(k+2) + 3x(k+1) + 2x(k) = 0$  6  
 $x(0) = 0 ; x(1) = 1$   
 Solve: Use z-transform method.

- b)  $G(z) = \frac{y(z)}{R(z)} = \frac{1}{z^2 + a_1 z + a_2}$  and 7  
 $a_1 = -3/4 ; a_2 = 1/8$

Find the response  $y(k)$  to the following inputs:

- i)  $r(k) = \delta(k)$   
 ii)  $r(k) = \mu(k)$

3. For the sampled - data system shown in fig. below. Find the output  $y(k)$  for  $r(t) = \text{unit step}$  13

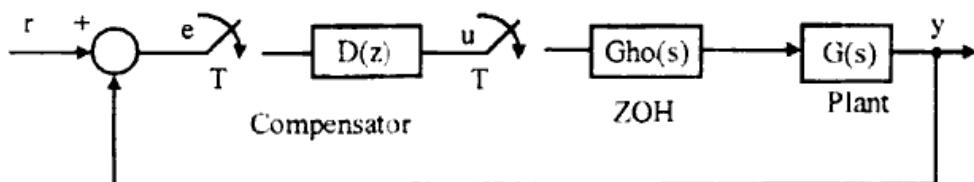


4. Consider the digital controller defined by: 13

$$D(z) = \frac{U(z)}{E(z)} = \frac{10(z^2 + z + 1)}{z^2(z - 0.5)(z - 0.8)}$$

Draw parallel realization diagram.

5. Consider feedback control system.



$$\text{Transfer function } G(s) = \frac{1}{s^2}$$

Design digital controller D(z) for

- a) Zero steady state error to ramp input
- b) Finite setting time
- c) Sampling period T = 0.1 sec.

**OR**

6. For feedback control system shown in Q 5.

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If Transfer function  $G(s) = \frac{k}{s(s+2)}$  Design digital control scheme for

- a)  $Kv = 6$
- b)  $M_p$  to step input  $\leq 15\%$
- c)  $t_s$  (2% tolerance band)  $\leq 5$  sec

### SECTION - B

- 7.

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$$\dot{x} = \begin{bmatrix} 1 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -1 \end{bmatrix}x + \begin{bmatrix} 0 \\ 1 \\ -2 \end{bmatrix}u$$

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

- a) Find eigen values of A and from there determine stability of system.
- b) Find transfer function model and from there determine stability of system.
- c) Are two results same? If not why? <http://www.sgbauonline.com>

**OR**

- 8.

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The following models realize the transfer function  $G(s) = \frac{1}{s+1}$

a)  $A = \begin{bmatrix} -2 & 1 \\ 1 & -2 \end{bmatrix}; b = \begin{bmatrix} 1 \\ 1 \end{bmatrix}; C = [0 \ 1]$

b)  $A = \begin{bmatrix} -1 & 0 \\ 0 & -3 \end{bmatrix}; b = \begin{bmatrix} 1 \\ 1 \end{bmatrix}; C = [1 \ 0]$

c)  $A = \begin{bmatrix} -2 & 0 \\ 0 & -1 \end{bmatrix}; b = \begin{bmatrix} 0 \\ 1 \end{bmatrix}; C = [0 \ 1]$

Investigate the controllability and observability properties of these models.

9. Find the state variable models for

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- $y(k+3) + 5y(k+2) + 7y(k+1) + 3y(k) = 0$
- $y(k+2) + 3y(k+1) + 2y(k) = 5r(k+1) + 3r(k)$

OR

10. Investigate controllability and observability of following system.

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

$$\begin{bmatrix} 1 & -1 \\ 0 & 0 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix} x(k)$$

11.

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$$\frac{u(z)}{U(z)} = \frac{z^{-2}}{(1+0.8z^{-1})(1+0.2z^{-1})}$$

- Find ( $F$ ,  $g$ ,  $C$ ) for plant in controllable canonical form.
- Find  $k_1$  and  $k_2$  such that  $u(k) = -k_1 x_1(k) - k_2 x_2(k)$  gives closed loop characteristic roots at  $0.6 \pm j0.4$ .

OR

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For  $\frac{y(s)}{U(s)} = \frac{9}{s^2 - 9}$

- Find ( $A$ ,  $b$ ,  $C$ ) for system in observable canonical form
- Compute  $k$ , so that  $u = -kx$  places closed loop poles at  $-3 \pm j3$
- Design full order observer, such that observer error poles are located at  $-6 \pm j6$ . also give all observer equation.

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