M.E. First Semester (Electrical & Elect.) (New-CGS)

13281 : Advanced Control Systems : 1 EEEME 1

P. Pages : 3 **AU - 3396**

Time : Three Hours Max. Marks : 80

Notes :
1. All question carry equal marks.
2. Answer **three** question from Section A and **three** question from Section B.
3. Use of pen Blue/Black ink/refill only for writing the answer book.

SECTION - A

1. Find y(k) for given equation $y(k)=r(k)-r(k-1)-y(k-1),\ k \geq 0$ **13**

where

$$r(k)=\begin{cases}1 & k \text{ is even}\\ 0 & k \text{ is odd}\end{cases}$$

$y(-1)=r(-1)=0$.

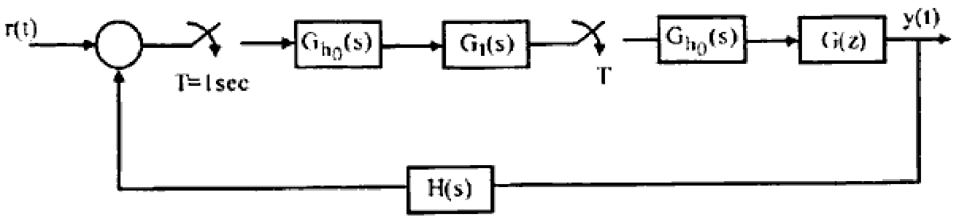
OR

2. Consider a discrete time system described by the differential equation. **13**

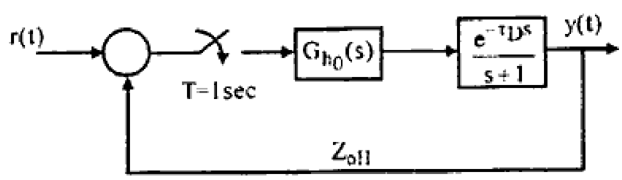
$$y(k+2)+\frac{1}{4}y(k+1)-\frac{1}{8}y(k)=3r(k+1)-r(k)$$

The system is relaxed $y(k)=0,\ k<0$ and is excited by the input $r(k)=(-1)^k u(k)$ obtained T.k model of discrete time system and hence find the output $y(k);\ k>0$.

3. a) Find $Y(z)/R(z)$ for the input data closed loop system. **6**



b) Consider the sample data system shown. find $Y(z)/R(z)$ when $T_D=0.4$ sec. **8**



Forward path gain

OR

4. a) A unity feedback system has open loop transfer function. **6**

$$G(s)=\frac{5}{s(s+1)(s+2)}$$

using Routh stability criteria show that closed loop system is stable.

b) Consider the digital controller defined by **8**

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

Draw the parallel realization.

5. Consider the control system in Fig. 5 the plant transfer func is **13**

$$G(s)=\frac{1}{s(s+2)} \text{ and } T=0.1\,\text{sec}.$$

a) Increase plant gain value that results in $k_v=5$. Then find phase margin.

b) Design a lead compensator that results in 55° phase margin with $k_v=5$

c) Design a lag compensator that results in 55° phase margin with $k_v=5$.

d) Obtain band with realized from the designs corresponding to (a), (b), (c)

e) Is the selection of T=0.1sec justified from closed loop bandwidth considerations.

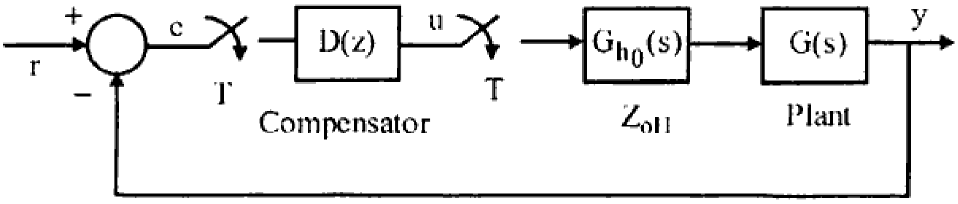


Fig. 5

6. Consider the feedback control system shown in fig. The plant is described by the Tf **13**

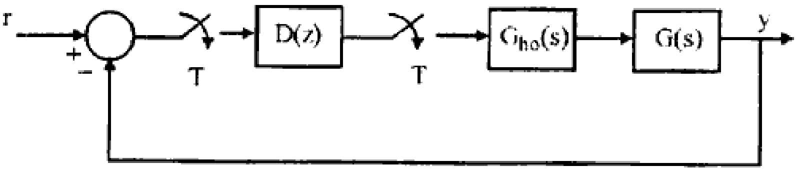
$$G(s)=\frac{k}{s(s+2)}$$

Design a digital is for the system to meet the fell. specifications.

i) Velocity error const $k_0=6$.

ii) Peak overshoot M_P to step i/p ≤ 15%

iii) Settling time ts (2% tolerance band) ≤ 5 sec.



A feedback system using digital compensation

SECTION - B

7. In following, realize three different form. **13**

$$G(s)=\frac{s+3}{s^3+9s^2+24s+20}=\frac{y(s)}{u(s)}$$

OR

8. a) Find T/F for given model. **5**

$$\dot{x}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}x+\begin{bmatrix}1\\ 0\end{bmatrix}u$$

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

b) Derive 2-state model for the system with **8**

$$T.f\ \frac{y(s)}{u(s)} = \frac{50\,(1+s/5)}{s(1+s/2)\,(1+s/50)}$$

for which system matrix is a companion form matrix.

9. a) State properties of STM in discrete system. **6**

b) Find whether the system **8**

$$u(k+1) = A\,x(k) + B\,u(k)$$

$$y(k) = c\,x(k)$$

$$A = \begin{bmatrix} 1 & -2 \\ 1 & -1 \end{bmatrix} B = \begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} C = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

is controllable.

OR

10. a) Find state model of system. **8**

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

b) Derive necessary conditions for digital control system to be controllable. **6**

11. Consider the system **13**

$$\dot{x} = Ax + Bu.$$

$$y = \ell x + du.$$

where

$$A = \begin{bmatrix} -2 & -1 \\ 1 & 0 \end{bmatrix}; B = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}; C = [0 \quad 1], D = [2 \quad 0]$$

Design a full order state observer so that the estimation error will decay in less than 4 seconds.

OR

12. Consider a plant defined by the foll. State variable model. **13**

$$x(k+1) = f\,x(k) + G\,u(k);$$

$$y(k) = cx(k) + du(k)$$

where

$$F = \begin{bmatrix} 1/2 & 1 & 0 \\ -1 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}; G = \begin{bmatrix} 1 & 4 \\ 0 & 0 \\ -3 & 2 \end{bmatrix}; C = [1 \quad 0 \quad 0];\ d = [0\ 4]$$

Design a prediction observer for estimation of state vector x. The observer error poles are required to Lie at $-\frac{1}{2} \pm j\frac{1}{4}$. Give all the relevant observer eq^{ns} & block diag description of observer structure.

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