First Semester M. E. Electrical (Electronics and Power Engg.) Examination

DIGITAL CONTROL SYSTEM

1 EEPME 1

P. Pages : 5

Time : Three Hours] [Max. Marks : 80

Note : (1) Separate answer book must be used for each Section in the subject Geology. Engineering material of civil branch and Separate answer book must be used for Section A and B in Pharmacy and Cosmetic Tech.
(2) Answer **three** questions from Section A and **three** questions from Section B.
(3) Due credit will be given to neatness and adequate dimensions.
(4) Assume suitable data wherever necessary.
(5) Illustrate your answer wherever necessary with the help neat sketches.

SECTION A

1. (a) What do you understand by Alising ? What are its effects ? 5

(b) Consider the difference equation

$$y(k+2)+a_1 y(k+1)+a_2 y(k)=b_0 r(k+2)+b_1 r(k+1)+b_2 r(k)$$

Assuming that the system is initially at rest and r (k) = 0 for k > 0 obtain the transfer function

$$G(z)=\frac{Y(z)}{R(z)}$$ 9

OR

2. (a) Explain practical aspects of the choice of sampling rate. 5

(b) Consider the first order discrete system described by the difference equation

$$y(k+1)+a_1 y(k)=b_0 r(k+1)+b_1 r(k)$$

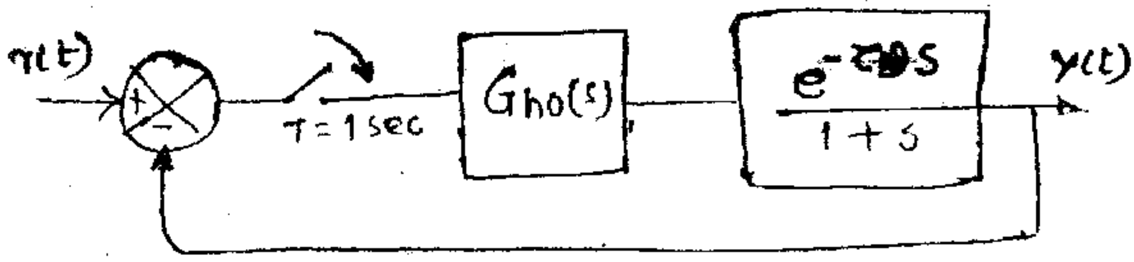
The input is switched to the system at k = 0 (r (k) = 0 for k (0) ; the initial state y (1) of the system is specified. Obtain the simulation diagram for the system. 9

3. (a) Explain in brief Non interacting velocity PID algorithm. 4

(b) Consider the sampled data system shown in fig. Find Y (z) / R (z) when

(i) τ_D = 0.4 sec

(ii) τ_D = 1.4 sec.



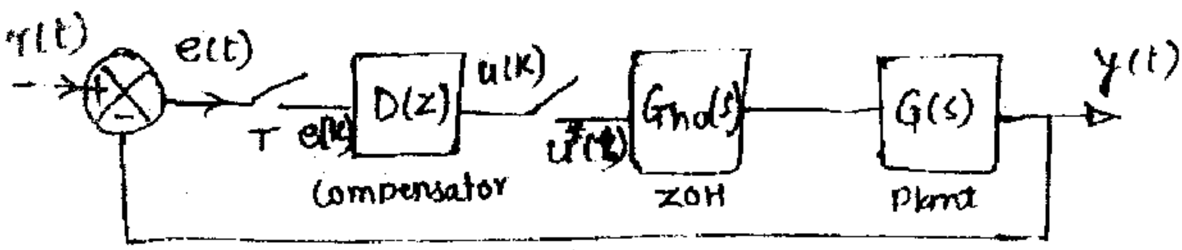
9

OR

4. Explain in detail Digital Temperature Control System with block diagram, control scheme model and block diagram of realization of controller. 13

5. Consider the feedback control system shown in fig. the plant to described by transfer function

$$G(S) = \frac{K}{S(S+5)}.$$



Design the digital control scheme for the system to meet the following specifications

(i) Velocity error constnat $K_V \geq 10$

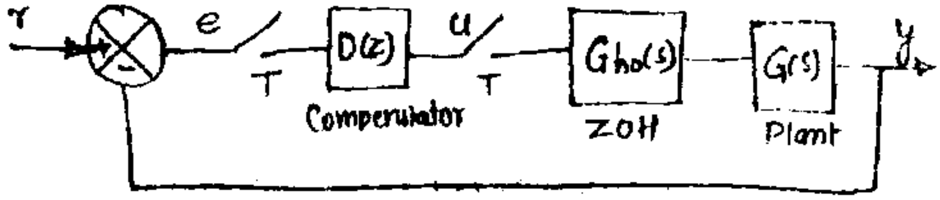
(ii) Peak overshoot MP to step input $\leq 25\%$

(iii) Settling time t_s (2% tolerance band) $\leq$ 2.5 sec. 13

OR

6. Consider a control system shown in fig. where the plant transfer function

$$G(S) = \frac{1}{S(S+5)} \text{ and } T = 0.1 \text{ sec}$$



(a) Increase the plant gain to the value that results in $K_V = 5$. Then find the phase margin.

(b) Design a lead compensator that results in 55^0 phase margin and $K_V = 5$.

(c) Obtain the bandwidth realized by two designs corrosponding to part (a) and (b). Comment on result.

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SECTION B

7. (a) Explain the concept of controllability and observability. 5

(b) Given

$$\underset{n \times n}{\Lambda} = \begin{bmatrix} \lambda_1 & 1 & 0 & \cdots & 0 \\ 0 & \lambda_1 & 1 & \cdots & 0 \\ \vdots & \vdots & \vdots & & \vdots \\ 0 & 0 & 0 & \cdots & 1 \\ 0 & 0 & 0 & \cdots & \lambda_1 \end{bmatrix}$$

Compute e^{At} using Cayley–Hamilton technique. 9

OR

8. Consider the system :

$$X = \begin{bmatrix} 1 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -1 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \\ -2 \end{bmatrix} u : y = [1 \quad 0 \quad 0] X$$

(a) Find the eigen values of A and from these determine the stability of the system.

(b) Find the transfer function model and from these determine the stability of the system.

(c) Are the two results same ? If not why ? 14

9. Give three different canonical state variable models corrosponding to the transfer function.

$$G(z) = \frac{4z^3 - 12z^2 + 13z - 7}{(z-1)^2(z-2)}$$ 13

OR

10. A closed loop computer controlled system is shown in fig. The digital controller is described by the difference equation

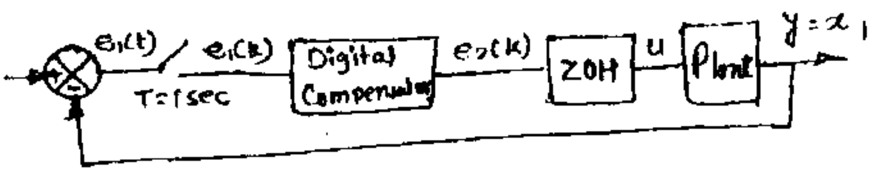
$$e_2(k+1) + a\,e_2(k) = b\,e_1(k)$$

State variable model of the plant is given below

$$\dot{X} = Ax + bu \,;\, y = cx$$

with

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



Obtain discrete – time state description for the closed loop system. 13

11. Consider the system

$$\dot{X} = Ax + Bu \,;\, y = cx + du$$

where

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

Design a full order state observer so that the estimation error will decay in less than 4 seconds. 13

OR

12. A regulator system has plant

$$\dot{X} = \begin{bmatrix} 0 & 1 \\ 20.6 & 0 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

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

(a) Design a control law $u = -kx$ so that the closed loop system has eigen values at $-1.8 \pm j\,2.4$.

(b) Design a full order state observer to estimate the state vector. The observer matrix is required to have eigen values at -8, -8. 13