TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2082 Chaitra

Exam.	Regular (New Course)		
Level	BE	Full Marks	60
Programme	BEL	Pass Marks	24
Year / Part	III / I	Time	3 hrs.

Subject: - Digital Control Systems *(ENEE 304)*

- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) With the help of block diagram, explain digital control system in detail. Also mention the advantages of digital control system over analog. [5]

   b) What do you mean by sample and hold circuit? How is tracking and hold mode employed in digital control system? [3]

2. a) Obtain the Z-transform of [4]

$$X(K) = k^2 a^{K-1}$$

   b) Find the inverse z-transform of [4]

$X(z) = \frac{z^2}{(z-1)^2(z-e^{-aT})}$ by using inversion integral method.

   c) Solve the following difference equation by use of Z –transform method

   $X(K+2) + 3X(K+1) + 2X(K) = 0$, given that $X(0) = 0$, $X(1) = 1$. [4]

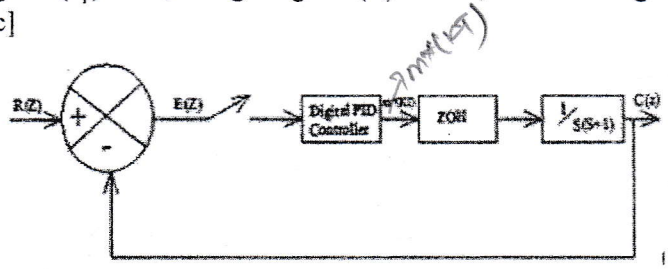
3. a) What do you mean by data hold circuit? Derive the transfer function of Zero Order Hold (ZOH). [3]

   b) Consider the digital filter defined by [5]

$$G(z) = \frac{2 + 2.2z^{-1} + 0.2z^{-2}}{1 + 0.4z^{-1} - 0.12z^{-2}}$$

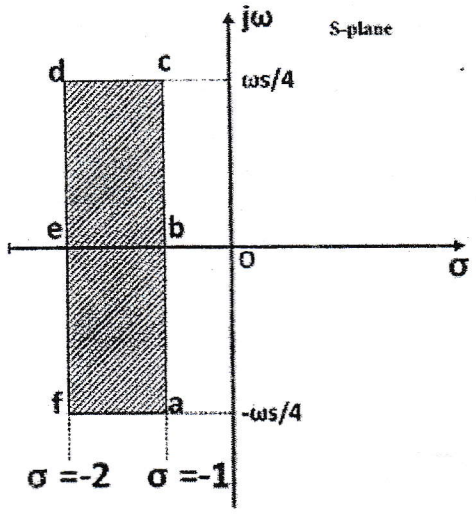
   Realize this filter in the ladder scheme.

   c) Obtain the closed loop transfer function of the system shown in figure below. Assume proportional gain (k_p) = 1, integral gain (k_i) = 0.2, derivative gain (k_d) = 0.2. [Take t = 1 sec] [4]

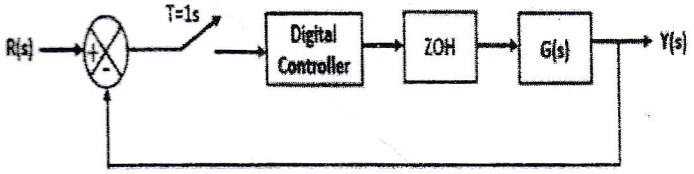


4. a) Examine the stability of the given characteristic equation using Jury stability test. [4]
   $P(z) = z^3 + 2.1z^2 + 1.44z + 0.32 = 0$

   b) Map the following system in Z-plane. [3]



c) Consider a digital control system shown in figure below. The plant is a second order system described as 1 $G(S) = \frac{1}{s(S+1)}$. The sampling period of the system is taken to be t =1s. Design a digital controller such that the dominant closed loop poles of the system will have damping ratio ζ=0.5 and number of samples per cycle of damped sinusoidal oscillation to be 8. Following the design, obtain the unit step response of the designed system and static velocity error constant Kv. [9]



5. a) Obtain a state-space representation of the following pulse-transfer-function system in the controllable canonical form. [4]

$$\frac{Y(z)}{U(z)} = \frac{z^{-1} + 2z^{-2}}{1 + 4z^{-1} + 3z^{-2}}$$

b) Obtain the state space representation of the system shown below in Jordan canonical form: [4]

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

c) Describe Discretization of continuous time state space representation. Obtain the state transition matrix for the discrete time system given below. [4]

x(k+1) = Gx(k) + Hu(k)

y(k) = Cx(k)

Where,

$G = \begin{matrix} 0 & 2 \\ -0.2 & -1.5 \end{matrix}$, $H = \begin{matrix} 1 \\ 1 \end{matrix}$ and $c = (1 \quad 0)$

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