Reg No.:_______________ Name:__________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), MARCH 2020

Course Code: AE407

Course Name: DIGITAL CONTROL SYSTEM

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Describe the working of a sample and hold circuit and using suitable timing diagram explain about aperture time and hold-mode droop. (9)

b) Derive the expression for transfer function of a first order hold system. (6)

2 a) Explain the concept of digital control system using a step motor control. (5)

b) Explain the mathematical modelling of the sampling process. Also plot the amplitude spectrum of the sampling process. (10)

3 a) Find the inverse z transform of X(z) (7)

$$X(z) = \frac{(z+2)z}{(z-1)^2}$$

b) Find the solution of the following difference equation: (8)

$$x(k+2) - 1.3x(k+1) + 0.4x(k) = u(k)$$

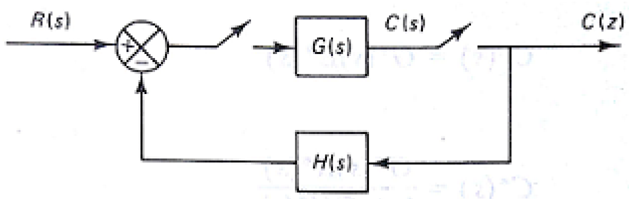
With x(0)=x(1) = 0 and x(k) = 0 for all k<0

$$u(k) = \begin{cases} 1 & k = 0,1,2 \dots. \\ 0 & k < 0 \end{cases}$$

PART B

Answer any two full questions, each carries 15 marks.

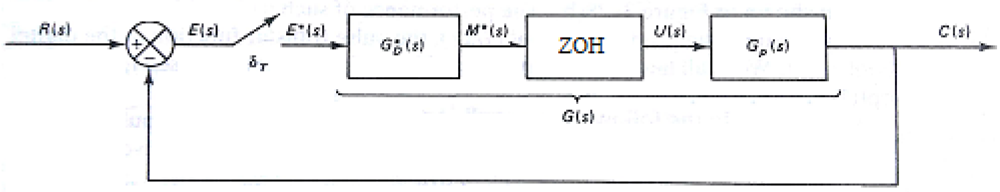
4 a) Obtain the pulse transfer function of the given closed loop system (6)



b) Examine the stability of the following characteristic equation (9)

$$P(z) = z^4 - 1.2z^3 + 0.07z^2 + 0.3z - 0.08 = 0$$

5 a) Determine the pulse transfer function for the closed loop system for a sampling time of T=1 sec. System transfer functions are $G_P(s) = \frac{1}{s+1}$ and $G_D^*(s) = G_D(z) = \frac{z}{z-1}$ (15)



6 a) Find the root locus diagram for the system and obtain the close loop poles corresponding to K=2. (12)

$$G(z) = \frac{0.8647Kz}{(z-1)(z-0.1353)}$$

b) Define gain margin and phase margin? (3)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Obtain the state equation and output equation for the system in observable canonical form: (10)

$$\frac{Y(z)}{U(z)} = \frac{2z^{-1} + 5z^{-2} - 2z^{-3}}{1 - 5z^{-1} - 2z^{-2} + 6z^{-3}}$$

b) Draw the state diagram representation of a linear time invariant discrete time control system and various matrices in the representation. Also prove the non-uniqueness of this representation (10)

8 a) Obtain the state transition matrix of the following discrete time system (12)

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

b) Convert the below discrete state equation to transfer function (8)

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -0.2 & -2 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

9 a) Determine whether the system is completely state controllable, output controllable and observable (10)

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 1 & 1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

b) List the procedure for designing a state regulator using pole placement method for a digital control system (10)

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