Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 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) Explain the difference between analog control system and digital control system. (5)

b) Solve the following difference equation by use of Z transform method. (5)

$x(k+2) = x(k+1) + x(k)$ where $x(0) = 0$ and $x(1) = 1$

c) Explain the sample and hold device using a suitable diagram. (5)

2 a) Derive the transfer function of first order hold. (7)

b) Explain the mathematical modelling of the sampling process. (8)

3 a) Explain in detail about the mapping between the S plane and Z plane for different loci. (9)

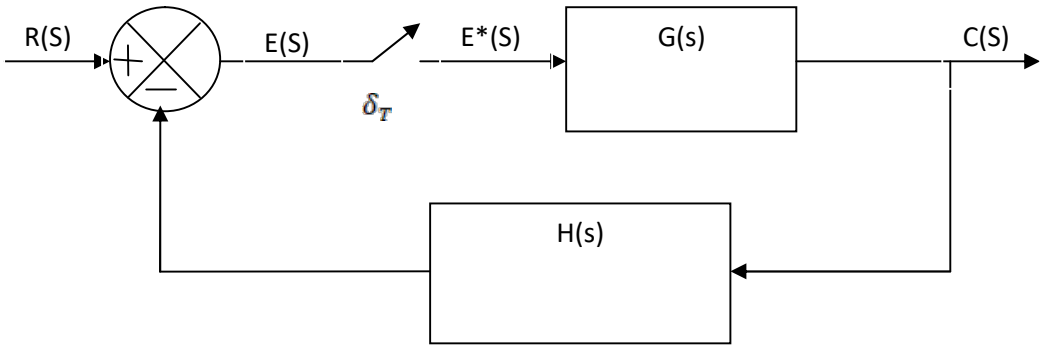
b) Find the inverse Z transform of a causal LTI system with the following transfer function. (6)

$$H[Z] = \frac{-1 + 2z^{-1}}{1 - \frac{1}{4}z^{-1} - \frac{3}{8}z^{-2}}$$

PART B

Answer any two full questions, each carries 15 marks.

4 a) Derive the pulse transfer function of the following system (7)



(8)

b) Obtain the modified Z transform of

i. $x(t) = e^{at}u(t)$, where $u(t)$ represents the unit step signal.

ii. $G(S) = \frac{1}{s+a}$, where $G(S)$ represents the Laplace Transform of $g(t)$

5) a) Check the stability of the system with the following characteristic equation using Jury's stability test. (10)

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

b) Explain the gain margin and phase margin. (5)

6) a) Draw the root locus diagram for the system with following characteristic equation (For T = 0.5 sec.) (15)

$$1 + \frac{Kz(1 - e^{-T})}{(z-1)(z - e^{-T})}$$

PART C

Answer any two full questions, each carries 20 marks.

7 a) Derive a state space representation of the following pulse transfer function system in the observable canonical form and draw the block diagram (10)

$$\frac{Y[Z]}{U[Z]} = \frac{z^{-2} + 4z^{-3}}{1 + 6z^{-1} + 11z^{-2} + 6z^{-3}}$$

b) Determine whether the following system with state space representation is completely controllable or not and observable or not. (10)

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

$$y[k] = \begin{bmatrix} 1 & 5 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix}$$

8 a) Derive the state space representation of the following pulse transfer function system in controllable canonical form and diagonal canonical form and draw the block diagram. (12)

$$\frac{Y[Z]}{X[Z]} = \frac{z+1}{z^2 + 1.3z + 0.4}$$

b) Obtain the transfer function of the system with the following state space representation (8)

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \\ x_3(k+1) \end{bmatrix} = \begin{bmatrix} -2 & -1 & 0 \\ 0 & -3 & 1 \\ -3 & -4 & -5 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = \begin{bmatrix} 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \\ x_3(k) \end{bmatrix}$$

9 a) Write short notes on: (12)

i. Pole placement using state feedback

ii. Dynamic Output feedback

b) Effects of finite word length on controllability and closed loop pole placement (8)

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