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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh semester B.Tech examinations (S), September 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) What is a discrete data control system? Briefly explain such a system with the help of a block diagram. (5)

b) What is zero order hold? Derive the expression for transfer function of zero order hold. (7)

c) State sampling theorem. What is the significance of Nyquist frequency in sampling process? (3)

2 a) Draw the input output relation and the quantization error plot for an 8-bit truncation quantizer and explain the following terms. (10)

i. Quantization

ii. Quantization level

iii. Quantization error

b) State and prove the final value theorem in z-transform. (5)

3 a) Solve the difference equation $y(k+2)+0.4y(k+1)+0.1y(k)=-(0.5)^{k+1}$ using z-transform. Given y(0) = 0, y(1) = 0. (9)

b) Find the z transform of the sequence $f(k)=\left(\frac{1}{2}\right)^k$ for k=0, 1, 2, … (6)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Determine the stability of the system using Jury's stability test for the characteristic equation $P(z)=z^4-1.2z^3+0.07z^2+0.3z-0.08=0$ (10)

b) Write short note on the stability analysis of digital control system using Routh-Hurwitz criterion. (5)

5 a) Derive the expression for acceleration error constant and velocity error constant of a Type 0 digital system. (10)

b) Explain the procedure for stability analysis using Bode plot. (5)

6 Given the feed-forward pulse transfer function of a system, plot the root locus and comment on the stability for the closed loop system with unity feedback. (15)

$$G(z) = \frac{Kz(1-e^{-T})}{(z-1)(z-e^{-T})}; \text{ Assume T = 0.5 s}$$

PART C

Answer any two full questions, each carries 20 marks.

7 a) For the following transfer function, obtain (15)

$$\frac{Y(z)}{U(z)} = \frac{z+1}{z^2+1.3z+0.4}$$

i. Controllable canonical form

ii. Observable canonical form

iii. Diagonal canonical from

b) Derive the expression for the pulse transfer function matrix of an LTI system governed by the standard state space equations. (5)

8 a) Obtain the discrete time state equation of the following continuous time system. Assume sampling period T=1s. (12)

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

b) Find the pulse transfer function representation of the system defined by the following state space equations. (8)

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 1 & 0.4323 \\ 0 & 0.1353 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0.2838 \\ 0.4323 \end{bmatrix} u(k)$$

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

9 a) Given the pulse-transfer function, determine whether the system is completely state controllable and state observable. (12)

$$\frac{Y(z)}{U(z)} = \frac{z^{-1}(1+0.8z^{-1})}{1+1.3z^{-1}+0.4z^{-2}}$$

b) Explain the concept of pole placement by state feedback. (8)