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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

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) With the help of a neat block diagram, explain the basic elements of a digital control system. Mention any one example and explain each block. (10)

b) Write any five advantages of digital control over analog control system. (5)

2 a) Derive the transfer function of Zero Order Hold from its impulse response. (5)

b) Find the cascaded open loop z transfer function, $G_{ZAS}(z)$ for the cruise control system for the vehicle, where *u* is the input force, *v* is the velocity of the vehicle, and *b* is the viscous friction coefficient. Given, $G(s) = \frac{K}{\tau s+1}$ (10)

3 a) Find the inverse Z transform of $X(z) = \frac{z^2}{(z-1)(z-0.5)^2}$ (5)

b) A DSP system is described by the following difference equation: (10)

$$y(k) + 0.1y(k-1) - 0.2y(k-2) = x(k) + x(k-1)$$

Determine the response $y(k)$ for the input $x(k) = \delta(k)$

PART B

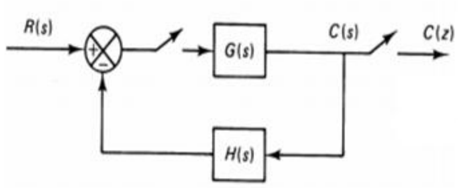
Answer any two full questions, each carries 15 marks.

4 a) For the analog system $G(s) = \frac{10(s+2)}{s(s+5)}$ with a sampling period of 0.05sec ,

(i) Obtain the pulse transfer function in z for the system with DAC and ADC. (5)

(ii) Determine the impulse response of the system with sampled output and analog input. (5)

b) Derive the Pulse transfer function of the system shown below. (5)



5 a) Briefly explain the concept of stability of a system in z-plane. (5)

b) Determine the stable range of parameter a using Jury's stability test, for the closed loop unity feedback system with $G(z) = \frac{1.2(z+0.1)}{(z-a)(z-0.9)}$ (10)

6 For the system $G(z) = \frac{0.4(z+0.2)}{(z-1)(z-0.1)}$ with unity feedback, find the (15)

(i) Position error constant

(ii) Velocity error constant

(iii)Acceleration error constant

PART C

Answer any two full questions, each carries 20 marks.

7 For the general discrete time transfer function

$$G(z) = \frac{Y(z)}{U(z)} = \frac{\beta_0 z^m + \beta_1 z^{m-1} + \dots + \beta_m}{z^n + \alpha_1 z^{n-1} + \dots + \alpha_n}, \quad m = n$$

(i) Derive the state and output equations in observable canonical form. (10)

(ii) Draw the block diagram with the unit delay blocks for the observable canonical form. (5)

(iii) Also write the matrices A, B, C and D in terms of α and β. (5)

8 a) Determine the discrete time state equation and output equation for the continuous time system given: (when T=1sec) $G(s) = \frac{Y(s)}{U(s)} = \frac{1}{s(s+2)}$ (10)

b) Derive the expression for state transition matrix $\phi(k)$ using z-transform method. (10)

9 a) Investigate the controllability and observability of the system given below after forming the controllability and observability matrix. (10)

$$x(k+1) = \begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k) \; ; \; y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} x(k)$$

b) The plant of a regulator system is given below. The system uses the state feedback control $u = -Kx$. Using the pole placement method, determine the state feedback gain matrix K so that the system will have the eigen values at $-2 \pm j4 \; and -10$ (10)

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u$$

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