Duration: 3 Hours Max. Marks 80

N.B.

1. **Q.1** is compulsory. Attempt **any three** from the remaining questions.
2. All questions carry equal marks.
3. Figures to the Right indicate full marks.
3. Assume suitable data if necessary

Q.1 Attempt **any four** 20

a. What is Quantization? Explain the difference between quantization and encoding.

b. Determine steady state error for unit step, ramp and acceleration inputs for the following system.

$$\frac{0.2385(z+0.8760)}{(z-1)(z-0.2644)}$$

c. Map the region from s-plane to the z-plane which is bounded by constant frequency lines at $\pm 5j$ and constant attenuation lines at ± 2.

d. Explain sampler as an impulse modulator.

e. What are the advantages of Digital Control System.

f. Obtain the pulse transfer function for the following system.

$$\begin{aligned} z(k+1) &= \begin{bmatrix} 2 & -5 \\ 0.5 & -1 \end{bmatrix} z(k) + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u(k) \\ y(k) &= [2 \;\; 0]\, z(k) \end{aligned}$$

Q.2 A. Explain working of ZOH device and derive its transfer function. 10

B. What is Signal Flow Graph? Explain Mason's Gain formula by giving appropriate example. 10

Q.3 A. Determine the values of K for asymptotic stability of the system given by characteristic equation using Jury's stability criteria 10

$$P(z) = z^4 + 0.2z^3 - 0.25z^2 - 0.05z + K = 0$$

B. Represent the given system in companion form and Diagonal canonical form along with its block diagram realization. 10

$$T(z) = \frac{z^3 + 8z^2 + 17z + 8}{(z+1)(z+2)(z+3)}$$

Q.4 A. Obtain state transition matrix for the system defined by **10**

$$z(k+1) = \begin{bmatrix} 1 & 2 & 0 \\ 3 & -1 & -2 \\ 1 & 0 & -3 \end{bmatrix} z(k)$$

B. What is multirate sampling? Explain multirate output feedback based state estimator. **10**

Q.5 A The discrete time control system is given by **10**

$$x(k+1) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -4 & -2 & -1 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(k)$$

Design a state feedback controller to place closed loop poles at $-0.5 \pm j0.5$ and 0.

B. Explain discrete-time PID controller in detail. **10**

Q.6 A. Design the deadbeat full order observer for the system **10**

$$\begin{aligned} x(k+1) &= \begin{bmatrix} 0.16 & 2.16 \\ -0.16 & -1.16 \end{bmatrix} x(k) + \begin{bmatrix} -1 \\ 1 \end{bmatrix} u(k) \\ y(k) &= \begin{bmatrix} 1 & 1 \end{bmatrix} x(k) \end{aligned}$$

B. Discretize the given system **10**

$$G(s) = \frac{4500K}{s(s+361.2)}$$

with $K = 14.5$ and sampling period of Ts=0.5 sec.

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