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. Determine steady state error for unit step, ramp and acceleration inputs for the following system.
$$\frac{0.049545(z + 2.972)(z + 0.2045)}{(z - 1)^2(z - 0.3679)}$$

  b. What do you mean by discretization? List various methods of discretization and explain any one.
  c. Check controllability and observability of the given system.

$$z(k + 1) = \begin{bmatrix} 0 & 1 \\ 0.05 & -0.4 \end{bmatrix} z(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$
$$y(k) = \begin{bmatrix} 1 & 1.5 \end{bmatrix} z(k)$$

  d. Explain block diagram of digital control system by giving appropriate example.
  e. What is meant by internal stability? How it is different from BIBO stability?
  f. Map the region from s-plane to the z-plane which is bounded by constant frequency lines at $\pm 5j$ and constant damping ratio lines at $\pm 60°$.

Q.2 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. Explain discrete-time PID controller in detail.   10

Q.3 A. Design the state feedback control law for the open loop system having all the poles at 0.5.   10

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

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

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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. Explain sampler as an impulse modulator.   10

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

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

Design a dead beat observer.

B. Discretize the given system   10

$$G(s) = \frac{s+3}{s^2+3s+2}$$

with sampling period of Ts=0.2 sec.

Q.6 A. Represent the given system in controllable and diagonal canonical form along with   10
its block diagram realization.

$$T(z) = \frac{z^3 + 8z^2 + 17z + 8}{(z+1)(z^2+5z+6)}$$

B. The block diagram of the system is shown in Figure 1, using signal flow graph   10
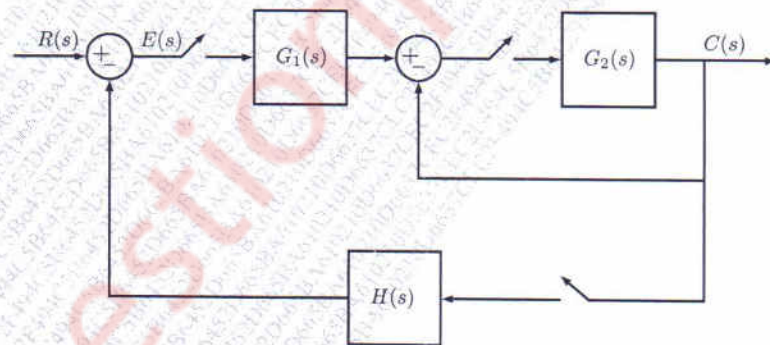determine transfer function of the system

Figure 1: