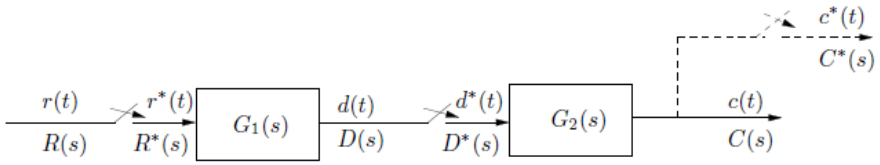
(3 Hours) **[Total Marks: 80]**

N. B.: (1) Question No. 1 is compulsory.
(2) Attempt any **THREE** questions from the remaining five questions.
(3) Assume suitable data if necessary.
(4) Figures to the right indicate full marks.

1. Answer in brief. Solve any FOUR. **20**

a. For a systems shown by block diagram given, the overall transfer function is C(z) / R(z) = ?



b. Derive relationship between discrete state space model and z transfer function.
c. What is feedforward controller?
d. Explain the concept of Reachability and Constructability of a given state space model
e. What are the advantages of state space based pole placement design as compared to root locus based approach?

2. (a) Obtain relationship between s plane and z plane mapping using bilinear transform. **10**

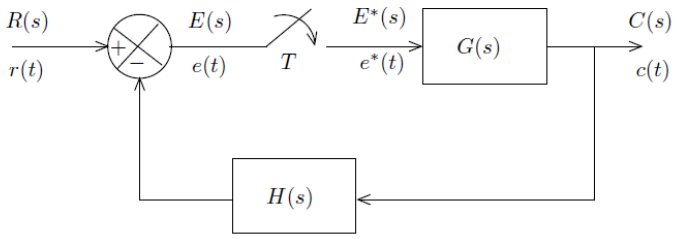
(b) Explain the algorithm of a Discrete PID Control law. Write continuous domain equation and discretize. Explain role of each in achieving the control objectives. **10**

3. (a) Determine closed loop stability of a system whose characteristic equation is given by **10**

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

3. (b) Obtain the closed loop transfer function for the following system, **10**

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



4. (a) For a given system obtain state transition matrix using Caley Hamilton Theorem and get expression for y(k) for k≥0. **10**

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

$$y(k) = [1 \quad 0]x(k) \qquad x(0) = [1 \quad 1]^T$$

(b) For a system given by transfer function

$$G(z) = \frac{z+1}{z^2 + z + 0.16}$$

Obtain state space model in Controllable Canonical Form, Observable Canonical Form and Jordan Canonical Form. **10**

5. (a) Investigate Controllability and Observability of the following system **10**

$$x(k+1) = \begin{bmatrix} 0 & 1 \\ -0.4 & -1.3 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

$$y(k) = [0.8 \;\; 1]x(k)$$

(b) Find out the state feedback gain matrix K for the following system such that the closed loop poles are located at 0.5+j0.5 and 0.5-j0.5. **10**

$$x(k+1) = \begin{bmatrix} 0 & 1 \\ -0.16 & -1 \end{bmatrix} x(k) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$

6. Write short notes on any two: **20**

1. State Observer based controller design
2. Internal Model Principle for control design
3. Static error constants and steady state error
