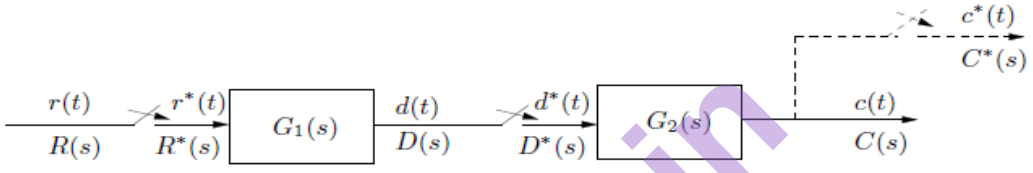
Time: 3 Hours Marks: 80

1. Attempt Any Four Questions
2. Question No. 1 is Compulsory
3. Marks to the right indicate full marks
4. Assume suitable data wherever necessary.

1. Answer in brief. Solve any four **(20)**

a. What is an ideal sampler? Explain it's operation.

b. For a system shown by block diagram below, obtain overall transfer function $\frac{C(z)}{R(z)}$



c. Derive relationship between discrete state space model and z transfer function.

d. What are the advantages of a state variable model as compared to transfer function model?

e. Explain the concept of Controllability and Observability of a given state space model.

Q2.

a. Obtain relationship between s plane and z plane mapping using finite difference approximation **(10)**

b. State and explain the advantages of digital control as compared to analog control system. **(10)**

Q3.

a. Obtain difference equation for a digital PI controller in recursive form. **(10)**

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

$$P(z) = z^3 - 1.25z^2 - 1.375z - 0.25 = 0$$

Q4.

a. For a given system obtain state transition matrix. **(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. Explain the steady error constants for a typical digital control system, with a sampler in forward path. **(10)**

Q5

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

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

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

b. Find out the state feedback gain matrix K for the following system by converting the system into controllable canonical form such that the closed loop poles are located at 0.5 and 0.6. **(10)**

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

Q 6) Write short notes on **any two**: **(20)**

a. State Observer based controller design
b. Impulse Invariance Method of discretization
c. Components of a Digital Control System

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