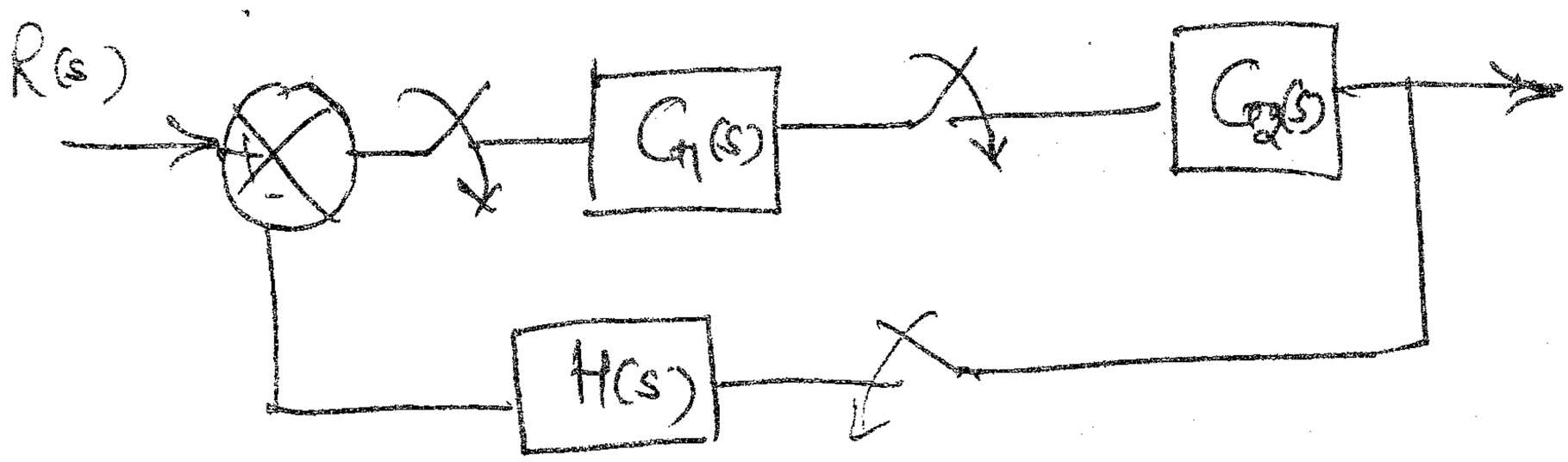
Con. 5148-09. SP-6882

(3 Hours) [Total Marks : 100

N.B. : (1) Question No. 1 is **compulsory**.
(2) Attempt any **four** questions from remaining **six** questions.
(3) Assume **suitable** data if **necessary**.
(4) **All** questions carry **equal** marks.

1. Attempt any **four** of the following :— 20
   (a) Explain the significance of Jordan Canonical form.
   (b) Explain the significance of Unit Circle in Z-domain analysis.
   (c) Explain in brief the various stability criterians as applied to digital control systems.
   (d) How is Mason's gain formula applied to Digital control system ? How is it different from analog systems ?
   (e) What are the different methods of discretization ? Explain in detail any one of them.

2. (a) For the block diagram shown below calculate static error constants and steady state error for unit step, unit ramp and unit acceleration inputs. 10



where $G_1(s) = \frac{1}{(s+1)}$, $G_2(s) = \frac{1}{(s+2)}$

$H(s) = \frac{1}{s}$ and sampling time $T_s = 1$ sec.

(b) Invenstigate the stability of system at origin. 10

$x_1(k+1) = x_1(k) + 0{\cdot}2x_2(k) + 0{\cdot}4$

$x_2(k+1) = 0{\cdot}5x_1(k) - 0{\cdot}5.$

3. (a) Check stability using Jury's criterian— 10
   (i) $z^4 - 1{\cdot}368z^3 + 0{\cdot}4z^2 + 0{\cdot}08z + 0{\cdot}002 = 0$
   (ii) $z^3 - 1{\cdot}8z^2 + 1{\cdot}05z - 0{\cdot}2 = 0$
   (b) Derive the transfer function of first order hold device, with neat input/output characteristics. 10

4. (a) Prove that the bilinear transformation maps the left half of the s-plane into the unit circle in the z-plane. 10
   The transformation $z = e^{ST}$ also maps the left half of s-plane into the unit circle in the z-plane. What is the difference between two maps ?

   (b) (i) Discretize $G(s) = \frac{3}{s(s+3)}$ using step invariance. 10

   (ii) Map $\xi = 0{\cdot}5$ line using impulse invariance from s-plane to z-plane.

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5. (a) What is an observer ? How is its design carried out ? Explain, for a control system defined by— 10

$$x(k+1) = Gx(k) + Hu(k)$$
$$y(k) = Cx(k)$$

Draw block diagram with all signals shown.

(b) What do you understand by dead beat response of an observer ? 10
Design a state observer to obtain dead beat response for the system given below :—

$$G = \begin{bmatrix} 1 & T \\ 0 & 1 \end{bmatrix}, \quad H = \begin{bmatrix} T^2/2 \\ T \end{bmatrix}, \quad C = [1 \quad 0]$$

use transformation matrix method and verify your results using Ackerman's formula.

6. (a) Realize the following transfer function as required. Show state variables chosen. 10

(i) $$\frac{Y(z)}{U(z)} = \frac{z^{-1} + 2z^{-2}}{1 + 4z^{-1} + 3z^{-2}}$$

→ controllable form

(ii) $$\frac{Y(z)}{U(z)} = \frac{z^{-2} + 4z^{-3}}{1+6z^{-1} + 11z^{-2} + 6z^{-3}}$$

→ observable form

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

→ Diagonal form

(b) For system matrix G given by— 10

$$x(k+1) = Gx(k) \quad \text{where G is}$$

$$G = \begin{bmatrix} 0 & 1 \\ -0{\cdot}16 & -1 \end{bmatrix}$$

Find state transition matrix $\phi(k)$

7. (a) Plot the root lous of system given by— 10

$$GH(z) = \frac{K\left(1-e^{-T}\right)z}{(z-1)\left(z-e^{-T}\right)}$$

Show the difference in root loci for the above systm for T = 0·1 sec and T = 1 sec.

(b) Explain following terms— 10

(i) Liapunov Functions
(ii) Equilibrium state
(iii) Stability in the sense of Liapunov.
(iv) Asymptotic stability
(v) Asymptotic stability in the large
(vi) Instability.

How to represent stability, asymptotic Stability and Instability graphically ?