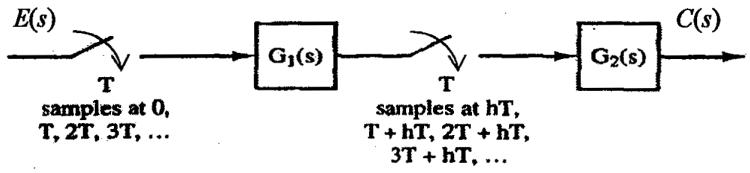
Ref. No.: **Ex/PG/ETCE/T/111C/2024**

M.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING FIRST YEAR FIRST SEMESTER - 2024

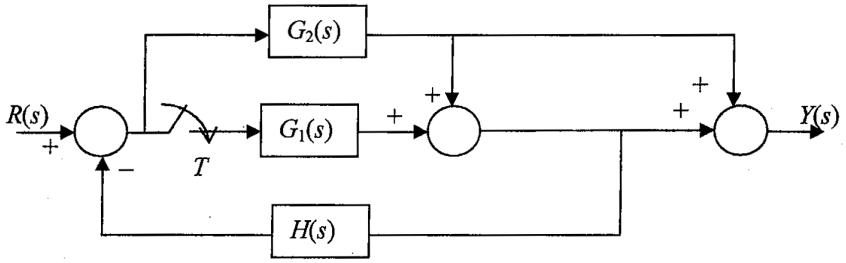
Subject: DIGITAL CONTROL SYSTEM (CON) Time: 3 Hours Full Marks: 100

All parts of the same question must be answered at one place only.
Answer any FOUR

1. (a) Derive the transfer function of a polygonal hold circuit. 7
   (b) Explain how a fast sampler with sampling period T/N ($N = 1, 2, \ldots$) can be realized by a slow sampler of sampling period T. 6
   (c) Determine $C(z)$ of the following system. 12



2. (a) Derive the closed loop transfer function of the following system. 8

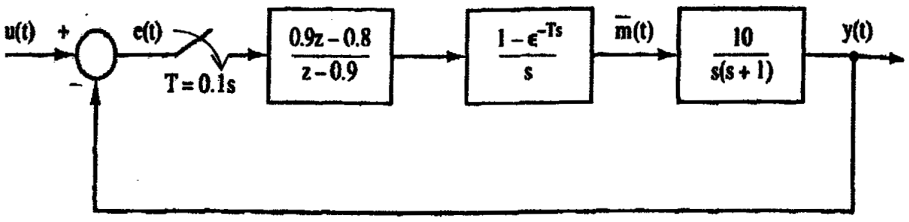


   (b) Derive the expression of maximum overshoot of a second-order closed loop digital control system. 12
   (c) For a discrete time control system with transfer function 5

$$\frac{Y(z)}{R(z)} = \frac{0.368z + 0.264}{z^2 - z + 0.632}, \quad T = 1 \text{ sec}$$

   determine the damping ratio and natural frequency of oscillation for the corresponding s-plane second order transfer function.

3. (a) Explain similarity transform. 5
   (b) Illustrate controllable canonical form of representation of state variables. 5
   (c) Derive the state equation of the close loop discrete-time system. 15



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4. (a) State and prove Nyquist stability criterion for digital control system. 12

(b) Using Nyquist stability criteria, comment on stability of a closed loop system with open loop transfer function $\overline{GH}(z) = \dfrac{0.632Kz}{(z-1)(z-0.368)}$. 6

(c) Discuss how the stability of a closed loop digital control system is influenced by the addition of poles to an open loop transfer function using root locus. 7

5. (a) For a plant described by 10

$$\vec{x}(k+1) = \begin{bmatrix} 1 & 0.0952 \\ 0 & 0.905 \end{bmatrix} \vec{x}(k) + \begin{bmatrix} 0.00484 \\ 0.0952 \end{bmatrix} u(k)$$

find the gain matrix K required to realize the closed loop characteristic equation with zeros providing a damping ratio of 0.46 and a time constant of 0.5 s.

(b) Derive the state dynamics and hence the transfer function of a reduced order state observer. 10

(c) Determine the control law $u(k)$ that minimizes 5

$$J_2 = \sum_{k=0}^{2} \left(x^2(k) + u^2(k) \right)$$

for the plant given by $x(k+1) = 2x(k) + u(k)$.

6. Write short notes on the followings. 12½×2

(a) Subsampling

(b) Current observer