Ref. No.: **Ex/PG/ETC/PE/T/114C/2025**

M.E. ELECTRONICS AND TELE-COMMUNICATION ENGINEERING FIRST YEAR
FIRST SEMESTER - 2025

Subject: DIGITAL CONTROL SYSTEMS Time: 3 Hours Full Marks: 100

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

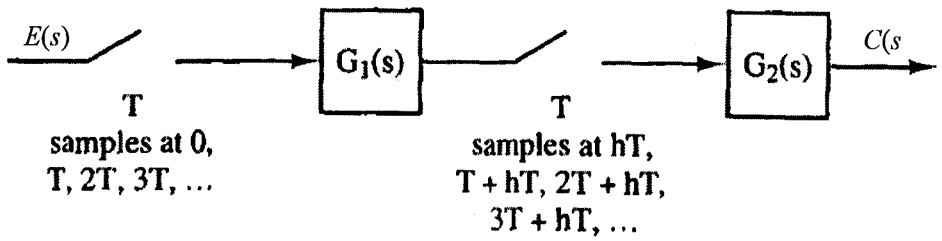
1. (a) Define similarity transform. 5×5 = 25
   (b) Illustrate observable canonical form of representation of state variables.
   (c) What is the advantage of state feedback?
   (d) Prove that $\mathbf{A}^T\mathbf{PA} - \mathbf{P} = -\mathbf{Q}$ where the symbols carry their usual meaning.
   (e) State the principle of optimality.

2. (a) Prove Nyquist sampling theorem. 10
   (b) Why sampler has no transfer function? Explain with example. 5

OR

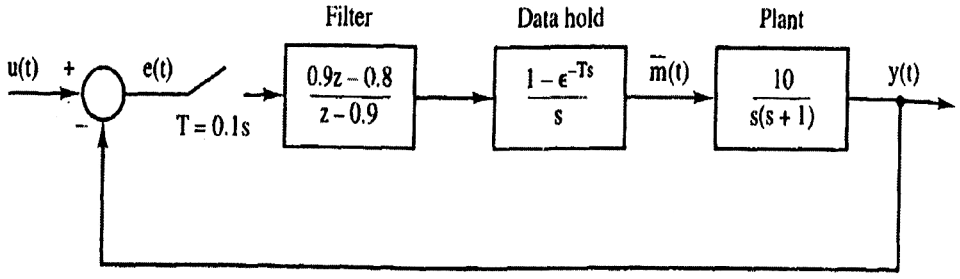
3. (a) Explain the advantage of a fractional order hold over its zero-th and first order counterparts with respect to their individual characteristics. 10
   (b) Derive the transfer function of a polygonal hold circuit. 5

4. Find $C(z)$. 20



OR

5. Find the state-space representation of the following closed-loop system. 20



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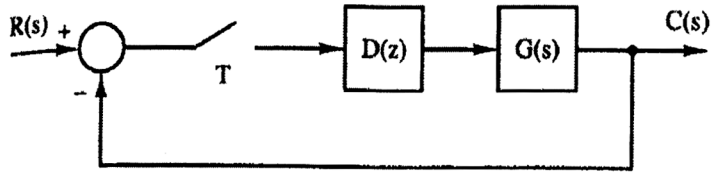
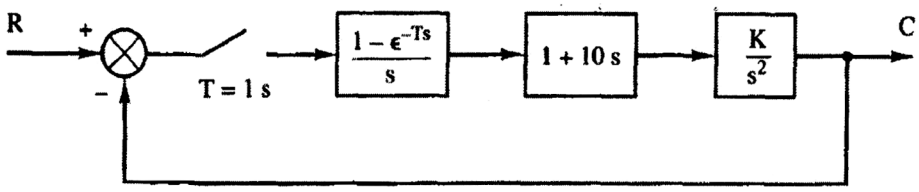
6. (a) What is bilinear transform? 7

(b) Design a digital controller $D(z)$ for the following system to attain a steady state error less than 0.01 for unit ramp input and to ensure stability of the entire system with $G(s) = \frac{1-\exp(-Ts)}{s(s+1)}$ and T=0.1 sec. 13



OR

7. (a) Find the range of K for stability of the following system from its root locus. 15



(b) Using root locus, explain the effect of addition of open-loop poles on the stability of a closed-loop system 5

8. Derive the state dynamics and hence the transfer function of a state observer. 20

OR

9. Determine the control law $u(k)$ that minimizes $J_2 = \sum_{k=0}^{2}\left(x^2(k) + u^2(k)\right)$ for the plant given by $x(k+1) = 2x(k) + u(k)$. 20