Ref. No.: **Ex/MECE 627/2024**

M.TECH. INTELLIGENT AUTOMATION AND ROBOTICS FIRST YEAR SECOND SEMESTER - 2024

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

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

1. (a) Draw and explain the basic block diagram of a digital control system. 5
   (b) State and prove Nyquist sampling theorem. 15
   (c) Explain why a sampler cannot be represented by transfer function. 5

2. (a) Prove that: 10

$$\overline{Err}(s) = \left[\sum_{k=0}^{\infty} err(kT)\exp(-kTs)\right]\frac{1-\exp(-Ts)}{T}$$

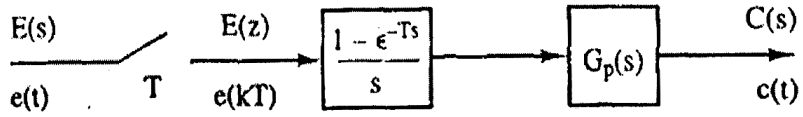
   Symbols carry their usual meaning.
   (b) Derive the transfer function of a first-order hold circuit. 15

3. Prove the following properties for $X(z) = Z(x(k))$
   (a) 10

$$Z(x(k+m)) = \left(X(z) - \sum_{k=0}^{m-1} x(k)z^{-k}\right)z^{m}$$

   (b) $\lim_{k\to\infty} x(k) = \lim_{z\to 1}(z-1)X(z)$ 8
   (c) $Z(kx(k)) = -z\frac{dX(z)}{dz}$ 7

4. (a) What is starred transform? 5
   (b) Prove the periodicity property of starred transform. 5
   (c) What is the relation between the starred transform and the z-transform of a signal? 3
   (d) Determine $C(z)$ for $E(s) = 1/s$. 12



5. (a) Write the state and the output equations of a discrete-time control system. Explain all the terms. 5
   (b) Find the state space representation of the discrete time control system with the following transfer function. 20

$$\frac{Y(z)}{U(z)} = \frac{a_{n-1}z^{n-1} + a_{n-2}z^{n-2} + \ldots + a_1 z + a_0}{z^n + b_{n-1}z^{n-1} + b_{n-2}z^{n-2} + \ldots + b_1 z + b_0}$$