M.E. ELECTRICAL ENGINEERING
1st YEAR 1ST SEMESTER EXAMINATION-2025
Subject: DIGITAL CONTROL SYSTEMS Time: 3 Hours Full Marks:100
Use separate answer-scripts for each part
Part I (50 marks**)**

Question No.		*Question No 1 is compulsory* Answer ***Any Two*** questions from the rest (2x20)	Marks
Q1.		Answer any **two**questions**(2X5=10)**	
	(a)	How do you differentiate analog, digital, discrete, and continuous signals?	5
	(b)	What do you mean by Finite word length effect?	5
	(c)	Solve the second-order difference equation $y(k+2)+5y(k+1)+6y(k)=5x(k+2)$, with initial condition $y(0)=0, y(1)=2.$	5
	(e)	Obtain the inverse z transform of $X(z)=\frac{z(z+2)}{(z-1)^2}$ by use of partial fraction method.	5
Q2.	(a)	Illustrate the *amplitude quantization*, the *quantization level* and the *quantization error* in analog-to-digital conversion in digital control system.	1+1+2
	(b)	Explain *Acquisition Time* (Ta), *Aperture Time* (T), *Settling Time* (Ts),*Hold Mode Droop* observed during sample and hold operation	4
	(c)	Consider the system shown in the Figure 1. Derive the difference equation describing when the input voltage applied is piecewise constant, i.e. $e(t)=e(KT)$ for $KT \le t \le (K+1)T$ and $T=1\text{sec}$. Draw the equivalent sampled-data block diagram.	10+2

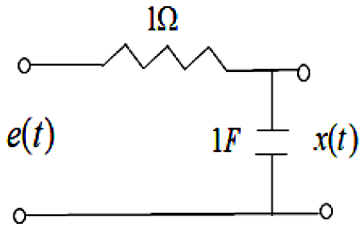

Figure 1

Q3. (a) Derive the transfer function of ZOH. Find the Z-transform of unit ramp function. 4+5

(b) Show that the output c(t) of pulse sampler and ZOH can be produced by ***impulse sampled r(t)*** when passed through a transfer function of ZOH. 7

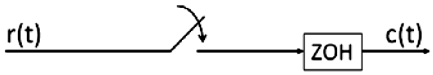

Figure 2

(c) Define the initial and final value of the system's impulse when 4

$$Y(z)=\frac{2z^2}{(z-1)(z-a)(z-b)},\ |a|,|b|<1$$

Q4. (a) For each of the following difference equation state the order of the equation. Is the equation (a) linear, (b) time invariant, or (c) homogeneous? Give justification. 2+2

1. $y(k+2)+0.6y(k+1)+0.07y(k)=u(k)$
2. $y(k+4)+\sin(0.4k)y(k+1)+0.3y(k)=0$

(b) Use the Jury's stability criterion determine the stability of the following polynomial 6

$$z^5-0.25z^4+0.1z^3+0.4z^2+0.3z-0.1=0$$

(c) Consider the system of the following scheme in Figure 3. Find the closed loop unit step response. 10

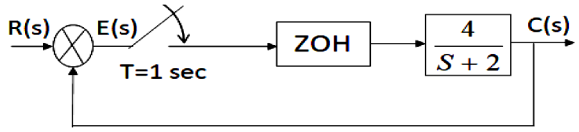

Figure 3

Q5. (a) Derive the transfer function of the Positional form of digital PID Controller. 8

(b) Draw the root locus diagram of the following open loop pulse transfer function $G(z)=k\left(\frac{0.092z+0.066}{z^2-1.368z+0.368}\right)$,where k is the variable gain. Clearly indicate the breakaway points and cross over points. 12

Ref. No.: Ex/PG/CTS/PE/T/114A/2025

MASTER IN CONTROL SYSTEM ENGINEERING
1ST YEAR 1ST SEMESTER EXAMINATION, 2025
MASTER OF ENGINEERING ELECTRICAL ENGINEERING
1ST YEAR 1ST SEMESTER EXAMINATION, 2025

Subject: DIGITAL CONTROL THEORY **Time: Three Hours** **Full Marks: 100**

Part II (50 marks)

Question No. — ***Question 1 is compulsory*** — Answer ***Any Two*** questions from the rest (2×20) — Marks

Q1 Answer ***Any Two*** of the following questions (2×5 = 10)

(a) Obtain the pulse transfer function for the system described by the state equations

$$\boldsymbol{x}(k+1) = \begin{bmatrix} 1.35 & 0.55 \\ -0.45 & 0.35 \end{bmatrix} \boldsymbol{x}(k) + \begin{bmatrix} 0.5 \\ 0.5 \end{bmatrix} u(k)$$
$$y(k) = [1 \quad -1]\boldsymbol{x}(k)$$

5

(b) Consider a system given by the pulse transfer function

$$G(z) = \frac{0.17z + 0.04}{z^2 - 1.1z + 0.24}$$

Obtain the state and output equations of the system in Controllable Canonical Form. 5

(c) Define complete state controllability and observability for a discrete-time system. State the *Principle of Duality* for discrete-time system. 2+3

(d) What is Deadbeat Response? How it can be achieved for discrete-time systems? 2+3

Q2 (a) Define State Transition Matrix for a discrete-time system. Show how the solution of the linear-time-invariant discrete-time state equation can be obtained in terms of the state transition matrix. 2+4

(b) Consider an asymptotically stable continuous-time system

$$\begin{bmatrix} \dot{x}_1(t) \\ \dot{x}_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$
$$y(t) = x_1(t)$$

Obtain the state equation for the discrete-time system, assuming that the input to the system is held constant between consecutive sampling instants of 1 sec. 8

(c) Consider the system

$$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} (-1)^k$$

with, $x_1(0) = x_2(0) = 1$ and $y(k) = x_1(k)$.

Find the expression for $y(k)$ for k ≥ 1. 6