Name: **Enrolment No:**	UPES University of Tomorrow

UPES

End Semester Examination, December 2023

Course: Advanced Digital Control Systems **Semester: III**
Program: M.Tech A & RE **Time : 03 hrs.**
Course Code: ECEG8017 **Max. Marks: 100**

Instructions: Attempt all the questions. Assume any missing data. Read all the instructions carefully

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Discuss the impact of the quantity of quantization levels on the performance of an Analog-to-Digital Converter (ADC) and clarify the trade-off between precision and conversion time.	**4**	**CO1**
Q 2	Illustrate the significance of analog to digital convertor and digital to analog converter in digital control system?	**4**	**CO1**
Q 3	Relate the correlation between the discrete-time domain's region of conversion and the stability region in the Laplace (s) domain.	**4**	**CO1**
Q 4	Brief the importance of eigenvalues and their connection to the stability of the closed-loop system when employing pole placement as a control technique.	**4**	**CO2**
Q 5	Describe the primary motivation behind the development and use of reduced-order observers in control applications.	**4**	**CO2**

SECTION B
(4Qx10M= 40 Marks)

Q 6	Determine the discrete-time pulse transfer function, G(z), corresponding to the continuous-time transfer function G(s) for a given system, with a specified sampling time of 10 seconds. $$G(s) = \frac{1}{s+5}$$	**10**	**CO2**
Q 7	Obtain the discrete time controllable state space observable form of the system represented by the following pulse transfer G(z). $$G(z) = \frac{1}{z^2 + 3z + 2}$$	**10**	**CO2**
Q 8	Explain the fundamental components of a digital PID controller: Proportional (P), Integral (I), and Derivative (D). Discuss the advantages of using a digital PID controller over analog PID controllers in modern control systems.	**10**	**CO3**

Q 9	Describe the procedure for designing a state feedback controller for a discrete-time system, including the selection of feedback gains.	**10**	**CO2**
SECTION-C **(2Qx20M=40 Marks)**			
Q 10	Discuss the significance of system controllability and provide an analysis of a system's controllability expressed below in discrete-time state-space form. $$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 3 & 1 \\ 4 & 4 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$ $$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} u(k)$$ Or Explain the concept of observability within a system and provide insights into how to evaluate observability for a system described in discrete-time state-space representation. $$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ 2 & 2 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$ $$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} u(k)$$	**20**	**CO3**
Q 11	Obtain the state transition matrix and solution of the following LTI discrete time system. $$\begin{bmatrix} x_1(k+1) \\ x_2(k+1) \end{bmatrix} = \begin{bmatrix} 0 & -0.5 \\ 0.5 & -1 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(k)$$ $$y(k) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1(k) \\ x_2(k) \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} u(k)$$	**20**	**CO2**