

6. Course Objectives

The objectives of this course are centered on giving the students:

- Coverage of time and frequency-domain representations of continuous and discrete-time signals and systems.
- Emphasis on the concepts and methods that are necessary for the analysis of continuous and discrete-time signals and systems.
- Knowledge of time-domain representation and analysis concepts as they relate to differential and difference equations, impulse response, continuous and discrete convolution, etc.
- Knowledge of frequency-domain representation and analysis concepts as they relate to Fourier series and transforms, Fourier spectrum, frequency response, Laplace transform, z-transform, transfer function, etc.
- Mathematical and computational skills needed in application areas like communications, signal processing and control, which will be taught in other courses.

7. Course Topics

a. Topics for continuous-time (CT) Signals and Systems

- Overview of CT signals and their properties
- Systems and their properties
- Orthogonality and Fourier series representation of signals
- Fourier spectrum
- Special functions: unit step and impulse functions
- System impulse response and transfer function
- Convolution integral for linear and time invariant systems
- Fourier transform and filter characteristics
- Laplace transform
- Transfer functions
- Stability
- System representations (Direct form I and II)
- Analog Communications-Amplitude modulation concepts
- State-Space representations

b. Topics for discrete-time (DT) signals and Systems

- Sampling theorem
- Discrete-time Fourier transform
- DT signals and systems and their properties
- DT Convolution
- Z-transform
- Difference equations and their use in DT systems
- Transfer functions
- Stability
- System representations (Direct Form I and II)
- Discrete-Fourier Transform (DFT)
- Fast-Fourier Transform (FFT)

8. Learning outcomes

1	Know the concepts of linearity, causality, time-invariance and stability for continuous-time systems.
2	Know how to apply Fourier series and transform for the analysis and representation of LTI continuous-time signals and systems.
3	Know how to characterize LTI continuous-time systems in the time domain using impulse response and differential equations.
4	Know how to determine from a differential equation the transfer function and frequency response of a LTI continuous-time system
5	Know how to use the impulse response and convolution to obtain the output of a LTI continuous-time system including the transient and the steady-state responses.
6	Know how to characterize LTI continuous-time signals and systems in the frequency domain using Laplace-transform (transfer function) and the Fourier transform (frequency response).
7	Know how to use the transfer function concept and inverse Laplace or Fourier transform to obtain the output of a LTI continuous-time system including the transient and the steady-state responses.
8	Know how to implement block diagram representation of a LTI continuous-time system described by a differential equation.
9	Know how to represent LTI continuous-time system in state-space representations.
10	Understand the concepts of signal modulation and transmission.
11	Understand the sampling process as a means for converting analog signals into discrete ones and the Nyquist criterion of sampling.
12	Know the concepts of linearity, causality, time-invariance and stability for discrete-time systems.
13	Know how to characterize LTI discrete-time systems in the time domain using impulse response and difference equations.
14	Know how to use the impulse response and discrete convolution to obtain the output of a LTI discrete-time system including the transient and the steady-state responses
15	Know how to characterize LTI discrete-time signals and systems in the frequency domain using z-transforms (transfer function) and the discrete-time Fourier transform (frequency response).
16	Know how to use the transfer function of a LTI discrete-time system and the inverse z-transform to obtain the system output including the transient and the steady-state responses.
17	Know how to implement block diagram representation of a discrete-time system described by a difference equation.
18	Understand the concept of circular convolution and its relation to linear convolution.
19	Demonstrate knowledge of the Discrete Fourier series for periodic signals (DFS).
20	Demonstrate knowledge of the DFT for finite duration signals and its computation using FFT.
21	Know how to represent LTI discrete-time systems in state-space representations.