SIGNALS AND SYSTEMS

ENEX 255

Lecture : 3 **Year : II**
Tutorial : 1 **Part : II**
Practical : 3/2

Course Objectives:
The objective of this course is to provide students with a fundamental understanding of how signals are represented, analyzed, and processed in various systems. Students will grasp essential concepts such as signal classification, time and frequency domain analysis, convolution and Fourier analysis. By the end of the course, students should be proficient in solving problems related to signal processing and system analysis, enabling them to design and optimize systems effectively.

1 Signal and its Types (7 hours)

1.1 Introduction to signal and signal processing
1.2 Classification of signal based on dimension
1.3 Classification of one-dimensional signal (CT and DT) and properties
1.4 Fundamental signals: Delta function, unit step, ramp, rectangular pulse, signum function
1.5 Relationship between unit step and delta function
1.6 Signal classification based on causality
1.7 Classification of signals based on periodicity (CT and DT)
1.8 Transformation of the independent variable
1.9 Energy and power signals
1.10 Even and odd signals
1.11 System, types of systems: Linear and non-linear, causal and non-causal, time-invariant and time-variant

2 Fourier Series (9 hours)

2.1 Introduction to Fourier series
2.2 Fourier series representation of continuous time periodic signal
2.3 Properties of continuous time Fourier series: Linearity, time shifting, time scaling, time reversal, convolution, multiplication, frequency shifting, conjugate symmetry, Parseval's relation
2.4 Fourier series representation of discrete time periodic signal
2.5 Properties of discrete time Fourier series: Linearity, time shifting, time scaling, time reversal, convolution, modulation, conjugate symmetry, Parseval's relation
2.6 Applications of Fourier series

3 Fourier Transform (9 hours)

3.1 Introduction to Fourier transform
3.2 Continuous time Fourier transform
3.3 Properties of continuous time Fourier transform: Linearity, time shifting, frequency shifting, time scaling, time reversal, convolution, multiplication, duality, conjugation, Parseval's relation
3.4 Discrete time Fourier transform
3.5 Properties of discrete time Fourier transform: Linearity, time shifting, frequency shifting, time reversal, convolution, modulation, conjugation, Parseval's relation
3.6 Fourier transform for periodic signals
3.7 Applications of Fourier transform

4 Linear Time Invariant (LTI) System (7 hours)

4.1 Linear time invariant (LTI) system
4.2 Convolution integral properties of LTI system
4.3 Representation of discrete-time signals in terms of impulses
4.4 Convolution sum
4.5 Representation of continuous-time signals in terms of impulses
4.6 Convolution integral
4.7 Practical applications of convolution

5 Sampling (6 hours)

5.1 Introduction to sampling
5.2 Sampling theorem
5.3 Practical consideration of sampling and impulse-train sampling
5.4 Signal reconstruction from sampled version
5.5 Aliasing
5.6 Band limited signals

6 Frequency Response of Continuous and Discrete Time Systems (7 hours)

6.1 Frequency response of continuous time systems
6.2 Transfer function of continuous time system
6.3 Impulse response of ideal low-pass, band-pass and high-pass filter
6.4 Response of ideal low pass filter to a step function input
6.5 Frequency and Impulse response of RC filter
6.6 Frequency response of discrete time systems: Transfer function
6.7 Impulse response of low-pass, band-pass and high-pass filter

Tutorial (15 hours)

1. Numerical related to signal construction and periodicity
2. Numerical related to extraction of even and odd part of both continuous and discrete time signals

3. Numerical to calculate the energy and power of both continuous and discrete time signals
4. Numerical related to Fourier series and its properties
5. Numerical related to Fourier transform and its properties
6. Numerical exercise to compute convolution sum and convolution integral
7. Numerical related to sampling and aliasing and signal reconstruction

Practical **(22.5 hours)**

1. Generation of continuous time sinusoidal signal, continuous time unit step signal, discrete time unit step signal, continuous time ramp signal, continuous time sinc function, discrete time sinusoidal signal, discrete time unit step signal, discrete time unit impulse signal, continuous time exponential signals, discrete time exponential signals, continuous time complex exponentials and discrete time complex exponentials
2. Convolution: Square wave with odd symmetry
3. Magnitude and phase of rational signal
4. Fourier series
5. Fourier transform

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Marks distribution*
1	7	10
2	9	12
3	9	12
4	7	10
5	6	7
6	7	9
Total	**45**	**60**

* There may be minor deviation in marks distribution.

References

1. Oppenheim, A.V., Willsky, A.S., Nawab, S.H. (2013). Signals and Systems. Pearson education second edition.
2. Oppenheim, A., Schafer, R. W. (2013). Discrete-Time Signal Processing: Pearson New International Edition. United Kingdom: Pearson Education.
3. Ingle, V. K., Proakis, J. G. (2000). Digital signal processing using MATLAB. United Kingdom: Brooks/Cole.
4. Lathi, B. P. (2010). Linear Systems and Signals. United Kingdom: Oxford University Press.