# Signals and Systems

1.1 Course Number: ECE211

1.2 Contact Hours: 3-0-0 Credits: 9

1.3 Semester-offered: Odd

1.4 Prerequisite: Basic knowledge of Integration, Differentiation, Complex Numbers

1.5 Syllabus Committee Member: Dr. Umakant Dhar Dwivedi, Dr. Abhishek Kumar Singh, Dr. Sajal Agarwal, Dr. Vijay Kumar Singh, Dr. Ankur Pandey.

**2. Objective:** This course introduces the fundamental principles of signals and system analysis. These concepts form the building blocks of modern digital signal processing, communication, and control systems. Hence, a sound understanding of these principles is necessary for all students of Electronics and Communication Engineering (ECE), Electrical and Electronics Engineering (EEE), and Instrumentation Engineering (IE). The course will cover various basic tools of signal and system analysis such as signal classification, LTI systems, Properties of LTI Systems, Frequency Response, Laplace Transform, Z-Transform, Fourier Transform, Fourier Series, Discrete-Time Fourier Transform (DTFT), Discrete Fourier Transform (DFT), Cascade/ Parallel structures and their various practical applications. Various concepts such as convolution, impulse/ frequency response, causality, stability of systems will be especially emphasized. Other additional topics such as state space techniques and solutions to state space equations will also be covered.

**3. Course Content:**

| Unit | Topics | Sub-topic | Lectures |
|---|---|---|---|
| 1 | Introduction to Signals System & Linear Time-Invariant (LTI) Systems | Introduction to Signals, Signal Classification, Continuous/ Discrete-Time Signals, Definition and Classification of Systems, Linear Time-Invariant (LTI) Systems, Properties of LTI Systems, Impulse Response, Convolution, Causality, Stability, Impulse Response of Discrete-Time Systems, Discrete-Time Convolution, Difference Equations and Analysis | 12 |
| 2 | Laplace & z-Transform | Laplace Transform, Properties of Laplace Transform, Inverse Laplace Transform, Introduction to z-Transform, Properties of z-Transform, Region of Convergence, Inverse z-Transform | 8 |
| 3 | Fourier Analysis | Introduction to Fourier Analysis, Fourier Series for Periodic Signals, Properties of Fourier Series, Introduction to Fourier | |

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|---|---|---|---|
| | | Transform, Properties of Fourier Transform, Frequency Response of Continuous-Time Systems, Examples of Frequency Response, Fourier Analysis of Discrete Signals, Discrete-Time Fourier Transform (DTFT), Properties of DTFT, Examples of DTFT, Frequency Response of Discrete-Time Systems, Discrete Fourier Transform (DFT), Properties of DFT, Examples of DFT | 14 |
| 4 | IIR/ FIR Filters & State Space Analysis | IIR/ FIR Filters, Direct Form Realization, Cascade and Parallel Form Realization, Problem Solving, Concept of State, State Space Analysis, State Space Representation of Continuous-Time Systems, Solution of State Equations for Continuous Systems | 06 |
| | | Total | 40 |

## 4. Readings

### 4.1 Textbook:

[1] A. V. Oppenheim and A. S. Willsky. Signals & Systems. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 1997.
[2] B. P. Lathi. Linear Systems and Signals. Oxford University Press, New York, NY, USA, 2nd edition, 2005.
[3] S. Haykin and B. Van Veen. Signals and Systems. John Wiley & Sons, Hoboken, NJ, USA, 2nd edition, 2005

### 4.2. Reference Books

[1] D. M. Etter, D. C. Kuncicky, and D. Hull. Introduction to MATLAB 6. Prentice Hall, Upper Saddle River, NJ, USA, 2nd edition, 2004.
[2] D. Hanselman and B. Littlefield. Mastering MATLAB 6: A Comprehensive Tutorial and Reference. Prentice Hall, Upper Saddle River, NJ, USA, 2001.
[3] L. B. Jackson. Signals, Systems, and Transforms. Addison Wesley, Menlo Park, CA, USA, 1991.
[4] P. V. O'Neil. Advanced Engineering Mathematics. Wadsworth Publishing Company, Belmont, CA, USA, 2nd edition, 1987.
[5] A. V. Oppenheim and R. W. Schafer. Discrete-Time Signal Processing. Pearson, Upper Saddle River, NJ, USA, 3rd edition, 2010.
[6] C. L. Phillips, J. M. Parr, and E. A. Riskin. Signals, Systems, and Transforms. Prentice Hall, Boston, MA, USA, 5th edition, 2014.
[7] M. J. Roberts. Signals and Systems: Analysis Using Transform Methods and MATLAB. McGraw-Hill, New York, NY, USA, 2nd edition, 2012.

5. **Outcome of the Course:** Analyze the spectral characteristics of continuous-time periodic and a periodic signal using Fourier analysis. Classify systems based on their properties and determine the response of LSI system using convolution. Analyze system properties based on impulse response and Fourier analysis.