CEN340
Detailed Syllabus

- **MATLAB**
  Reference: Notes - Introduction to MATLAB; S. Rahal; 10/9/1437.
- ***Signals and Systems:***
  Textbook: Signals & Systems; Oppenheim A. and Willsky A. With S. Nawab: 2-edition: 1997, Prentice Hall – Chapters: 1, 2. 3, 4, 8, 9.

1- Signals and Systems:

- What are Signals & Systems?
- Basic types of signals.
- Representation of CT & DT.
- Basic Signal Operations:
  - Time shift.
  - Time reversal.
  - Time scaling.
- Signals characteristics:
  - Causal vs. Anticausal vs. Noncausal Signals.
  - Periodic vs. Aperiodic Signals.
  - Even vs. Odd signals.
- Some Basic Signals
  - Sinusoidal Signals.
  - Complex Exponential Signals & Sinusoidal Signals.
- Exponential Signals & Sinusoidal Signals:
  - Continuous-Time Complex Exponential Signals & Sinusoidal Signals:
    - Real Exponential Signals.
    - Periodic Complex Exponential and Sinusoidal Signals.
    - Signal Energy & Power.
    - General Complex Exponential Signals.
  - Discrete-Time Complex Exponential and Sinusoidal Signals.
    - Real Exponential Signals
    - Sinusoidal Signals.
    - Periodicity Properties of Discrete-Time Complex Exponentials.

- The Unit Impulse & Unit Step Functions.
  - The Discrete-Time Unit Impulse & Unit Step Sequences.
  - The Continuous-Time Unit Step & Unit Impulse Functions.
- **Continuous-Time and Discrete-Time Systems.**
  - Simple Examples of Systems.
  - Interconnections of Systems.
  - Basic System Properties "BSP"
    - Systems with and without Memory.
    - Inverse Systems.
    - Causality.
    - Stability.
    - Time Invariance.
    - Linearity.
- Summary.

2- Linear Time-Invariant "LTI" Systems.

- Introduction.
- Discrete-Time LTI Systems: The Convolution Sum.
  - Representation of Discrete-Time Signals in Terms of Impulses.
  - Discrete-Time Unit Impulse Response and the Convolution Sum Representation of LTI Systems.
- Continuous -Time LTI Systems: The Convolution Integral.
  - Representation of a continuous-Time signal in Terms of Impulses.
  - Continuous –Time Unit Impulse Response and the Convolution Integral Representation of LTI Systems.
  - Graphical Interpretation of Convolution.
- Properties of LTI systems:
  - Commutative Property.
  - Distributive Property.
  - Associative Property.
  - Systems with and without Memory.
  - Invertibility of LTI Systems.
  - Causality of LTI Systems.
  - Stability of LTI Systems.
  - Unit Step Response of LTI Systems.
- Causal LTI Systems Described by Differential and Difference Equations.

  - Linear Constant-Coefficient Differential Equations
  - Solution of Differential Equations.
    - Homogeneous solution.
    - Particular solution.
  - Higher order differential equations.
  - Linear Constant-Coefficient Difference Equations.
  - Block Diagram Representations of First-Order Systems Described by Differential and Difference Equations.
- Summary.

3- Fourier Series Representation of Periodic Signals:

- Introduction
- Historical Perspective.
- The response of LTI Systems to Complex Exponentials.
- Fourier Series Representation of Continuous-Time Periodic Signals:
  - Linear Combination of Harmonically Related Complex Exponentials.
  - Determination of the Fourier Series Representation of Continuous-Time Periodic Signals.
- Convergence of the Fourier Series.
- Properties of Continuous-Time Fourier Series.
- Fourier Series Representation of Discrete-Time Periodic Signals.
- Properties of Discrete-Time Fourier Series:
  - Linearity.
  - Time Shifting.
  - Time Reversal.
  - Time Scaling.
  - Multiplication.
  - Conjugation and Conjugate Symmetry.
  - Parseval's Relation for Continuous-Time Periodic Signals.
  - Summary of Properties of Continuous-Time Fourier Series
- Fourier Series & LTI Systems – Frequency Response of the System.
- Filtering.
  - Frequency-Shaping Filters.
  - Frequency-Selective Filters.
- Examples of Continuous-Time Filters Described by Differential Equations:
  - A simple *RC* lowpass Filter.
  - A Simple *RC* Highpass Filter.
- Summary.

4- Continuous-Time Fourier Transform.

- Introduction.
- Representation of Aperiodic Signals: Continuous-Time Fourier Transform.
  - Development of Fourier Transform Representation of an Aperiodic Signal.
  - Convergence of Fourier Transforms.
  - Examples of Continuous-Time Fourier Transforms.
- Fourier Transform for Periodic Signals
- Properties of the continuous-Time Fourier Transform:
  - Linearity.
  - Time Shifting.
  - Conjugation and Conjugate Symmetry.
  - Differentiation and Integration.
  - Time and Frequency Scaling.
  - Duality.
  - Parseval's Relation.
- Convolution Property.
- Multiplication Property.
- Tables of Fourier Properties and of Basic Fourier Transform Pairs.
- Systems Characterized by Linear Constant–coefficient Differential Equations.
- Summary.

5- LAPLACE TRANSFORM

- Introduction
- Laplace Transform.
- Region of Convergence "ROC" for Laplace Transform.
- Inverse Laplace Transform.
- Properties of Laplace Transform:
  - Linearity.
  - Time Shifting.
  - Shifting in s-Domain.
  - Time Scaling.
  - Conjugation
  - Convolution Property.
  - Differentiation in Time Domain.
  - Differentiation s-Domain.
  - Integration in Time Domain.
- Some Laplace Transform Pairs.

- Analysis & Characterization of LTI System Using Laplace Transform.:
  - Causality.
  - Stability.
  - LTI Systems Characterized by Linear Constant-Coefficient Differential Equations.
- System Function Algebra & Block Diagram Representations:
  - System Function for Interconnections of LTI Systems.
- Unilateral Laplace Transform:
  - Representation of Unilateral Laplace Transform.
  - Properties of Unilateral Laplace Transform.
- Summary.

6- Application to Communication Systems

- Introduction.
- AM Modulation & Demodulation.
- FM Modulation & Demodulation.