Department of Electrical and Electronic Engineering
Bangladesh University of Engineering and Technology
Dhaka-1000 Bangladesh

Lecture Plan for EEE 301
(Continuous Signals and Linear Systems)

Teacher: Dr. S. M. Mahbubur Rahman **E-mail:** mahbubur@eee.buet.ac.bd
Office: ECE 326 **Class Room:** ECE 535
Period: Saturday, Monday, and Wednesday @ 9:00 am – 10:00 am
Hour: Wednesday @ 12:00 pm – 1:00 pm

Objectives:

- To expose the students in the area of analysis of electrical signals using elementary functions such as the step, ramp, sampling, and impulse.
- To introduce basic analyzing approach and modular-type representations of linear time invariant systems those are common in practice.
- To expose with the approach of signal decomposition using orthogonal basis functions such as the complex exponentials (with the use of Fourier transform).
- To introduce with the representation of a system by differential equations and finding the response of the system using algebraic equations (with the use of Laplace transform).
- To familiarize with the analogy between the analysis of electrical systems and that of the mechanical or electromechanical systems.

Texts:

T1: 'Continuous and Discrete Signals and Systems' – Samir S. Soliman and Mandyam D. Srinath (2nd Ed)

T2: 'Analysis of Linear Systems' – David K. Cheng

OUTLINE OF THE LECTURES (T1: 2nd Ed and T2)

Week	Topics	Section(s) in Texts
1	L-1: Introduction to Signals and Systems	**T1:** 1.1, 2.1
	L2: Classification of Signals with Examples	**T1:** 1.2, 1.3, 1.4, 1.7
	L3: Operations on Signals	**T1:** 1.5
2	L1: Elementary Signals with Examples	**T1:** 1.6
	L2: Properties of Elementary Signals	**T1:** 1.6
	L3: Orthogonal Representations of Signals	**T1:** 3.2
	Class Test #1 - 'Analysis of Signals'	
3	L1: Classification of Systems. Linear or Nonlinear	**T1:** 2.2.1, 2.2.2

	Systems, Time-invariant and Time-variant Systems	
	L2: Systems with or without Memory, Causal Systems, Stable or Unstable Systems	**T1:** 2.2.4, 2.2.5, 2.2.6
	L3: Linear Time-invariant Systems, Convolution Integral, Impulse Response	**T1:** 2.3.1
4	L1: Examples of Convolution Integral and Graphical Interpretations	**T1:** 2.3.2
	L2: Properties of LTI Systems	**T1:** 2.4
	L3: Systems Represented by Linear Differential Equation. Finding Impulse Response from Differential Equation	**T1:** 2.5.1, 2.5.4
5	L1: Basic System Components. Realization of Systems using First Canonical Form	**T1:** 2.5.2, 2.5.3
	L2: Realization of Systems using Second Canonical Form	**T1:** 2.5.3
	Class Test #2 - ‘Analysis of LTI Systems’	
	L3: Introduction to Exponential Fourier Series, Examples. Fourier Series for real Signals, Trigonometric Fourier Series, Effect of Symmetry, Linearity	**T1:** 3.1, 3.3, 3.5.2, 3.5.3
6	L1: Dirichlet Conditions, Least-Squares Approximations using Fourier Series, Product and Convolution of Signals	**T1:** 3.4, 3.5.1, 3.5.4, 3.5.5
	L2: Perseval’s Theorem, Effect in Fourier Coefficients for Time shift, Integration, and Differentiation.	**T1:** 3.5.6, 3.5.7, 3.5.8
	L3: Analysis of Systems with Periodic Inputs	**T1:** 3.6
7	L1: Gibb’s Phenomenon	**T1:** 3.7
	L2: Introduction to Fourier Transform, Existence of Fourier Transform	**T1:** 4.1, 4.2.1, 4.2.2
	L3: Fourier Transform of Elementary Signals	**T1:** 4.2.3
8	L1: Properties of Fourier Transform: Linearity, Symmetry, Time-shifting, Time-scaling, Differentiation	**T1:** 4.3.1, 4.3.2, 4.3.3, 4.3.4, 4.3.5
	L2: Energy of Signal, Convolution in terms of Fourier Transform. Duality in Time and Frequency Domain Representations.	**T1:** 4.3.6, 4.3.7, 4.3.8
	L3: Application of Fourier Transform in Modulation and Multiplexing	**T1:** 4.3.9, 4.4.1, 4.4.2
9	L1: Analysis of Sampling and Filtering of Signals in Frequency Domain	**T1:** 4.4.3, 4.4.4
	L2: Definition of Bandwidth and Uncertainty Principle	**T1:** 4.5
	Class Test #3 - ‘Applications of Fourier Series and Transform’	
	L3: Introduction to Laplace Transform: Unilateral and Bilateral	**T1:** 5.1, 5.2, 5.3
10	L1: Properties of Unilateral Laplace Transform	**T1:** 5.5

	L2: Bilateral Transform using Unilateral Transform, Initial and Final Value Theorems	**T1:** 5.4, 5.5.10, 5.5.11
	L3: Laplace Transform of Periodic Signals	**T2:** 7.6, 7.7
11	L1: Inverse Laplace Transforms and Simulation Diagrams	**T1:** 5.6, 5.7
	L2: Applications of Laplace Transform: Solution of Differential Equations and Control Theory	**T1:** 5.8
	L3: Satiability of Systems in Laplace Domain	**T1:** 5.10
12	L1: State Variable Representation of Systems, State Equation	**T1:** 2.6.1
	L2: State Equation in Time Domain and Solutions	**T1:** 2.6.2
	L3: State Equation in Laplace Domain and Solutions	**T1:** 5.9
13	L1: Evaluating State Transition Matrix in Time and Laplace Domains	**T1:** 2.6.2, 5.9
	L2: State Equations in First and Second Canonical Forms, Stability Analysis	**T1:** 2.6.3, 2.6.4, 2.6.5, 5.9
	L3: Introduction to Analogous Systems, Linear Mechanical Elements	**T2:** 4.1,4.2,4.3
14	L1: Force-voltage and Force-current analogies for Translational and Rotational Systems	**T2:** 4.4,4.5
	L2: Coupling Devices, Electromechanical Systems	**T2:** 4.6,4.7
	Class Test #4 - 'Analogous System Described by Laplace Transform'	
	L3: Discussions	---

References:

R1: 'Signals, Systems, and Transforms' – Charles L. Phillips, John M. Parr, Eve A. Riskin (4th Ed).

R2: 'Signal Processing and Linear Systems' – B. P. Lathi (1st/2nd Ed).

R3: 'Signals and Systems' – Alan V. Oppenheim and Allan S. Willsky (1st/2nd Ed)

R4: 'Continuous-Time Signals and Systems'– Michael D. Adams
(Free e-book available at http://www.ece.uvic.ca/~frodo/sigsysbook/)

Assessment Policy (as per University Rule):

There will be 4 (Four) short quizzes each being 20 – 25 minutes long. The best 3 (Three) will be considered. The weights of the final grading are

- Class participation – 10%
- Quizzes – 20%
- Final Exam – 70%

Outcomes:

In completion of EEE 301, the students are expected to learn an introductory approach to analyze an electrical signal by applying their knowledge in basic mathematics and science. A modular approach of analysis and representation of linear time invariant systems using the theorems would build a capacity in a student to analyze and synthesize more complex digital systems such as those in communication systems to be covered in subsequent studies. The students are also expected to be exposed with the approach of orthogonal signal decomposition and its use in practical electrical systems. They will also gain skills of representing high dimensional system in terms of ordinary differential equations and obtaining system response using the knowledge of linear algebra. Another outcome of the course is to apply analogy for analyzing complex systems that consist of electrical, mechanical or electromechanical components.