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## Signals and Systems

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# **ELEG 3124 Signal and Systems**

## **Course Outlines and Guides**

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# 1 Overview

This course covers the topics of signal and system analysis, with an emphasis on the analysis of linear time-invariant systems. The materials presented in this course are designed for a 15-week course for junior or senior level students. The course materials can be fit into the curriculum of Electrical Engineering, Biomedical Engineering, Computer Engineering, Mechanical Engineering, or other related fields that rely on system analysis.

The course materials are divided into six chapters. The titles of all chapters, and the approximate amount of instruction time allocated for each chapter, are listed as follows.

- Chapter 1. Continuous-Time Signals (2 weeks)
- Chapter 2. Continuous-Time Systems (3 weeks)
- Chapter 3. Fourier Series (3 weeks)
- Chapter 4. Fourier Transform (3 weeks)
- Chapter 5. Laplace Transform (3 weeks)
- Chapter 6. Discrete-time Signals and Systems (1 weeks)

# 2 Course Materials

The open access course materials include the following contents

- Lecture Notes (Chapters 1 to 6).
- Homework Manual (Homework Assignments 1 to 14).
- Homework Solution Manual.
- Lab Manual (Labs 1 to 8).
- Tests (Tests 1 to 3)

## 2.1 Lecture Notes

The detailed table of contents of the lecture notes are given as follows.

- Chapter 1. Continuous-Time Signals
  1. Introduction: what are signals and systems?
  2. Signal Definitions
  3. Signal Classifications
  4. Basic Signal Operations
  5. Elementary Signals
- Chapter 2. Continuous-Time Systems
  1. Classifications of Continuous-time Systems
  2. Linear Time-Invariant System (LTI)
  3. Properties of LTI Systems
  4. System Described by Differential Equations
- Chapter 3. Fourier Series
  1. Introduction
  2. Fourier Series
  3. Properties of Fourier Series
  4. Systems with Periodic Inputs
- Chapter 4. Fourier Transform
  1. Introduction
  2. Fourier Transform
  3. Properties of Fourier Transform
  4. Applications
- Chapter 5. Laplace Transform
  1. Introduction
  2. Laplace Transform

3. Properties of Laplace Transform
  4. Inverse Laplace Transform
  5. Applications of Laplace Transform
- Chapter 6. Discrete-Time Signals and Systems
    1. Discrete-Time Signals
    2. Discrete-Time Systems
    3.  $Z$ -Transform

## 2.2 Homework

Homework is assigned weekly, and there are 14 homework assignments. The detailed description of the homework assignments and the corresponding section in the lecture notes are given as follows.

- Homework 1: Signal definition and classifications (Ch. 1.1–Ch. 1.3)
- Homework 2: Signal operations and elementary signals (Ch. 1.4–Ch.1.5)
- Homework 3: Classifications of continuous-time systems (Ch. 2.1)
- Homework 4: LTI system and convolution (Ch. 2.2)
- Homework 5: LTI system properties and applications (Ch. 2.3–Ch. 2.4)
- Homework 6: Fourier series (Ch. 3.1–Ch. 3.2)
- Homework 7: Fourier series properties and applications (Ch. 3.3-3.4)
- Homework 8: Fourier transform (Ch. 4.1–Ch. 4.2)
- Homework 9: Fourier transform properties (Ch. 4.3)
- Homework 10: Fourier transform applications (Ch. 4.4)
- Homework 11: Laplace transform (Ch. 5.1–Ch. 5.2)
- Homework 12: Laplace transform properties (Ch. 5.3)

- Homework 13: Inverse Laplace transform and applications (Ch. 5.4–Ch. 5.5)
- Homework 14: Discrete-time signals and systems (Ch. 6)

## 2.3 Labs

There are 8 labs spread out the 15-week session. The first 4 labs are tutorials for the computing tool of Matlab, and they are not directly tied to the lecture notes. In Labs 5 to 8, students will use Matlab to solve problems by using knowledge they learned during the lectures. The detailed description of the lab sessions are given as follows.

- Lab 1: Matlab tutorial: Introduction (Week 1)
- Lab 2: Matlab tutorial: Matrix Operations (Week 2)
- Lab 3: Matlab tutorial: Programming in Matlab (Week 3)
- Lab 4: Matlab tutorial: Symbolic Operations and Exercises (Week 4)
- Lab 5: Continuous-Time Signals (Ch. 1, Week 6)
- Lab 6: Linear Systems (Ch. 2, Week 8)
- Lab 7: Fourier Series (Ch. 3, Week 10)
- Lab 8: Fourier Transform (Ch. 4, Week 12)

## 2.4 Tests

There are 3 tests for this course, each covers about one third of the contents. Tests 1 and 2 are designed to be taken in-class with a length of 75 minutes. Test 3 is to be taken at the end of the semester with a length of 120 minutes. The coverage and schedule of the tests are given as follows.

- Test 1 (Week 6, 75-minute): covers Ch. 1 and Ch. 2, Homeworks 1 - 5.
- Test 2 (Week 11, 75-minute): covers Ch. 3 and Ch. 4.1-4.3, Homeworks 6 - 9.
- Test 3 (Week 15, 75-minute): covers Ch. 4.4, Ch. 5 and Ch. 4.1-4.3, Homeworks 10 - 14.

### 3 Weekly Instruction Schedules

- Week 1:
  - Lecture: Ch. 1.1, Ch. 1.2, Ch. 1.3
  - Homework: Assignment 1
  - Lab: Lab 1
- Week 2:
  - Lecture: Ch. 1.4, Ch. 1.5
  - Homework: Assignment 2
  - Lab: Lab 2
- Week 3:
  - Lecture: Ch. 2.1, Ch. 2.2
  - Homework: Assignment 3
  - Lab: Lab 3
- Week 4:
  - Lecture: Ch. 2.2
  - Homework: Assignment 4
  - Lab: Lab 4
- Week 5:
  - Lecture: Ch. 2.3, Ch. 2.4
  - Homework: Assignment 5
- Week 6:
  - Lecture: Ch. 3.1, Ch. 3.2
  - Test: Test 1 (Covers Ch. 1 and Ch. 2)
  - Lab: Lab 5

- Week 7:
  - Lecture: Ch. 3.2, 3.3
  - Homework: Assignment 6
  
- Week 8:
  - Lecture: Ch. 3.4, Ch. 4.1, Ch. 4.2
  - Homework: Assignment 7
  - Lab: Lab 6
  
- Week 9:
  - Lecture: Ch. 4.2, Ch. 4.3
  - Homework: Assignment 8
  
- Week 10:
  - Lecture: Ch. 4.3, Ch. 4.4
  - Homework: Assignment 9
  - Lab: Lab 7
  
- Week 11:
  - Lecture: Ch. 5.1, 5.2
  - Homework: Assignment 10
  - Test: Test 2 (Covers Ch. 3, Ch. 4.1–Ch. 4.3)
  
- Week 12:
  - Lecture: Ch. 5.3
  - Homework: Assignment 11
  - Lab: Lab 8
  
- Week 13:



- Lecture: Ch. 5.4
- Homework: Assignment 12
- Lab: Lab 8

- Week 14:

- Lecture: Ch. 5.5
- Homework: Assignment 13

- Week 15:

- Lecture: Ch. 6
- Homework: Assignment 14
- Test: Test 3 (Covers Ch. 4.4, Ch. 5, Ch. 6)