Minnesota State University, Mankato

Electrical and Computer Engineering Department

Lab Assignment 1 – Waveform Analysis and Visualization Using Python

Date of experiment: 01/21/2025

Date of Submission: 01/28/2025

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Spring 2025

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Waveform Analysis and Visualization Using Python

*Abstract*

In this lab, we explored the use of Python for signal processing and waveform visualization. Specifically, we analyzed and plotted two waveforms, X2(t) & X4​(t), which incorporate step function transformations and trigonometric elements. The lab also involved creating a Python function to introduce a user with their name, major, and gender. By implementing unit step functions and combining them with mathematical operations, we generated the desired waveforms and visualized their behavior using the matplotlib library. This exercise demonstrated the practical application of Python programming in understanding and visualizing complex waveforms.

*Materials*

**Equipment Needed                                        Quantity.**

Laptop (Visual Studio Code)                                 1

Python libraries: matplotlib and numpy 1

**Methods (Procedure, Data Collection, and Analysis)**

**Part A (Define a Function to Return a String)**

1. **Objective**: Create a Python function that accepts three parameters: name, major, and hobby. The function should return a formatted string introducing the user.
2. **Implementation**:
   1. Define a function named introduction with parameters for name, major, and hobby.
   2. Use Python's f-string formatting to construct a sentence incorporating the input values.
   3. Return the formatted string.
3. **Steps**:
   1. Write the function in Python, ensuring it does not directly print the string but instead returns it.
   2. Call the function with example values and use the print statement to display the returned result.

**Part B (Plot the Waveforms X2(t) and X4​(t))**

1. **Objective**: Plot the waveforms X2(t) and X4​(t) using Python's matplotlib and numpy libraries. The waveforms are defined using unit step functions and mathematical expressions.
2. **Implementation**:
   1. Define a unit step function u(t) that returns 1 for t≥0t \geq 0t≥0 and 0 otherwise.
   2. Define X2(t)X\_2(t)X2​(t) and X4(t)X\_4(t)X4​(t) using the unit step function and their respective mathematical expressions.
   3. Create a time array t using numpy's arange function for a range of values (e.g., from -1 to 1 with small increments).
   4. Use matplotlib.pyplot to plot the waveforms.
3. **Steps**:
   1. Define the unit step function.
   2. Implement the mathematical expressions for X2(t) and X4​(t) using Python arithmetic.
   3. Generate plots for each waveform and label the axes.
   4. Add gridlines for better readability.

*Results*



A graph with a line

Description automatically generated

A graph with blue lines

Description automatically generated

*Conclusion*

In this lab, we successfully implemented and analyzed step-function-based waveforms. We learned how step functions can be used to enable/disable sections of a waveform and how mathematical transformations impact waveform behavior. Challenges included debugging the logical construction of X2(t) and ensuring smooth transitions, which were resolved using fine time steps and proper function calls. This exercise deepened the understanding of waveform analysis and Python programming for signal processing.

*Appendices*

A screenshot of a computer

Description automatically generated

*A screen shot of a computer program

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*References*

1. <https://rodzah.files.wordpress.com/2011/07/how-to-write-lab-report.pdf>
2. EE343- LAB Assignment 1.pdf