Lab 2: Basics of Signals

1 Objectives

1. Generate some basic signals using signal generator.
2. Determine important properties of a signal by visual inspection and algorithmic approaches.
3. Mathematically model the generated signals.
4. Appreciate the relationship between analogue signals and their digital version.

2 Equipments

1. Signal generator
2. Breadboard (**bring your own one**)
3. Oscilloscope
4. Arduino
5. PC
6. MATLAB (or other computing/programming tools of your choice)

3 Procedures

3.1 Sinusoidal Signal

1. Use signal generators to create a sinusoid where its frequency (in Hz) is equal to your student ID. The amplitude and phase can be chosen arbitrarily.
2. Display the signal on oscilloscope and calculate the amplitude, period, angular frequency, and phase of the signal by visual inspection. In your report, you should include the relevant (captured) figures to justify your answer.
3. Provide a mathematical model for the generated signal.
4. Measure the DC component of the generated signal. If it is equal to 0, then add a non-zero DC offset to the generated signal. Repeat steps 1 to 3 above.

3.2 Square and Triangular Waves

Repeats all the steps in Section 3.1 for square and triangular signals.

3.3 Analogue and Discrete Signals

You are given a periodic sawtooth signal generator and an Arduino board.

1. Supply appropriate power for the generator (**red wire to +5V** and **black wire to ground**) and observe the resulting signal using an oscilloscope (**green line to oscilloscope**).
2. By visual inspection, determine the frequency and peak-to-peak amplitude of the signal. You must include relevant figures in your report to justify your answer.
3. Now connect the output of the sawtooth generator (i.e., **the green wire**) to one of the analogue pins in the Arduino board.
4. Write a code to read the data from the Arduino board. Use the delay function in Arduino to choose the interval between two reads.
5. Open the serial monitor to observe the obtained discrete signal. You can copy the data
6. Plot the obtained signal using a plotting tool of your choice. (e.g., use the command plot in Matlab, Python).
7. Write a program to determine its frequency and peak-to-peak amplitude.
8. Relate the values obtained from Step 7 to those in Step 2.
9. Change the interval (make it large) between two reads in your code and comment on the output.

4 Reports

4.1 Report Contents

Your report should include the following components

- Provide a brief background on continuous signals and what the lab is about.
- For each type of signals considered in the lab, write a short paragraph discussing their applications in terms of signal processing.
- Write a short introduction, explaining
  - how digital signals are generated from their continuous version.
  - why digital signals are often represented by integers.
  - the effect if the sampling interval is large.
- All the plots you obtained during the lab and the your comments and opinions on the results.
- A summary of what you gained in the lab.

4.2 Submission

- Each group submits a **single report** (group marking).
- To be uploaded via moodle **before 5 PM the following** day.
- A penalty 10% of each day will be applied to late submission.
- Poorly written report is subject to deduction.