Homework 2

ELEN0071 University of Liège, Spring 2021

Due: Wednesday 14/04/2021 11:59 pm

Instructions: Form a group of two students and perform the following steps.

1. Register on Gradescope using your `@student.uliege.be` address (use entry code: 74GYRD).
2. Name your homework report `LastName1_LastName2_homework2.pdf` (in alphabetical order).
3. Compress your m-files (and possible related files, except the `.wav` files) into a single ZIP file, and name it as `LastName1_LastName2_homework2.zip`.
4. Submit both files on Gradescope:
   (a) Submit your report (the PDF file) to *Homework 1 (report)*.
   (b) Submit your codes (the ZIP file) to *Homework 1 (code)*.
5. Ensure that all group members are correctly added to the submissions.

If you are not familiar with Gradescope, please click on each step of the following guideline: (1) Joining a course using a course code, (2) Submitting a PDF, (3) Code submission, (4) Adding group members.

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1. **Single-sided magnitude spectrum.** The following MATLAB script generates four signals `x1`, `x2`, `x3`, and `x4`.

```
Fs=1000; % Sampling frequency (Hz)
F0=50; % Fundamental frequency (Hz)
t = 1/Fs:1/Fs:0.1; % Time vector
x1 = square(2*pi*F0*t); % Square wave
x2 = sawtooth(2*pi*F0*t); % Sawtooth wave
x3 = sawtooth(2*pi*F0*t,1/2); % Triangle wave
x4 = sin(2*pi*F0*t); % Pure sinusoidal
```

   (a) Plot each signal in a separate frame.
   (b) Plot their single-sided magnitude spectra in one frame.
   (c) Try to interpret the figure from part (b) in few lines.

   Hint: the MATLAB command `hold on` could be used to plot several figures in one frame.

2. **Noise elimination.** An electrocardiogram signal was recorded at the sampling frequency of 250 Hz (`hw2_electrocardiogram.mat`). The signal is corrupted with noise. Our goal is to recover the original signal.

   (a) Plot the given signal entirely (the time axis should be expressed in second).
   (b) Plot only 3 seconds of the given signal (from the second 2 to second 5).
   (c) Plot the single-sided magnitude spectrum of the given signal.

(d) Identify the noise frequencies.

(e) Recover the original signal and plot 3 seconds of the both (noise-corrupted and original) signals in a single frame.

(f) Explain clearly your filter design procedure.

Hint: you may need more than one notch filter to recover the original signal.