# Homework 3

ELEN0071 University of Liège, Spring 2021

Due: Wednesday 12/05/2021 11:59 pm

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*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_homework3.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_homework3.zip`.
4. Submit both files on Gradescope:
   (a) Submit your report (the PDF file) to *Homework 3 (report)*.
   (b) Submit your codes (the ZIP file) to *Homework 3 (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. Noise filtering.** Consider the following noisy signal

$$x_{\text{ns}}[n] = x[n] + v[n]$$

where $x[n] = 0.8\cos(10\pi n) + \cos(20\pi n) + 0.5\cos(40\pi n + 1.4) + 0.8\cos(120\pi n + 0.7) + 0.6\cos(140\pi n)$ and $v[n]$ is a band-limited noise. The file `hw3.mat` contains $x_{\text{ns}}[n]$ and $x[n]$, which are sampled at 1 kHz.

The goal is to design a filter to remove the noise $v[n]$ preserving the shape of the original signal $x[n]$.

(a) Plot $x[n]$ and $x_{\text{ns}}[n]$ in the same axis (range: `[N/2-200, N/2+200]` where `N` is the length of $x[n]$).
(b) Plot the single-sided amplitude spectrum of the noisy signal $x_{\text{ns}}[n]$.
(c) Determine the approximate frequency range of the noise $v[n]$.
(d) Design a filter to remove the noise from $x_{\text{ns}}[n]$ preserving the shape of the signal (*i.e.*, without distortion). Explain your filter design procedure.
(e) Plot the single-sided amplitude spectrum of the filtered signal ($x_{\text{filt}}[n]$).
(f) Plot $x[n]$ and $x_{\text{filt}}[n]$ in the same axis (range: `[N/2-200, N/2+200]` where `N` is the length of $x[n]$).