Physics 427 – Introduction to Computational Physics
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Homework 10 – due April 16, 2021

Problem 1: On the previous homework, we looked at a zero-padding transformation in Fourier space. Here we will investigate the impact of re-sampling.

As with last time, consider a signal $h(t_n)$ sampled at N values, and a corresponding Fourier transform $H(\nu_m)$.

a) *Up-sampling*: Suppose we construct a new signal from $H(\nu_m)$ by doubling the number of points as follows. Let $m' = 0, 1, \ldots, 2N-1$ and

$$G(\nu_{m'}) = \begin{cases} H(\nu_{m'/2}), & m' \text{ even} \\ 0 & m' \text{ odd.} \end{cases}$$

Show that

$$g(t_{n'}) = \begin{cases} h(t_{n'}), & 0 \le n' < N \\ h(t_{n'-N}), & N \le n' < 2N\,. \end{cases}$$

b) *Down-sampling*: Suppose we construct a new signal from $H(\nu_m)$ by removing the frequencies with odd m, that is for $m' = 0, 1, \ldots, N/2-1$ we let $G(\nu_{m'}) = H(\nu_{2m'})$. Show that

$$g(t_{n'}) = \frac{1}{2}\left(h(t_{n'}) + h(t_{n'+N/2})\right)\,.$$

Problem 2: In place of a final exam, we will have a final project. Your goal for this week will be to develop a project topic. Make sure to choose something you think you can complete with a reasonable amount of work–this should be roughly 3 homework assignments worth of effort. To get a sense for the scope of a project idea, here is a list of project topics from a similar course:
https://www.asc.ohio-state.edu/physics/ntg/780/project_list.php

a) Read through the project guidelines (available on Canvas).

b) Provide a short written description of your chosen topic, a few sentences and/or bullet points. Outline what steps you will need to take to complete the project.

c) Sign up for an individual meeting time on Friday to discuss your chosen topic, https://www.signupgenius.com/go/904044EA5A82EA5FE3-p427

Optional midterm review: Review your exam, and correct any incorrect or missing work. For a fully corrected exam, you can collect up to half of the grade you missed (eg. $C \to B$).