Homework 2: Fourier Synthesis of Square Wave

In this homework, you will create a square wave on Matlab using fourier synthesis and investigate some of its properties.

Homework can be divided into three parts:

Part 1:
Write the Matlab code that generates a square wave with amplitude = 0.5, fundamental frequency = 100 Hz for 2 seconds by summing up fourier series terms. You can check lecture slides or the textbook for details on how to synthesize a square wave .

Calculate for n = 5, n = 15, n= 150, n = 500. Plot each of them between times 0 and 20 ms and values between - 1 and 1.

Note that, in the formula for square wave series, only the odd numbered terms are non-zero. This means that n = 5 should be adding up 3 terms (terms for 1 3 and 5).

File corresponding to this part should be named *part1.m.* This file should create these waves and create plots for each of them between times 0 and 20 ms and values -1 and 1. You can use the *subplot* feature to accommodate multiple plots in a single figure.

Part 2:
You should be observing the Gibbs phenomenon in the plots from part 1. If you are not observing the Gibbs phenomenon, your sample rate might be the suspect. Check Nyquist Theorem in order to learn the minimum sample rate you should set. (Don't forget to update your part 1 plots too!)

In your generated square waves, find the [(overshoot distance) - amplitude]/2*amplitude for every n = 5,15,150,500 value. Theoretically, this value should approach ~0.0895 as you increase n. It should also be close to 0.09 for all n values.

Plot this value for n = 5, 15, 150 and 500.

File corresponding to this part should be named *part2.m*. This file should be similar to the part1.m however, instead of creating plots for each wave, it should calculate the overshoot error (hint: max() function) for each wave and put it in a single plot for n = 5, 15, 150, 500.

Part 3:

Select the minimum sample rate for each n = 5, 15, 150, 500 according to Nyquist Theorem, (briefly explain why that value). Then save each wave generated with their corresponding minimum sample rate using audiowrite() function as .wav files. In your resulting 4 files, you should be observing an upwards trend in the file sizes as n increases, how are they correlated? Write the file sizes (exact values are not important) and explain the reasoning behind the increase in file sizes in your report.

Submission

You need to submit 3 files. **part1.m**, **part2.m** and **report.pdf**. Contents of part1.m and part2.m have been explained above. In your report,

- Make sure to write your name, surname, student id.
- Put a screenshot or an image of the plots generated in part 1. Write a brief comment.
- Put a screenshot or an image of the plot generated in part 2. Write a brief comment.
- Write all the minimum sample rates you have selected for n = 5, 15, 150 and 500. Briefly explain why those values by referring to Nyquist Theorem. Also write the file sizes for each n and briefly explain the reason behind the increase in file sizes.

If your report pdf exceeds moodle upload limit, you can provide an online link in a .txt file.