Fall 2017 EE 313 Linear Systems and Signals Prof. Evans

Homework #2

Fourier Series

Assigned on Friday, September 8, 2017
Due on Friday, September 15, 2017, by 12:30 pm via Canvas submission

Late homework will not be accepted.

Reading: McClellan, Schafer and Yoder, *Signal Processing First*, 2003, Sec 3.1 to 3.8.
Companion Web site with demos and other supplemental information: http://dspfirst.gatech.edu/
Web site contains solutions to selected homework problems from *DSP First*.

Office hours for Ms. Ghosh and Prof. Evans follow, as well as Prof. Evans' coffee hours on Friday. Please note that Prof. Evans' office hours on Tuesday will start at 2:30pm instead of 2:00pm.

Location of TA office hours and Ms. Ghosh's e-mail address are given on Canvas at

https://cluster34-files.instructure.com/courses/1017~1202937/files/1017~42941474/course%20files/signals/homework/homework1.pdf

and you must already be logged into Canvas at canvas.utexas.edu for the above link to work

Time Slot	***Monday***	***Tuesday***	***Wednesday***	***Thursday***	***Friday***
9:00 am			**Ghosh**		
9:30 am			**Ghosh**		
10:00 am			**Ghosh**		
10:30 am					
11:00 am		**Ghosh**		**Ghosh**	
11:30 am		**Ghosh**		**Ghosh**	
12:00 pm		**Ghosh**		**Ghosh**	Evans (EER cafe)
12:30 pm		Evans (EER 1.516)		Evans (EER 1.516)	Evans (EER cafe)
1:00 pm		Evans (EER 1.516)		Evans (EER 1.516)	Evans (EER cafe)
1:30 pm		Evans (EER 1.516)		Evans (EER 1.516)	Evans (EER cafe)
2:00 pm				Evans (EER 6.882)	
2:30 pm		Evans (EER 6.882)		Evans (EER 6.882)	
3:00 pm		Evans (EER 6.882)		Evans (EER 6.882)	

1. Fourier Synthesis. 22 points.

Signal Processing First, problem P-3.5, page 65

2. Periodic Rectangular Pulse Train. 27 points.

Signal Processing First, problem P-3.15, page 68

Also please complete the following part:

(c) Let $T_0 = 1 / f_0$ where $f_0 = 440$ Hz. Write MATLAB code to play $x(t)$ as an audio signal for 3 seconds. How does the sound compare to $\cos(2 \pi f_0 t)$ played for 3 seconds? Please submit the MATLAB code that you have written.

3. Chirp Signal. 24 points.

Signal Processing First, problem P-3.17, page 68

Also please complete the following part:

(d) Write MATLAB code to play $y(t) = \mathrm{Re}\{e^{j(800\pi t^2 + 540\pi t + 260\pi)}\}$ as an audio signal. Describe what you hear. Please submit the MATLAB code that you have written.

4. Audio Effects. 27 points.

Consider the signal $x(t) = \cos(2 \pi f_0 t)$ where $f_0 = 440$ Hz which an 'A' note on the Western scale.

Write MATLAB code to implement the following audio effects:

(a) $y(t) = x(t) \cos(2 \pi f_1 t)$ where $f_1 = 220$ Hz.

(b) $y(t) = x^2(t)$

(c) $y(t) = x^3(t)$

For each part, give a mathematical analysis to determine what frequencies are present in $y(t)$ and play $y(t)$ as an audio signal and describe what you hear vs. $x(t)$.

Note that in part (b), $y(t)$ will have a DC value. You can either remove the DC value from $y(t)$ and play the resulting signal with the `sound` command, or simply play $y(t)$ using the `soundsc` command. To remove the DC (average) value from vector `sig` in MATLAB, use `sig - mean(sig)`.

Please submit the MATLAB code that you have written.

As stated on the course descriptor, "Discussion of homework questions is encouraged. Please be sure to submit your own independent homework solution."

NOTE: In your solutions, please put all work for problem 1 together, then all work for problem 2 together, etc.