

Homework #1 Sinusoidal Signals

Assigned on Friday, August 25, 2023

Due on Friday, September 1, 2023, by 11:59 pm via Gradescope submission

Late homework is subject to a penalty of two points per minute late.

Reading: McClellan, Schafer and Yoder, *Signal Processing First*, 2003, Ch. 1 & 2. [Errata](#).
 Companion Web site with demos and other supplemental information: <http://dspfirst.gatech.edu/>
 Web site contains solutions to selected homework problems from *DSP First*.

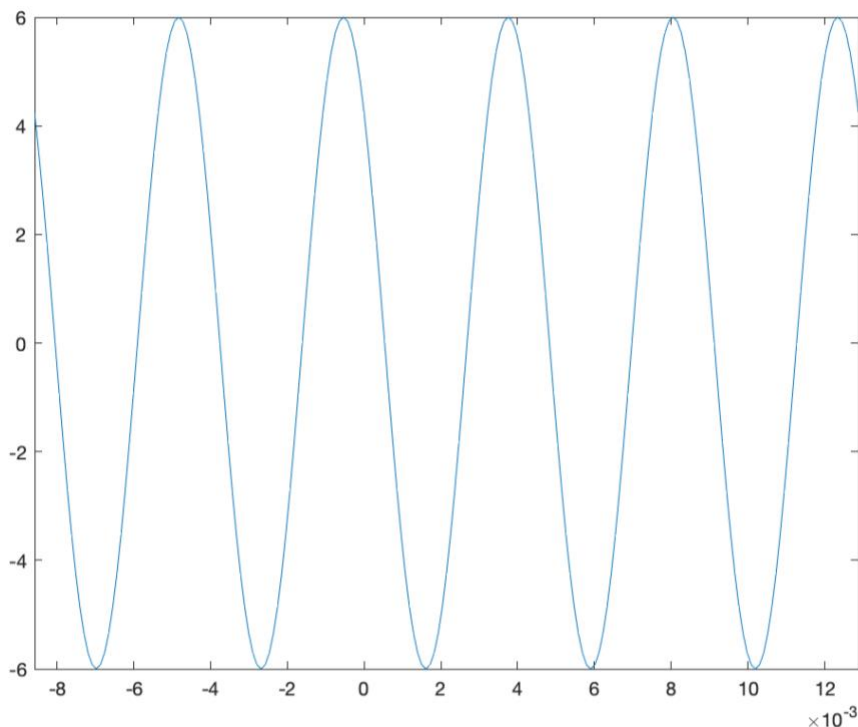
E-mail address for Mr. Elyes Balti (TA) is ebalti@utexas.edu. Please consider posting questions on the class [Ed Discussion site](#), which can be answered by anyone in the class. You can post anonymously to the other students and the instructors would still be able to see your name.

Lecture and office hours for Mr. Balti and Prof. Evans follow ([link for Zoom office hours](#)):

<i>Time Slot</i>	<i>Monday</i>	<i>Tuesday</i>	<i>Wednesday</i>	<i>Thursday</i>	<i>Friday</i>
11:00 am		Evans (ECJ 2.104)		Evans (ECJ 2.104)	
11:30 am		Evans (ECJ 2.104)		Evans (ECJ 2.104)	
12:00 pm		Evans (ECJ 2.104)		Evans (ECJ 2.104)	
12:30 pm					
1:00 pm					
1:30 pm					
2:00 pm			Evans (EER 6.882 and Zoom)	Evans (EER 6.882 and Zoom)	Balti (EER 3.648)
2:30 pm			Evans (EER 6.882 and Zoom)	Evans (EER 6.882 and Zoom)	Balti (EER 3.648)
3:00 pm			Evans (EER 6.882 and Zoom)	Evans (EER 6.882 and Zoom)	Balti (EER 3.648)
3:30 pm		Balti (EER 3.648)			
4:00 pm		Balti (EER 3.648)			
4:30 pm		Balti (EER 3.648)			
5:00 pm				Balti (EER 3.648)	
5:30 pm				Balti (EER 3.648)	
6:00 pm				Balti (EER 3.648)	

1. Finding Parameters of a Sinusoidal Waveform from a Plot. 20 points.

Signal Processing First, problem P-2.2, page 31, but use the plot below instead of the plot in Fig. P-2.2:



2. Using Phasors. 20 points.

Define $x(t) = 240 \cos(\omega_0 t) + 240 \cos(\omega_0 t + 60^\circ)$

- Express $x(t)$ in the form $x(t) = A \cos(\omega_0 t + \theta)$.
- Assume that $\omega_0 = 100\pi$ rad/s, which is 50 Hz, a common powerline main AC frequency worldwide. At a 50 Hz wall outlet, the voltage is commonly 240 V, which is the value of A here. Plot $x(t)$ over the range $-0.05s \leq t \leq 0.05s$ in MATLAB. Please write and submit your MATLAB code.
- Find a complex-valued signal $z(t)$ such that $x(t) = \text{Re}\{z(t)\}$.

Based on *Signal Processing First*, problem P-2.9, page 32.

3. Time Shift Corresponds to a Phase Shift. 20 points.

Signal Processing First, problem P-2.16, page 33. This fundamental idea of a time shift causing a phase shift and vice-versa is used in localization of an object in space, such as by radar and sonar. Radar and sonar systems transmit a known signal, receive the returned signal that has bounced off an object, use the time shift between the transmitted and received signals to estimate the roundtrip delay t_{RTT} , and then computes the distance to the object via $d = \frac{1}{2} c t_{RTT}$ where c is the speed of propagation in the medium.

4. Mobile Radio System. 40 points.

Signal Processing First, problem P-2.21, pages 34-35. Please see the [book errata](#).

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

NOTE: In your solutions, please put all work for problem 1 together, then all work for problem 2 together, etc. Please follow the other guidelines for your solutions on the homework page.

Homework Guidelines

Amount of work to show:

1. An explanation should be given for every single answer. Answers written without explanation will lose two-thirds of the points allotted for that part.
2. Only "standard" formulas (like Euler's formula, trigonometric formulas, etc.) can be used without a reference. If you're using something non-standard, then please put a reference to the formula number in the book, or whatever source you got it from. Just using the final result of a similar problem done in the class, and omitting the intermediate steps, is not okay. You have to show show your work.
3. There shouldn't be big jumps in logic from one step to the next.
4. For everything, expect to show at least one intermediate step between the first line and the answer. Even if it seems unnecessary to you, please err on the side of caution. Things that seem obvious to you when you're writing the solution are not quite so obvious for someone reading it.
5. If you're in any doubt about how much work to show, please ask the instructor or the teaching assistant.

MATLAB source code guidelines:

1. Put a comment before the solution of each part, telling the question number of the solution.
2. If you're using complicated logic, leave a comment telling what that block of code is supposed to do.
3. Use variable names that related to their meaning/use.
4. Avoid using two different variables for the same thing.
5. Try to avoid using "magic numbers" in the code. If you're using a number, write a comment telling me how you derived it.
6. Make sure that your code will compile & run in a clean workspace; i.e., one without any variables present. Use a clear all; at least once before submitting it.
7. No marks will be deducted based on the efficiency of the code unless the problem asks you to write efficient code.

Technical points:

1. Merge all the files together into one PDF file.
2. Please adjust the contrast, exposure etc., to get a good scan quality so that the TA can easily read what you write. Take extra care to get a good scan for parts written in pencil.
3. For the MATLAB code you write for an assignment, please copy the code into Word or include a screenshot showing the code. Do not submit handwritten code.

Other things:

1. All plots must have axis labels, with units.
2. Final answers must be boxed, or underlined or otherwise differentiated from the rest of the solution.
3. All final answers must have units, if they exist.
4. Read the questions carefully.
5. Try to answer all parts of a question together. If the solution to some parts of a question is written elsewhere, then leave a note telling the reader where to find it.