Lab 1: Introduction to Matlab

Appendix B.1, Pages -

0.1 Introduction

I begin with introductions (myself and the role of labs in the class). This is the time I use to discuss lab policies, the use of the questions queue, and lab report expectations, as described above.

Appendix B of DSPFirst is a wonderful introduction to Matlab. *Brian Storey has written an even better introduction to* Matlab *in general, although it is less specifically applicable to our work.* The largest time sink students experience in this class is from struggling with Matlab commands. Use `help` liberally, but if you are struggling with a feature of Matlab, ask for help before you get frustrated!

As soon as possible, find out how well each student knows Matlab and set up tutorials for those who need them. This might be done in the same questionnaire that asks for a self-assessment of each student's competencies or an early feedback survey.

Now help everyone install the DSPFirst functions (see 0.1.1 below).

Demo `zdrill`. In class, you've been working with complex numbers. `zdrill` may be helpful for you to improve your understanding of them, though we're not going to use it directly.

Explain the format of the book labs (introduction/background, warm-ups, and exercises), and that they do not have to do the warm-ups unless specified, but might find them useful.

The first lab is comprised of exercises in Matlab. If you are comfortable with Matlab, the exercises should take very little time.

0.1.1 Installing DSPFirst

Have some network cables for those who do not have their books.

1. Copy `dspfirst.exe` from the CD (`MATLAB\WINDOWS\DSPFIRST.EXE`) or StuFac (`stufps01/stufac/Si and Systems/DSPFirst/MATLAB/WINDOWS/DSPFIRST.EXE`) and place it in your Matlab toolbox directory (`C:\MATLAB...\toolbox`).

2. Run `dspfirst.exe`. It will open a window and extract its contents (a `DSPFIRST` directory) to your toolbox.

3. Open MATLAB.

4. From the `File` menu, select `Add Path...`. Click `Add with subfolders` and browse to the new `DSPFIRST` directory. Select it and click okay. Your path list will be updated with the subdirectories of `DSPFIRST`. Then click `Save`.

Spend time this week familiarizing yourself with the CD, which has many goodies *and the website, which might too.*

0.1.2 Measuring Phases

There are two common ways to measure the phase of a sinusoid from a graph. You may use any method you wish, but your answer should be correct to at least 2 significant figures.

The first method is the most intuitive. Draw a sinusoid with coordinate axes and a peak left of the origin. Start by measuring the period (mark the x-coordinate of two peaks). Now, imagine, then if this were an unshifted cosine wave, its first peak would be at 0. Intuitively, then, the fraction of this first peak location (indicate the peak closest to zero) to the total period, times 2π is the phase shift. Remember to adjust the sign of the phase shift: left is positive, right is negative. In other words, the relation between time shift and phase shift is $-\frac{t_0}{T} = \frac{\phi}{2\pi}$, where t_0 is the peak location, T is the period, and ϕ is the phase shift.

The second method is more analytic, and more precise, if you know the value at 0. The equation for a sinusoid is $x(t) = Acos(\omega t + \phi)$. Evaluate this at $t = 0$ and rearrange to get $\frac{x(0)}{A} = cos(\phi)$ or $\phi = \cos^{-1}(\frac{x(0)}{A})$. In other words, if you measure the y-intercept, which you can usually do precisely with MATLAB, divide by the amplitude, and take the inverse cosine, you get the phase shift. The result will always be positive, so you still have to add on the sign.

0.2 Additional Notes

0.2.1 Question Help

Students will have trouble with the vectorization question (see C.1.2.7: Vectorization). After they've worked on it a while, the questions will start. Here are some ways to point students in the right direction.

1. Go back to part 1 and explain how `A = A .* (A > 0)` works. What is the value of `(A > 0)`?

2. Try to get two matrices, one with the positive values and zeros elsewhere, and one with 77 for negative values and zeros elsewhere. Then combine them.

I include this problem because I think that programs in MATLAB *should use as little procedural and loop programming as possible.*

Also, you may have to give the above description of how to measure phase shifts several times.

0.2.2 Section Commentary

C.1.2.6**: Functions** :

1. I don't believe there is a mistake here in the book, but on the CD, the output variable `xx` is mixed up with `yy`.
2. `x1` and `x2` are replaced by `z1` and `z2`.

0.3 Deliverables

- C.1.2.2: MATLAB Array Indexing: Run the commands, understand them, but you only need to include in your write-up your work for part 3.
- C.1.2.5: MATLAB Sound: Do it, and answer the length question. *Now change the sampling frequency to 16000; Do you hear a difference? Now double xx (*`xx = 2*sin(2*pi*2000*t);`*), still using the doubled sampling frequency. Do you hear a difference? Explain any differences.*
- C.1.2.7: Vectorization: Include in your lab report your vectorized code.
- C.1.3.1: Manipulating Sinusoids with MATLAB: Do parts 1, 4, 5, and 6.