

# Math 313/513, Homework 10, MATLAB (due Thurs Apr. 12th)

Name: \_\_\_\_\_ 313 or 513 (circle)

**Problems** These are given in a separate file.

## MATLAB assignment

From the course webpage, download the file `audio.m`, and store it in your working directory for matlab/octave. Use `signal = load('audio.m');` to store the contents of the file as a vector `signal`. What `signal` stores is an audio clip: a list of the sound amplitude, with a sampling frequency of 8000 Hz. This means the numbers represent the amplitude at time spacings of  $1/8000$  of a second. `signal` has length 44,000, which means the sound clip lasts for 5.5 seconds. To hear it, run `sound(signal,8000);` (the 8000 is the sampling frequency).

You'll surely recognize that the sound contains a phone number being dialed (not to mention some static noise and music in the background!). Your assignment is to use Fourier analysis to determine what the phone number is.

Traditional phones use DTMF (dual-tone multi-frequency signaling). This means that each number on the keypad corresponds to the sum of two pure "tones" (sine waves) of differing frequencies. See

[http://en.wikipedia.org/wiki/Dual-tone\\_multi-frequency\\_signaling](http://en.wikipedia.org/wiki/Dual-tone_multi-frequency_signaling)

for the details, where you will find, for instance, that the number 6 is a 770 Hz wave added to a 1477 Hz wave.

(By the way, you can re-create a sound of the number 6 by `sound(sin(2*pi*770*x) + sin(2*pi*1477*x),8000);`, where `x` holds time values spaced at a particular frequency such as `x = [0:1/8000:1];`)

Run `plot(signal);` The seven large bumps you see correspond to seven numbers being dialed. To figure out the first digit, find a range of indices of `signal` that correspond to the first bump. Pick, say, 256 consecutive indices within this range, and let `sample1` consist of these.

Why 256? The *fast fourier transform* (FFT) works best on a vector whose length is a power of 2. So take a look at the documentation at

<http://www.mathworks.com/help/techdoc/ref/fft.html>

and get comfortable with the `fft` command. Run it on `sample1` and determine the phone number (one digit at a time)!

In your file, `lastname_fourier.m`, please include all your work and your usual comments. In your comments at the bottom, include the phone number.