Lab Assignment - 5
Fourier Analysis using the Fast Fourier Transform (FFT)

March 1, 2016

PROBLEM 1:

In this lab, we will numerically compute Fourier series as well as Fourier transform using the FFT command of MATLAB. The FFT command computes the discrete Fourier transform of a sequence.

Consider a periodic signal $x_1(t)$ of time period 2 seconds and an aperiodic signal $x_2(t)$ defined by

$$x_1(t) = e^{-2t},\ 0 \leq t \leq 2$$
$$x_2(t) = e^{-t}u(t).$$

(a) Write MATLAB code to compute the exponential Fourier series of $x_1(t)$ using the FFT command. Plot both the magnitude and phase response of Fourier series and label the frequency axis in terms of frequency in Hz. What value of F_s did you choose and why? What are the values of first and last frequencies in your response.

(b) Write MATLAB code to compute the Fourier transform of $x_2(t)$ using the FFT command and label the frequency axis in terms of frequency in Hz. What value of F_s and T_0 did you choose and why? What are the values of first and last frequencies in your response.

(c) Your plot for both the questions may include only positive frequencies, whereas in the class we usually form our frequency-domain plots from negative frequencies to positive frequencies. Let f_0 be the fundamental frequency for part (a). Which positive frequencies do $-f_0$, $-2f_0$ correspond to and why? Plot magnitude and phase response for (a) again but

this time label frequency axis such that it includes negative frequencies as well. What are the values of the first and last frequencies in your response? How many frequencies are positive and how many are negative while giving your answer in terms of F_s and not numbers?

(d) Repeat the above question for part (b).

(e) Does the count of positive and negative frequencies change if $N_0 = T_0/T_s$ is odd or even?

(f) Let `x` holds the value of a signal sampled at F_s and for T_0 duration. What happens to T_0 when you take `fft(x, length(x)+10)`?

(g) What are the main differences of using the FFT command when you use it to compute the Fourier transform and the Fourier series? Write in the form of a list.

Deliverable

You are supposed to bring a hand-written report of the assignment to the lab. You don't need to print plots and only need to write the code corresponding to different plots. The first page of your report should answer the short questions in different parts of the assignment.