ECE 410 Introduction to Signal Processing

Problem Set 9

Fall 2003

Issued: Thursday, November 20, 2003 **Due:** Monday, December 1, 2003

Reading in *Oppenheim and Schafer with Buck*

11/24/03 – Section 8.7
12/1/03 – Sections 10.0-10.2
12/3/03 – Sections 10.3, 10.5

This problem set is short so that you'll have time to work on Matlabs IV (due 11/24) and V (nominally due 12/3, but I will accept them up until 4pm on 12/5).

Problem 9.3 in *Oppenheim/Schafer/Buck*
Hint: for part c, you may want to consider the following:

- What is $x[n]$? (Remember: you are given $X[k]$.)
- Compare the flowgraph to Figure 9.3 in the textbook. What does the vector $C[r]$ correspond to in this flowgraph?
- What is the basic idea of the decimation in time approach? Can you use this basic idea to easily figure out what $C[r]$ is?

ECE410-3
This problem builds on the in-class exercises from 11/19/03.

(a) Determine and sketch the 4-point DFT of the sequence $x[n]$:

$$x[n] = 4\delta[n] + 3\delta[n-1] + 2\delta[n-2] + \delta[n-3].$$

You may attach a photocopy of your solution from the in-class exercise if you wish.

(b) Decimation-in-Frequency FFT approach

(i) Briefly summarize how a 4-point decimation-in-frequency FFT works. What is the basic idea?

(ii) Show how the decimation-in-frequency algorithm can be used to solve for the 4-point DFT of the sequence $x[n]$ given in part a. The method will involve calculating 2-point DFT's and combining them appropriately. You should show the results for each of the 2-point DFT's and indicate how they are combined to obtain the 4-point sequence $X[k]$.

(iii) Sketch a flowgraph for a 4-point decimation-in-frequency FFT. Verify that your flowgraph correctly computes the output $X[k]$ for the sequence $x[n]$ given in part a.

(c) Decimation-in-Time FFT approach

(i) Briefly summarize how a 4-point decimation-in-time FFT works. What is the basic idea?

(ii) Show how the decimation-in-time algorithm can be used to solve for the 4-point DFT of the sequence $x[n]$ given in part a. The method will involve calculating 2-point DFT's and combining them appropriately. You should show the results for each of the 2-point DFT's and indicate how they are combined to obtain the 4-point sequence $X[k]$.

(iii) Sketch a flowgraph for a 4-point decimation-in-time FFT. Verify that your flowgraph correctly computes the output $X[k]$ for the sequence $x[n]$ given in part a.