Reading Assignment: Oppenheim & Schafer: Chapter 8, Section 8.7; Chapter 9, Sections 9.0–9.1, 9.3–9.5.

REMINDER: the final exam will take place in class on Wednesday, December 17, 2002, 1:30-3:30pm. This exam will cover material through lecture 27 (Wednesday, December 10) and problem sets 1-10 (including the specified reading assignments from Oppenheim & Schafer). You will be allowed to bring three 8 1/2” × 11” sheets of notes. You can write on both sides of your note sheets.

Problem 10.1

Oppenheim and Schafer problem 8.41

Problem 10.2

Oppenheim and Schafer problem 8.46

Problem 10.3

Oppenheim and Schafer problem 8.43, parts (a) and (b) only

Problem 10.4

Oppenheim and Schafer problem 8.64
(Assume in part (b) that the impulse response of the inverse filter, \( h_i[n] \), is a stable sequence.)
Problem 10.5

The decimation-in-frequency FFT algorithm was developed in Section 9.4 for radix 2, i.e., \( N = 2^\nu \). A similar approach leads to a radix-3 algorithm when \( N = 3^\nu \).

(a) Draw a flow graph for a 9-point decimation-in-frequency algorithm using a \( 3 \times 3 \) decomposition of the DFT.

(b) For \( N = 3^\nu \), how many complex multiplications by powers of \( W_N \) are needed to compute the DFT of an \( N \)-point complex sequence using a radix-3 decimation-in-frequency FFT algorithm?

(c) For \( N = 3^\nu \), is it possible to use in-place computation for the radix-3 decimation-in-frequency algorithm?

Problem 10.6

Someone approaches you professing to be an expert on the subject of DFT’s. He/she tells you that if you have an FFT subroutine for computing a length-\( N \) DFT, the inverse DFT of an \( N \)-point sequence \( X[k] \) can be implemented using this subroutine as follows:

1. Swap the real and imaginary parts of each DFT coefficient \( X[k] \).
2. Apply the FFT routine to this input sequence.
3. Swap the real and imaginary parts of the output sequence.
4. Scale the resulting sequence by \( \frac{1}{N} \) to obtain the sequence \( x[n] \), corresponding to the inverse DFT of \( X[k] \).

Determine whether this procedure works as claimed. If it doesn’t, propose a simple modification that will make it work. Show all relevant work.

Problem 10.7

*Oppenheim and Schafer* problem 9.32
Problem 10.8

Suppose $x[n]$ is the 8-point complex-valued sequence with real part $x_r[n]$ and imaginary part $x_i[n]$ shown in Fig. 7.10-1 (i.e., $x[n] = x_r[n] + jx_i[n]$). Let $y[n]$ be the 4-point complex-valued sequence such that $Y[k]$, the 4-point DFT of $y[n]$, is equal to the odd-indexed values of $X[k]$, the 8-point DFT of $x[n]$ (the odd-indexed values of $X[k]$ are those for which $k = 1, 3, 5, 7$).

![Figure 7.10-1](image)

Determine the numerical values of $y_r[n]$ and $y_i[n]$, the real and imaginary parts of $y[n]$. 