Digital Signal Processing

http://kom.aau.dk/~zt/cources/DSP/

Exercises of Lecture 9 (MM9)

Exercise 9.1.

Compute the DFT of each of the following finite-length sequences considered to be of length N (where N is even).

(a) $x[n] = \delta[n]$

(b) $x[n] = \delta[n - n_0], \quad 0 \le n_0 \le N-1$

(c) $x[n] = \begin{cases} 1, & n \text{ even}, \quad 0 \le n \le N-1 \\ 0, & n \text{ odd}, \quad 0 \le n \le N-1 \end{cases}$

(d) $x[n] = \begin{cases} 1, & 0 \le n \le N/2-1 \\ 0, & N/2 \le n \le N-1 \end{cases}$

(e) $x[n] = \begin{cases} a^n, & 0 \le n \le N-1 \\ 0, & \text{otherwise} \end{cases}$

Exercise 9.2.

Consider the complex sequence

$$x[n] = \begin{cases} e^{j\omega_0 n}, & 0 \le n \le N-1, \\ 0, & \text{otherwise.} \end{cases}$$

(a) Find the Fourier transform $X(e^{j\omega})$ of $x[n]$.

(b) Find the N-point DFT $X[k]$ of the finite-length sequence $x[n]$.

(c) Find the DFT of $x[n]$ for the case $\omega_0 = 2\pi k_0/N$ where k_0 is an integer.

Exercise 9.3.

Suppose we have two 4-point sequences $x[n]$ and $h[n]$ as follows:

$$x[n] = \cos\left(\frac{\pi n}{2}\right), \qquad n = 0, 1, 2, 3,$$

$$h[n] = 2^n, \qquad n = 0, 1, 2, 3.$$

(a) Calculate the 4-point DFT $X[k]$.

(b) Calculate the 4-point DFT $H[k]$.

(c) Calculate $y[n] = x[n] \circledast_4 h[n]$ by doing the circular convolution directly.

(d) Calculate $y[n]$ of part (c) by multiplying the DFTs of $x[n]$ and $h[n]$ and performing an inverse DFT.

Thanks Borge Lindberg for providing the exercises and solutions.