Exercise 3

Problem 1

a) A signal $x_1(t) = \cos(2 \cdot \pi \cdot f_0 \cdot t)$ where $f_0 = 125Hz$, is sampled with spacing $T = 0.5\ ms$ between the samples and the first sample is taken at $t = 0$. Suppose we calculate a 128-point DFT of the first 128 samples of $x_1(t)$. For what values of k, will $X(k)$ be different from 0?

b) What is the frequency resolution, i.e. the frequency distance between the calculated values in a 128-point DFT? Suppose the sequence is sampled with 2000 Hz.

c) A signal is sampled with 2000 Hz sampling frequency. How long a section of the signal (measured in time) must be analyzed to determine the frequency content with better than 1 Hz frequency resolution?

Problem 2

a) Find with a 8-sample DFT of the unit impulse, $x(n)$=1 0 0 0 0 0 0 0 ......

b) Explain the result.

c) What result do you expect if you take a 128-sample DFT of the unit impulse sequence?

Problem 3

a) $X_1(k) = DFT\{x_1(n)\}$. Find $X_1(k)$ for the sequence $x_1(n) = \{2, 2, 0, 0, 2, 2, 0, 0\}$.

b) The sequence $x_1(n)$ is sampled with sampling frequency 1000 Hz. What frequency components in the range $-f_s/2$ and $+f_s/2$ are present in $x(n)$?

c) Suppose $x_1(n)$ is a sampled version of $x_1(t)$ and $x_1(t)$ is low pass limited to $f_s/2$. Write the expression for $x(t)$ from what you found in a) and b) above.