Homework 09

Problem 1 (5 points)

Have a look at particular realization of the N point forward DFT.

$$C_n = \sum_{k=1}^{N} y_k exp(-i2\pi(k-1)n/N)$$

here the normalization coefficient is omitted.

Prove that forward discrete Fourier transform is periodic i.e. $c_{n+N} = c_n$. Note: recall that $exp(\pm i2\pi) = 1$.

Does it extends to the fact that $c_{-n} = c_{N-n}$?

Problem 2 (5 points)

Use proven in the previous problem relationships and show that, for any sample set which has only real values (i.e. no complex part), the following relationship holds

$$c_n = c^*_{N-n}$$

Where * depicts complex conjugation.

Problem 3 (15 points)

Load the data from the file 'hw09pr3.dat' provided at the class web page. It contains a table with y vs t data points (first column is the time second is y). They data points are taken with the same sampling rate.

Subproblem: 3a (2 points)

What is the sampling rate?

Subproblem: 3b (3 points)

Calculate forward DFT of the data and find which 2 frequency component of the spectrum (measured in Hz not rad$^-$1) are the largest. Note I refer to the real frequency of the sin or cos component i.e. not to negative frequencies.

Subproblem: 3c (2 points)

What is the largest possible frequency (in Hz) in this data set which we can scientifically discuss?

Subproblem: 3d (5 points)

We consider everything else but above 2 components as DFT of noise. Construct a low pass filter which will bass this two components. Plot it's frequency representation (positive and negative frequency). Explain your choice of the filter and its parameters.

Subproblem: 3e (3 points)

Apply the filter to the data Fourier representation and calculate inverse DFT. Plot the resulting filtered data representation and raw data points at the same plot. Did it completely get rid of noise? If not why is so?