Homework 5 (Due: 6/21)

(1) Write the Matlab or Python code to compute the FFT of two N-point real signals x and y using only one N-point FFT.   (20 scores)

$$[Fx, Fy] = \text{fftreal}(x, y)$$

The code should be handed out by NTUCool.

(2) Compared to the original non-sectioned convolution, what are the two main advantages of the sectioned convolution?   (8 scores)

(3) Are the following applications suitable for the Walsh transform? Why? (a) calculating the linear convolution; (b) compressing a natural image; (c) stair-like signal analysis.   (12 scores)

(4) What is the number of addition operations when we what to implement (a) the 16-point Walsh transform and (b) the 16-point Haar transform?   (10 scores)

(5) What are the <u>two main advantages</u> of the OFDM when compared to the original FDM? (8 scores)

(6) (a) What is the results of CDMA if there are three data [1 1 0], [0 1 1], [1 0 1] and these three data are modulated by the 1st, 6th, and 12th rows of the 16-point Walsh transform? (The beginning row is the 1st row). (10 scores)

(b) In (a), if the 8th and the 15th entries of the CDMA results are missed, can we recover the original data? Why? (5 scores)

(7) (a) Please determine 3^{2049} (mod 11).

(Hint: Try to find a such that 3^a (mod 11) = 1).

(b) Suppose that N mod 23 = 12 and N mod 47 = 8. Please determine the minimal positive integer solution for N.

(Hint: We can use the fact that 46 mod 47 = -1 mod 47.) (8 scores)

(8) Write at least three similarities between the NTT and the DFT. (7 scores)

(9) For the complex number theoretic transform (CNT), if a complex integer number $a + ib$ satisfies $a^2 + b^2 = 1 \bmod M$, then we say that $a + ib$ is on the unit circle.

(a) Is $2 + i11$ and $5 + i10$ on the unit circle when $M = 31$?

(b) Is $(2 + i11)(5 + i10)$ on the unit circle when $M = 31$?

(c) When $a = 10$, find all $b \in [1, 2, .., 30]$ such that $a + ib$ is on the unit circle.

(12 scores)

(Extra): Answer the questions according to your student ID number.

(ended with (1, 6), (2, 7), (3, 8), (4, 9))