Homework 5 (Due: 6/30)

(1) Write a Matlab program that can generate the forward and inverse N-point number theoretic transform matrices (modulus M).

[A, B] = NTTm(N, M) % A: forward, B: inverse

The outputs A and B are $N \times N$ matrices. Choose the smallest positive α.
The program should be able to run for large N (avoid calculating α^k directly).
The Matlab program should be mailed to me. (25 scores)

(2) In addition to the linear complexity, what is the other important advantage of the sectioned DFT convolution? (10 scores)

(3) What are the most important applications of (a) the Walsh transform, (b) the Haar transform, and (c) the NTT nowadays? (15 scores)

(4) How many entries of (a) the N-point Walsh transform and (b) the N-point Haar transform that are equal to 0, 1, and -1? (10 scores)

(5) What are the advantages and limitation when using the NTT to calculate the convolution? (10 scores)

(6) Why the orthogonal transform plays an important role in signal processing? (10 scores)

(7) (a) What is the results of CDMA if there are three data [1 0 0], [1 0 1], [0 1 1] and these three data are modulated by the 1^{st}, 5^{th}, and 10^{th} rows of the 16-point Walsh transform?

(b) Is it better to use the Haar transform and the number theoretic transform for CDMA? Why? (20 scores)