Homework 5 (Due: 7/6)

(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 displab531@gmail.com.

(25 scores)

(2) What are the two main advantages of the sectioned convolution?

(10 scores)

(3) (a) How many additions operations required for the 16-point and the 32-point Walsh transforms? (10 scores)

(b) Suppose that $h[n] = f[n] \star g[n]$ where $\star$ means the logic convolution. Express $h[6]$ in terms of $f[n]$ and $g[n]$ (The 8-point Walsh transform is applied). (5 scores)

(4) What are the most important applications of (a) the Walsh transform and (b) the Haar transform nowadays? (10 scores)

(5) Which are the possible applications of the NTT? Why? (a) Filter design. (b) Compression. (c) Integer LTI system analysis. (d) Encryption. (10 scores)

(6) What are the two main advantages of the OFDM when compared to the original FDM? (10 scores)

(7) (a) What is the results of CDMA if there are three data [1 1 0], [0 1 1], [1 0 0] and these three data are modulated by the 1^{st}, 6^{th}, and 11^{th} columns (equivalent to the 1^{st}, 6^{th}, and 11^{th} rows (m = 0, 5, 10)) of the 16-point Walsh transform?
(b) Is it better to use the NTT for CDMA? Why? (20 scores)