Homework 5 (Due: 6/17)

(1) Write a Matlab or Python code 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 or Python code should be handed out by NTUCool.

(25 scores)

(2) (a) How do we use one DFT to compute the DFTs of two real signals? (b) How do we use one DFT to compute the DFTs of two real and even signals and two real and odd signals? (10 scores)

(3) (a) If we denote the beginning row as the 1st row, then write the 23rd row of the 32-point Haar transform. (b) What are the most important applications of the Haar transform nowadays? (10 scores)

(4) Are the following applications proper or improper to use the Walsh transform? Why? (a) LTI system analysis; (b) step-like signal expansion; (c) modulation; (d) localized feature extraction. (10 scores)

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

(6) What are the two main advantages of the OFDM when compared to the original FDM? (5 scores)

(7) Describe two concepts that you learned from the oral presentation on 6/10. (10 scores)

(8) (a) What is the results of CDMA if there are three data [1 0 1], [0 1 0], [1 1 0] and these three data are modulated by the 1^{st}, 5^{th}, and 10^{th} columns (equivalent to the 1^{st}, 5^{th}, and 10^{th} rows (m = 0, 4, 9)) of the 16-point Walsh transform? (15 scores)

(b) Is it better to use the NTT for CDMA? Why? (5 scores)

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

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