## 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)

14-1/p.451

Fx=fft(x) Fy=fft(y) $[Fx, Fy]$ =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)

12-3/p.442

(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)

14-2/p.516

convolutionn:no
Walsh 只能在logical convolution 做
transform後變成乘法

當運算量不是問題的話
比較少使用到Walsh 而是DCT

跟 walsh一樣都是菱菱
角角的樣子 用walsh有
優勢

(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)

14-2/p.514

4個 stage
16x4=64個加法

14-2/p.519

orthogonal

(5) What are the <u>two main advantages</u> of the OFDM when compared to the original FDM? 14-3/p.537 14-4/p.541 (8 scores)

總共有16x3=48個點

(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 $1^{st}$, $6^{th}$, and $12^{th}$ rows of the 16-point Walsh transform? (The beginning row is the $1^{st}$ row). (10 scores)

14-4/p.549

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

2^169 mod 15
2^1 mod 15 =2
2^2 mod 15 =4
2^3 mod 15 =8
2^4 mod 15 =1
2^5 mod 15 =2
2^6 mod 15 =4

每4次會循環
169/4 餘 1
=> 2^169 mod 15 =2

(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)

14-1/p.473

N = 12+23*k => mod 47
=12 for k =0
=11 for k = 2
=10 for k = 4
=9 for k = 8 ?

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

13-2/p.475
14-1

orthogonal:
DFT不同row做內積會＝0
NTT不同row也是orthogonal

*(Continued)*

(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^2+b^2 mod M =1

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

2^2+11^2 mod 31
5^2+10^2 mod 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))

p.473

3306 x 225 mod 11 = ?