Homework 5 (Due: 6/11th)

(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?   (7 scores)

(3) Design an efficient way to compute the convolution operation of

$$y[n] = x[n] * h[n] \text{ where}$$

$$h[n] = \begin{bmatrix} 0.09 & 0.36 & 0.55 & 0.55 & 0.36 & 0.09 \end{bmatrix} \quad -2 \leq n \leq 3$$

The number of multiplications should be as small as possible.   (10 scores)

(4) Suppose that length($x[n]$) = 1500. What is the best way to implement the convolution of $x[n]$ and $y[n]$ if
      (a) length($y[n]$) = 250,   (b) length($y[n]$) = 50,
      (c) length($y[n]$) = 10,   and (d) length($y[n]$) = 2?
Please show (i) the <u>calculation method</u> (direct, non-sectioned convolution, or sectioned convolution), (ii) the <u>number of points of the FFT</u>, (iii) and the <u>number of real multiplications</u> for the best implementation method. Also, consider the general case where $x[n]$ and $y[n]$ are complex sequences and the FFT of $y[n]$ can be computed in prior.   (25 scores)

(5) Are the following applications <u>suitable for the Walsh transform? Why?</u> (a) calculating the linear convolution; (b) stair-like signal analysis.   (8 scores)

(6) What is the number of addition operations when we what to implement (a) the 32-point Walsh transform, (b) the 16-point Haar transform?   (10 scores)

(7) (a) What is the results of CDMA if there are three data [1 0 1], [1 1 0], [0 1 1] and these three data are modulated by the 1st, 4th, and 10th rows of the 16-point Walsh transform? (The beginning row is the 1st row).   (10 scores)

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

(c) Is it proper to use the Haar transform instead of the Walsh transform for CDMA? Why?   (5 scores)

(Extra): Answer the questions according to your student ID number.
        (ended with 1, 2, 3, 4, 6, 7, 8, 9)