Homework 1 (Due: 6th Oct.)

(1) Which of the following applications are the proper applications of the short -time Fourier transform? Also illustrate the reasons. (a) Signal sampling. (b) convolution computation; (c) music signal analysis. (d) video analysis. (15 scores)

(2) How do we determine the frequency of a signal without the Fourier transform if its local maximums are positive and local minimum are negative? (10 scores)

(3) (a) Why the sinc function may not reflect the frequency distribution of a rectangular function? (b) Suppose that

$x(t) = 1$ for $-2 < t < 2$, $x(t) = 0$ otherwise.

Determine the rec-STFT of $x(t)$ if $B = 1$. (15 scores)

(4) (a) How does the parameter σ affect the resolution of the scaled STFT?
(b) If we want to analyze a vocal signal (the units in the *t*-axis and the *f*-axis are second and Hz), should we use a larger or a smaller value of σ? Why?
(15 scores)

(5) (a) Why sometimes it is better to use the STFT with an asymmetric window instead of a symmetric one? (b) What is the relation between a rectangular function and a Gaussian function? (c) Why better time-frequency analysis result can be obtained if one uses the Gaussian window instead of the rectangular window? (15 scores)

(6) Why $x(t) = A\exp\left(j(Bt+C) - \pi(Dt+E)^2\right)$ satisfies the lower bound of the uncertainty principle ($\sigma_t\sigma_f = \frac{1}{4\pi}$) for any *A*, *B*, *C*, *D*, *E*? (10 scores)

(7) Write a Matlab or Python program that can generate a *.wav file whose instantaneous frequency is $\pm(at^2 + bt + c)$ Hz, the length of the file is T second, and the sampling frequency is Fs Hz.

gwave (a, b, c, T, Fs)

The code should be handed out by NTUCool. (20 scores)

(Extra): Answer the questions according to your student ID number.
(ended with 0, 1, 2, 3, 5, 6, 7, 8)