Homework 2 (Due: 24th Oct.)

(1) We know that $\exp(-\pi t^2)$ satisfies $\sigma_t \sigma_f = 1/4\pi$ (the lower bound of the uncertainty principle). Are the following functions also satisfy $\sigma_t \sigma_f = 1/4\pi$? Why? (a) $2\exp(-t^2)$; (b) $\exp(-2\pi(t-10)^2)$; (c) $\exp(-\pi|t|)$; (d) $\exp(-\pi t^2) * \exp(-\pi t^2)$ where $*$ means the convolution.

(20 scores)

(2) (a) What is the complexity when using the recursive method to implement the STFT? (b) What are the two main disadvantages when using the recursive method to implement the STFT? (10 scores)

(3) Calculate the WDF of $\exp(-\pi t^2/2)$ (10 scores)

(4) Why (a) Cohen's class distribution, (b) the polynomial WDT, and (c) the Gabor-Wigner transform can avoid the cross-term problem in some cases?

(15 scores)

(5) In what condition the output of Cohen's class distribution is real?
(Written the constraint for $\Phi(\eta, \tau)$) (10 scores)

(6) Write a code for the rectangular STFT. (35 scores)
(the window is $w(t) = 1$ if $|t| < B$, $w(t) = 0$ otherwise).
y = recSTFT(x, t, f, B)
x: input, t: samples on t-axis, f: samples on f-axis, y: output

(i) 要交本題的程式碼 (*.m 檔或 *.py檔，可用 Matlab 或 Python寫)，
(ii) 自己選一個 input x, 用你們的程式將 output y 算出來並畫出來
(iiii) 計算程式的 computation time
(iv) 不可以用 direct implementation 的方法
(v) The code should be handed out by NTUcool.

(續)

Example：

```
dt=0.05;
df=0.05;
t1=[0:dt:10-dt]; t2=[10:dt:20-dt]; t3=[20:dt:30];
t=[0:dt:30];
f=[-5:df:5];
x=[cos(2*pi*t1),cos(6*pi*t2),cos(4*pi*t3)];
tic
y=Gabor(x,t,f);
toc
```

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

(ended with 0, 1, 2, 4, 5, 6, 7, 9)