Homework 2 (Due: 11h Nov.)

Note: Do not forget the extra question.

(1) When using the scaled Gabor transform with window $\exp(-\pi\sigma t^2)$ to analyze a music signal, should we choose a larger or a smaller σ? Why? (10 scores)

(2) (a) Calculate the Wigner distribution function (WDF) of $\exp(-\pi t^2)$.
Hint: Using the fact that the FT of $\exp(-\pi t^2)$ is $\exp(-\pi f^2)$.
(b) Calculate the WDF of $\delta(2t - 1)$. (15 scores)

(3) Compare the 4 methods to implement the STFT in terms of (a) complexity and (b) constraints. (c) Which methods can also be used for implementing the WDF? (15 scores)

(4) Why (a) the windowed Wigner distribution function, (b) Cohen's class distribution, 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 Matlab or Python code for the scaled Gabor transform (unbalanced form). (page 98)

y = Gabor(x, tau, t, f, sgm) (35 scores)

x: input, *tau*: samples on *t*-axis for the input, *t*: samples on *t*-axis for the output

f: samples on *f*-axis, *sgm*: scaling parameter, *y*: output

(i) The Matlab or Python code should be handed out by NTUCool, (ii) Choose an input x (Use *.wav)， plot the output y. (iii) Also show the running time，(iv) Determine tau of the following example，(v) The running time should be as short as possible (for the following example, within 1.5 seconds)

```
[a1, fs] = wavread('Chord.wav');
x=a1(:,1).';    % only extract the first channel
tau = (?  Please think how to determine tau);
dt = 0.01;                df= 1;
t= 0:dt:max(tau);      f= 20:df:1000;
sgm= 200;
tic
y= Gabor (x, tau, t, f, sgm);
toc
```

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

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