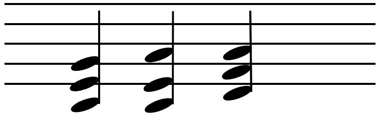
Homework 2 (Due: 26th Oct.)

(1) (a) Compute the Fourier transform of $g_1(t) = 2\exp(-\pi(2t^2+4t+2))$. (b) Calculate the Gabor transform of $g_1(t)$. (c) Does $g_1(t)$ satisfy the lower bound of the uncertainty principle? Why? (15 scores)

(2) 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)

(3) Which of the following signals are suitable to be analyzed by the Wigner distribution function (WDF)? Why? (a) $\exp(j2t^3)$, (b) Music signal, (c) $\sin(|t|^{0.5}+1)$, (d) Gaussian functions?



(10 scores)

(4) (a) Prove that the WDF of any signal is a real function. (b) How do we make the windowed WDF for any function always be real (show the constraint for the window $w(\tau)$) ? (c) How do we make Cohen's class distribution for any function always be real (show the constraint for the mask function $\Phi(\tau, \eta)$) ?

(15 scores)

(5) Why (a) Cohen's class distribution and (b) the polynomial WDF can avoid the cross term in some case? (10 scores)

(6) Write a Matlab or Python code for the scaled Gabor transform (unbalanced form). (page 102)

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] = audioread('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
```

Add scores for the top 20.

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

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