Homework 3 (Due: Nov. 13th)

(1) (a) In what condition the polynomial WDF cannot remove the cross term (write two conditions)? (b) In what condition Cohen's class distribution cannot remove the cross term (write two conditions)? (10 scores)

(2) (a) Compared to the original STFT, what is the advantage of the S transform? (b) Which of the following function is most suitable to be the window function of the S transform? Why?

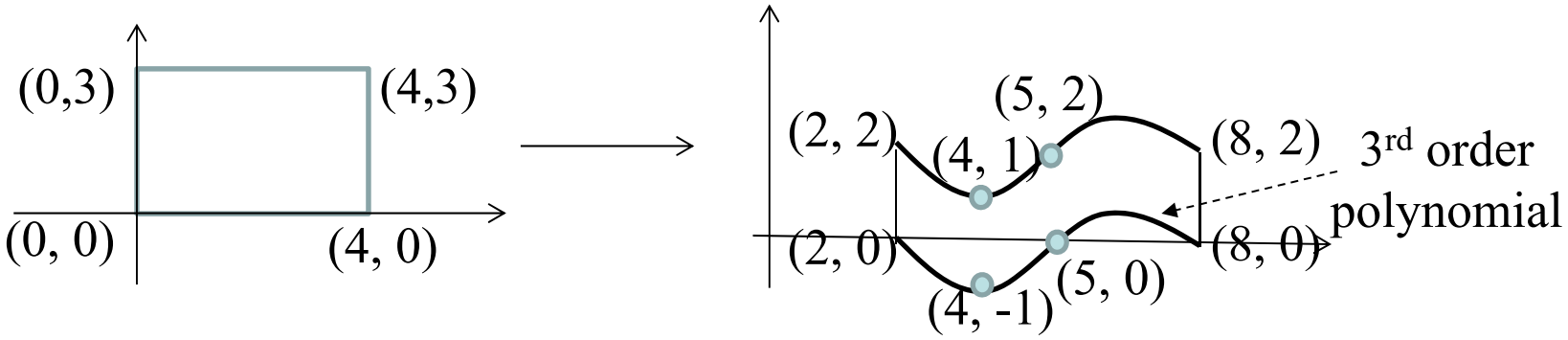
(i) $w(t) = |f|^3 \exp\left[-\pi t^2 f^6\right]$ (ii) $w(t) = \left|(1+0.2\sqrt{|f|})\right| \exp\left[-\pi t^2 (1+0.2\sqrt{|f|})^2\right]$

(iii) $w(t) = |2+\cos(f)|$ (15 scores)

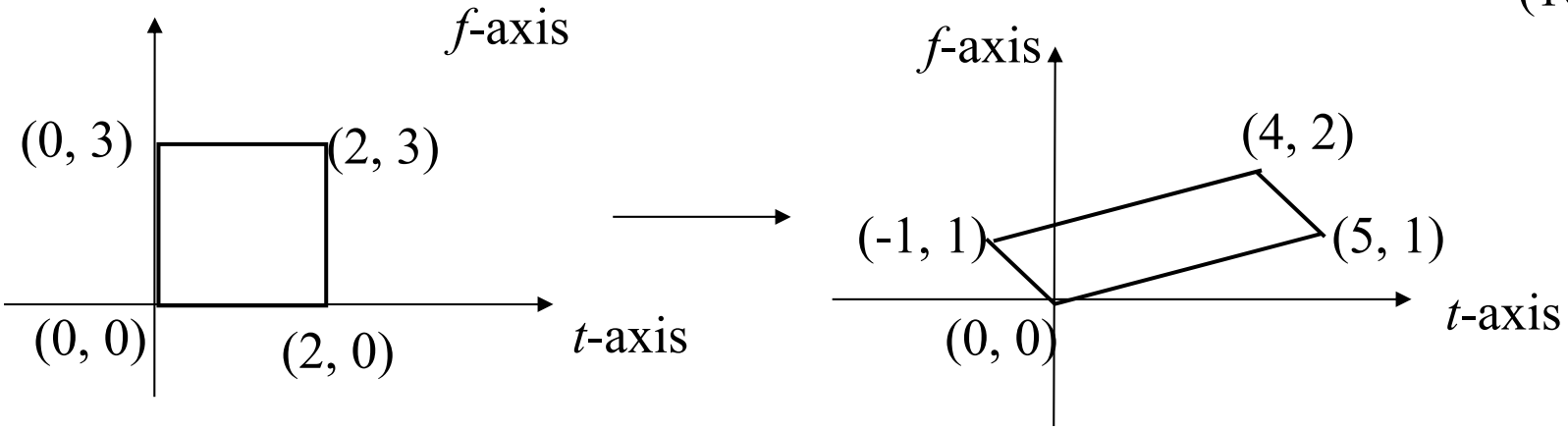
(3) Why (a) the generalized spectrogram and (b) reassignment can make time-frequency distribution more concentrated? (10 scores)

(4) Give an example of the physical system that the input and the output have the relation of (a) chirp multiplication and (b) chirp convolution. (10 scores)

(5) Suppose that the WDF of a signal is as the left figure. How do we change its WDF into the right figure? (10 scores)



(6) Suppose that the time-frequency distribution of $x(t)$ is as the left figure. How do we change the time-frequency distribution into the right figure using the LCT? (10 scores)



(7) Write a Matlab or Python program for the scaled Gabor transform (unbalanced form).

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 code should be handed out by NTU Cool, (ii) Choose an input x (Use *.wav)， plot the output y ， (iii) Use tic and toc to show the running time，(iv) The running time for the following example should be 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;       sgm= 200;
t= 0:dt:max(tau);      f= 20:df:1000;
tic
y= Gabor (x, tau, t, f, sgm);
toc
```

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

(ended with 0, 1, 3, 4, 5, 6, 8, 9)