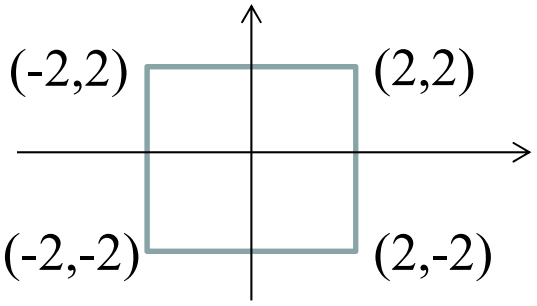
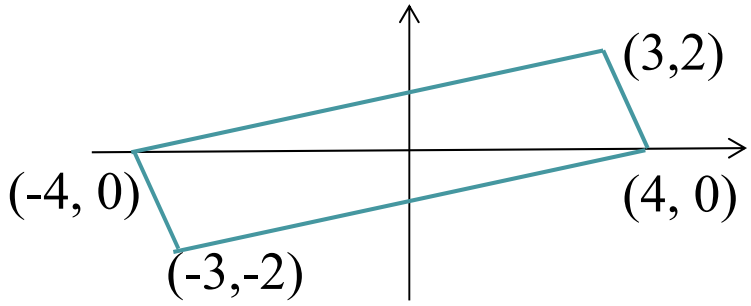
Homework 3 (Due: Nov. 19th)

(1) (a) Compared to the Fourier transform, what are the main advantage of the 3-parameter atom? (b) Compared to original spectrogram, what is the advantage of the generalized spectrogram? (10 scores)

(2) The window of the S transform is $s(f)\exp(-\pi\tau^2 s^2(f))$. Which of the following function is the best choice for $s(f)$? Why? (a) $f^{1.2}$, (b) $1+\sin(f^{0.6})$, (c) $10+f^{0.6}$ (10 scores)

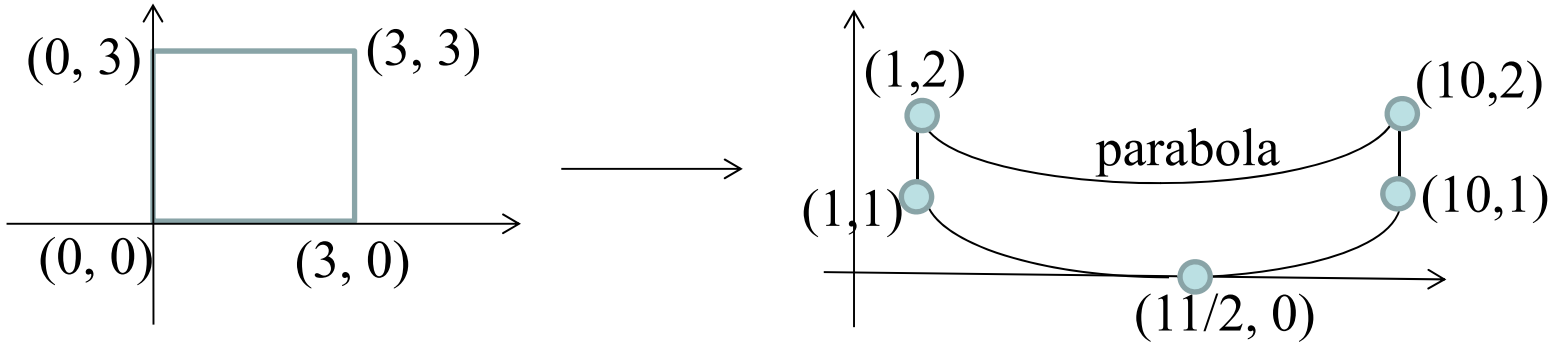
(3) Suppose that the WDF of $x(t)$ is as the left figure. Find the LCT parameters $\{a, b, c, d\}$ such that the WDF of the LCT of $x(t)$ is as the right figure.





(10 scores)

(4) Suppose that the WDFs of $x(t)$ and $\exp(j(at^3+bt^2+ct))x(dt+e)$ are the left and the right figures, respectively. Determine the values of a, b, c, d , e. (15 scores)



(5) (a) Compared to the FT, what is the advantage of using the FRFT for filter design? (b) What is the advantage to use the generalized modulation for filter design? (10 scores)

(6) Suppose that $x(t)$ is a white noise. Which of the following random processes are also a white noise? Why? (i) $x(t/3)$; (ii) $x(t)\exp(-\pi t^2)$; (iii) $FT[x(t)]$; (iv) $x(t)\exp(j\pi t^2)$; (v) $x(t)$ * $\exp(j\pi t^2)$ (* means the convolution).

(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)