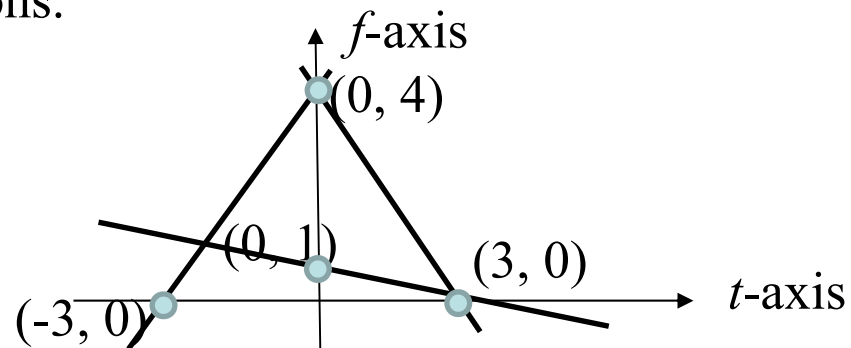


Homework 4 (Due: 4th Dec.)

- (1) Suppose that $x(t)$ is a chirp function. Which of the following functions are also chirps? Why? (i) $FT(x(t))$; (ii) the FrFT of $x(t)$; (iii) the generalized modulation of $x(t)$; (iv) $x(t) * x(t)$ where $*$ means the convolution. (Note that the time-frequency distribution of $x(t)$ is a line). (10 scores)

- (2) Suppose that the time-frequency distribution of a signal is as the following triangular regions.



Suppose that the signal is interfered by the white noise How do we use the FrFT filters to reduce the effect of white noise? $H(u)$ and α of each FrFT filter should be shown. (15 scores)

- (3) Suppose that there are 6 signals. Their time length are all 10 seconds and their frequencies are all from $-20000\text{Hz} \sim 20000\text{Hz}$. Also suppose that the channel is almost full except for $f \in [1000000 + 1000t, 1010000 + 1000t]$ and $f \in [-1000000 - 1000t, -1010000 - 1000t]$, $0 < t < 120$. How do we transmit the 6 signals by the channel? (15 scores)
- (4) (a) What are the two main differences between the IMF and a sinusoid function?
(b) Which function is an IMF? Why? (i) $\sin(\pi t^3)$; (ii) $(3 - \cos(12\pi t))\cos(\pi t)$
(10 scores)
- (5) (a) What is the most important advantage of the Haar transform nowadays?
(b) Write the 6th row of the 16-point Haar transform. (10 scores)
- (6) (a) What is the role of the vanish moment in the wavelet transform?
(b) Suppose that $x(t) = a + bt + t^2$ for $-2 < t < 2$, $x(t) = 0$ otherwise.
If $x(t)$ has the vanish moment of 2, determine a and b . (10 scores)

(7) Write a Matlab or Python program of the Hilbert-Huang transform.

$$y = \text{hht}(x, t, \text{thr})$$

x: input, y: output (each row of y is one of the IMFs of x), t: samples on the t -axis, thr : the threshold used in Step 7.

In Step 8, the number of non-boundary extremes can be no more than 3.

Step 9 is not required. The code should be handed out by NTUCool.

(30 scores)

Example: $t = [0: 0.01: 10];$
 $x = 0.2*t + \cos(2*\pi*t) + 0.4*\cos(10*\pi*t);$
 $\text{thr} = 0.2;$
 $y = \text{hht}(x, t, \text{thr});$

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

(ended with 0, 2, 3, 4, 5, 7, 8, 9)