Homework 2 (Due: 4/16)

(1) Write a Matlab or Python code that uses the frequency sampling method to design a $(2k+1)$-point discrete differentiation filter $H(F) = j2\pi F$ when $-0.5 < F < 0.5$ (k is an input parameter and can be any integer). (25 scores)

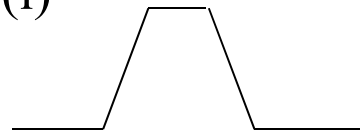
The transition band is assigned to reduce the error (unnecessary to optimize). (i) The impulse response and (ii) the imaginary part of the frequency response (DTFT of $r[n]$, see pages 112 and 113) of the designed filter should be shown in the homework. The code should be handed out by NTU Cool.

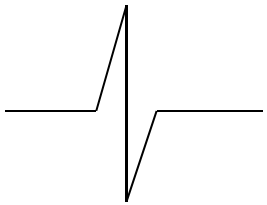
(2) (a) What are the two main advantages of the minimum phase filter compared to other IIR filters?
(b) What is the advantage of the Hilbert transform compared to the difference for edge detection?
(c) What is the advantage of the Wiener filter compared to pass-stop band filters for noise removal?
(d) What are the two advantages of the cepstrum compared to the equalizer for multipath problems? (20 scores)

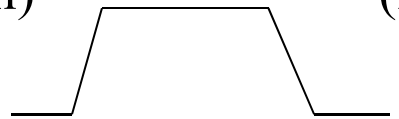
(3) Why it is improper to use $IFFT(FFT(x[n])H(F))$ for filter design in practice? (5 scores)

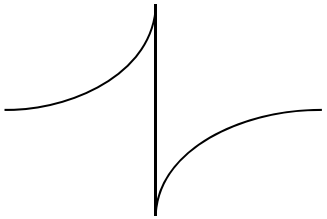
(4) (a) What is the role of the weight function in FIR filter design? (b) Can the techniques of the weight function be applied in the FIR filter designed by (i) the MSE method and (ii) the frequency sampling method? (10 scores)

(5) The following figures are the impulse responses of some filters. Which one is a suitable edge detector when we want to extract (a) small scaled features? (b) large scaled features? Also illustrate the reasons. (10 scores)

(i) 

(ii) 

(iii) 

(iv) 

(6) If the z-transform of $h[n]$ is $H(z)=\dfrac{2z^3-2z^2-3z-2}{z^2-0.7z+0.1}$

(a) Convert the IIR filter into the minimum phase filter.

(b) Determine the cepstrum of $h[n]$. (20 scores)

(7) Suppose that the cepstrum of a signal $x[n]$ is

$$\hat{x}[2]=0.8, \quad \hat{x}[n]=0 \quad \textit{otherwise.}$$

Determine $x[n]$ using the Z transform and exp( ). (10 scores)

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

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