Homework 1 (Due: March 26th)

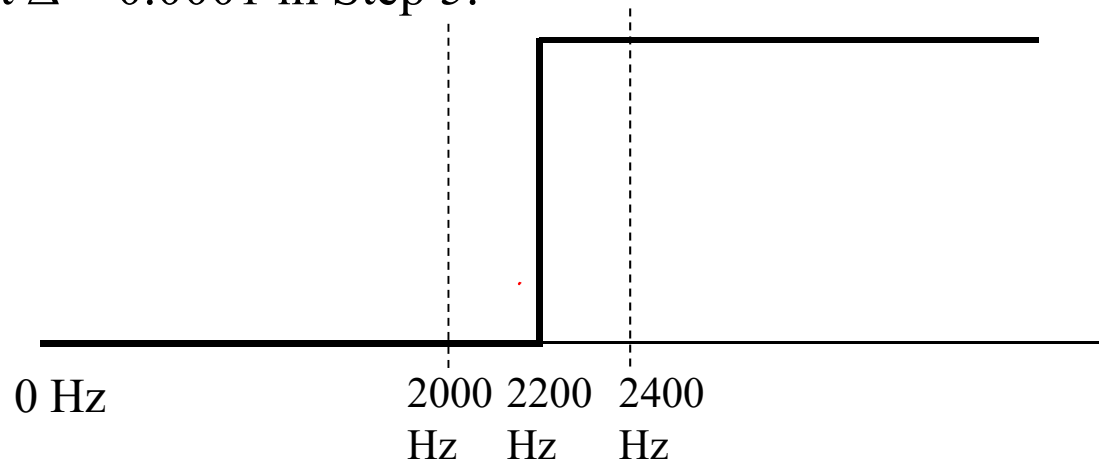
(1) Design a Mini-max **highpass** FIR filter such that (40 scores)

① Filter length = 19, ② Sampling frequency f_s = 8000Hz,

③ Stop Band 0~2000Hz ④ Transition band: 2000~2400 Hz,

⑤ Weighting function: $W(F) = 1$ for passband, $W(F) = 0.6$ for stop band .

⑥ Set $\Delta = 0.0001$ in Step 5.



※ The Matlab or Python code should be handed out by NTUCool, too.

Show (a) the frequency response, (b) the impulse response $h[n]$, and
(c) the maximal error for each iteration.

(2) (a) How do we convert convolution into an addition operation?

(b) What are two main advantages of the FT in engineering?

(c) From the view point of implementation, what are the disadvantages of the discrete Fourier transform? (15 scores)

(3) Discuss how to implement $y[n] = x[n] * h[n]$ efficiently where

$h[n] = (0.7^n + (-0.6)^{n+1})u[n]$, $u[n]$: unit step function (10 scores)

(4) Why (a) the step invariance method and (b) the bilinear transform can reduce or avoid the aliasing effect in IIR filter design? (10 scores)

(5) Design the 7-point FIR filter in the MSE sense where the ideal filter is

$H_d(F) = 1$ for $|F| < 0.25$, $H_d(F) = 0$ for $0.25 < |F| < 0.5$ (10 scores)

(Cont.)

(6) (a) Write two reasons why the transition band plays a critical role in Minimax filter design.
(b) Estimate the pass and stop band ripples if filter length = 21, Δ_t = 0.0002, and the transition band is 1950~2050 Hz.
(c) Estimate the pass and stop band ripples if filter length = 31, Δ_t = 0.0001, and the transition band is 1750~ 2250 Hz.
In (b)(c), suppose that pass and stop band ripples are equal. (15 scores)

(Extra): Answer the questions according to your student ID number.
(ended with 0, 1, 2, 3, 5, 6, 7, 8)