Homework 1 (Due: March 18th)

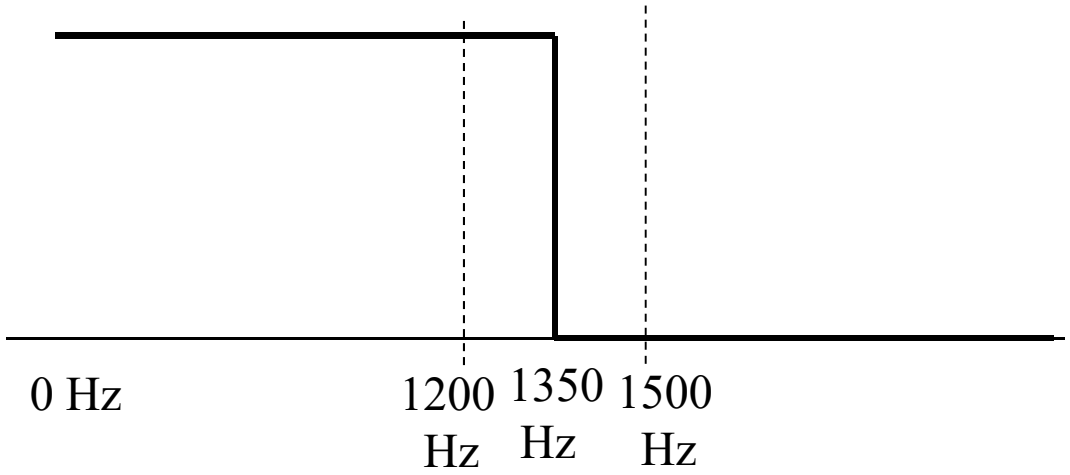
(1) Design a Mini-max **lowpass** FIR filter such that (40 scores)

① Filter length = 17, ② Sampling frequency f_s = 6000Hz,

③ Pass Band 0~1200Hz ④ Transition band: 1200~1500 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 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 addition?

(b) From the view point of implementation, what are the disadvantages of the discrete Fourier transform? (10 scores)

(3) How do we implement $y[n] = x[n] * (0.8^n u[n] - 0.6^n u[n])$ efficiently where * means convolution and $u[n]$ is the 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) Suppose that $x[n] = y(0.002n)$ and the length of $x[n]$ is 2000. If $X[m]$ is the FFT of $x[n]$, which frequency do (a) $X[300]$ and (b) $X[1800]$ correspond to? (10 scores)

(6) Suppose that we want to design a 25-point lowpass filter where $F < 0.25$ is the passband. Which one has the least error in the passband? W(F) means the weight function. (10 scores)

(a) transition : $0.23 < F < 0.27$, $W(F) = 0.5$ for $F < 0.23$, $W(F) = 1$ for $F > 0.27$;

(b) transition : $0.2 < F < 0.3$, $W(F) = 2$ for $F < 0.2$, $W(F) = 2$ for $F > 0.3$;

(c) transition : $0.2 < F < 0.3$, $W(F) = 1$ for $F < 0.2$, $W(F) = 0.5$ for $F > 0.3$;

(d) transition : $0.23 < F < 0.27$, $W(F) = 3$ for $F < 0.23$, $W(F) = 2$ for $F > 0.27$.

(7) Use the MSE method to design the 5-point FIR filter that approximates the lowpass filter of $H_d(F) = 1$ for $|F| < 0.3$ and $H_d(F) = 0$ for $0.3 < |F| < 0.5$. (10 scores)

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

(ended with 0, 1, 2, 3, 5, 6, 7, 8)