FIR Filter Design using Window Method.

AIM: To design FIR filters using window method.

SOFTWARE: Spyder 3.8.

THEORY:

Steps of FIR design using window method.

step1: Find ~~th~~ $h_d(n)$ ie impulse response of the filter for different values of n.

step2: Find window coefficients for all values of n.

step3: Multiply the values of $h_d(n)$ and $w(n)$.

step4: Plot the filter ~~is~~ response.

Effect of changing length and shape of window on designed filter characteristics:

Main lobe width of window function is responsible for transition band of designed filter.

Ripple in the designed filter depends of peak side lobe amplitude of window function.

Problem. LPF

Design fir filter of length $N = 9$ and $\omega_c = \frac{\pi}{2}$ using Rectangular, hamming and blackman window.

~~hd~~ $h(n) = h_d(n) \cdot W(n)$

step 1: To find $h_d(n)$ for low pass filter

$$h_d(n) = \frac{\sin \omega_c n}{\pi n} \quad ; \quad -\infty < n < \infty$$

$$= \omega_c/\pi \quad ; \quad n = 0.$$

$$\frac{\sin \pi/2\, n}{\pi n} \quad ; \quad 0 < n < 8.$$

$$\frac{\sin \pi/2}{\pi} \quad ; \quad n = \frac{N-1}{2}$$

step 2: Find window function coefficients.

for rectangular window

$$w(n) = 1 \quad ; \quad 0 < n < N$$

$$\therefore w(n) = 1 \quad ; \quad 0 \le n \le 8.$$

n	0	1	2	3	4	5	6	7	8
hd(n)	0	−0.106	0	0.3183	0.5	0.3183	0	−0.106	0
w(n)	1	1	1	1	1	1	1	1	1
h(n)	0	−0.106	0	0.3183	0.5	0.3183	0	−0.106	0

For hamming window. $w(n) = 0.54 - 0.46 \cos\left(\frac{2\pi n}{m}\right)$

n	0	1	2	3	4	5	6	7	8
hd(n)	0	−0.106	0	0.313	0.5	0.3183	0	−0.106	0
w(n)	0.08	0.2147	0.54	0.865	1	0.8653	0.54	0.2147	0.08
h(n)	0	−0.025	0	0.2753	0.5	0.2753	0	0.2147	0

For blackman window

$$w(n) = 0.42 - 0.5 \cos\left(\frac{2\pi n}{M}\right) + 0.08 \cos\left(\frac{4\pi n}{M}\right)$$

$$; \quad 0 \le n \le m$$

$$= 0 \quad ; \text{ otherwise.}$$

n	0	1	2	3	4	5	6	7	8
hd(n)	0	-0.106	0	0.3183	0.5	0.3183	0	-0.106	0
w(n)	0	0.6	0.34	0.77	1	0.77	0.34	0.06	0
h(n)	0	-0.006	0	0.244	0	0.244	0	-0.006	0

STEPS OF PROGRAM:

1. Import necessary packages.
2. Define length of window.
3. Define cutoff frequency
4. Plot frequency response of filter
5. Print the coefficients of response.

CONCLUSION:— In this experiment, we have studied how to design FIR filter using window method.

1. For constant length, filter designed with rectangular window is having minimum transition band and maximum transition band and maximum ripple, whereas filter designed using blackman window is having maximum transition band and minimum stopband. ripple.
2. Increasing the length of window function in time domain reduces the transition band of designed filter and increases the ripple oscillations in stopband.
3. Changing shape of the window, ie using more tapered window functions, reduces the ripple in designed filter.
4. Window length and shape are the two parameters of window which can be used to get better trade off between transition band and ripple of the designed filter.