SNS COLLEGE OF TECHNOLOGY

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DEPARTMENT OF BIOMEDICAL ENGINEERING

19BMB302- BIOMEDICAL SIGNAL PROCESSING

III B.E. BME / V SEMESTER

Two Marks with Answers

Academic Year : 2022-2023 (Odd Semester)

UNIT II - FIR FILTER DESIGN

1. What are the properties of FIR filter?
   1. FIR filters is always stable.
   2. A realizable filter can always be obtained.
   3. FIR filter has a linear phase response.

2. What are the desirable characteristics of the windows?
   1. The central lobe of the frequency response of the window should contain most of the energy and should be narrow.
   2. The highest side lobe level of the frequency response should be small.
   3. The side lobes of the frequency response should decrease in energy rapidly as w tends to π.

3. What is the necessary and sufficient condition for linear phase characteristics in FIR filter? (Or) What is linear phase characteristic of an FIR filter?
   The phase function should be a linear function of w, which in turn requires constant group delay and phase delay. $\theta(w) = -\alpha w$ and h(n)=h(N-1-n)

   i.e. The impulse response must be symmetrical about =$\alpha = (\frac{N-1}{2})$

4. State Gibb's phenomenon
   In FIR filter design by Fourier series method, the infinite duration impulse response is truncated to finite duration impulse response. The abrupt truncation of impulse response introduces oscillations in the passband and stopband. This effect is known as Gibbs phenomenon.

5. Distinguish between FIR and IIR filters

S. No	FIR filter	IIR filter
1	All the infinite samples of impulse response are considered.	Only N samples of impulse response are considered.
2	The impulse response cannot be directly converted to digital filter transfer function.	The impulse response can be directly converted to digital filter transfer function.
3	Linear phase characteristics cannot be achieved.	Linear phase characteristics can be easily designed.
4	Less flexibility, usually limited to specific kinds of filters.	Greater flexibility to control the shape of magnitude response.

6. What are the characteristics of FIR filters designed using windows.
   1. The width of the transition band depends on the type of window.
   2. The width of the transition band can be made narrow by increasing the value of N where N is the length of the window sequence.
   3. The attenuation in the stop band is fixed for a given window, except in case of Kaiser window where it is variable.

7. Give hamming window function.
   The weighing function for the hamming window is given by
   W_H (n) = {$0.54 + 0.46\cos\left(\frac{2\pi n}{N-1}\right)$ for $-\left(\frac{N-1}{2}\right) \leq n \leq \left(\frac{N-1}{2}\right)$

             0 otherwise

8. What is the reason that FIR filter is always stable?
   FIR filter is always stable because all the poles of its poles of FIR filter are located at the origin in z plane.

9. Write the equation of blackman window function.
   The weighing function for the blackman window is given by
   W_B (n) = { $0.42 + 0.5\cos\left(\frac{2\pi n}{N-1}\right) + 0.08\cos\left(\frac{4\pi n}{N-1}\right)$ for $-\left(\frac{N-1}{2}\right) \leq n \leq \left(\frac{N-1}{2}\right)$

             0 Otherwise

10. Compare the rectangular window and Hanning window.

S.No	Rectangular window	Hanning Window
1	The width of main lobe in window spectrum is 4π/N	The width of main lobe in window spectrum is 8π/N
2	The maximum side lobe magnitude in window spectrum is –13dB.	The maximum side lobe magnitude in window spectrum is –31dB.
3	In window spectrum the side lobe magnitude slightly decreases with increasing w.	In window spectrum the side lobe magnitude decreases with increasing w.
4	In FIR filter designed using rectangular window the minimum stop band attenuation is 22dB	In FIR filter designed using hanning window the minimum stop band attenuation is 44dB

11. Compare the rectangular window and hamming window.

S.No	Rectangular window	Hamming Window
1	The main lobe width is equal to 4π/Nand the peak side lobe level is –13dB.	The main lobe width is equal to 8π/N and the peak side lobe level is –41dB.
2	The low pass FIR filter designed willhave minimum stop band attenuationof –21dB	The low pass FIR filter designed will have minimum stop band attenuation of –53 dB

12. Give rectangular window function.
    The weighing function for the hamming window is given by
    W_R (n) = { 1 for $-\left(\frac{N-1}{2}\right) \leq n \leq \left(\frac{N-1}{2}\right)$

              0 otherwise

13. What are the advantages of FIR filter?
    1. FIR filters are always stable.
    2. FIR filter can be realized in both recursive and recursive structures.
    3. Linear phase FIR filter can easily designed.
    4. FIR filter are free of limit cycle oscillation, when implemented on a finite wordlength digital system.

14. Give hanning window function.
    The weighing function for the hanning window is given by
    W_{Hn} (n) = {0.5+0.5 cos $\left(\frac{2\pi \, n}{N-1}\right)$ for - $\left(\frac{N-1}{2}\right) \leq n \leq \left(\frac{N-1}{2}\right)$
               0   otherwise

15. What are the disadvantages of FIR filter?
    1. Memory requirement and execution time are very high.
    2. The implementation of narrow transition band FIR filters is very costly, as it requires
       considerably more arithmetic operation and hardware components such as multipliers, adders and delay elements.

16. List the well-known design technique for linear phase FIR filter design.
    1. Fourier series method
    2. Window method
    3. Frequency sampling method.

17. Under what conditions a finite duration sequence h(n) will yield constant group delay in its frequency response characteristics and not the phase delay?
    If the impulse response is anti-symmetrical, satisfying the condition h (n)=-h(N-1-n) the frequency response of FIR filter will have constant group delay and not the phase delay.

18. Write the steps involved in FIR filter design.
    i) Choose the desired frequency response H_d(w).
    ii) Take the inverse Fourier transform and obtain h_d(n)
    iii) Convert the infinite duration sequence h_d(n) to h(n)
                h(n)=h_d(n)*w(n)
    iv) Take Z transform of h (n) to get H (Z).
    v) Substitute z=e^{-jw}, find the frequency response H (e^{-jw})

19. Define filter coefficients.
    Filter Coefficients are the set of constants, also called tap weights, used to multiply against delayed sample values. For an FIR filter, the filter coefficients are, by definition, the impulse response of the filter.

20. Define impulse response.
    A filter's time domain output sequence when the input is an impulse.

21. What is the principle of designing FIR filter using frequency sampling method?
    In frequency sampling method, a set of sample is determined from the desired frequency response and are identified as discrete Fourier transform coefficients. The inverse discrete Fourier transform of this set of samples then gives the filter coefficients. The set of sample points used in this procedure can be determined by

sampling a desired frequency response $H_d(e^{jw})$ at N points w_k, k=0,1,...,N-1 uniformly spaced around the unit circle.

22. What are the conditions to be satisfied for constant phase delay in linear phase FIR filters? (or) How constant group delay & phase delay is achieved in linear phase FIR filters?
The conditions for constant phase delay are
   ➢ Phase delay, $\alpha = \left(\frac{N-1}{2}\right)$ (i.e., phase delay is constant)
   ➢ Group delay, $\beta = \frac{\pi}{2}$ (i.e., group delay is constant)
   ➢ Impulse response, h (n) = -h (N-1-n) (i.e., impulse response is anti-symmetric)

23. What are the possible types of impulse response for linear phase FIR filters?
There are four types of impulse response for linear phase FIR filters
   1. Symmetric impulse response when N is odd.
   2. Symmetric impulse response when N is even.
   3. Anti-symmetric impulse response when N is odd.
   4. Anti-symmetric impulse response when N is even.

24. Write the characteristic features of rectangular window.
   1. The main lobe width is equal to $\frac{4\pi}{N}$.
   2. The maximum side lobe magnitude is –13dB.
   3. The side lobe magnitude does not decrease significantly with increasing w.

25. List the features of FIR filter designed using rectangular window.
   1. The width of the transition region is related to the width of the main lobe of window spectrum.
   2. Gibb's oscillations are noticed in the pass band and stop band.
   3. The attenuation in the stop band is constant and cannot be varied.

26. Why the limit cycle problem does not exist when FIR digital filter is realized in direct form or cascade form?
In case of FIR filter there are no limit cycle oscillations, if the filter is realized in direct form
or cascade form since these structures have no feedback.