

AIM:—To plot and learn Window Characteristics in Time and Frequency domain.

SOFTWARE USED:— Spyder (Python 3.8).

THEORY:—

Window functions:— The impulse response of an ideal filter is infinite in length and also non-causal. Both these observation make it impossible to implement an ideal filter practically. Window functions are used to truncate (cut) in order to make it finite.

Equations of various Window functions. (for Causal).

1. Rectangular:

$$w(n) = 1 \quad ; \quad 0 \leq n \leq m$$
$$= 0 \quad ; \quad \text{otherwise.}$$

2. Hanning Window:

$$w(n) = 0.5 - 0.5 \cos \left(\frac{2\pi n}{M} \right) \quad ; \quad 0 \leq n \leq M$$
$$= 0 \quad ; \quad \text{otherwise.}$$

3. Hamming Window:

$$w(n) = 0.54 - 0.46 \cos \left(\frac{2\pi n}{M} \right) \quad ; \quad 0 \leq n \leq M$$
$$= 0 \quad ; \quad \text{otherwise.}$$

(4) Blackman Window:

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

$$= 0$$

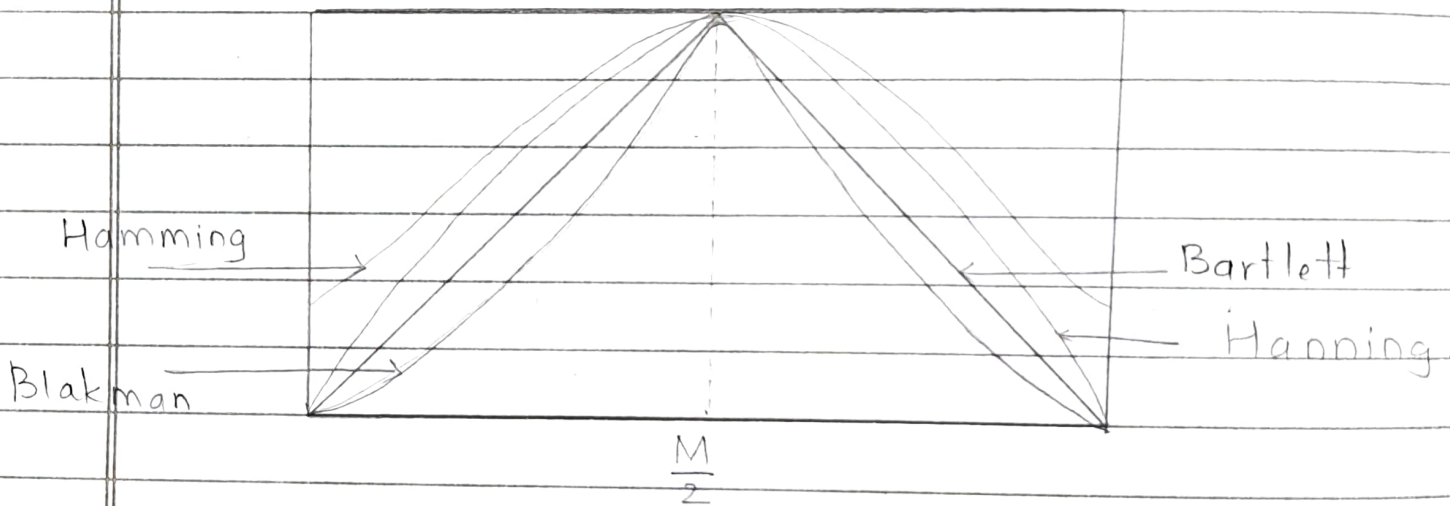
; $0 \leq n \leq M$
; otherwise.

(5) Bartlett (Triangular) Window:

$$w(n) = \frac{2n}{M} ; 0 \leq n \leq \frac{M}{2}$$

$$= 2 - \frac{2n}{M} ; \frac{M}{2} \leq n \leq M$$

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



Window Type	Main lobe width	Peak side lobe amplitude.
Rectangular	$4\pi / M + 1$	-13
Bartlett	$8\pi / M$	-25
Hanning	$8\pi / M$	-31
Hamming	$8\pi / M$	-41
Blackman	$12\pi / M$	-57

Effects of changing length and shape of the window.

- (1) The peak side lobe amplitude depends on shape of window and not size of window.
- (2) Main lobe width is ~~responsible~~ decreases as the length of the sequence increases.
- (3) The peak & side lobe amplitude remains the same only rate of oscillation increases.

STEPS OF PROGRAM:

1. Import Necessary packages.
2. Define length of window.
3. Define all the window functions
4. Plot the window function and magnitude response.
5. Change the length of the window and observe the output.

CONCLUSION: In this experiment, we have studied different window function and its characteristics in time and frequency domain.

(1) Increasing the length of window function in time domain, reduces the main lobe width but increases main lobe amplitude in frequency domain.

(2) Changing shape of the window, i.e. using more tapered window functions, reduces the peak side lobe amplitude.

(3) The extent of ripple (oscillation of side lobe) are independent of length of window, but depends on window shape in time domain.