Aim: Design FIR filter with windowing method.

Theory:-

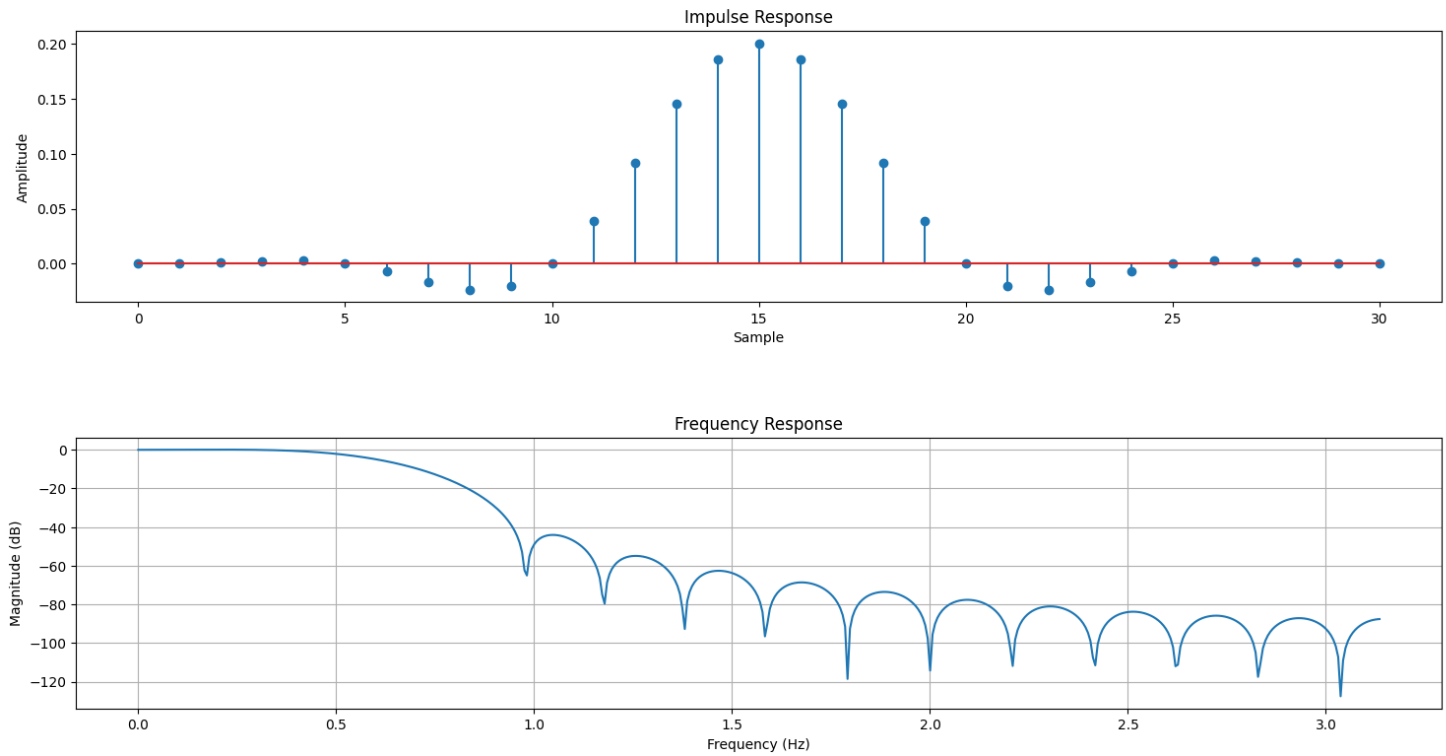
- The windowing method is a commonly used technique for designing FIR filters. It involves designing an ideal frequency response and then applying a window function to obtain a practical FIR filter.
- The steps involved in designing an FIR filter using the windowing method are as follows:
- Specify the desired filter specifications, such as the cutoff frequency, filter length, and window type.
- Design an ideal frequency response that meets the desired specifications.
- Apply a window function to the ideal frequency response to obtain the filter coefficients.
- Normalize the filter coefficients to ensure stability.
- There are various window functions available, such as the rectangular, Bartlett, Hann, Hamming, and Blackman windows, among others. The choice of window function depends on the desired trade-off between the main lobe width and sidelobe suppression.

Programm:-

```
import matplotlib.pyplot as plt
import numpy as np
from scipy.signal import firwin, freqz

# Filter parameters
cutoff_frequency = 0.2  # Normalized cutoff frequency (0.0 to 0.5)
filter_length = 31  # Number of filter taps (odd for symmetry)

# Design the FIR filter using Hanning window method
filter_coefficients = firwin(filter_length, cutoff=cutoff_frequency, window="hann")

# Plot the impulse response of the filter
plt.figure(figsize=(10, 5))

# Impulse response
plt.subplot(2, 1, 1)
plt.stem(filter_coefficients, use_line_collection=True)
plt.title("Impulse Response")
plt.xlabel("Sample")
plt.ylabel("Amplitude")

# Frequency response
plt.subplot(2, 1, 2)
frequencies, response = freqz(filter_coefficients)
plt.plot(frequencies, 20 * np.log10(np.abs(response)))
plt.title("Frequency Response")
plt.xlabel("Frequency (Hz)")
plt.ylabel("Magnitude (dB)")
plt.grid(True)
```

```
# Final layout and display
plt.tight_layout()
plt.show()
```

Output :-



Filter Coefficients :-

5.621724098249910630e-03,-2.248408570661841743e-02,3.372191305732654548e-02,-2.247846538775357186e-02,5.618913938795535787e-03

1.000000000000000000e+00,-4.000320181991981805e+00,6.000960591637167774e+00,-4.000960637301628431e+00,1.000320227656443350e+00