Filter impulse response, $h[n]$: 

![Impulse response of filter $h[n]$](image)

FFT of filter impulse response: 

![Magnitude of $\text{fft}(h)$](image)
Warm-up questions

- What frequency vector should be used for plotting the FFT results? i.e., what frequencies (in radians) are associated with each of the indices in the plot of \( \text{abs}(\text{fft}(h)) \)?

- What kind of filter is this?

- If this filter were used to process a signal sampled at a rate of \( f_s = 1000 \text{ Hz} \), what frequencies would be passed by the system?
Plotting frequency responses: \texttt{freqz}

Matlab command \texttt{freqz} can be used to plot frequency responses:

Example: \texttt{[Hfreqz, w]}=\texttt{freqz(b, a, N, 'whole')}  

- \texttt{b} and \texttt{a} refer to filter coefficients; for FIR filters, \texttt{a=1}  
- \texttt{'whole'} tells it to compute over interval 0 to 2\pi

Can normalize frequency axis:
Plotting frequency responses: \texttt{fr\_resp}

KEW's function to plot frequency responses: \texttt{fr\_resp}

- uses \texttt{fftshift} to get response between $-\pi$ to $\pi$

Frequency response computed with $[Hw,w]=\texttt{fr\_resp}(h,2048)$

Can use an optional sampling frequency argument to plot vs. Hz

Frequency response computed with $[Hf,f]=\texttt{fr\_resp}(h,2048,1000)$
Plotting frequency responses in dB

Plot of magnitude response in dB: $10 \log_{10}(\text{abs}(H_f))$

Frequency response computed with $[H_f,f] = \text{fr resp}(h,2048,1000)$
Filtering example: creating the input signal

Input signal consists of a sinusoid buried in highpass noise:

- \( f_0 = 68 \text{ Hz}; f_s = 1000 \text{ Hz} \)
Filtering example: output of lowpass filter

Filter using the `filter` command:

**Example:** \( y = \text{filter}(h, 1, x) \)