Lab 8: Frequency Response of different Windows

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Main Namespace

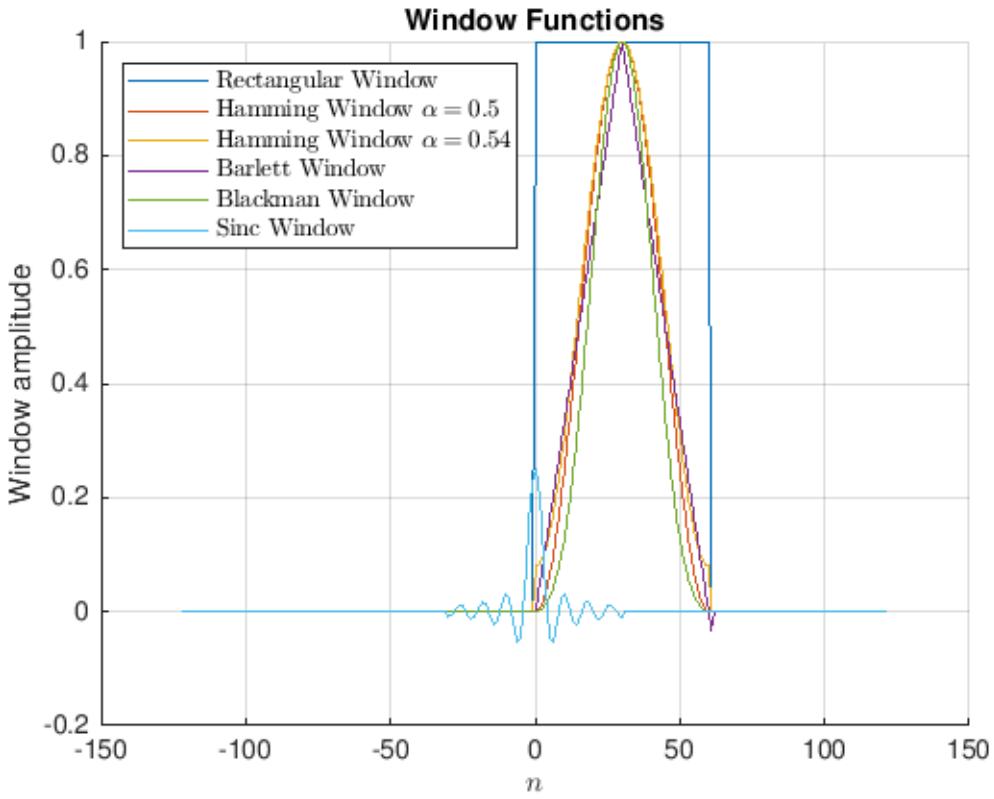
```
function main()

    clc;
    [n1, w1] = rectangular_window(61);
    [n2, w2] = hamming_window(0.5, 61);
    [n3, w3] = hamming_window(0.54, 61);
    [n4, w4] = barlett_window(61);
    [n5, w5] = blackman_window(61);
    [n6, w6] = last_window(pi/4, 61);
```

Window Plots

```
    figure;
    hold on;
    grid on;
    plot(n1, w1);
    plot(n2, w2);
    plot(n3, w3);
    plot(n4, w4);
    plot(n5, w5);
    plot(n6, w6);
    legend('Rectangular Window', 'Hamming
 Window $\alpha=0.5$', 'Hamming Window $
```

```
\alpha=0.54$', 'Barlett Window', 'Blackman Window', 'Sinc
 Window', 'location', 'northwest', 'interpreter', 'latex');
    xlabel('$n$', 'interpreter', 'latex');
    title('Window Functions');
    ylabel('Window amplitude');
```

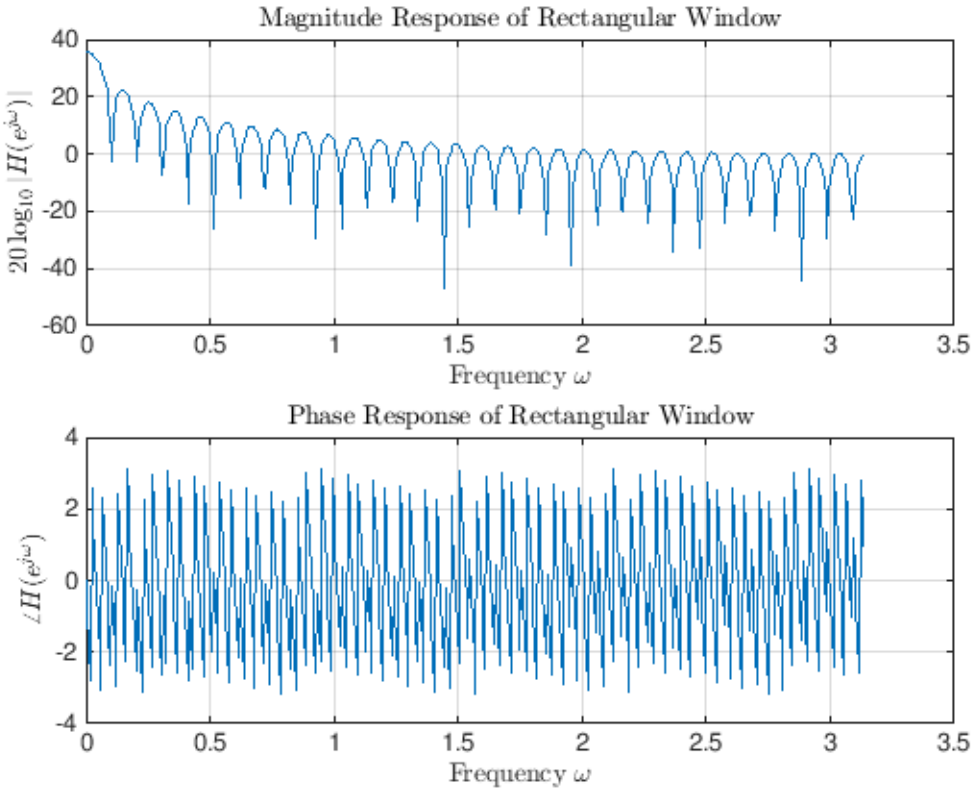


Frequency Response of the Windows

Rectangular Window

```
    [h1, o1] = freqz(w1);
    figure;
    subplot(2,1,1);
    plot(o1, 20*log10(abs(h1)));
    grid on;
    title('Magnitude Response of Rectangular
 Window', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$20\log_{10}|H(e^{j \omega})|$', 'interpreter', 'latex');
    subplot(2,1,2);
    plot(o1, angle(h1));
    grid on;
    title('Phase Response of Rectangular
 Window', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
```

```
ylabel('$\angle H(e^{j \omega})$', 'interpreter', 'latex');
```

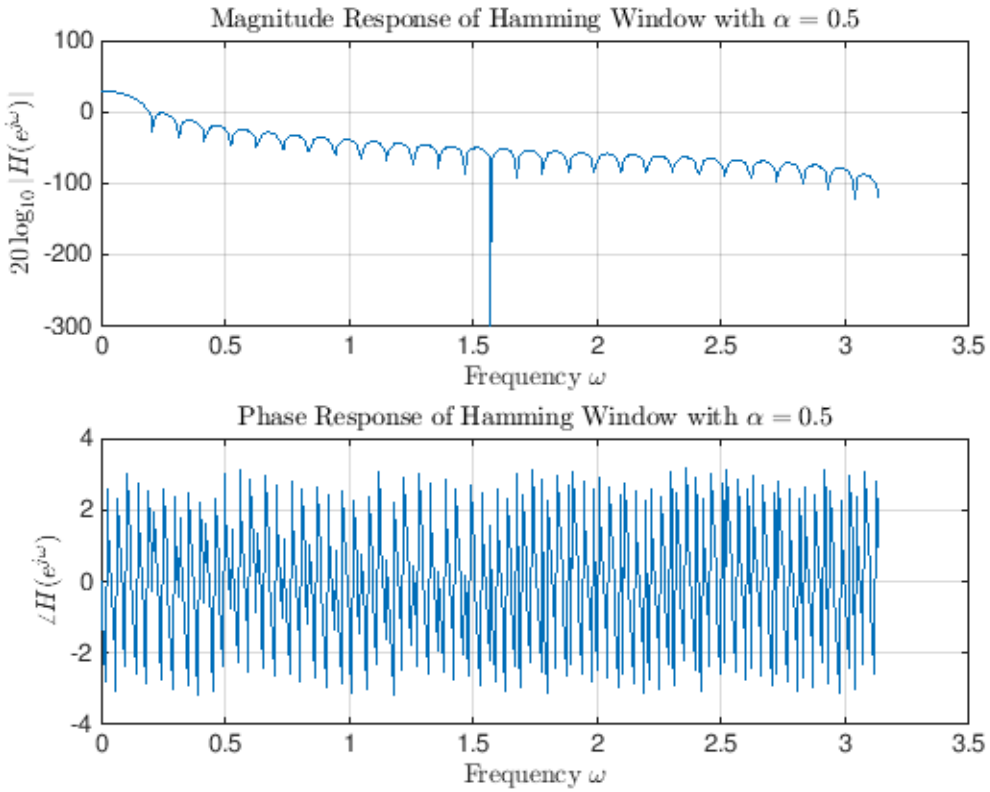


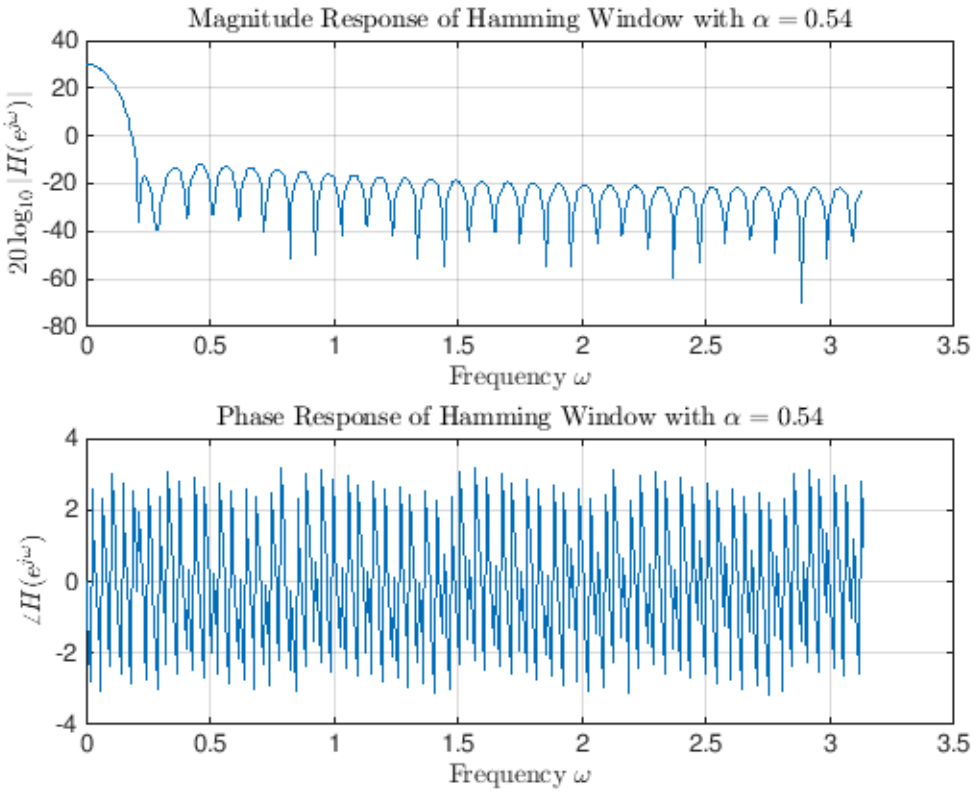
Hamming Windows

```
% alpha is 0.5
[h2, o2] = freqz(w2);
figure;
subplot(2,1,1);
plot(o2, 20*log10(abs(h2)));
grid on;
title('Magnitude Response of Hamming Window with $
\alpha=0.5$', 'interpreter', 'latex');
xlabel('Frequency $\omega$', 'interpreter', 'latex');
ylabel('$20\log_{10}|H(e^{j \omega})|$', 'interpreter', 'latex');
subplot(2,1,2);
plot(o2, angle(h2));
grid on;
title('Phase Response of Hamming Window with $
\alpha=0.5$', 'interpreter', 'latex');
xlabel('Frequency $\omega$', 'interpreter', 'latex');
ylabel('$\angle H(e^{j \omega})$', 'interpreter', 'latex');

% alpha is 0.54
[h3, o3] = freqz(w3);
figure;
subplot(2,1,1);
```

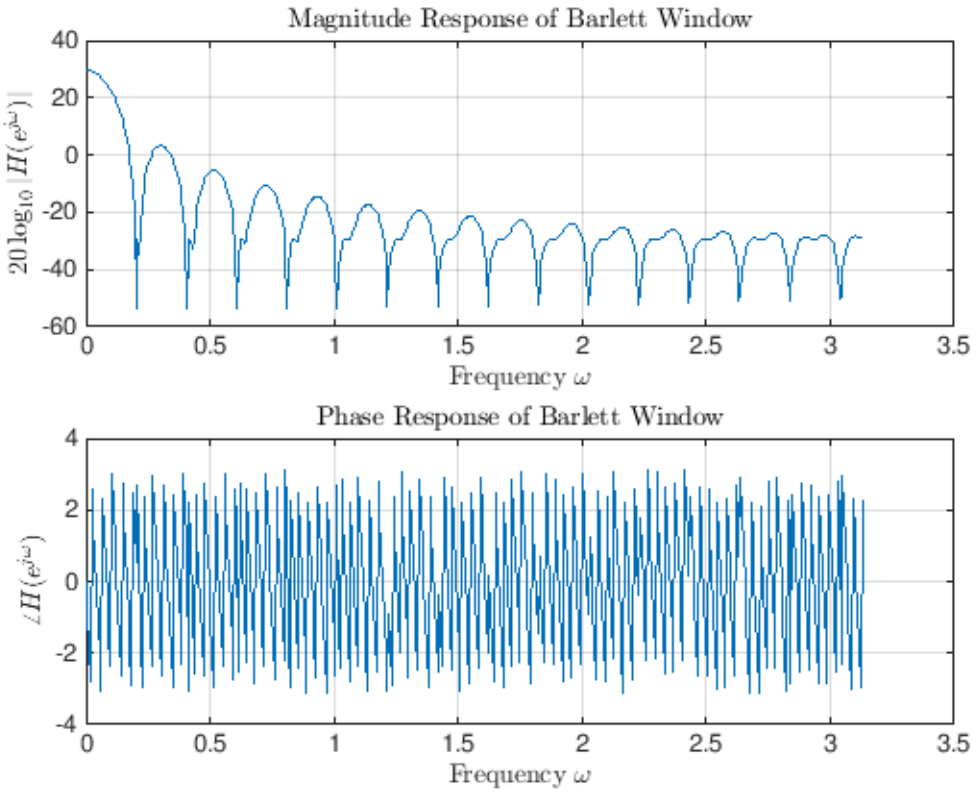
```
    plot(o3, 20*log10(abs(h3)));
    grid on;
    title('Magnitude Response of Hamming Window with $
\alpha=0.54$', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$20\log_{10}|H(e^{j \omega})|$', 'interpreter', 'latex');
    subplot(2,1,2);
    plot(o3, angle(h3));
    grid on;
    title('Phase Response of Hamming Window with $
\alpha=0.54$', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$\angle H(e^{j \omega})$', 'interpreter', 'latex');
```





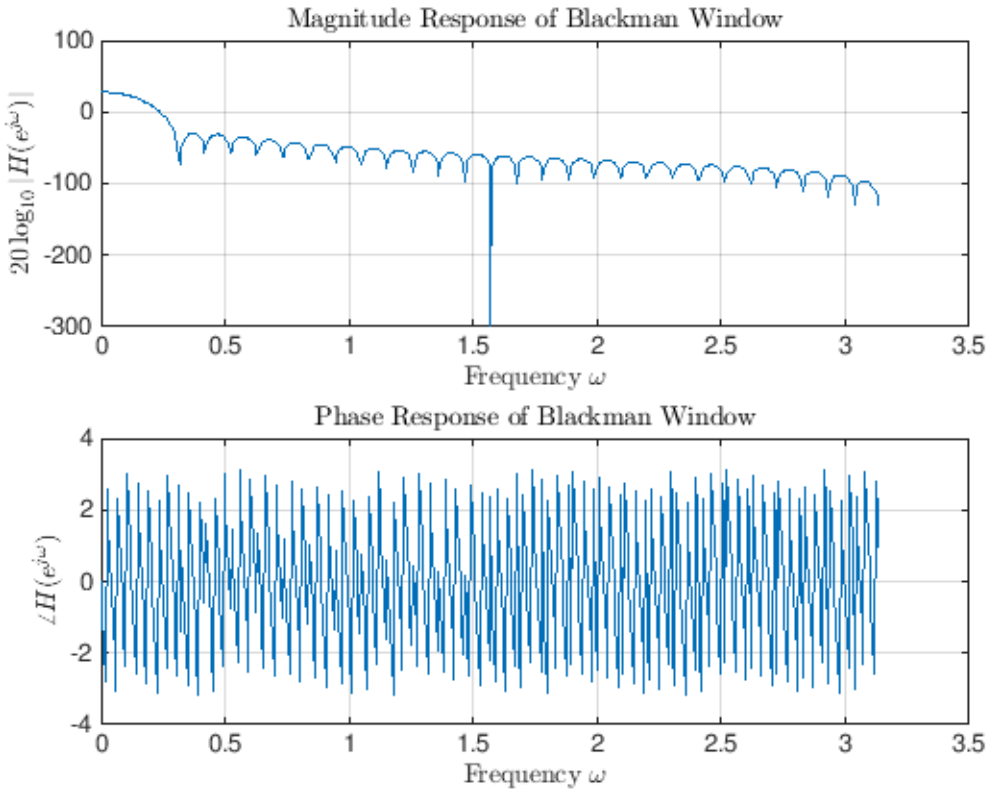
Barlett Window

```
    [h4, o4] = freqz(w4);
    figure;
    subplot(2,1,1);
    plot(o4, 20*log10(abs(h4)));
    grid on;
    title('Magnitude Response of Barlett
Window', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$20\log_{10}|H(e^{j \omega})|$', 'interpreter', 'latex');
    subplot(2,1,2);
    plot(o4, angle(h4));
    grid on;
    title('Phase Response of Barlett Window', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$\angle H(e^{j \omega})$', 'interpreter', 'latex');
```



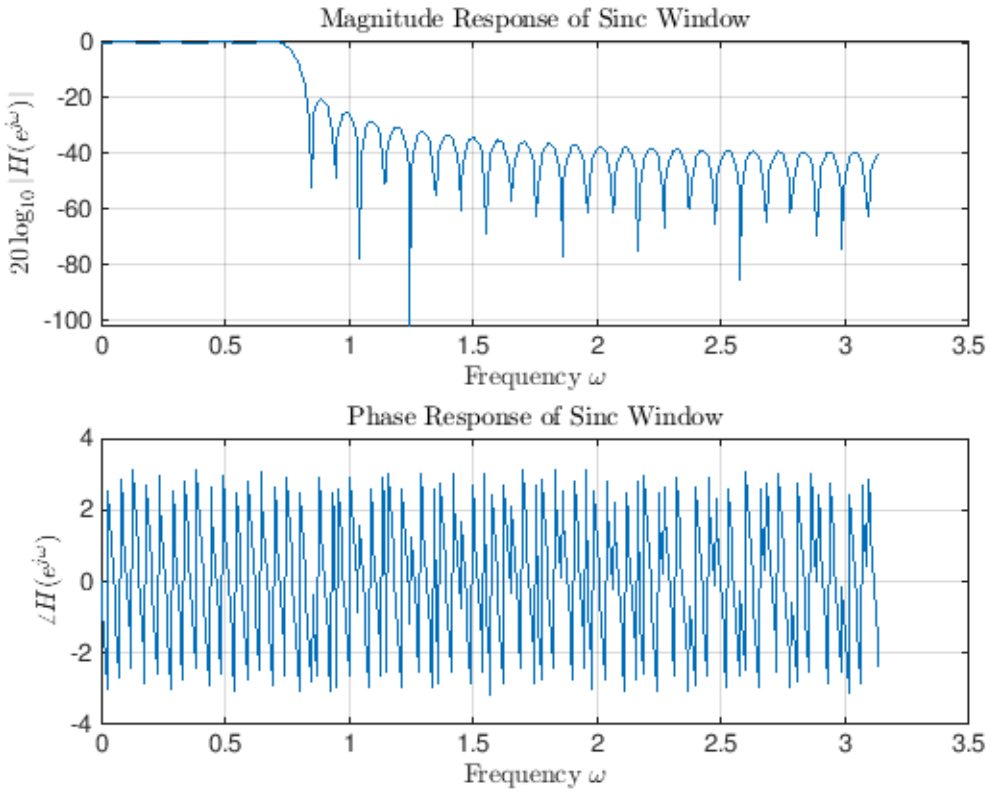
Blackman Window

```
    [h5, o5] = freqz(w5);
    figure;
    subplot(2,1,1);
    plot(o5, 20*log10(abs(h5)));
    grid on;
    title('Magnitude Response of Blackman
Window', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$20\log_{10}|H(e^{j \omega})|$', 'interpreter', 'latex');
    subplot(2,1,2);
    plot(o5, angle(h5));
    grid on;
    title('Phase Response of Blackman
Window', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$\angle H(e^{j \omega})$', 'interpreter', 'latex');
```



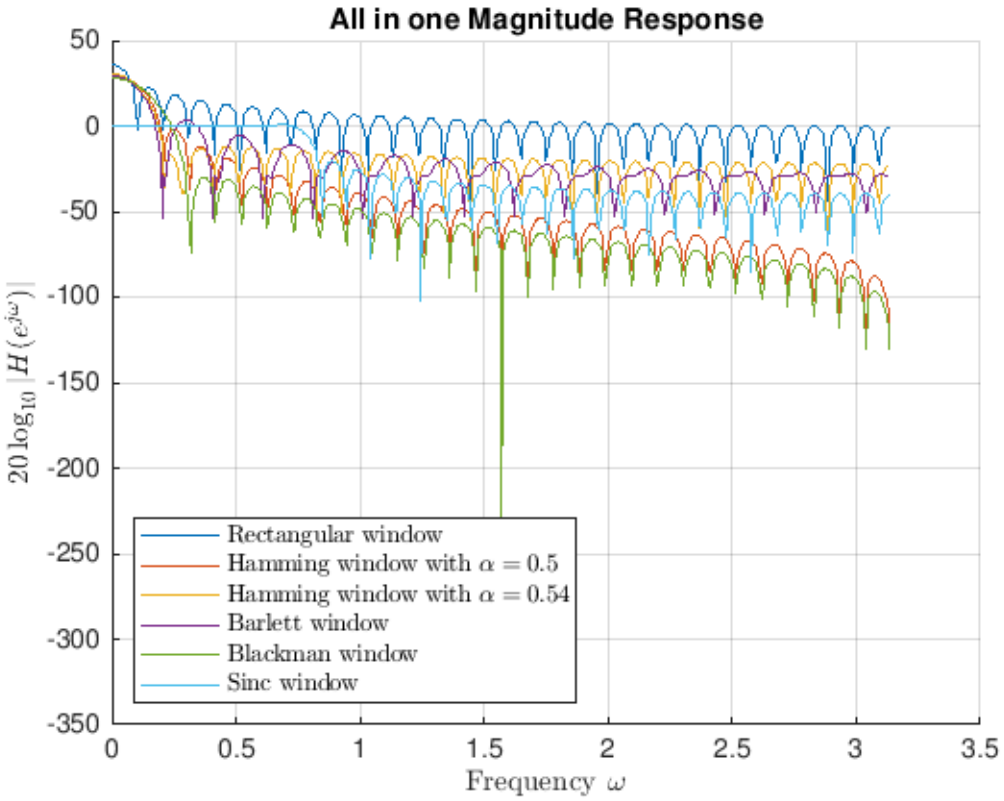
Sinc Window

```
    [h6, o6] = freqz(w6);
    figure;
    subplot(2,1,1);
    plot(o6, 20*log10(abs(h6)));
    grid on;
    title('Magnitude Response of Sinc
Window', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$20\log_{10}|H(e^{j \omega})|$', 'interpreter', 'latex');
    subplot(2,1,2);
    plot(o6, angle(h6));
    grid on;
    title('Phase Response of Sinc Window', 'interpreter', 'latex');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$\angle H(e^{j \omega})$', 'interpreter', 'latex');
```



All in one plot for the frequency response.

```
    figure;
    hold on;
    grid on;
    plot(o1, 20*log10(abs(h1)));
    plot(o2, 20*log10(abs(h2)));
    plot(o3, 20*log10(abs(h3)));
    plot(o4, 20*log10(abs(h4)));
    plot(o5, 20*log10(abs(h5)));
    plot(o6, 20*log10(abs(h6)));
    legend('Rectangular window', 'Hamming window
 with $\alpha=0.5$', 'Hamming window with $
\alpha=0.54$', 'Barlett window', 'Blackman window', 'Sinc
 window', 'interpreter', 'latex', 'Location', 'southwest');
    xlabel('Frequency $\omega$', 'interpreter', 'latex');
    ylabel('$20\log_{10}|H(e^{j \omega})|$', 'interpreter', 'latex');
    title('All in one Magnitude Response');
```



Rectangular Window Function

```
function [n, output] = rectangular_window(N)
   % generates a rectangular window of magnitude 1 when n is in
range 0 and N - 1.
   output = [];
   n = -2*N:2*N;
   for i = 1:length(n)
       if n(i) >= 0 && n(i) <= N-1
          output = [output 1];
       else
          output = [output 0];
       end
   end
end
```

Hamming Window Function

```
function [time, output]=hamming_window(alpha, N);
   % generates a generalized hamming window where, alpha >= 0.5
and n is in range 0 to N-1.
   time = -2*N:2*N;
   output = [];
   if alpha >= 0.5
      for i=1:length(time)
```

```
                if time(i) >=0 && time(i) <= N-1
                    output = [output, alpha - (1-
alpha)*cos(2*pi*time(i)/(N-1))];
                else
                    output = [output, 0];
                end
            end
        end
    end
```

Barlett Window Function

```
    function [n, output]=barlett_window(N)
        n = -2*N:2*N;
        output = [];

        for i=1:length(n)
            if n(i) >= 0 && n(i) <= (N-1)/2
                output = [output 2*n(i)/(N-1)];
            else
                if n(i) > (N-1)/2 && n(i) <= N
                    output = [output 2-(2*n(i)/(N-1))];
                else
                    output = [output 0];
                end
            end
        end
    end
```

Blackman Window Function

```
    function [n, output]=blackman_window(N)
        n = -2*N : 2*N;
        output = [];

        for i=1:length(n)
            if n(i) >= 0 && n(i) <= N-1
                output = [output 0.42-0.5*cos(2*pi*n(i)/
(N-1))+0.08*cos(4*pi*n(i)/(N-1))];
            else
                output = [output 0];
            end
        end
    end
```

Sinc Window Function

```
    function [n, output]=last_window(Wc, N)
        n = -2*N:2*N;
        output =[];

        for i=1:length(n)
```

```
            if n(i) == 0
                output = [output Wc/pi];
            else
                if abs(n(i)) <= 30
                    output = [output (Wc/pi)*(sin(Wc*n(i))/
(Wc*n(i)))];
                else
                    output = [output 0];
                end
            end
        end
    end

end
```

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