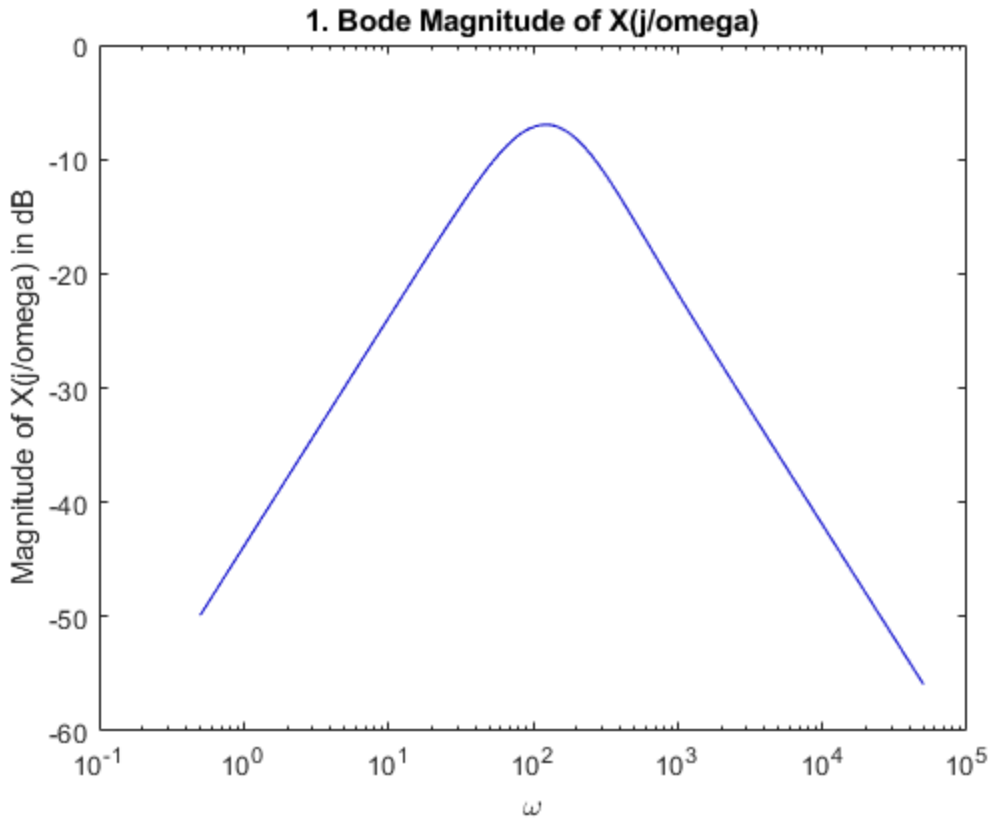
```
% Aaron Bruner
% C16480080
% MATLAB 5
clear; clc; close all;

%1
w = 0.5 .* logspace(0,5,500);
Xjw = 80.*1i.*w.*(60+1i.*w).*(400+1i.*w)./
((80+1i.*w).*(100+1i.*w).*(150+1i.*w).*(250+1i.*w));
hmag = 20*log10(abs(Xjw));

figure();
semilogx(w,hmag,'LineStyle','-','Color',[0,0,0.8]);
title('1. Bode Magnitude of X(j/omega)');
ylabel('Magnitude of X(j/omega) in dB');
xlabel('\omega');

%2
maxVal = max(hmag);
fprintf('The max value of the Bode magnitude plot is db is: %0.2fdB.
\n', maxVal);
if maxVal < 0
    fprintf('The filter is passive.\n\n');
else
    fprintf('The filter is active.\n\n');
end

%3
check = 0; i = 1;
while i < width(hmag)
    if (hmag(i) > max(hmag-20) && check == 0)
        lowFreq = i;
        check = 1;
    end
    if (check == 1)
        if (hmag(i) < max(hmag-20))
            highFreq = i;
            break;
        end
    end
    i = i + 1;
end

fprintf('The lower frequency is #L = %f\n', w(lowFreq-1));
fprintf('The upper frequency is #U = %f\n', w(highFreq));
fprintf('The 20db bandwidth of this filter is = %f\n', w(highFreq) -
 w(lowFreq));

%4
figure();
semilogx(w(2:end),diff(hmag)./diff(log10(w)),'LineStyle','-','Color',
[0,0,0.8]);
```

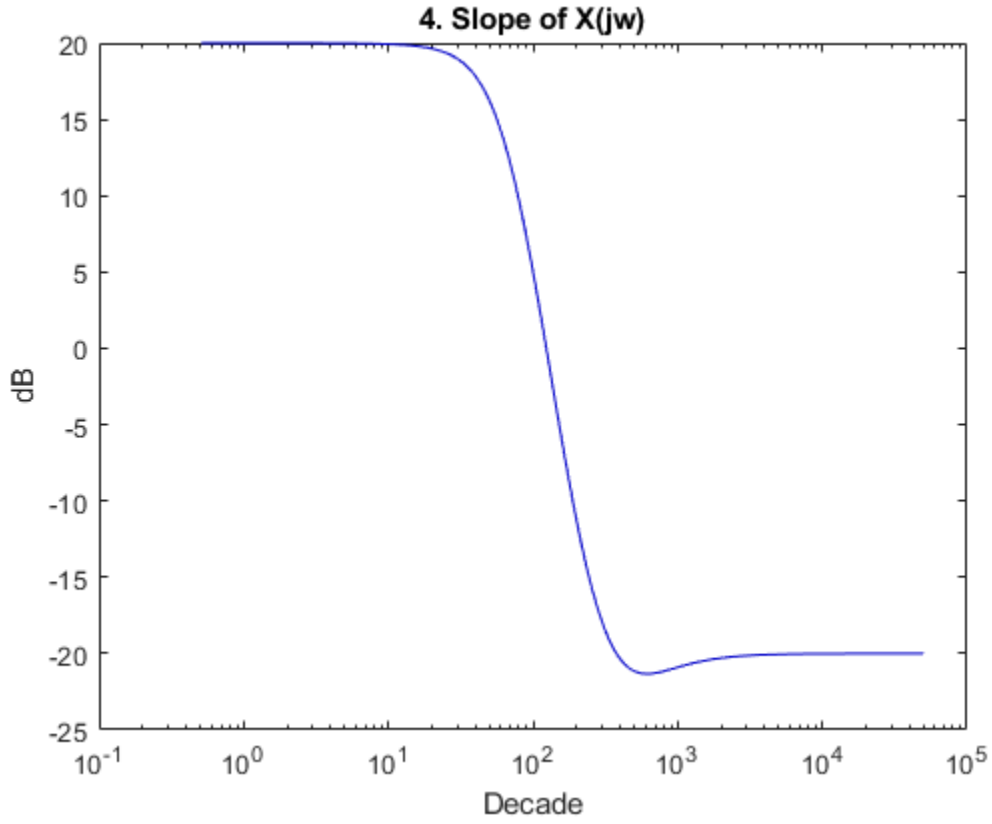
```
title('4. Slope of X(jw)');
ylabel('dB');
xlabel('Decade');

%5
figure();
semilogx(w,angle(Xjw),'LineStyle','-','Color',[0,0,0.8]);
title('5. Bode phase plot');
ylabel('Phase of X(j/omega) in dB');
xlabel('\omega');

%6
figure();
semilogx(w(2:end),-1*diff(angle(Xjw))/0.01,'LineStyle','-','Color',
[0,0.8,0],'LineWidth',2);
title('6. Group Delay Plot');
ylabel('D(w)');
xlabel('time(w)');

%7
groupDelay = -1.*diff(angle(Xjw))./diff(log10(w));
wLow = w(lowFreq-1);
wHigh = w(highFreq);
Davg = 1/(wHigh -
 wLow)*sum(groupDelay(lowFreq-1:highFreq).*diff(w(lowFreq-2:highFreq)));
fprintf('\nThe average group dealy is = %f\n', Davg);

DMES = sum(abs(groupDelay(lowFreq-1:highFreq)-Davg).^2./
diff(w(lowFreq-2:highFreq)));
fprintf('The Mean Squared Error is = %f\n',DMES);

norm = sqrt(DMES/(wHigh-wLow))/Davg*100;
fprintf('The normalized value is = %f\n', norm);
```

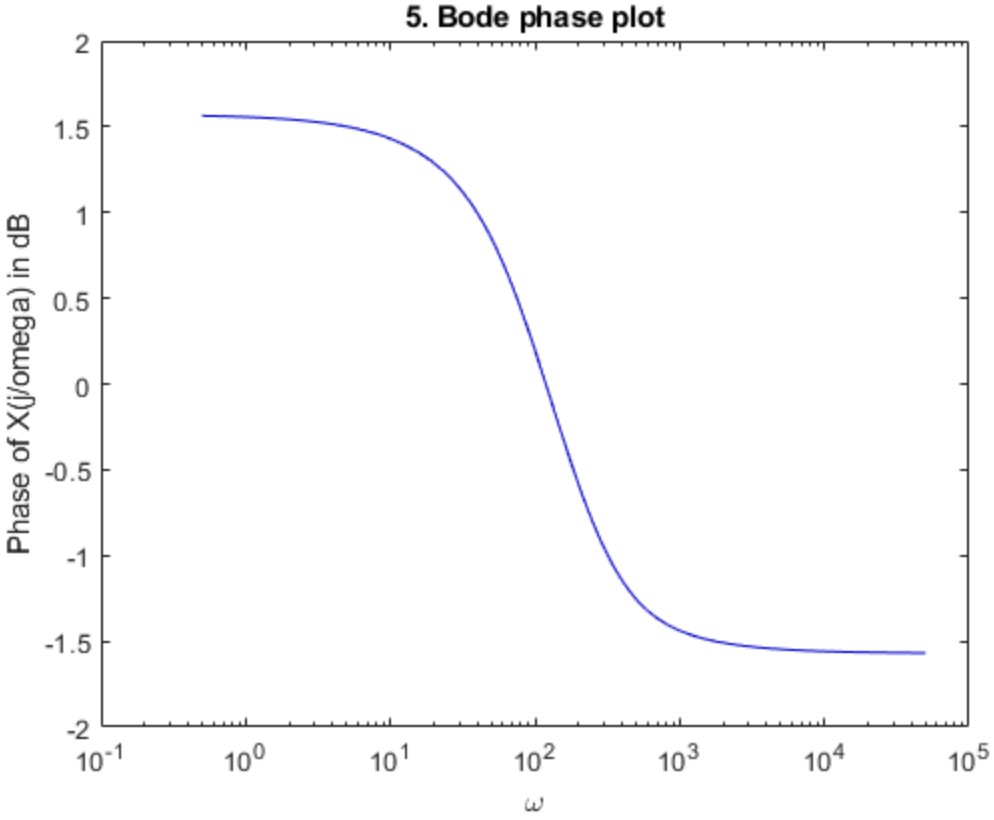
The max value of the Bode magnitude plot is db is: -6.97dB.
The filter is passive.

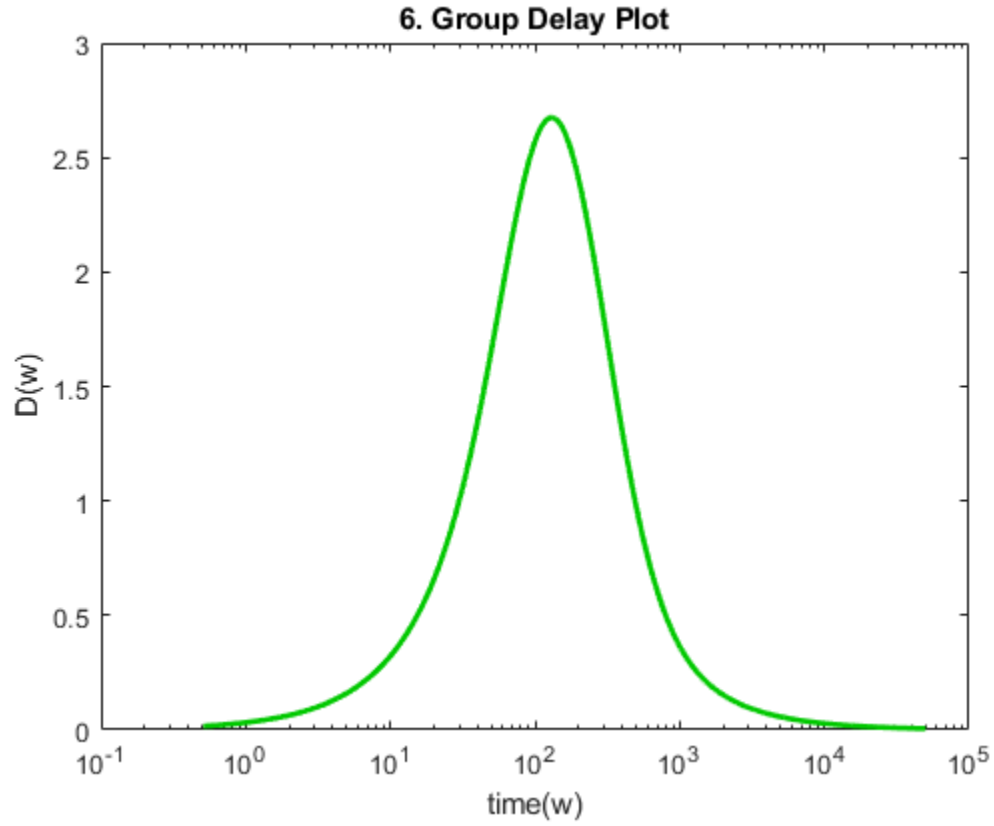
The lower frequency is #L = 6.938324
The upper frequency is #U = 1803.367476
The 20db bandwidth of this filter is = 1796.267210

The average group dealy is = 0.745405
The Mean Squared Error is = 115.809999
The normalized value is = 34.062453


1. Bode Magnitude of X(j/omega)
Magnitude of X(j/omega) in dB
0
-10
-20
-30
-40
-50
-60
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
ω


4. Slope of X(jw)
dB
20
15
10
5
0
-5
-10
-15
-20
-25
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
Decade


5. Bode phase plot
Phase of X(j/omega) in dB
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
ω


6. Group Delay Plot
D(w)
3
2.5
2
1.5
1
0.5
0
10^{-1}
10^{0}
10^{1}
10^{2}
10^{3}
10^{4}
10^{5}
time(w)

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