Contents

1 Problem 1

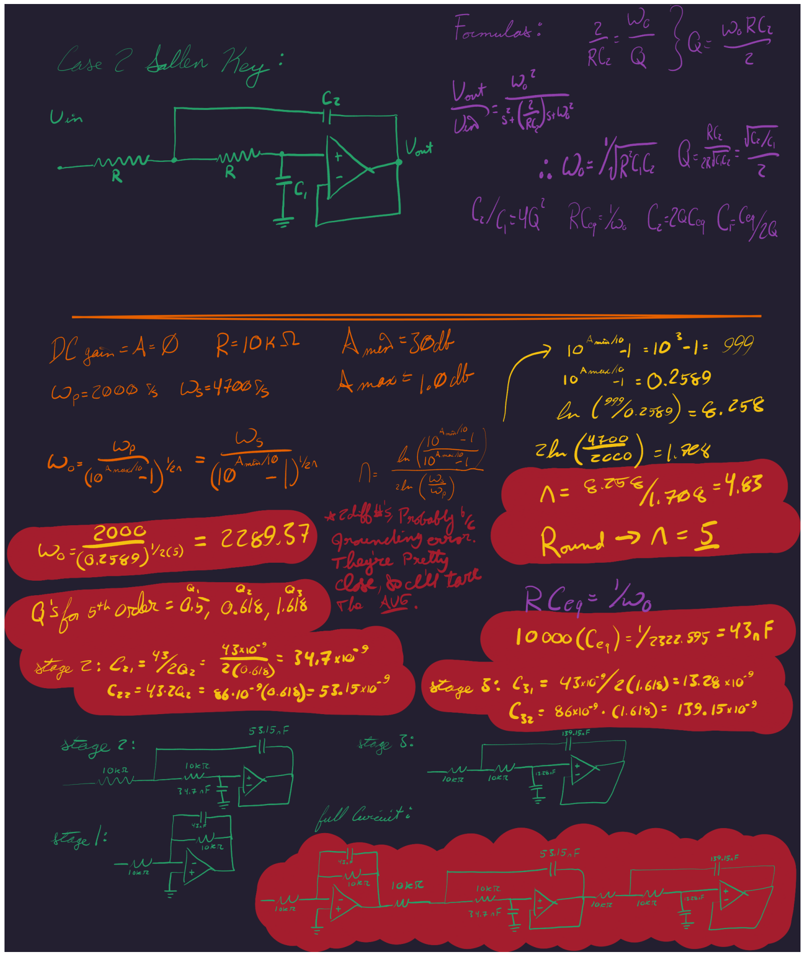
1.0.1 A. Design a Butterworth LOW PASS filter

1. Specifications:

   - DC Gain = 0 dB
   - Amax = 1.0 dB
   - Amin = 30 dB
   - p = 2000 rad/sec
   - s = 4700 rad/sec

   Use Case 2 Sallen-Key circuit(s) (Figure 4.8) with R = 10k

2. My Work

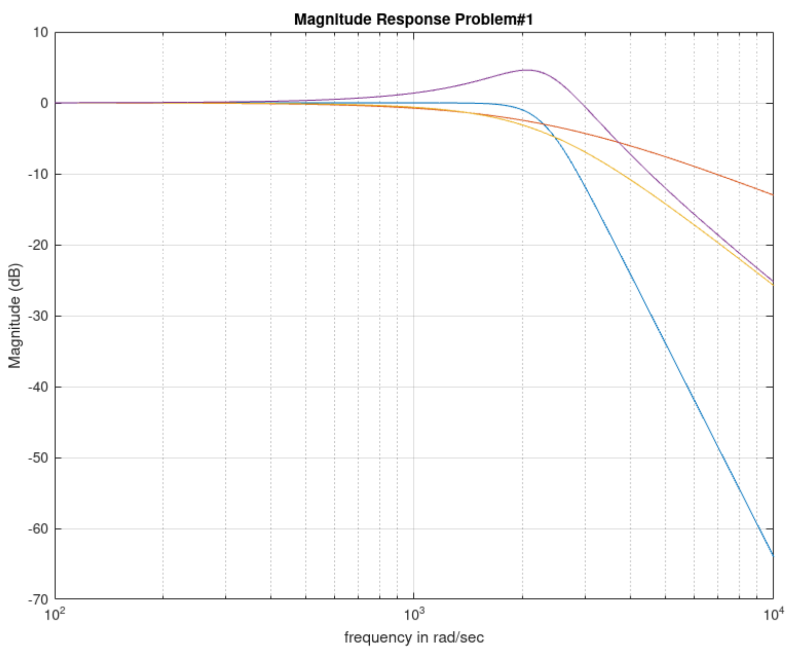


1.0.2 B. Matlab Plot

Plot the MAGNITUDE response for each section of your design and the overall MAGNITUDE response.

```
%Problem#1
wo1=2289.37;Q1=0.5;
wo2=2289.37;Q2=0.618;
wo3=2289.37;Q3=1.618;
Num1=wo1;
Num2=wo2^2;
Num3=wo3^2;
Den1=[1 wo1];
```

```
Den2=[1 wo2/Q2 wo2^2];
Den3=[1 wo3/Q3 wo3^2];
w=logspace(2,4,1000);
H1=freqs(Num1,Den1,w);
H2=freqs(Num2,Den2,w);
H3=freqs(Num3,Den3,w);
H=H1.*H2.*H3;
H1db=20*log10(abs(H1));
H2db=20*log10(abs(H2));
H3db=20*log10(abs(H3));
Hdb=20*log10(abs(H));
semilogx(w,Hdb,w,H1db,w,H2db,w,H3db);
grid;xlabel('frequency in rad/sec');ylabel('Magnitude (dB)')
title('Magnitude Response Problem#1');
```



2 Problem 2

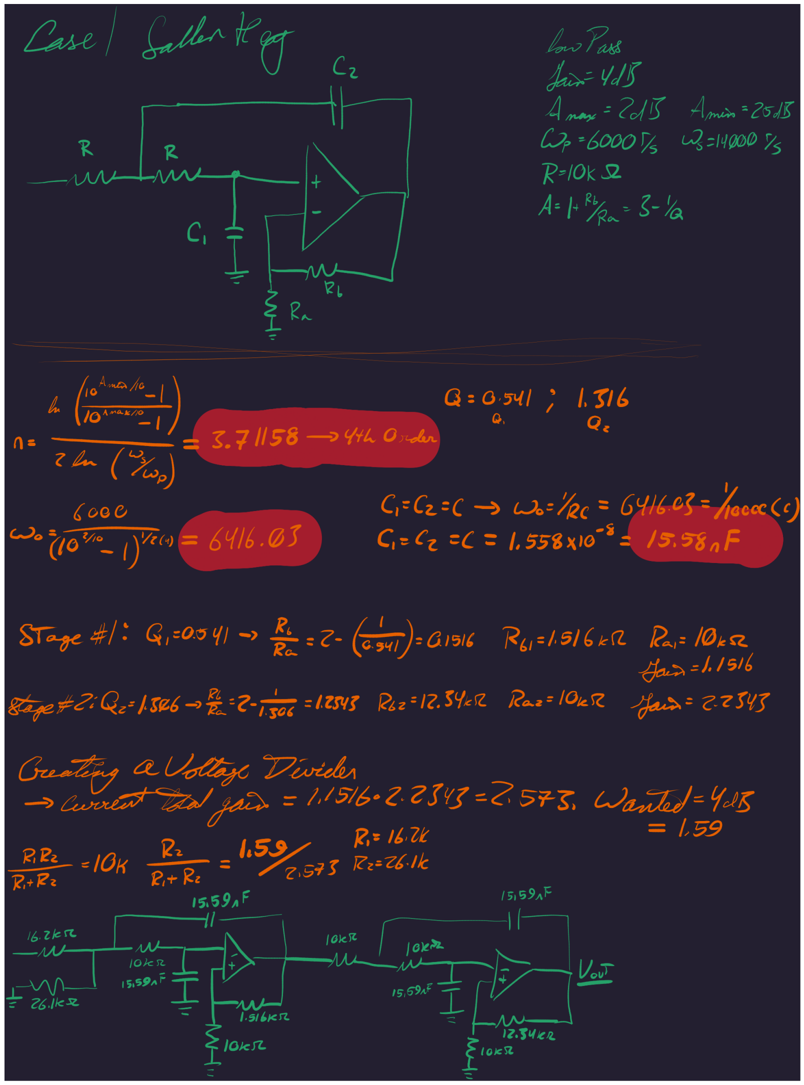
2.0.1 A. Design a Butterworth LOW PASS filter

1. Specifications:

- DC Gain = 4 dB
- Amax = 2 dB
- Amin = 25 dB
- p = 6000 rad/sec
- s = 14000 rad/sec

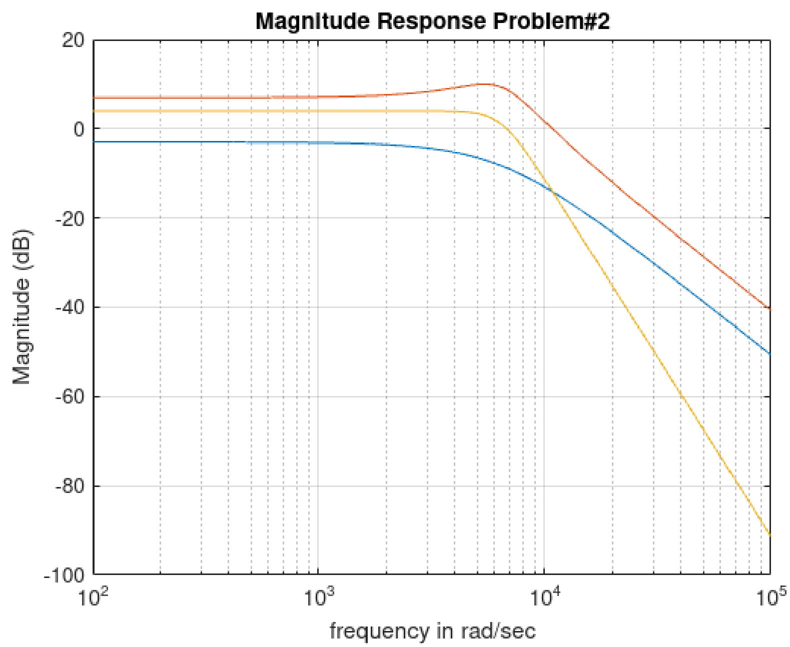
Use Case 1 Sallen-Key circuit(s) and a voltage divider with R = 10k **NOTE** each stage will have a gain of $A = 1 + \frac{R_b}{R_a} = 3 - \frac{1}{Q}$, which means we need a voltage divider. (Probably only one).

2. My work



2.0.2 B. Matlab Plot

Plot the MAGNITUDE response for each section of your design and the overall MAGNITUDE response.

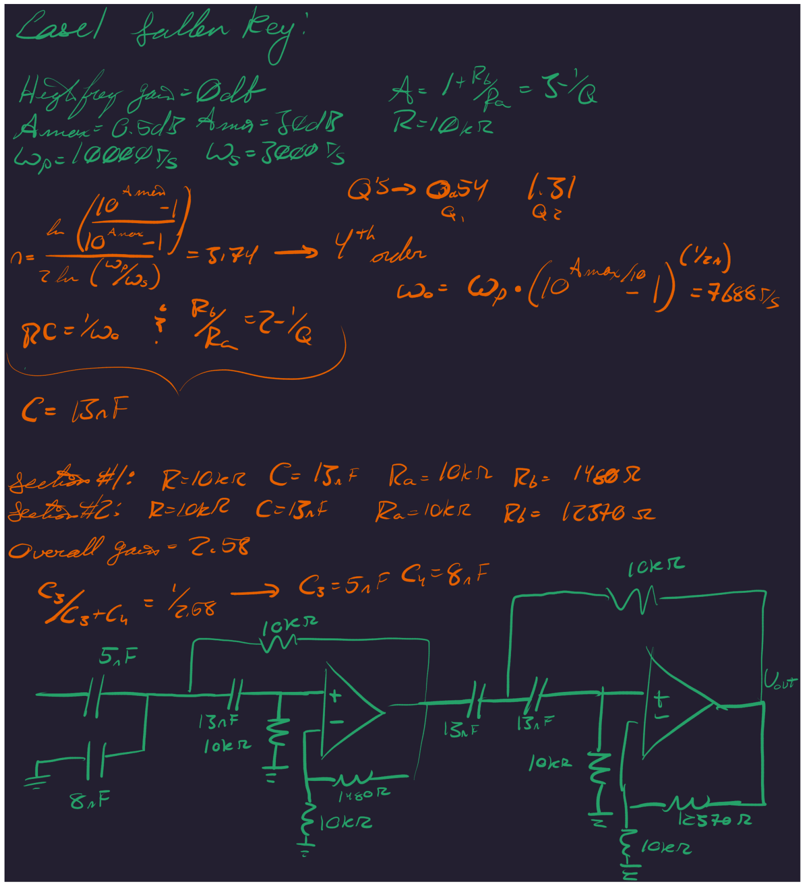


3 Problem 3

3.0.1 A. Design a Butterworth HIGH PASS filter

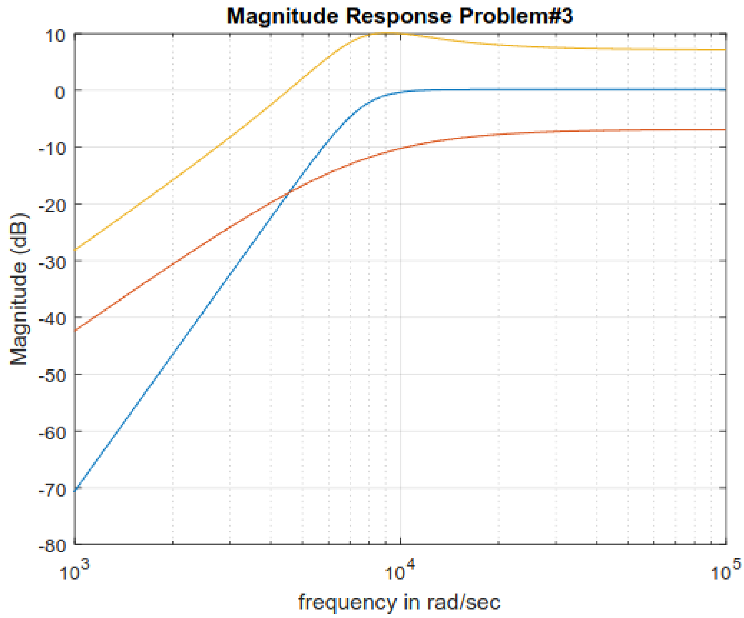
1. Specifications: Design for Problem 4.17 in your textbook Use Case 1 Sallen-Key circuit and design equations (4.53) and (4.54) You should require a 4th order filter to meet this specification Use ONE voltage divider (a capacitive voltage divider!) at the beginning of the 1st stage to set your overall DC Gain to 0dB. Use R = 10k where possible in your design.

2. My work



3.0.2 B. Matlab Plot

Plot the MAGNITUDE response for each section of your design and the overall MAGNITUDE response.



4 Problem 4

Write a MATLAB function to calculate the pole locations for a Butterworth low pass filter, given filter specifications.

```
function[poles] = CJ_Butterpoles(n,w)
    k=0:(2*n-1);
    if(mod(n,2)==1)
        poles=w*exp(j*2*pi*k/(2*n));
    else
        poles=w*exp(j*(2*k+1)*pi/(2*n));
    end
    poles=poles(real(poles)<0);
    return
```

5 Problem 5

Write a MATLAB function to display Wo's and Q's associated with a set of poles.

```
function[] = CJ_QWgraph(poles)
% Function Name: Display_Wos_and_Qs
%% Parameters: Poles (get passed in)
% Returns: dummy (i.e. nothing)
% Description: Displays Wo's and Q's for any set of poles
    Q = (1./(2*cos(angle(poles))));
    numpoles = length(poles);
    k = 0:numpoles-1;
    wo = zeros(size(k));
    if (mod(numpoles,2)==1)
        for i = 1:length(k)
            wo(i) = poles(i)/exp(1j*k(i)*pi/numpoles)
        end
    else
        for i = 1:length(k)
            wo(i) = poles(i)/exp((1j*(2*k(i)+1)*pi)/(2*numpoles))
        end
    end
    polarplot(poles,'o');
    return;
end
```