ECE 321 - Homework #26

Filter Design in Matlab

1) Use *fminsearch()* to find the 'optimal' filter of the form

$$Y = \left(\frac{bd}{\left(s^2+as+b\right)\left(s^2+cs+d\right)} \right) X$$

so that the gain vs. frequency is as close as possoble to an ideal low-pass filter

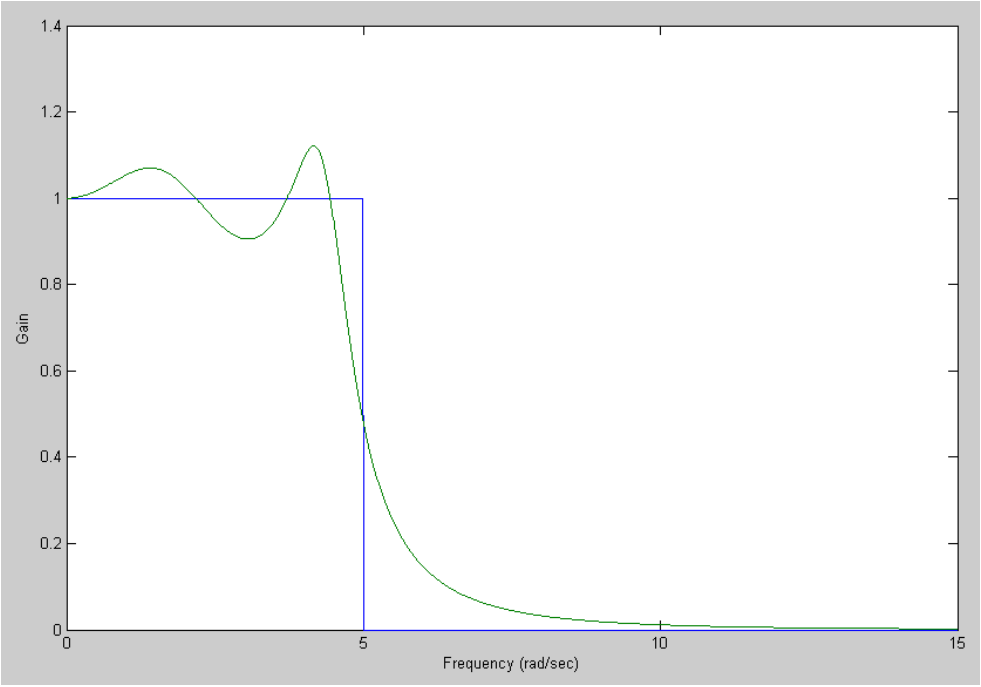
$$G_{ideal}(j\omega) = \left\{ \begin{array}{ll} 1 & 0 < \omega < 5 \\ 0 & otherwise \end{array} \right\}$$

Start with an M-file to compute how 'good' your filter is:

```
function [J] = Filter( Z )
%UNTITLED3 Summary of this function goes here
%   Detailed explanation goes here

a = Z(1);
b = Z(2);
c = Z(3);
d = Z(4);

w = [0:0.01:15]';
s = j*w;
Gideal = 1 * (w < 5);

G = b*d ./ ( (s.^2 + a*s + b).*(s.^2 + c*s + d) );

E = abs(Gideal) - abs(G);

J = sum(E .^ 2);

plot(w,Gideal,w,abs(G));
pause(0.01);

end
```

Optimize in matlab:

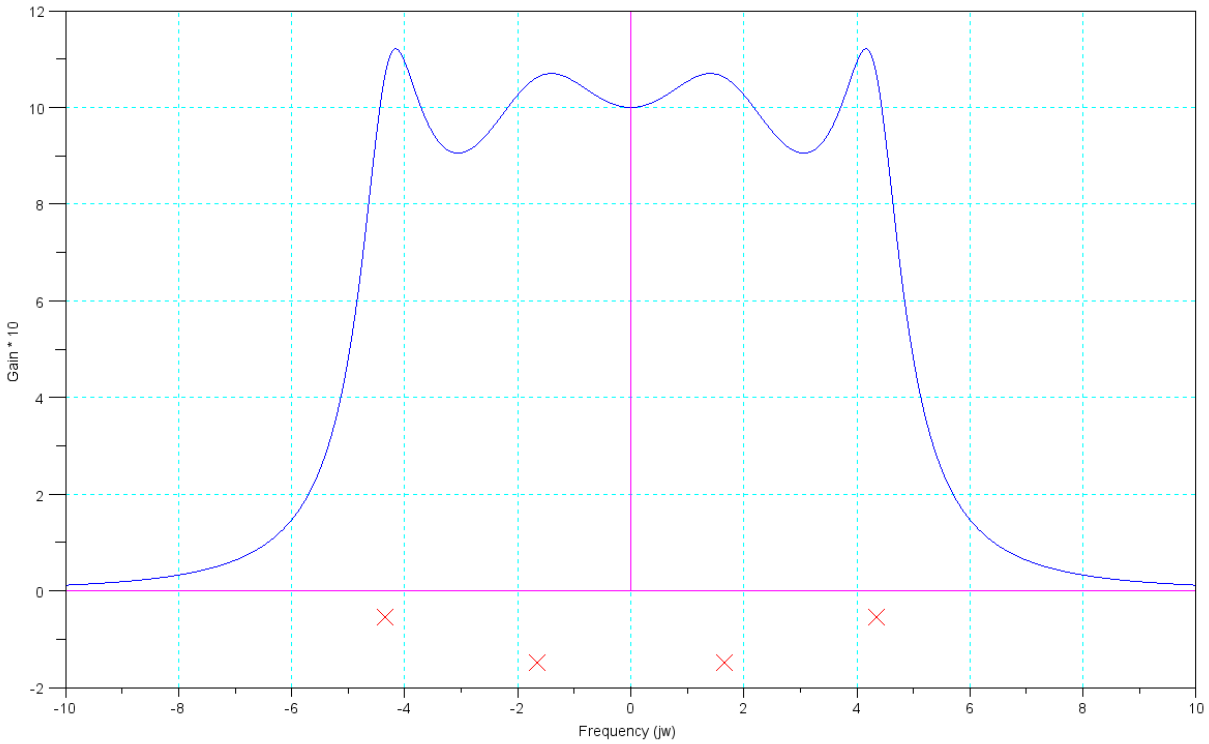
```
>> [z,e] = fminsearch('Filter',20*rand(1,4))

z =   2.9792    4.9478    1.0719   19.1750

e =   16.7451
```



Net Result:

2.9792 4.9479 1.0719 19.1750

$$G(s) = \left(\frac{4.9479}{s^2+2.9792s+4.9479}\right)\left(\frac{19.1750}{s^2+1.0719s+19.1750}\right)$$



Gain vs. Frequency x 10 (top) and Pole Location (bottom)

2) Design a circuit to implement this circuit

$$G(s) = \left(\frac{4.9479}{s^2+2.9792s+4.9479}\right)\left(\frac{19.1750}{s^2+1.0719s+19.1750}\right)$$

Stage 1: Let R = 100k

$$\left(\frac{1}{RC}\right)^2 = 4.9479$$

$$C = 4.496\mu F$$

$$\left(\frac{3-k}{RC}\right) = 2.9792$$

$$k = 1.661$$

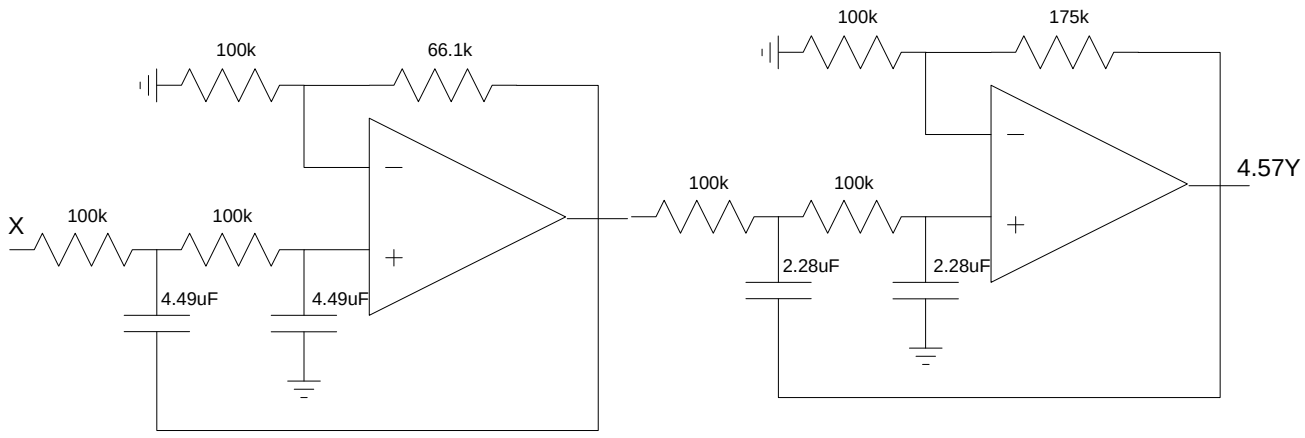
Stage 2: Let R = 100k

$$\left(\frac{1}{RC}\right)^2 = 19.1750$$

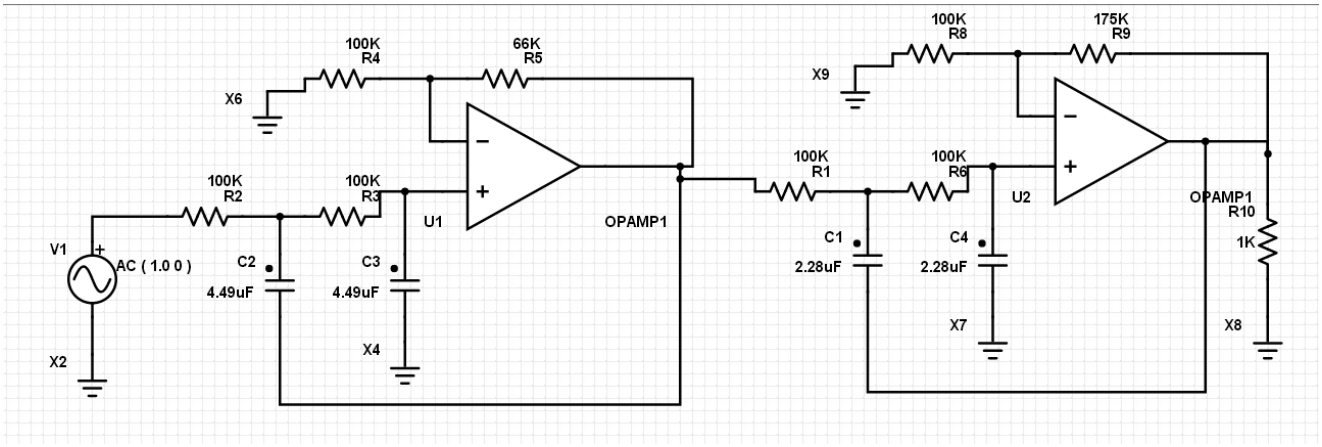
$$C = 2.2837\mu F$$

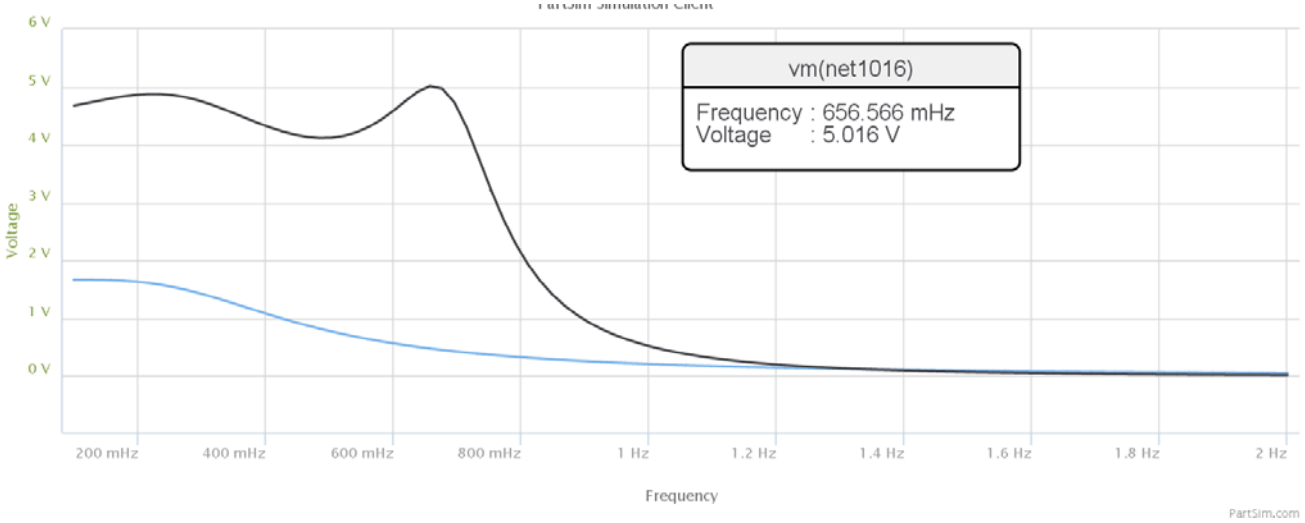
$$\left(\frac{3-k}{RC}\right) = 1.0719$$

$$k = 2.7552$$



3) Test your design in PartSim: Assume a load of 1k Ohms is added (should be part of the requirements: capable of driving a 1k Ohm load)





4) Build your circuit and check the gain vs. frequency against your calculations and simulation results.