Extra Credit
First Quarter -- Filter Circuits

You can receive extra credit the first ¼ of the semester by building two simple filter circuits. If you would like to learn more about designing Chebyshev and Butterworth filters, go to the following website: http://www-users.cs.york.ac.uk/~fisher/lcfilter/

The way extra credit works

The course has four quarters. For each quarter, you can get points back on one experiment, the project, OR the test. You cannot get more than 100 on any one assignment. (ie. If you get a 94 on the test and try to apply 8 points of extra credit, your grade will only go up to 100, not 102.) As shown in the table, the amount of points chosen for each type of assignment has roughly an equivalent effect on your final grade.

	Q1	Q2	Q3	Q4	max added points per quarter	max effect on final grade per quarter
Test	1	2	3	4	8	8* 25% / 4 = 0.5 pts
Project	1	2	3	4	6	6* 30% / 4 = 0.45 pts
Experiment	1, 2 or 3	4 or 5	6 or 7	8	12	12 * 30% / 8 = 0.45 pts

Each of the two circuits in this extra credit is worth half of the total available points for the quarter. You can build only one circuit or you can build both. You can apply the points from each circuit towards a different assignment grade, but you cannot apply the points from one circuit to more than one assignment grade. (For example: You can get 4 points on test 1 for building circuit 1 and 3 points on project 1 for building circuit 2. Or you can get 8 points on test 1 for building circuits 1 and 2. You cannot take the points from circuit 1 and apply some of them to the test and some to the project.) There is no set time limit on completion of these circuits.

Circuit	Points on Experiment	Points on Project	Points on Quiz
Chebyshev filter	6	3	4
Butterworth filter	6	3	4

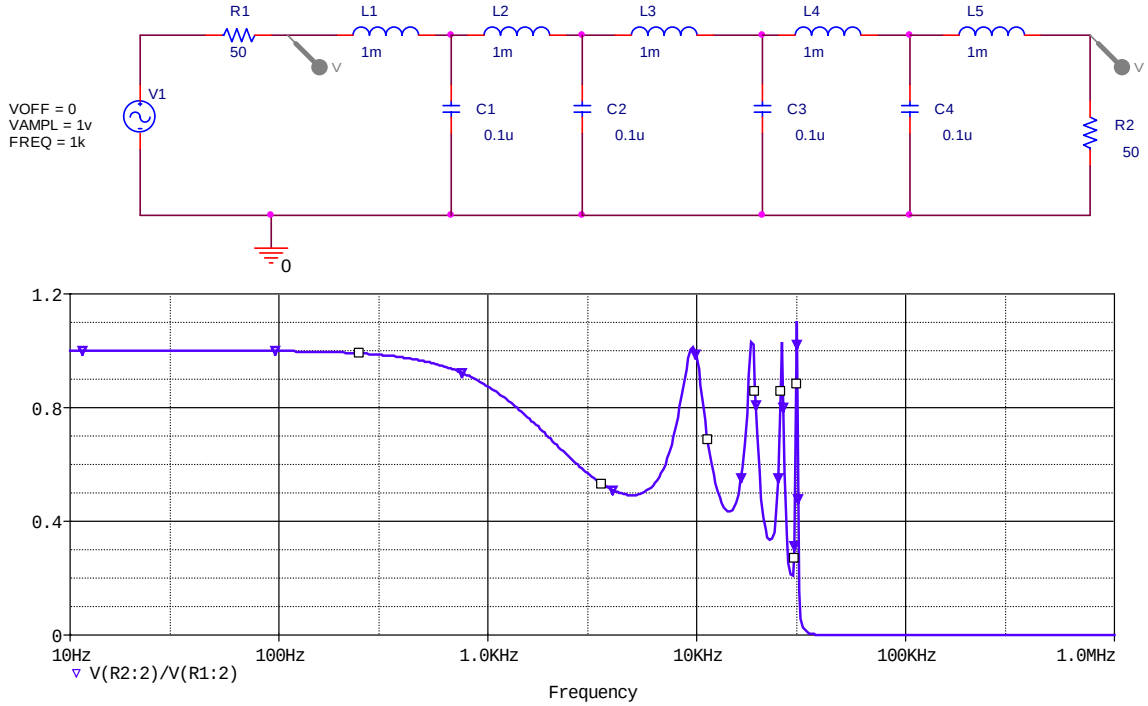
Fill out one sheet for each circuit. YOU MUST do the extra credit as an individual. Your points will be applied towards your grade on an individual basis.. These circuits are not difficult, so it is unlikely that it will take more than one open shop to build one of them.

Ground Rules:

1) Sign out a protoboard and build the circuit
2) Demonstrate to a staff member that the circuit generates the appropriate output.
3) Have a staff member sign the attached sheet.
4) Return the protoboard. (If you are not finished, we will store the board for you and return it when you wish to continue.)
5) YOU MUST tell the staff member what you would like to apply the extra credit towards at the time s/he signs the sheet.

Filter 1 – Chebyshev Filter

The circuit below is a 9th order Chebyshev-type filter. It has nine components (five inductors and four capacitors). If we choose these components fairly arbitrarily, we get a filter with several resonances (four peaks and four valleys), as shown in the AC sweep. [In this filter, R1 is internal impedance of the function generator, L1=L2=L3=L4=L5=1mH, C1=C2=C3=C4=0.1uF, and R2=50 ohms.]



Build the circuit. Demonstrate to the staff member that it has four peaks and four valleys at roughly the same frequencies shown on the AC sweep above.

Name of student:_____

Section _____ Group _____

Apply Towards: _____

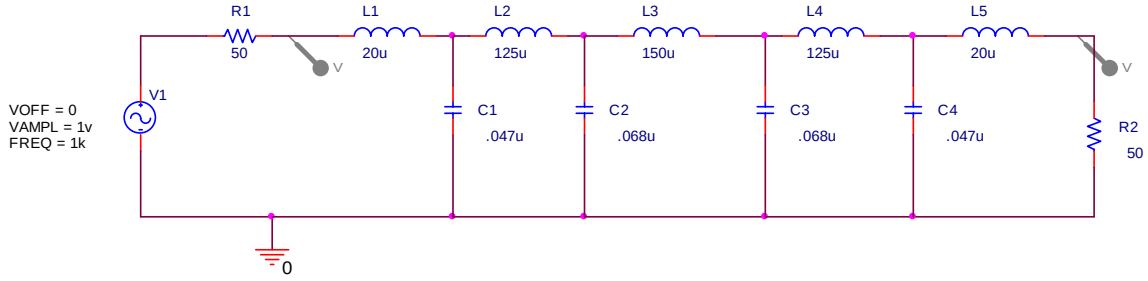
Points _____ (Points per circuit: quiz = 4, project = 3, experiment = 6)

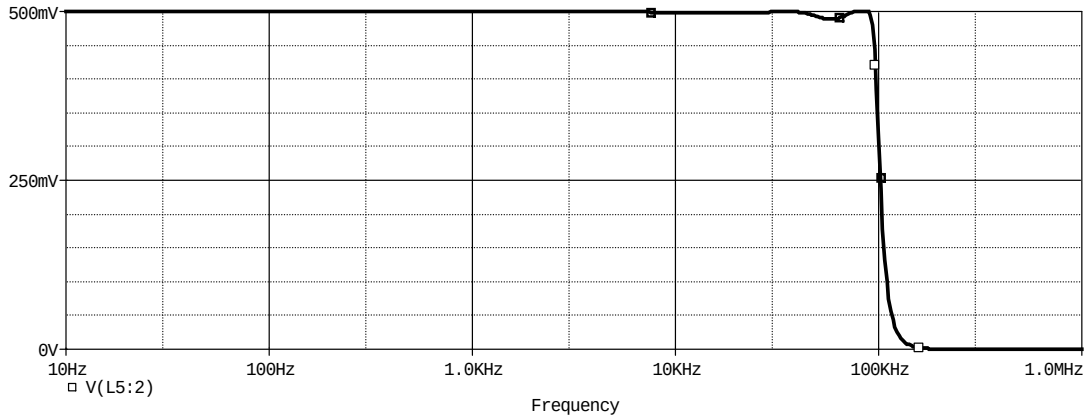
Protoboard returned _____

Staff Signature _____

Filter 2 – Butterworth Filter

The circuit below is a 9th order Butterworth-type filter. If we use the same basic design as the Chebyshev (five inductors and four capacitors), but choose the values of the components carefully, we can get rid of the resonances and make a very clean filter. This type of design is called a Butterworth filter. [In this filter: R1 is the internal impedance of the function generator, L1=L5=20uH, L2=L4=125uH, L3=150uH, C1=C4=0.047uF, C2=C3=0.068uF]. This is only an approximation to a true Butterworth filter. It uses the components that we have available in the studio. Its behavior is shown in the AC sweep.





Build the circuit. Demonstrate to the staff member that it has little or no peaks and valleys and that it stops passing the input signal at roughly the same frequency shown on the AC sweep above. (The input signal from the function generator will show behavior that varies, only the output should stay fairly constant.)

Name of student:_____

Section _____ Group _____

Apply Towards: _____

Points _____ (Points per circuit: quiz = 4, project = 3, experiment = 6)

Protoboard returned _____

Staff Signature _____