Final Project, Mastering Electronics 1 Lab,
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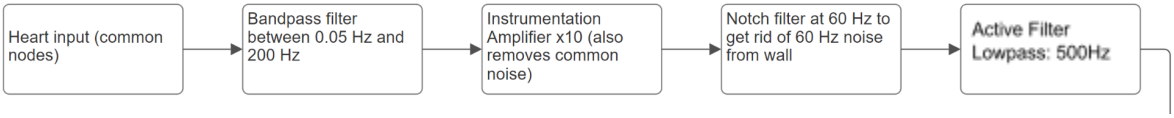
ECG.

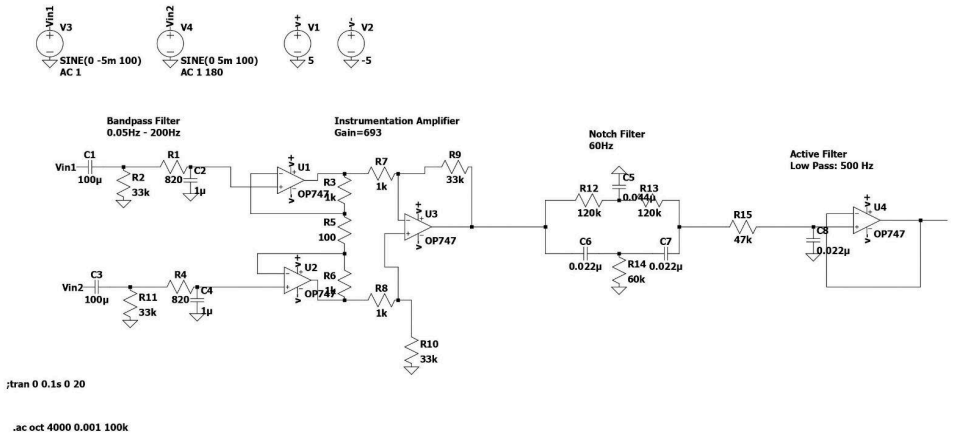
Block Diagram



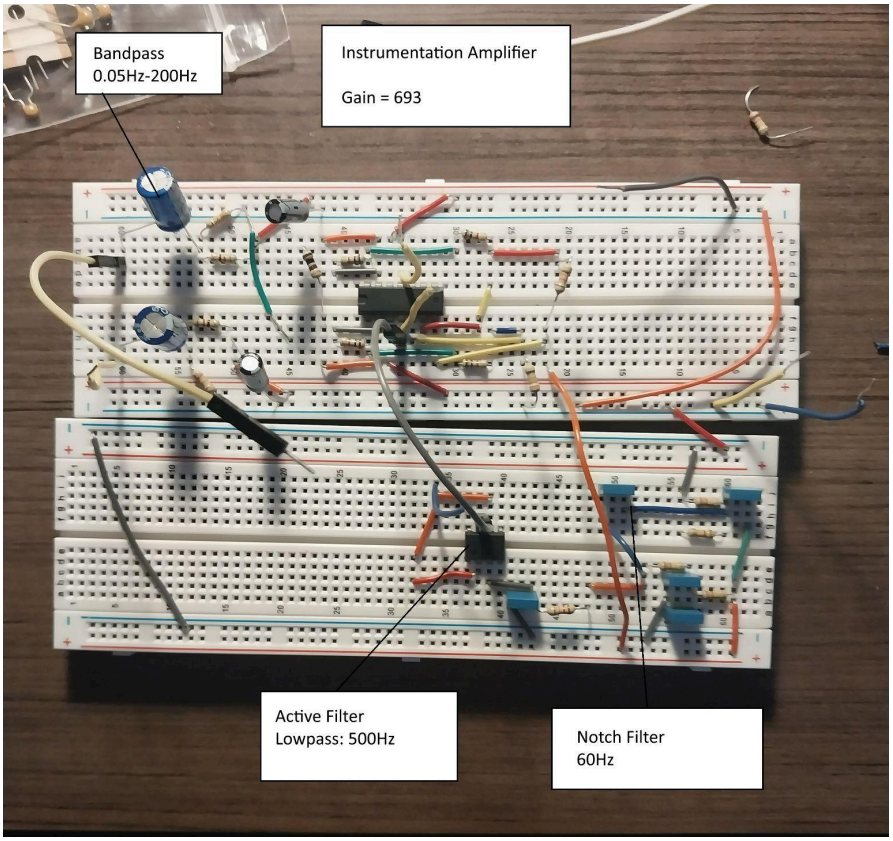
Theoretical Calculations

Frequency	R (Ohms)	C (Farads)
0.05Hz	$R = \frac{1}{0.05*2\pi*100*10^{-6}} = 31830\Omega \approx 33k\Omega$	100u
200Hz	$R = \frac{1}{200*2\pi*1*10^{-6}} = 795.8\Omega \approx 820\Omega$	1u
500Hz	$R = \frac{1}{500*2\pi*0.022*10^{-6}} = 14468\Omega \approx 12k\Omega$	0.022u
60Hz	$R = \frac{1}{60*2\pi*0.022*10^{-6}} = 120572\Omega \approx 120k\Omega$	0.022u

LTSpice Schematic



Picture of Circuit

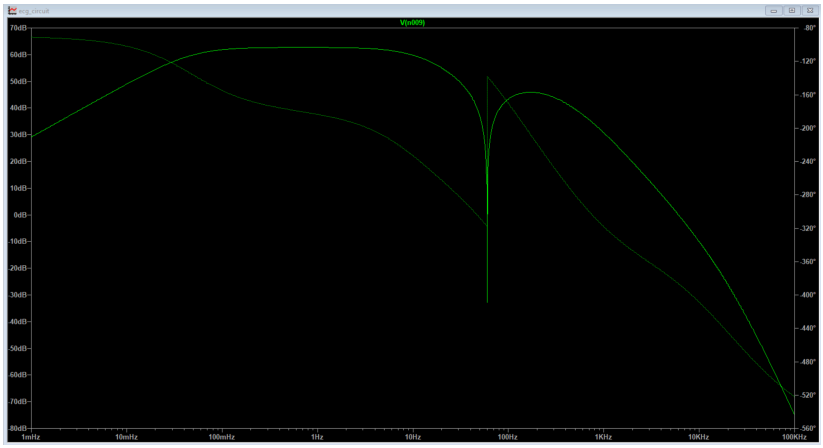


This project is the ECG option. This reads in a heartbeat input (with inputs ranging from 1mV to 5mV, and a frequency between 0.05Hz to 200Hz), amplifies the wanted signal, and filters out all the noise. The bandpass filter filters out the frequencies before 0.05Hz and after 200Hz initially. Afterward, an instrumentation amplifier amplifies the resulting filtered signal while also removing the common node noise (that is why two inputs are collected). After an amplification of 693, the notch filter filters out the 60 Hz noise from the wall. The reason why the gain for the instrumentation amplifier is high is because the notch filter also knocks out every signal. After the notch filter, the signal still may have some noise from the notch filter. As a result, there is another filter to get rid of any high-frequency (anything above 500Hz) noise with a low-pass filter.

Results and Reactions

Resulting Bode Plot

LTSpice Bode Plot



As can be seen, the BODE plot of the real circuit is much different from the LTSpice Bode plot. This is because SCOPY takes the absolute value of the circuit. Despite this, however, there seems to be some sort of issue with filtering near the beginning (at around 1 Hz). This is likely due to the EMF effects caused by the wires all being next to each other in the breadboard. The connections of the breadboard are also an issue, as the loose connections would cause the instrumentation amplifier to not amplify as much as it should. Not only that, but the capacitors used for filtering frequencies also see the impedances used throughout the circuit, not just the resistor calculated. To prevent this, unit gain op-amp buffers can be used to single out certain impedances. Enhancing the organization of the wires would also prevent the EMF noise from all the wires.