Thoughts on Signal x3 ECG

How do you know if you filtered the ECG signal well enough? For this data, we do not have an exact metric, so you'll need to use your best engineering judgement, and I will be interested in your thought process on how you approach this problem.

In the assignment it says:

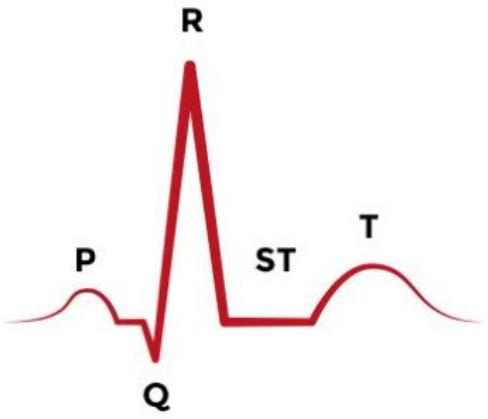
> Implement a digital filter of your choice to reduce the power line artifact such that you restore the ECG signal to as close to what it would have been had there been no power line contamination. This means you don't want to have too much attenuation in the stopband, nor too little. Hint: observe the spectrum of the ECG signal and estimate what the signal "should" probably be at the frequency band you are filtering. Observe the spectrum of the signal after you've filtered it and see how well you did. This may take a few iterations. How does the signal look in the time domain before and after filtering (zoomed in to one pulse)?

Background on ECG can be found in your text book on pages 30-33, 628-31, 673, 878-81.

One approach is to

- Plot the log spectrum of the signal
- Determine where the power line artifact is in this spectrum
- Imagine what the ideal signal would look like if the power line artifact was not there
- Try to implement a filter to achieve this ideal spectrum.
- Look at a zoomed plot of one pulse of the input signal and see if you can see the power line noise
- Compare this to a zoomed plot of one pulse after filtering to see if you removed the noise yet preserved the shape of the ECG.

Here are some plots from the web of example ECGs:



How do BioEngineers tune their filters?

One way is to bring in medical ECG experts to evaluate the output of various filters on test data. (this is subjective, and we do not have the experts for this exercise)

Another way I've heard one team used was to leverage their database of clean ECG signals and their system that automatically measure the parameters in the image above (ie, P, Q, R, ST, T). The can then artificially induce the power line noise on the test data, and see how bad the P, Q, R, ST, T measures are. Then then iterated making the filter more and more aggressive until the P, Q, R, ST, T measure had an error less than a certain threshold. (We do not have this database, or the time, so you'll need to use your best judgement as to your best filter)