

EECE 2150 - Circuits and Signals: Biomedical Applications Fall 2018, Quiz 10

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Student Name: _____

In an optical fetal blood oxygen monitor laser light passes through the mother's abdomen into the fetus. Some light is scattered back and it is thus possible to measure the absorption of light by blood. Because the amount of blood changes with the pulse, it is possible to measure the pulse rate of the fetus. A sample synthetic, but realistic, signal is shown as a function of time and of frequency. The frequency spectrum is shown in a broad view, zoomed to show only the important positive frequencies, and zoomed to show the "noise floor."

1. What is the pulse rate of the mother? Hint: The fetal pulse is faster than that of the mother.

_____ Beats per minute.

2. What is the pulse rate of the fetus?

_____ Beats per minute.

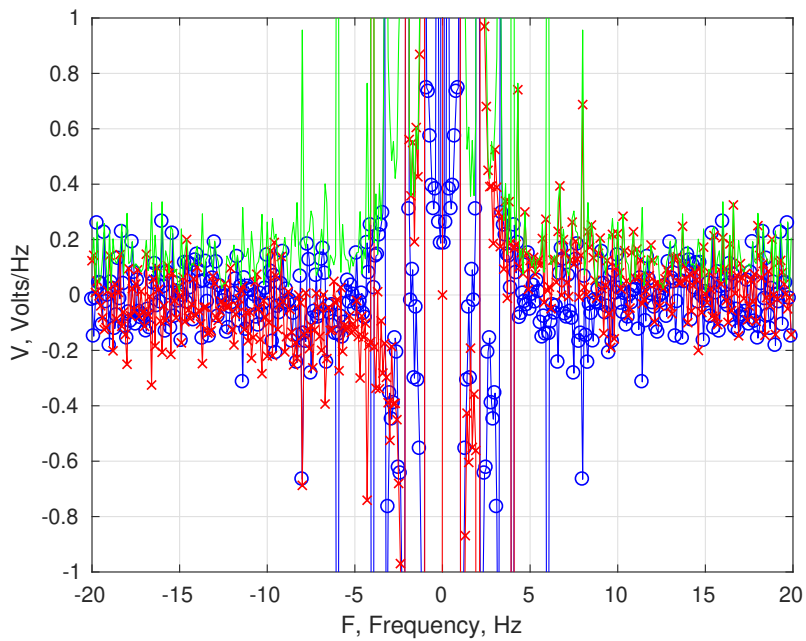
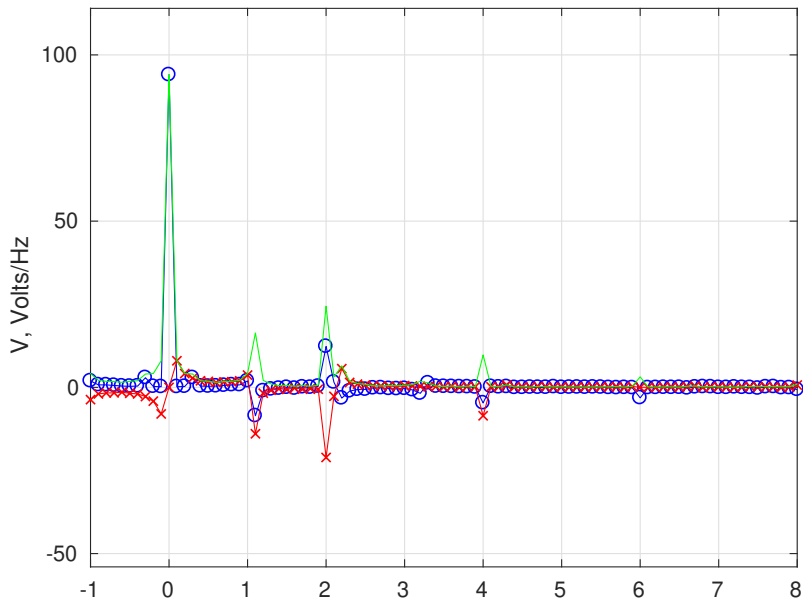
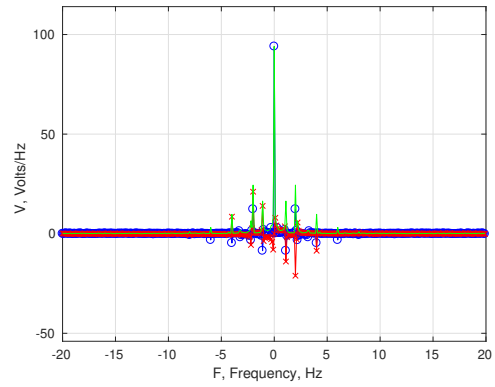
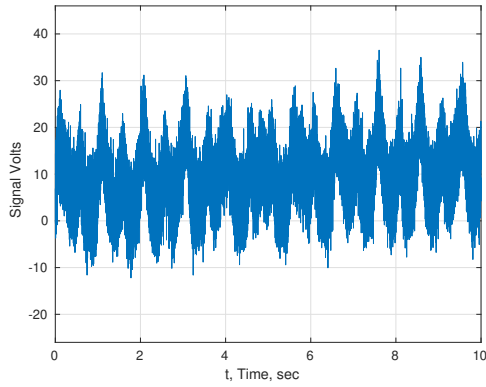
3. What sampling frequency is really needed to capture the information seen without aliasing? Here I mean to capture all the signals, and not the noise. We'll deal with that in another way.

_____ Hz.

4. If we sampled at 3 Hz, at what frequency would the fetal heartbeat be observed?

_____ Hz.

5. What do you think is causing the signal at 4 Hz?



1. The maternal pulse rate is about 1.1 Hz or 66 beats per minute. Actually I used 65 beats per minute to generate the signal.
2. The fetal pulse rate is about 2 Hz or 120 per minute, which is exactly what I used in the program.
3. The highest signal I see is 6 Hz, so I'd want to sample at twice that, or 12 Hz.
4. Sampling at 3 Hz, the centered spectrum would cover ± 1.5 Hz. The fetal rate at 2 Hz would alias to -1 Hz and that at -2 Hz would alias to 1 Hz.
5. 4 Hz is twice 2 Hz, so this is probably the second harmonic of the fetal signal.