Sam Wisnoski

Introduction to Sensors, Instrumentation, and Measurement

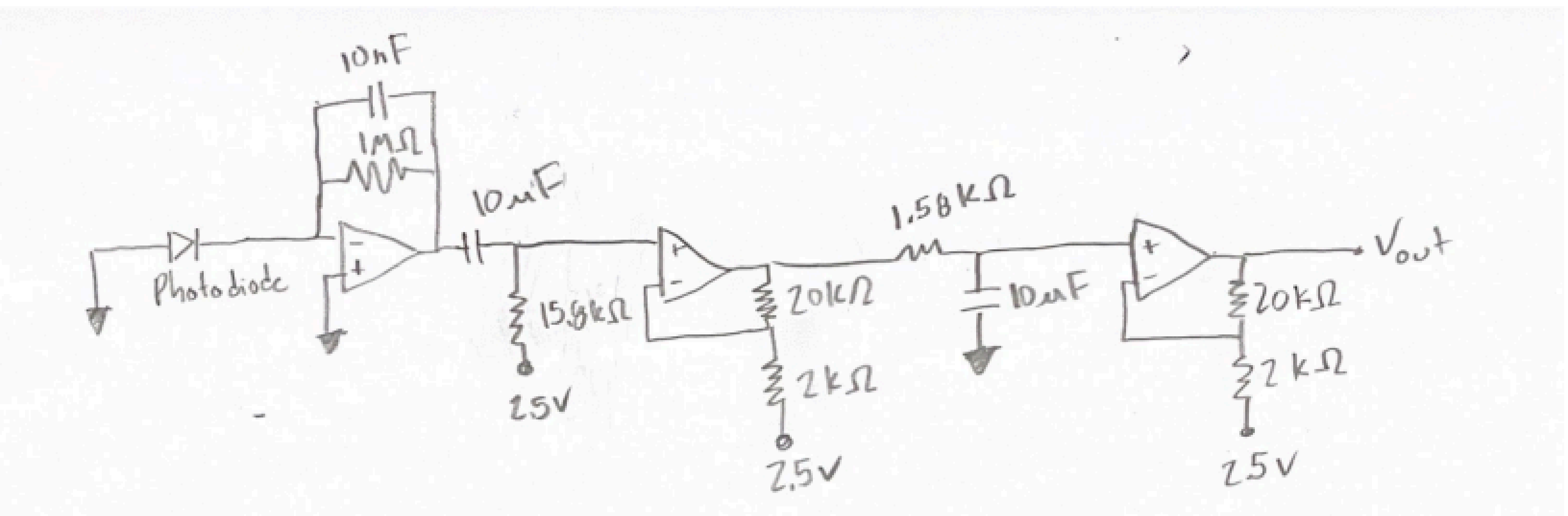
03/17/2024

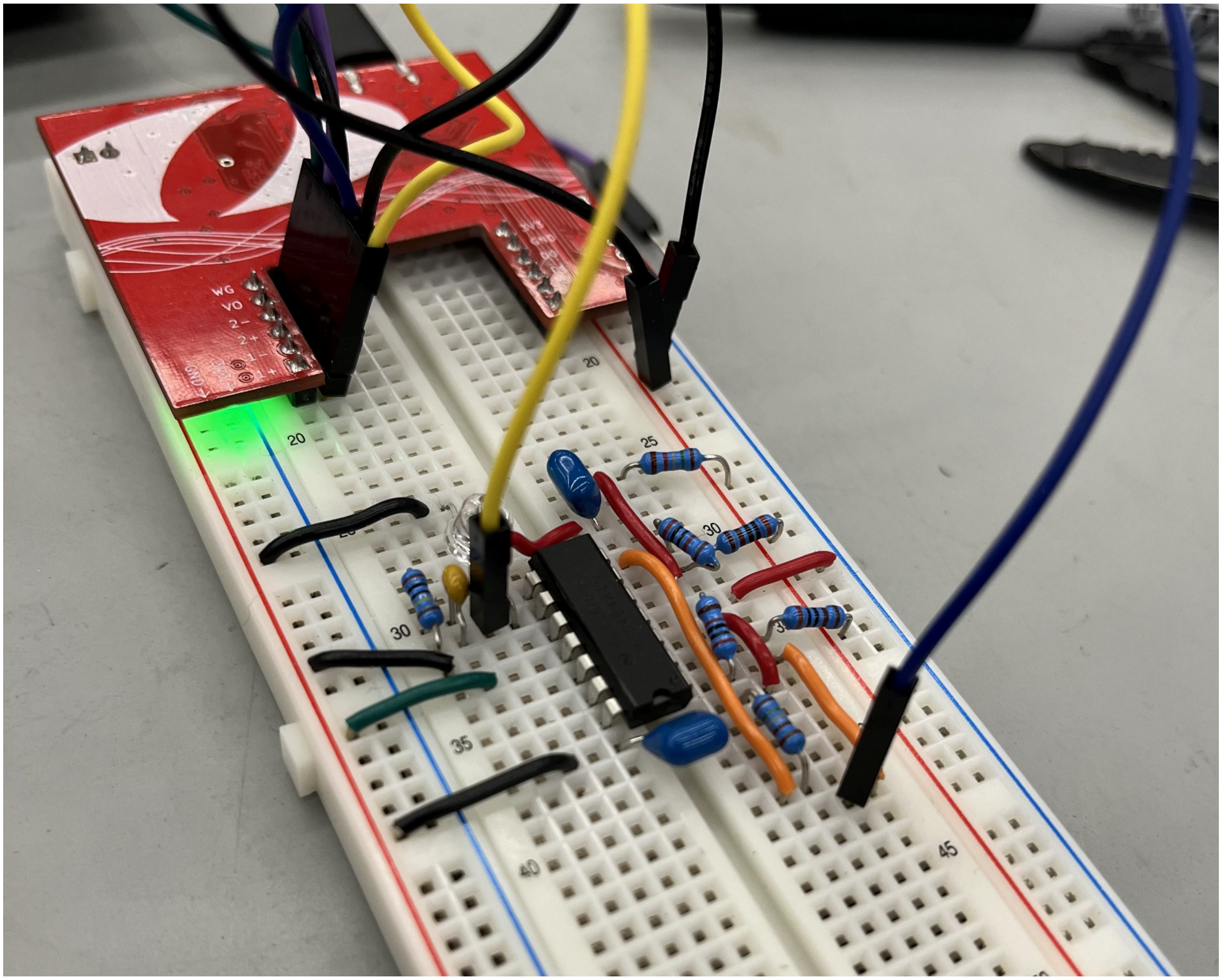
Lab Seven: Pulse measurement with light

Purpose:
Design an oximeter using a photodiode, filters and op-amps.

Results:

1.) 1 point: Your final circuit schematic with labeled component values and a photo of your circuit. Sketch the circuit so someone else could build the circuit from your drawing.




WG
VO
20
25
30
35
40
45

2.) 1 point: A short explanation that shows how you selected resistor and capacitor values with calculations.

There were four separate parts of the circuit that I needed to calculate capacitor and resistor values for: high-pass filter with cutoff frequency of 1Hz, low-pass filter with cutoff frequency of 10Hz, and two op-amps with a gain of ~10. For the two op-amps, I chose values of 20kΩ and 2kΩ to ensure that the op-amp wouldn't require more than 20 mA of current (V/(R1+R2) can't be higher than 20mA).

a.) high-pass filter with cutoff frequency of 1Hz:

*cutoff frequency = 1/(2*π*R*C)*
*1Hz = 1/(2*π*RC)*
*R*C = 1/(2*π) = 0.158*
If we choose C = 10μF, then R must be R = 15.8kΩ

b.) low-pass filter with cutoff frequency of 10Hz:

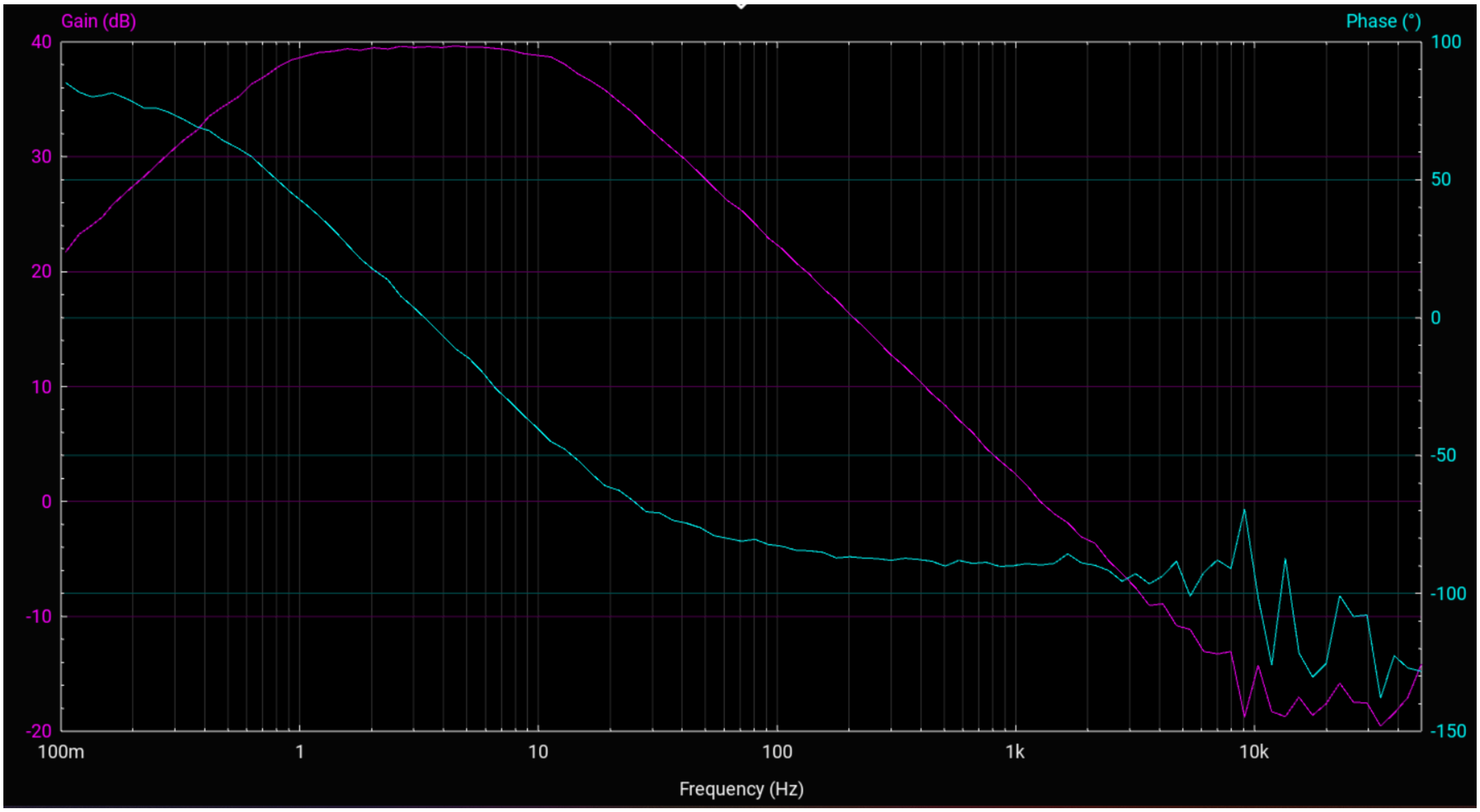
*cutoff frequency = 1/(2*π*R*C)*
*10Hz = 1/(2*π*RC)*
*R*C = 1/(2*π) = 0.0158*
If we choose C = 10μF, then R must be R = 1.58kΩ

c.) two op-amps with a gain of ~10

gain = R1/R2 + 1
11 = R1/R2 + 1
R1/R2 = 10
If we choose R1 = 20kΩ, then R2 must be R2 = 2kΩ

3.) 1 point: Measured cutoff frequencies and amplifier gains for your full circuit (a Bode plot will do).

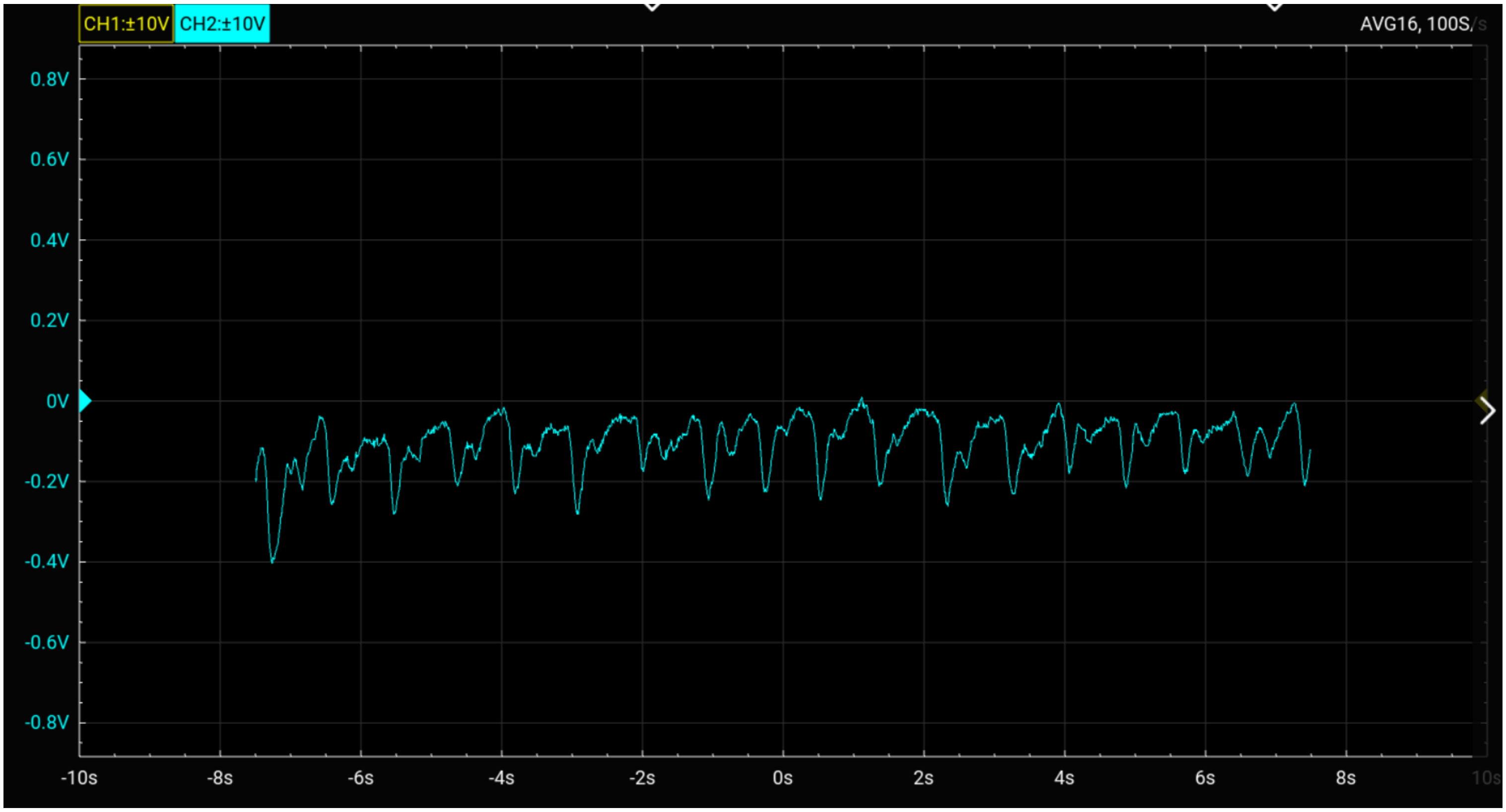
Bode Plot for Photodiode Circuit



This circuit contains a high-pass filter with a cutoff frequency of 1Hz, a op-amp with a gain of 11, a low-pass filter with a cutoff frequency of 10Hz, and a second op-amp with a gain of 11. In the plot, you can clearly see the gain at a max between frequencies of 1Hz and 10Hz. The Bode Plot was run with an amplitude of 16.59 mV between 100mHz and 50kHz.

4.) 1 point: Clean scope trace of your pulse with this circuit (screenshot is fine) with a caption.

Trace of my Pulse (measured with voltage over time)



My pulse is measured using a photodiode. The photodiode and integrated circuit measures the variation in light through my finger in the 1 Hz to 10 Hz range (using a high-pass and low-pass filter), then amplifies that variation by 121 through two op-amps with gains of 11. In the graph, each dip in voltage is a heartbeat, since the increased amount of blood in my finger blocks the light.