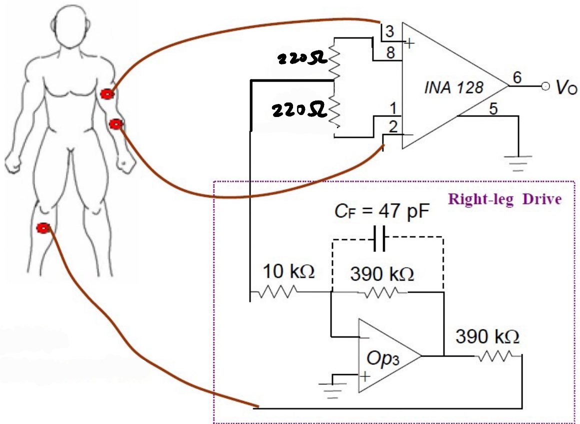
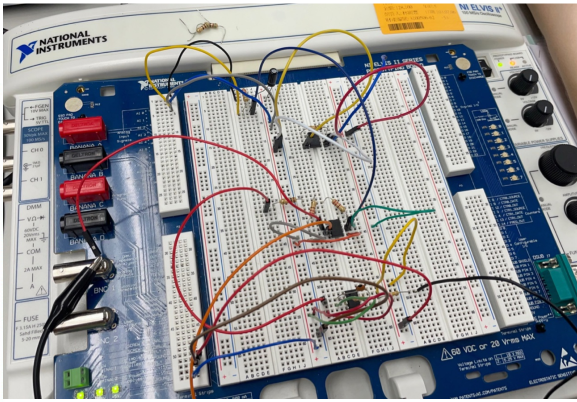
Lab 9 Electromyography (EMG)

電機系大三E班
0811562 何祁恩

* Circuit image:



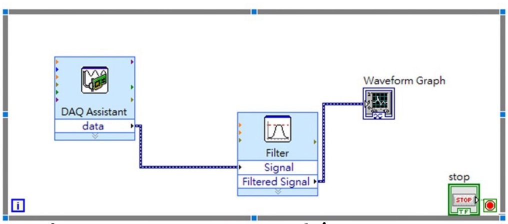
↑ fig1 circuit diagram



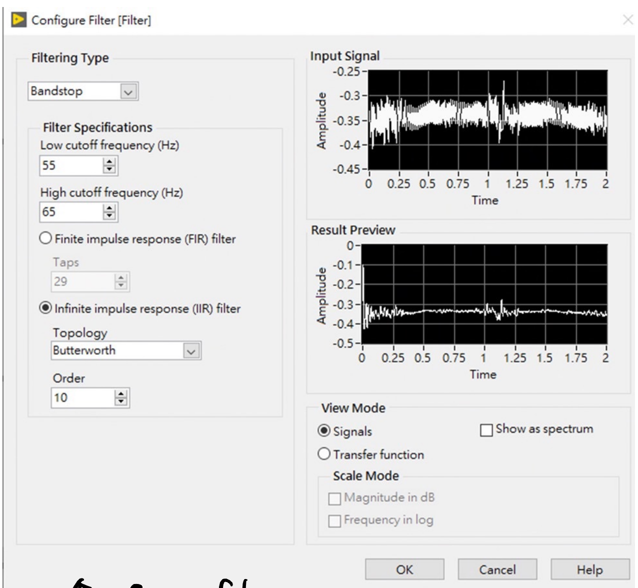
↑ fig2 circuit on board.

$$R_g = 220\,\Omega + 220\,\Omega = 440\,\Omega \Rightarrow G = 1 + \frac{50k\Omega}{440\Omega} \approx 115\,(V/V)$$

* Labview filter circuit and settings.



↑ fig3. Labview filter circuit



↑ fig4 filter settings.

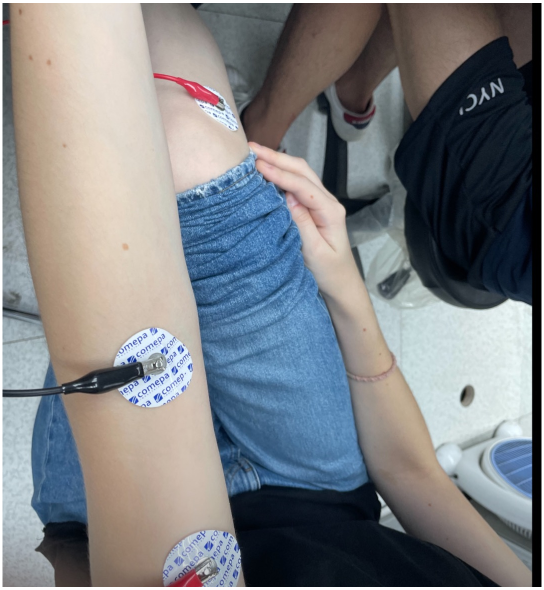
* Filter design:

Type: bandstop

Low/high cut frequency: 55/65Hz

Topology: Butterworth (n=10)

<Exercise 1>



↑ fig 5 electrode placement

Biceps → Pin 2

Elbow → Pin 3

Right leg → Right-leg-drive circuit.

* Relax EMG

fig 6 →

Raw EMG signal without labview filter

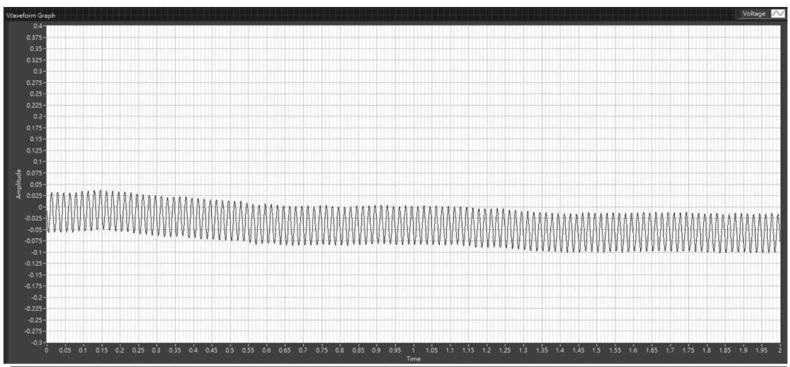
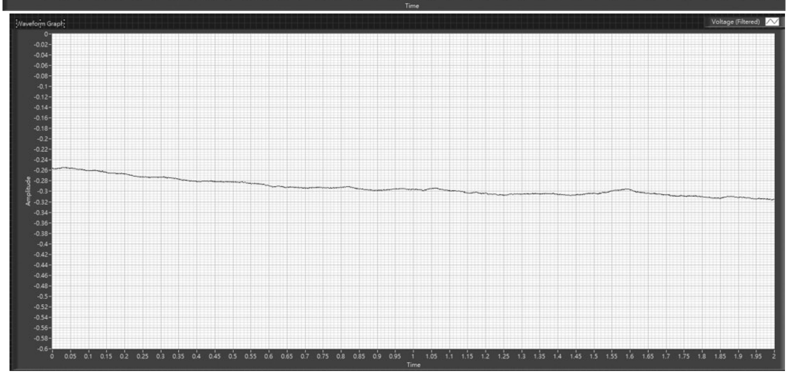
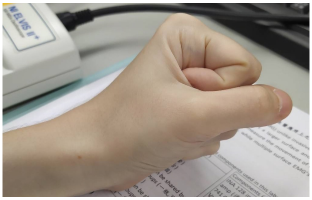


fig 7 →

EMG filter signal with labview bandpass filter



* Clench fist EMG



← fig 8 clench fist

fig 9 →

Raw EMG signal when clenching fist

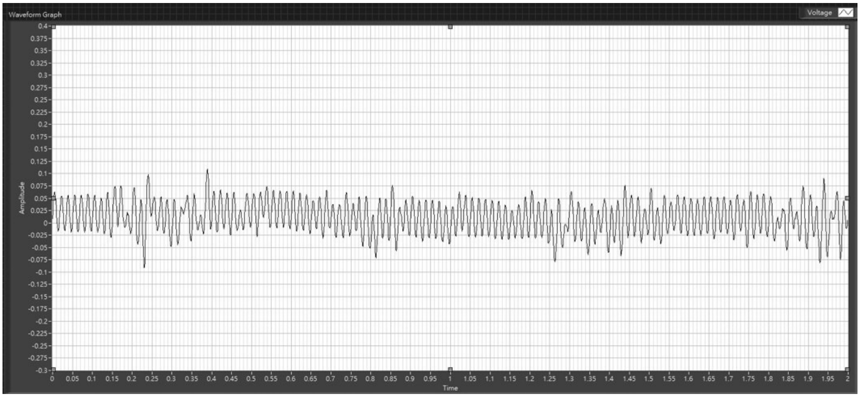
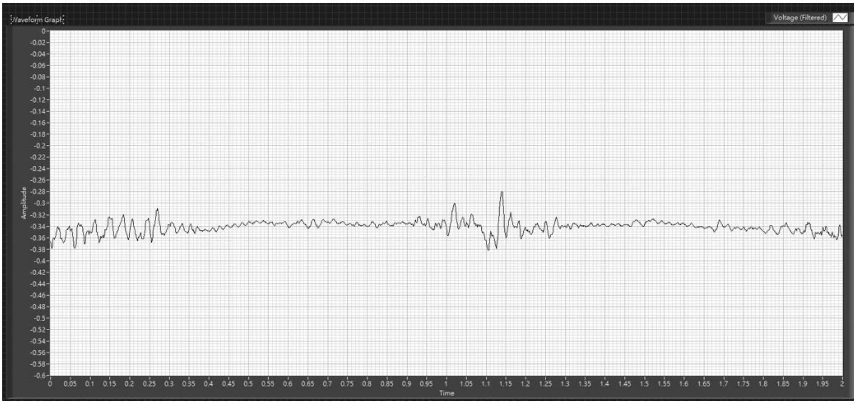
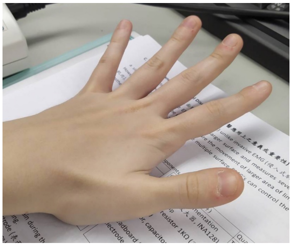


fig10 →

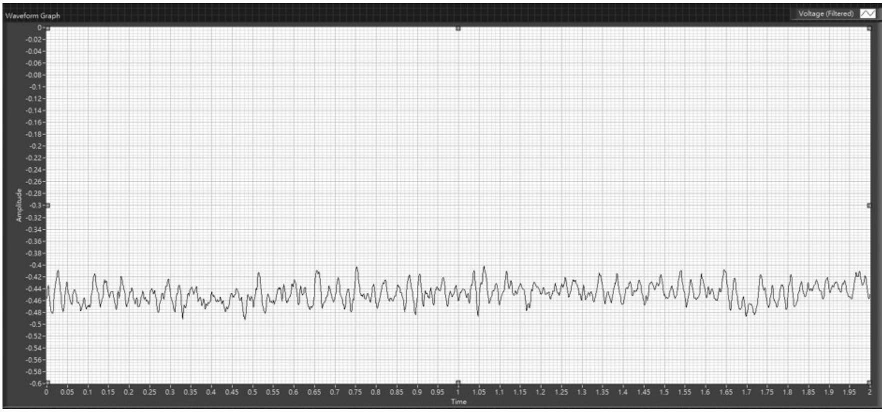
Filtered EMG signal when clenching fist



* Push down

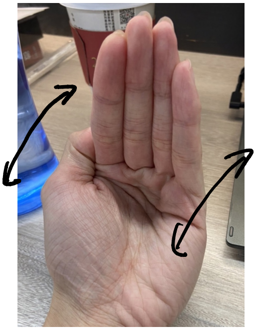


↑ fig 11 push down



↑ fig12 Filter EMG signal when pushing down

* Tense forearm

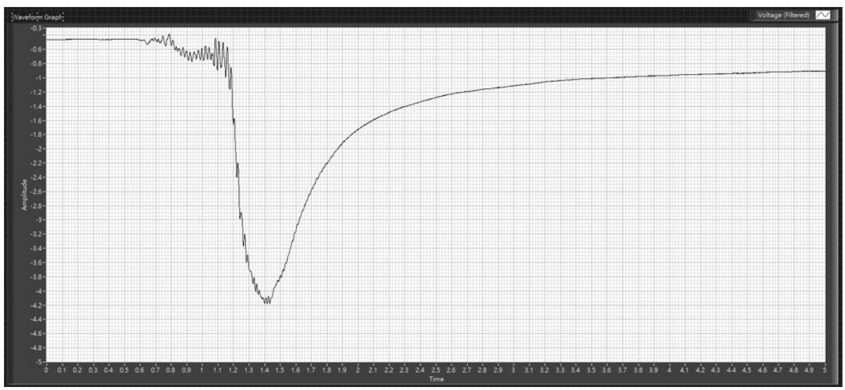


↑ fig13
Tense forearm

↑ fig14 Filtered EMG signal when tensing forearm.

* Fold forearm

↑ fig15
Folding forearm



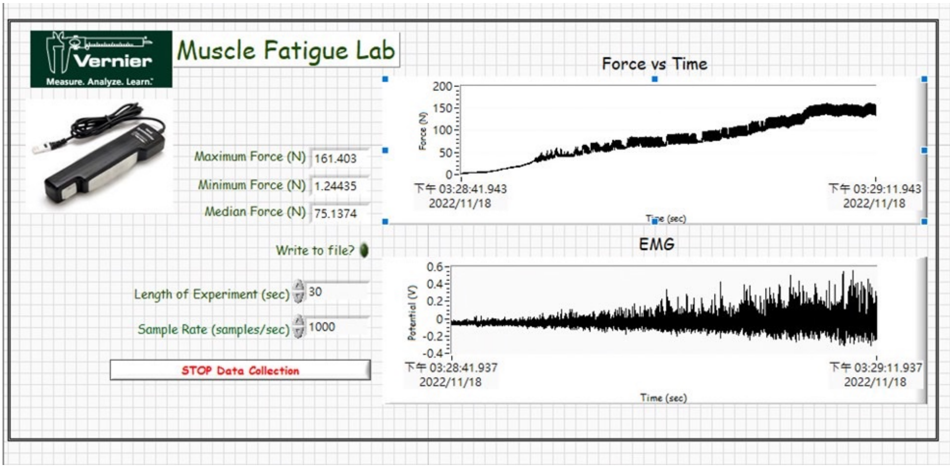
↑ fig16
Filtered EMG signal when folding forearm.

< Exercise 2 >

* Commercial EMG - rising pressure.

fig 17 →

Commercial EMG sensor : rising pressure



< Exercise 3 >

* Bicep static :

fig 18-1 →

Bicep static (0kg)

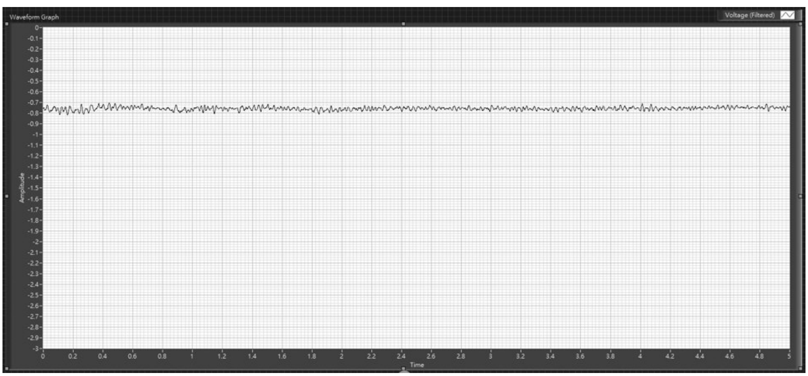


fig 18-2 →

Bicep static (1kg)

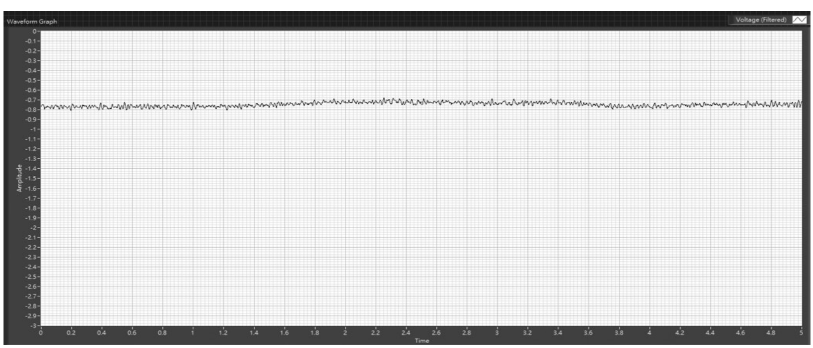


fig 18-3 →

Bicep static

(2kg)

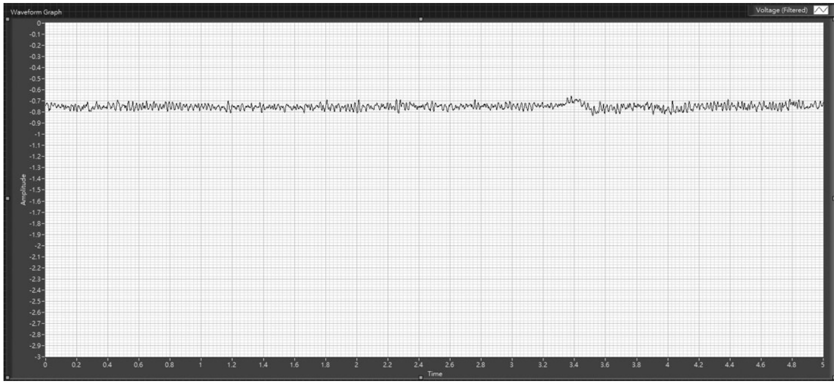


fig 18-4

Bicep static

(3kg)

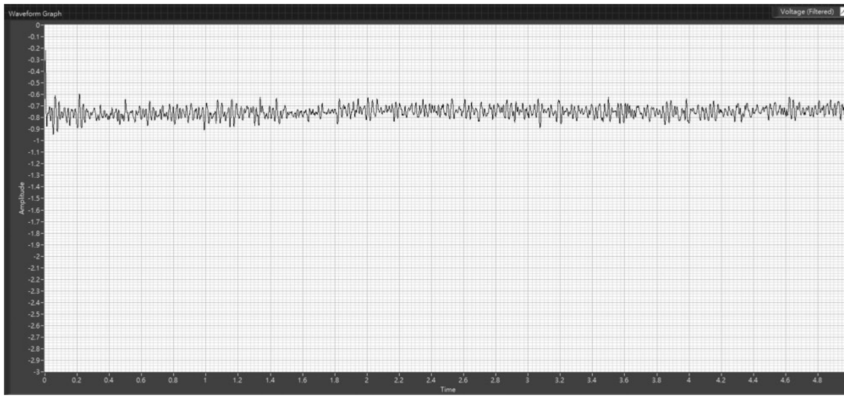
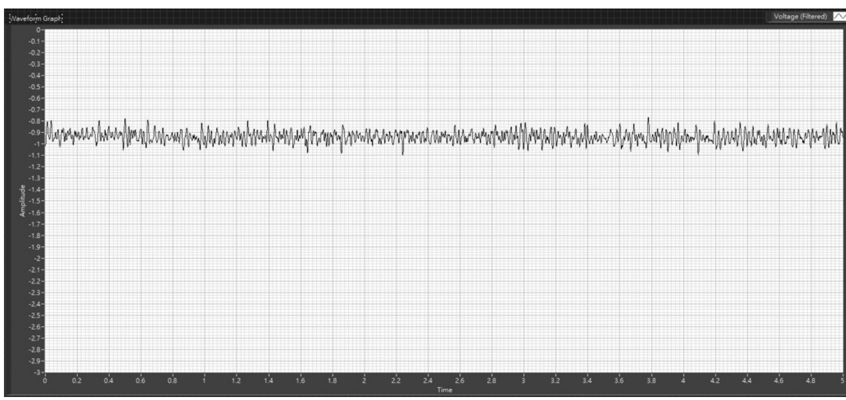


fig 18-5

Bicep static

(4kg)



From figure 18-1 to figure18-5, one can notice that as the weight increase, the subject needs more force to lift those water bottles, therefore, the peak-to-peak value of the EMG signal increases as the weight increases.

* Bicep moving.

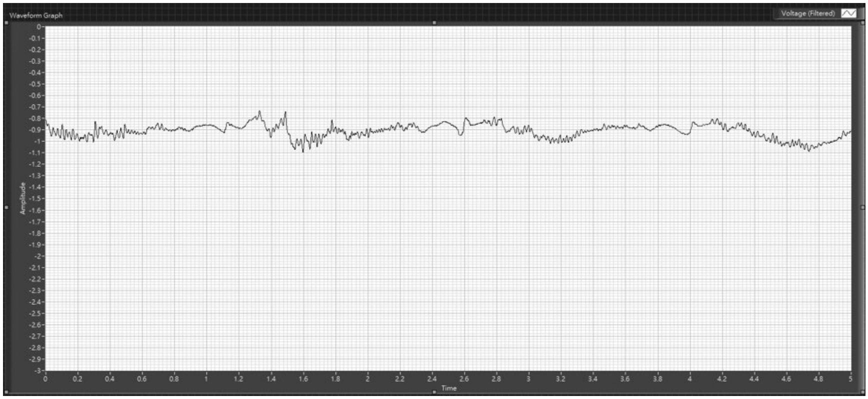


fig 19-1
bicep moving
(0 kg)

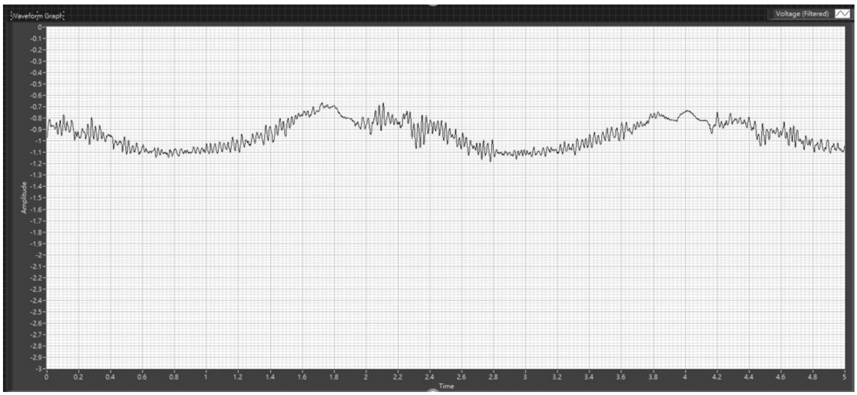


fig 19-2
bicep moving
(1 kg)

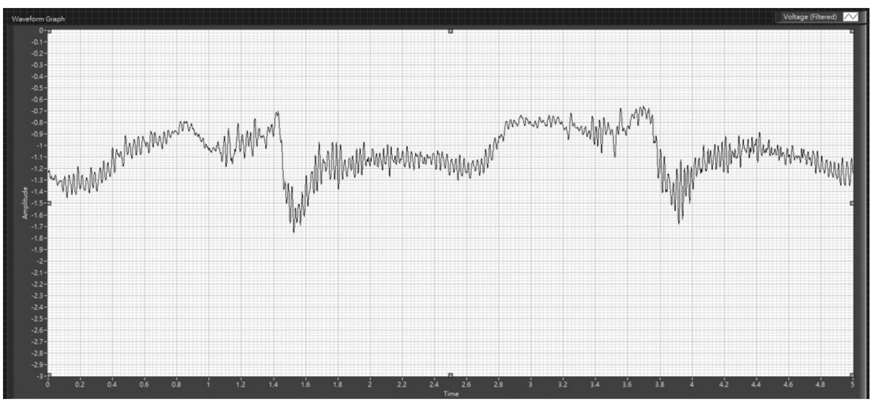


fig 19-3
bicep moving
(2 kg)

fig 19-4
bicep moving
(3kg)

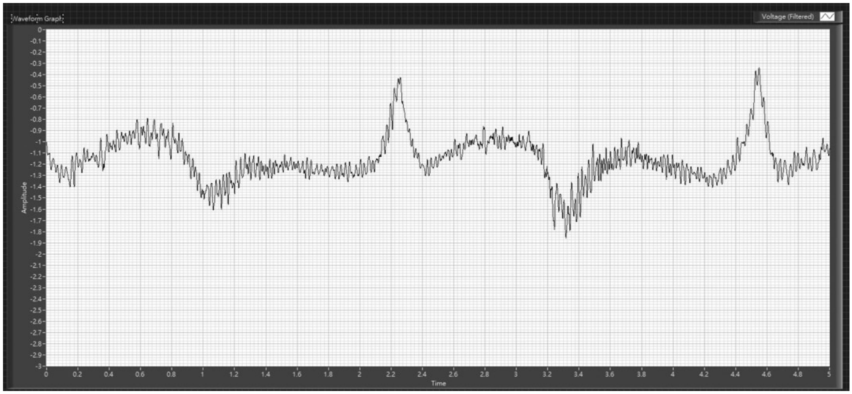
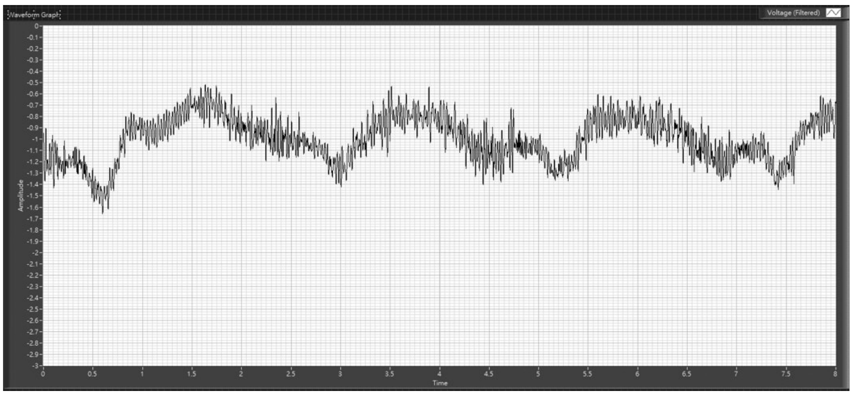


fig 19-5
bicep moving
(4 kg)



From figure 19-1 to figure 19-5, one can notice that as the weight increases, the peak-to-peak value of the EMG signal increase. In figure 19-3 and 19-4, we can clearly observe that there exist some similar waveforms when the subject uses the same muscle but with different weights. However, not all of the waveforms can observe those similar patterns because the subject can't exactly control one's muscles to do the same thing all the time. Thus, perhaps the coaches at the gyms can use EMG to ensure their students do the correct poses to train the particular muscles. That might be a great application for EMG signals in modern life.

* Tricep static

fig 20-1

tricep static

(0 kg)

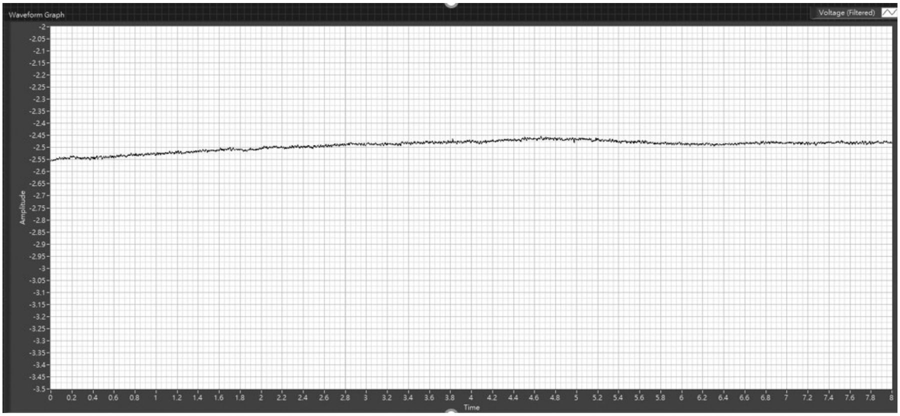


fig 20-2

tricep static

(1 kg)

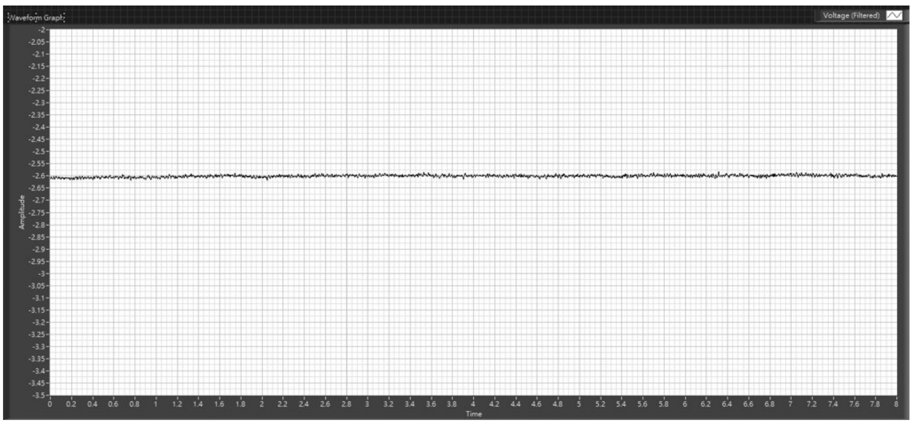


fig 20-3

tricep static

(2 kg)

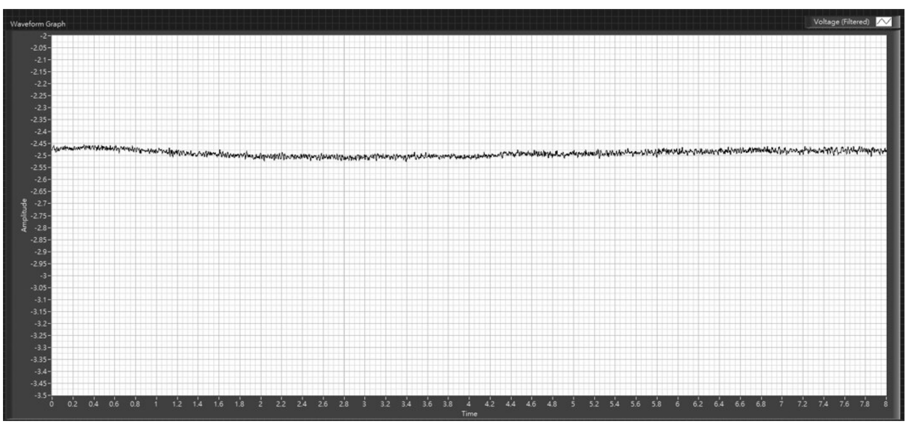
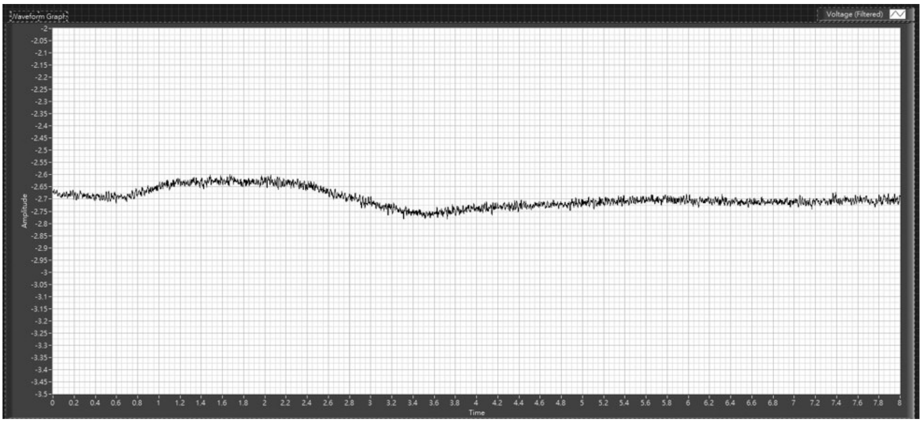


fig 20-4
tricep static
(3kg)

fig 20-5
tricep static
(4kg)



Because the action of lifting the water bottles will not use the tricep muscles, therefore, there are no big changes in figure 20-1 to figure 20-5.

* Tricep moving

fig 21-1
tricep moving
(0kg)

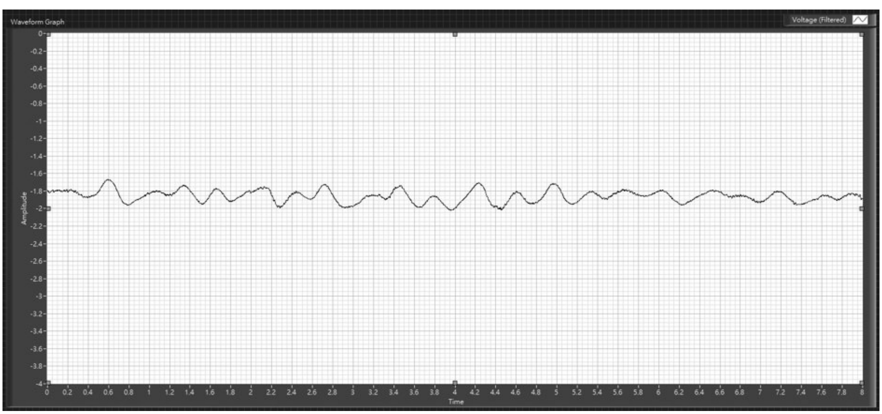


fig 21-2
tricep moving
(1kg)

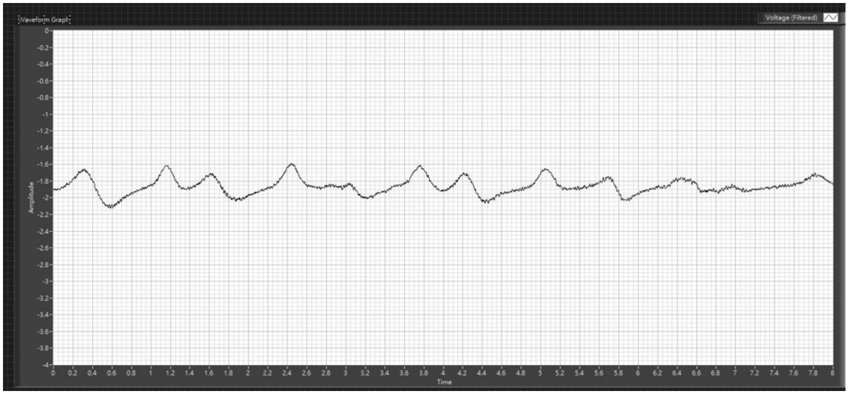


fig 21-3
tricep moving
(2kg)

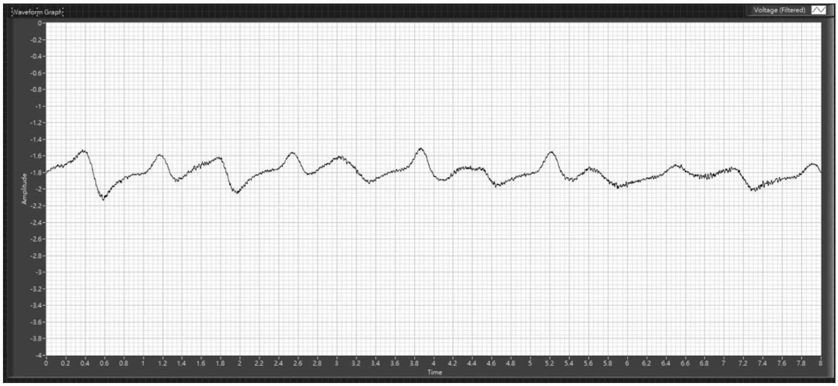


fig 21-4
tricep moving
(3kg)

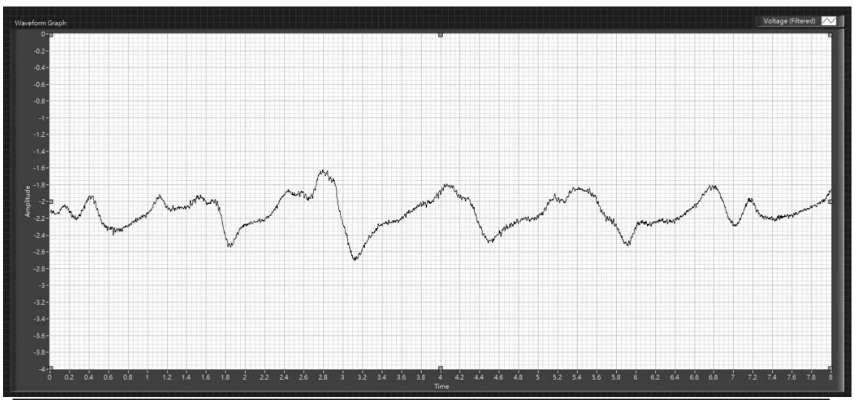
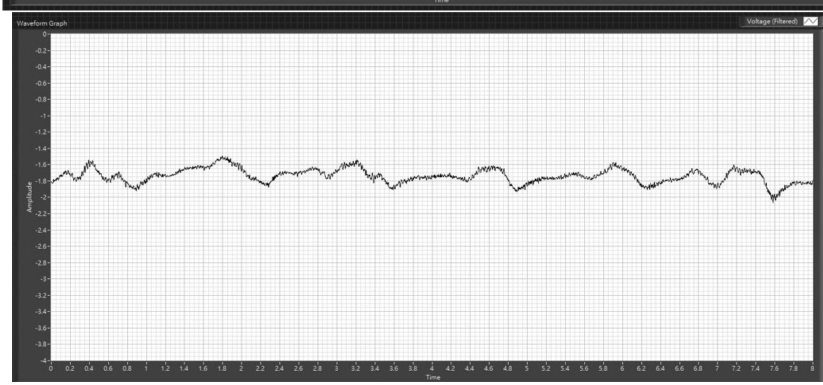


fig 21-5
tricep moving
(4kg)



Compare with the EMG signals from the bicep and tricep when lifting those bottles, one can observe that the peak-to-peak value of the bicep is higher than the peak-to-peak value of the tricep. Therefore, one can know that the action of lifting those heavy bottles will use the bicep more than the tricep.

* Question and Discussion:

1. What did you discover in Exercise 1?

From figure 9 and 10, one can notice that as the subjects clench their fist, there exists a pulse on the EMG signal. In figure 14, the subject tenses their forearm repeatedly, one can also observe a similar pulse on the EMG signal. Thus, one can know that both clenching fists and tensing forearms will use the same muscle and generate almost the same signal. Furthermore, in figure 16, when the subject folds their forearm, there exists a huge voltage drop in the EMG signal.

2. In exercise 2, how does waveform change from the minimum muscle force to the maximum muscle force?

In figure 17, one can notice that as the force increases, the peak-to-peak amplitude of the EMG signal also increases.

3. In exercise 3, how does the signal change with the same arm repeating the same movement but on a different muscle? You might need to adjust the voltage scale.

Compare with the EMG signals from the bicep and tricep in figure 19 and figure 21 when lifting those bottles, one can observe that the peak-to-peak value of the bicep is higher than the peak-to-peak value of the tricep. Therefore, one can know that the action of lifting those heavy bottles will use the bicep more than the tricep.

4. Analyze how does different force affect the EMG signal.

When the subjects increase force, the EMG signal becomes continuously denser and the peak-to-peak magnitude will have a larger amplitude. The reason why different forces will affect the EMG signals is the increasing degree of superimposition of action potentials from the different neuro units.

5. Did you encounter any noise (雜訊) during the lab exercises? Describe how to eliminate the noise.

Yes, there are some noises in our EMG signals. This might come from the electrical noise from power lines, cross-talk contamination from unwanted muscle, and so on. These noises might be eliminated by a well-designed band stop filter to filter out those unwanted signals. Besides, make sure the electrodes are well-placed so that the signal will not be contaminated by other muscles.

6. When performing these lab exercises, why do we need to use a body part as a reference in addition to the Input signal? If there is no reference, how would it affect the signal?

The reference drive circuit can be used to eliminate noise interference from the human body. The body will act as an antenna which induced radio-frequency interference and result in a large noise. With the reference drive circuit's help, one can actively eliminate the noise from the body. If there is no reference, the signal will be interfered with the large noise from the body.

* Feedback :

Thanks to TA's demonstration, I can understand biology knowledge in a short time. The explanation of the bicep and the tricep muscles are so fun. I am looking forward to the last experiment this semester.