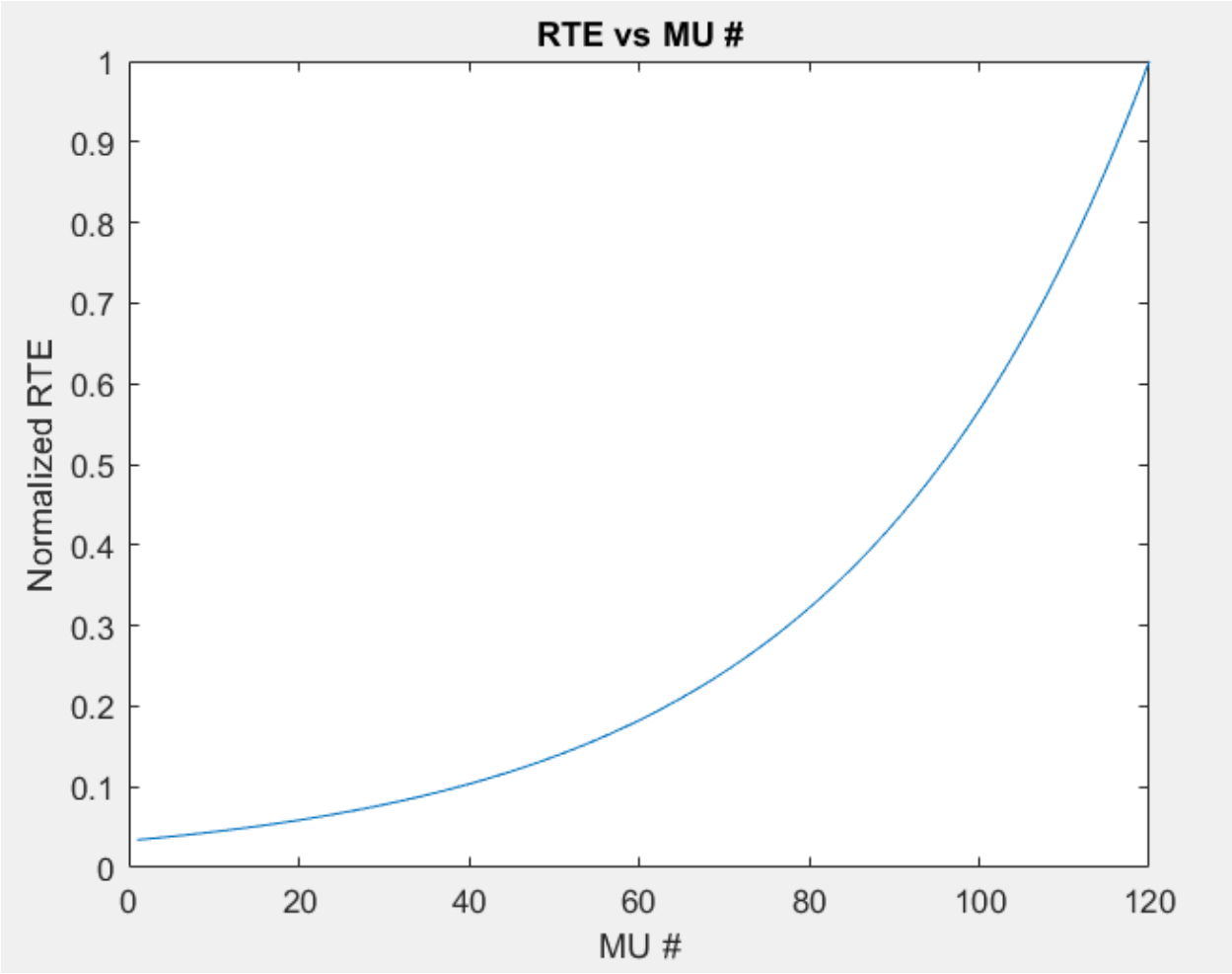
SYDE544- Assignment 4

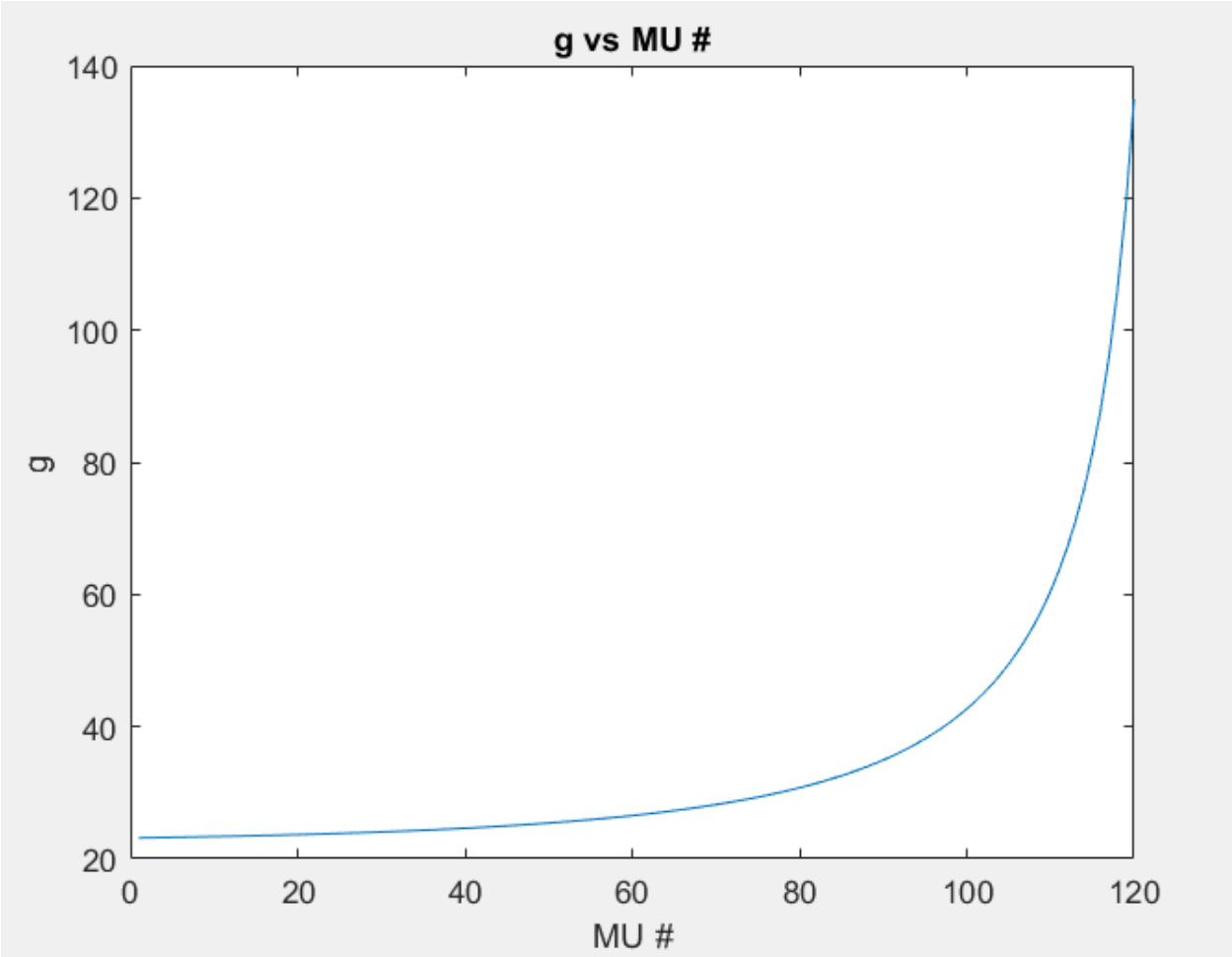
Part 1

Problem 1a



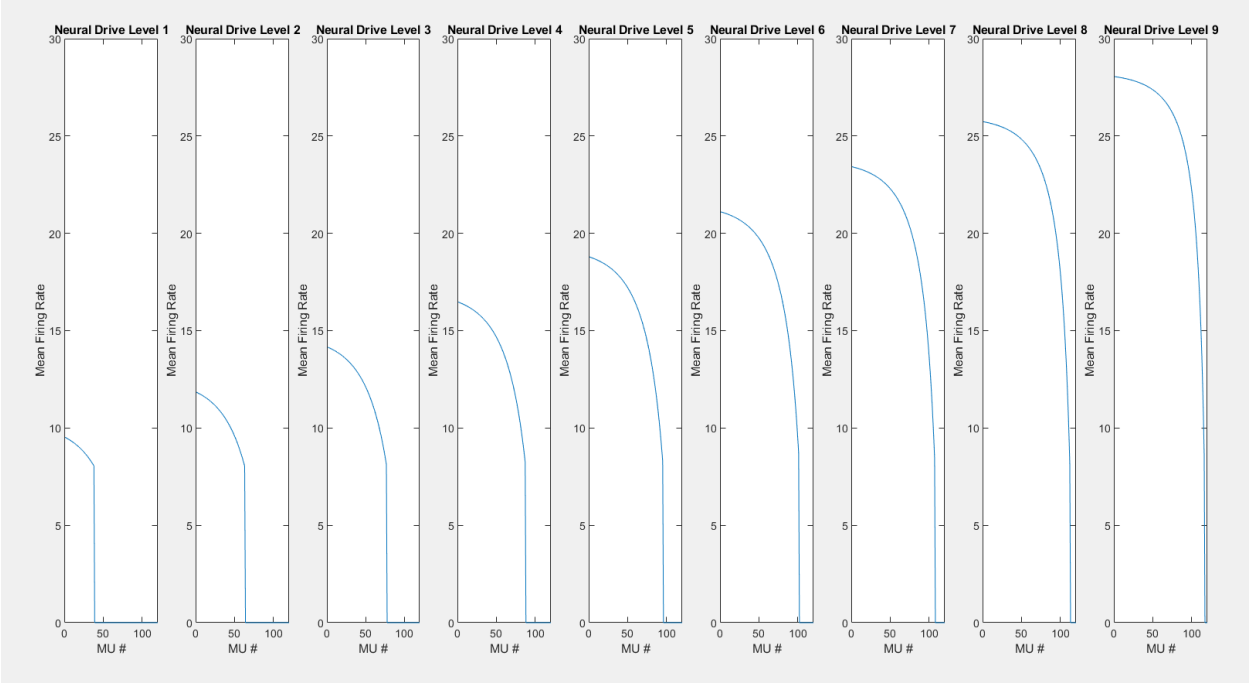
Above is the plot for the RTEi (recruitment threshold) for each of the 120 IMUs. These 120 MUs are representative to the physiological recruitment order: smaller units are recruited first (at lower threshold), larger units are recruited at higher threshold. Once the neural drive applying to the MU pool is larger than RTEi, then the ith MU will be recruited, and start firing.

Problem 1b



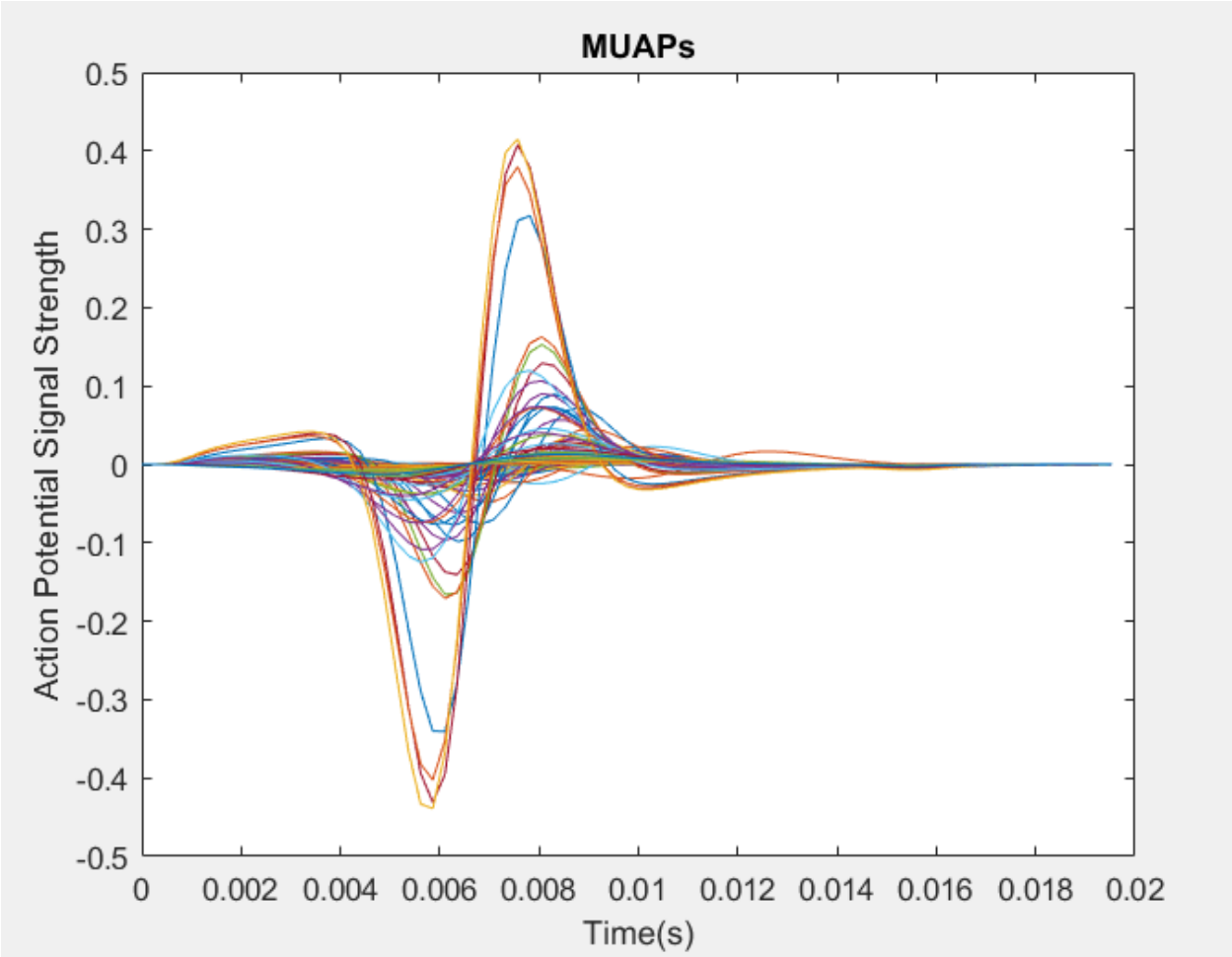
Above is the plot for gi (gain factor) for each of the 120 MUs. It is assumed that the maximal firing rate of all units to be 35 Hz, and the maximal neural drive is 36 (1.2 times larger than the maximal recruitment threshold). As the MU# increases, so does the gain factor, because the denominator gets smaller for equation 4, due to increasing RTEs.

Problem 2

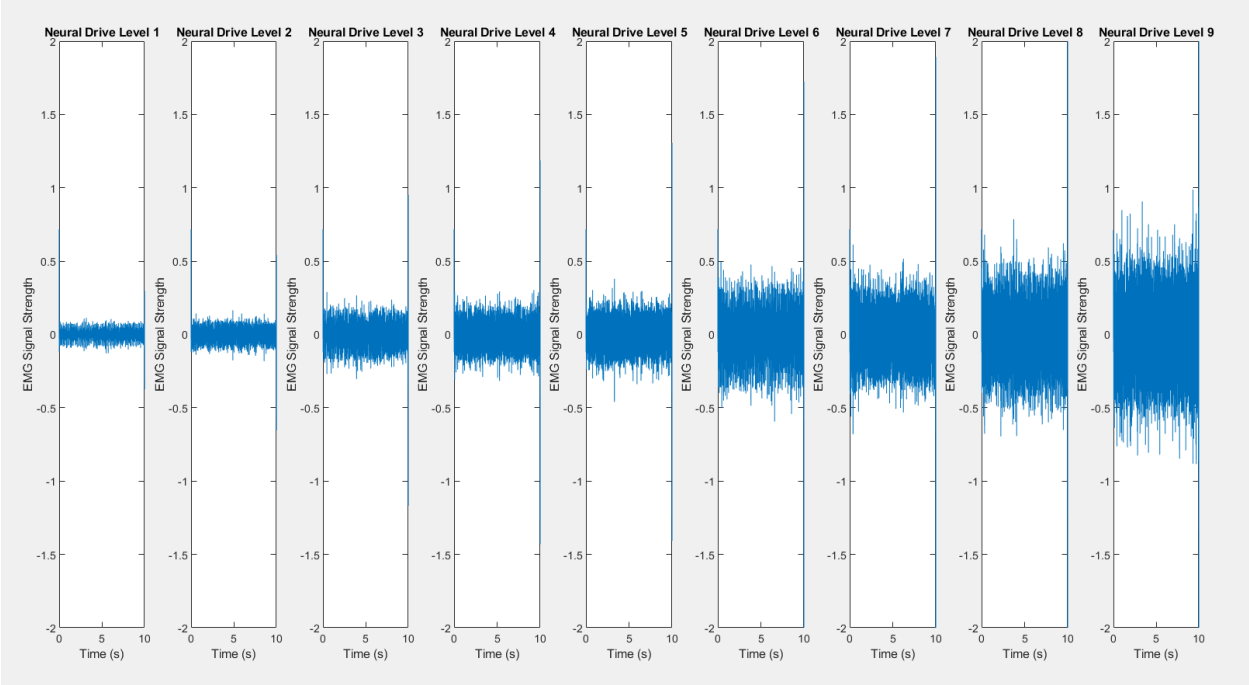


Above is the firing timings of all 120 MUs over 10 seconds, at each of the neural drive levels. The ith MU fires at its minimal firing rate once it is recruited at its recruitment threshold. MUs increase their firing rates as the neuronal drive increases.

Problem 3

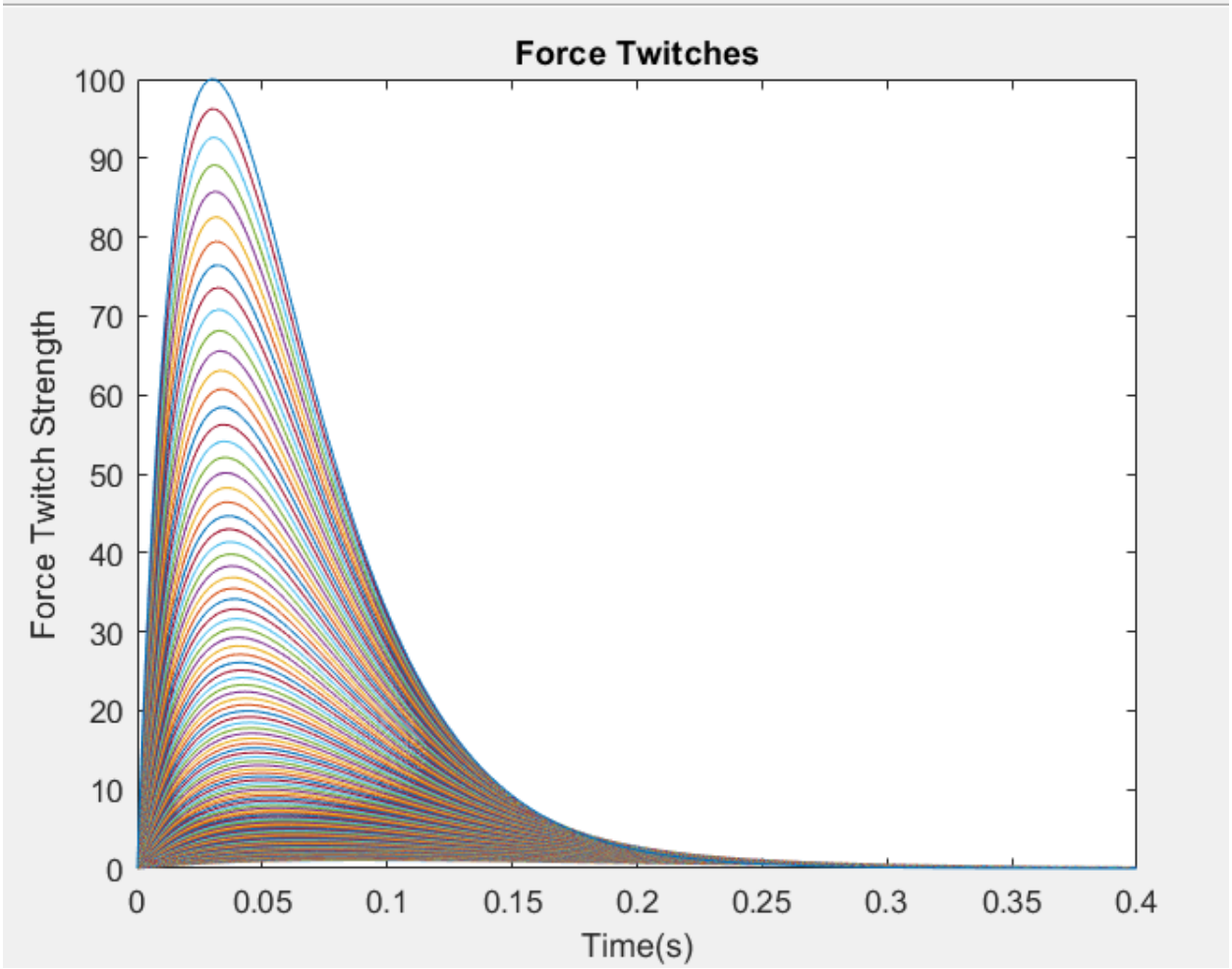


Above is a graph of the 120 MUAPs. There is no difference between the size of the MUAP and MU # (size refers to the size of the axon of the motoneuron and the size of force twitch generated by the MU, not the size of the action potential detected at skin surface).

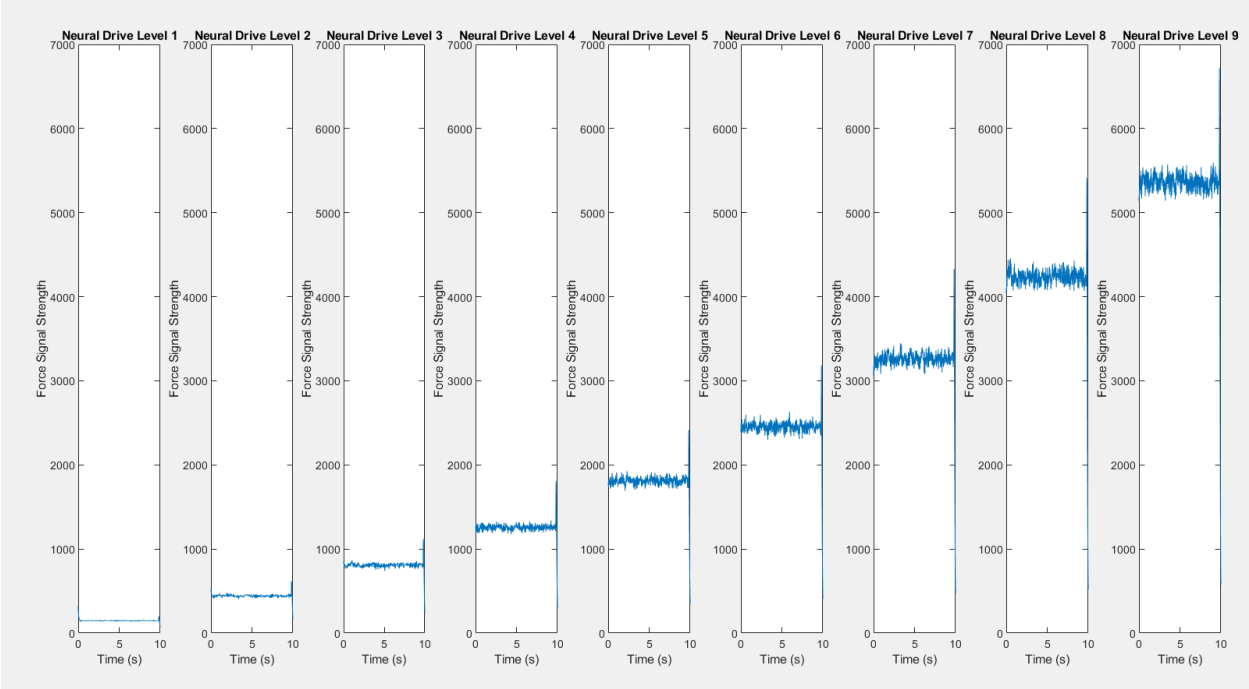


Above is a plot of the simulated EMG for each neuronal drive level. This uses the firing timings, simulates MUAP trains of all units at the 9 neural drive levels and sums them together. We can see the EMG signal strength increases with the neural drive level. At lower levels there are fewer motor units recruited, corresponding to fewer MU action potential trains (MUAPs) due to smaller firing rates, fewer firing timings and overall fewer MUAPs. When neural drive increases, more MUs are recruited (small and large), meaning overall more signal.

Problem 4

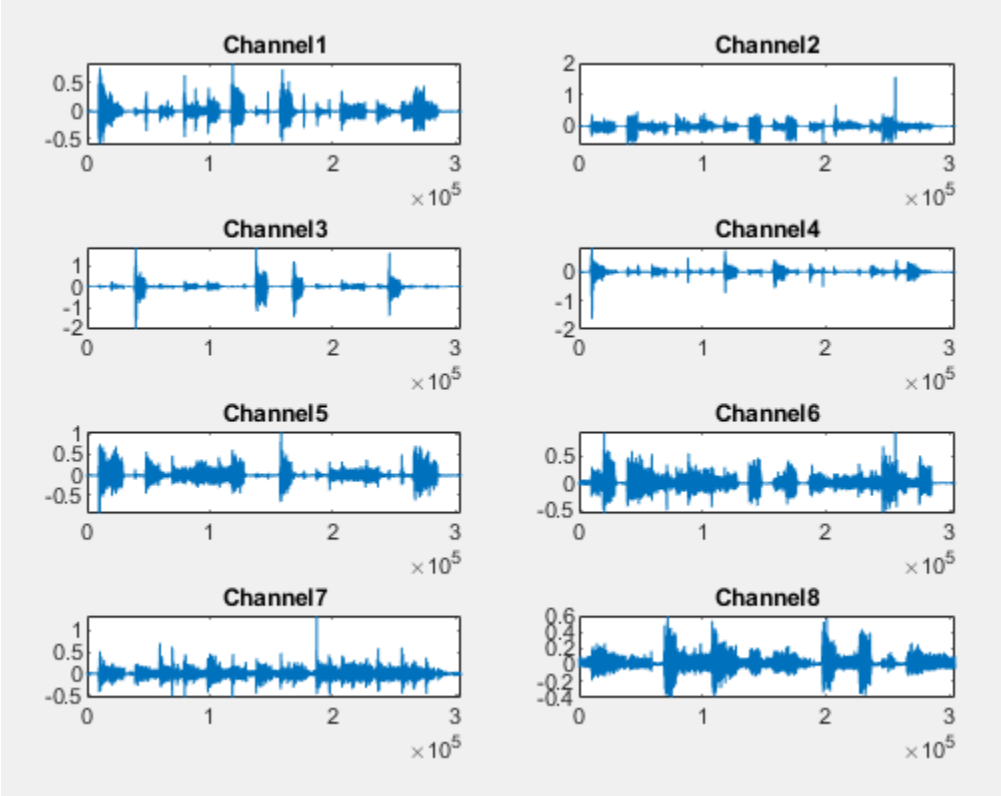


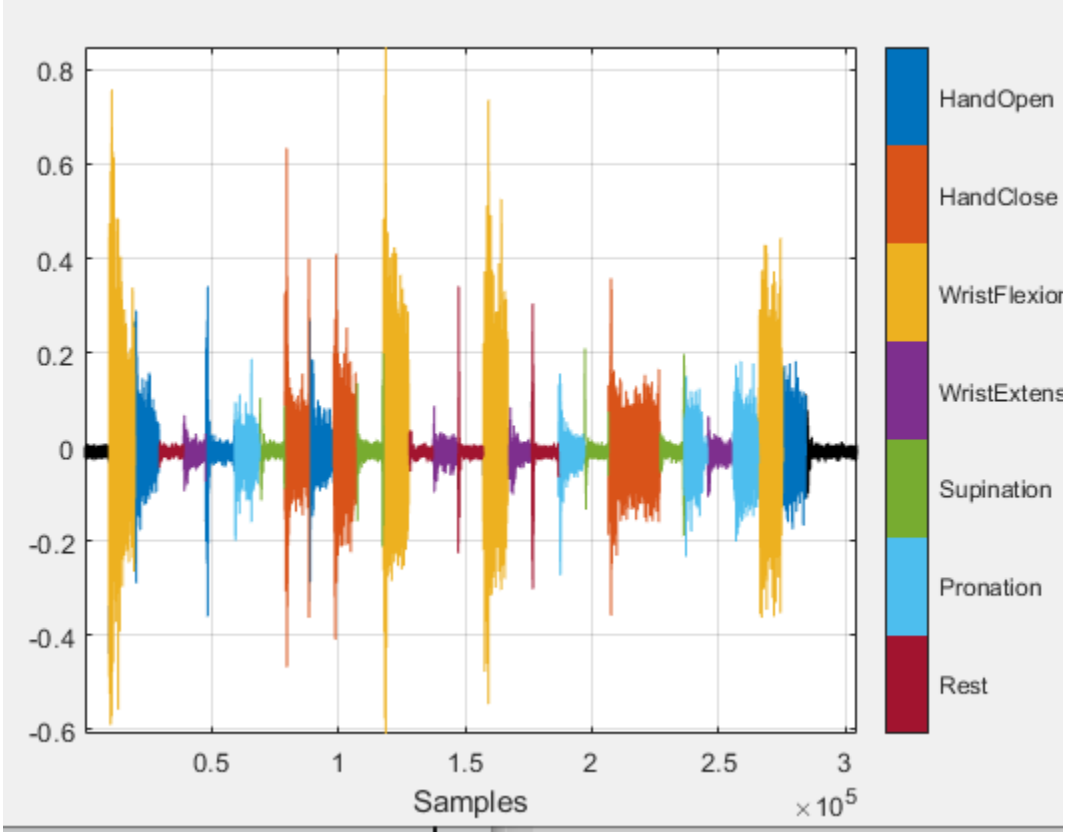
Above is a plot of the force twitches for each of the 120 MUs. The force twitches increase with MU#.

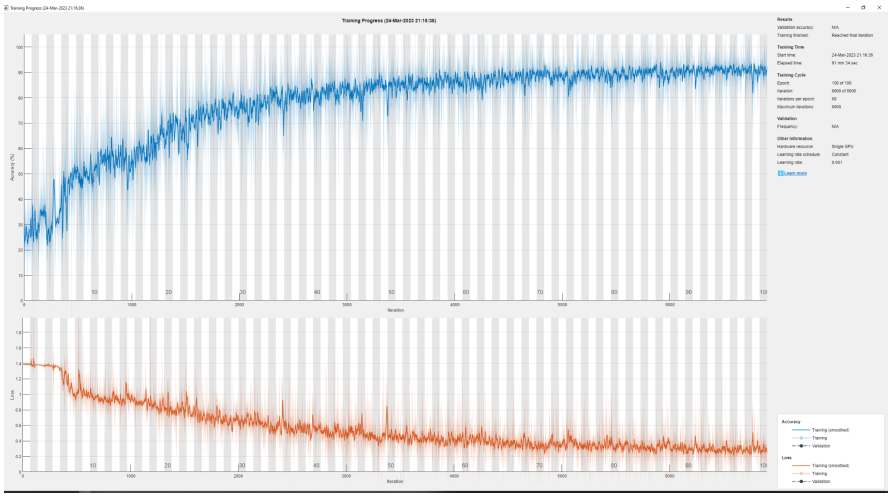


Above is the force output for all of the 120 MUs at the 9 neuronal drive levels. The force output increases with increasing neuronal drive level. This makes sense as more recruited MUs correspond to more force. At lower levels there are fewer motor units recruited, corresponding to fewer MU action potential trains (MUAPs) due to smaller firing rates, fewer firing timings and overall fewer MUAPs. When neural drive increases, more MUs are recruited (small and large).

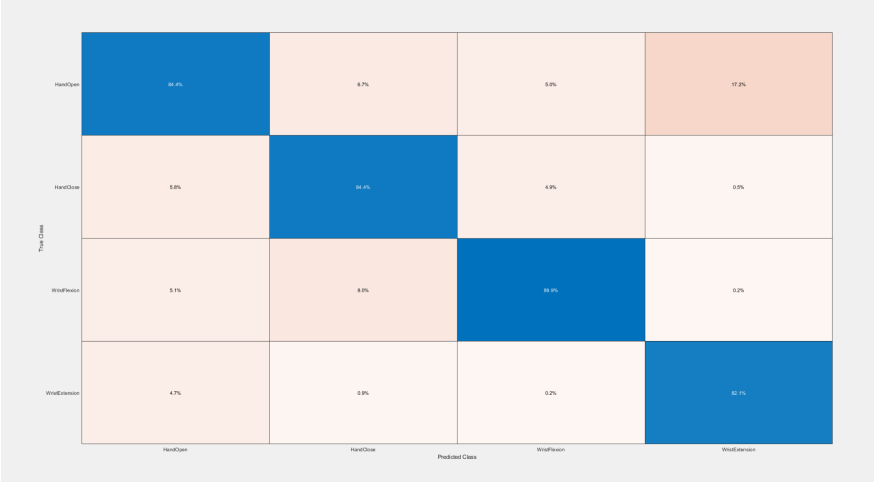
Part 2


Channel1
Channel2
Channel3
Channel4
Channel5
Channel6
Channel7
Channel8
×10^5


HandOpen
HandClose
WristFlexion
WristExtens
Supination
Pronation
Rest
Samples
×10^5



Above is the network training progress for the classification of arm motion using EMG signals. It can be observed that as training progresses (iterations), the training accuracy increases and the loss decreases, meaning the model is learning as it should.



Above is the confusion matrix for the classification of arm motion using EMG signals. An overall accuracy of about 85% was achieved using an LSTM network with 80 hidden units. The highest misclassification occurred between wrist flexion and hand close and between hand open and wrist extension. The model classified wrist flexion with the highest accuracy which could be because the placement of the EMG electrodes on the arm target mostly muscles used in flexion.