EE 3EY4
Lab 4
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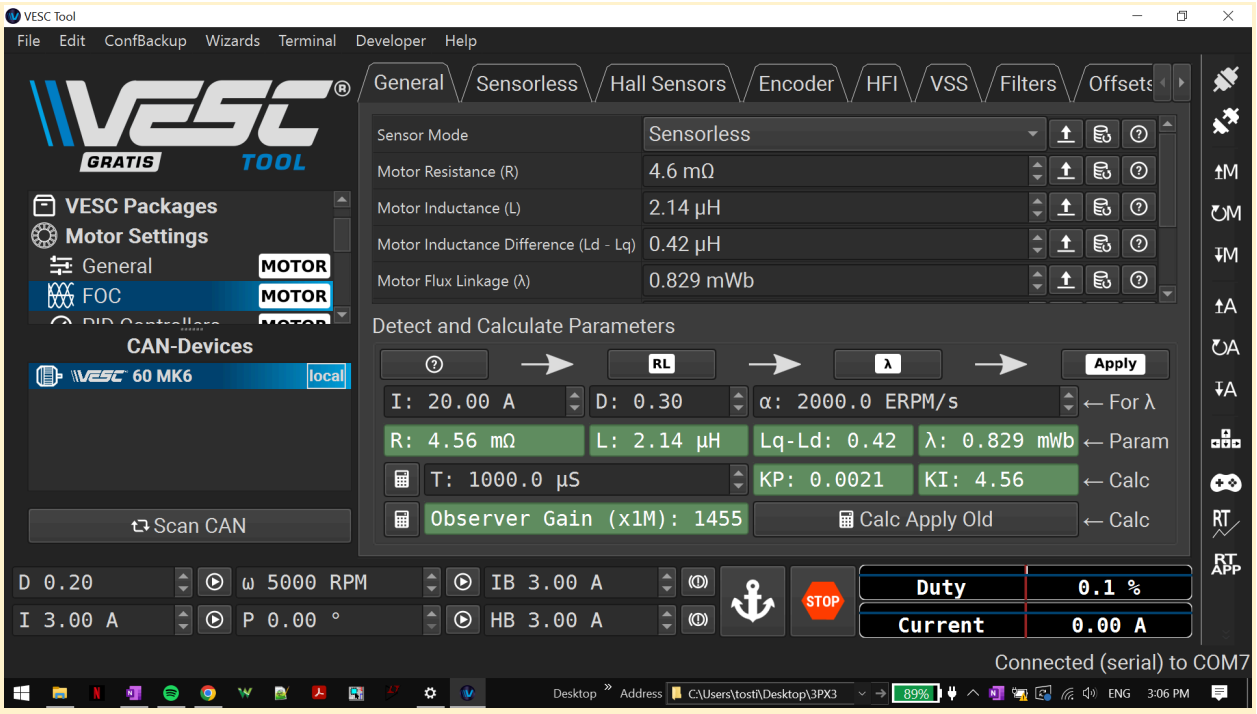
2024 - 02 - 09

Objective 3

This objective was led by Stefan, as he had a remote connection into the VESC. Luke was responsible for going over the lab manual and instructing the team what to do, and Soham was responsible for compiling all relevant information into the lab manual and answering questions.

Question 1

Screenshot of the VESC tools window when the identification process is done…



The first parameter here is R. R represents the resistance experienced by applied current that flows through the motor windings. It is important to determine the resistance of the motor for current control strategies, such as field oriented control, which allow us to achieve certain desired torque and efficiency.

L represents the inductance from the motors coils, and the motors ability to store energy in the form of a magnetic field. Inductance is important to determine because it plays a role in generating a back EMF. This back EMF opposes the applied voltage and helps with motor speed regulation.

Lambda represents the proportionality between the motor's back EMF and its rotational speed. Lambda can help with determining the needed applied voltage to generate a certain speed for the motor.

Objective 4

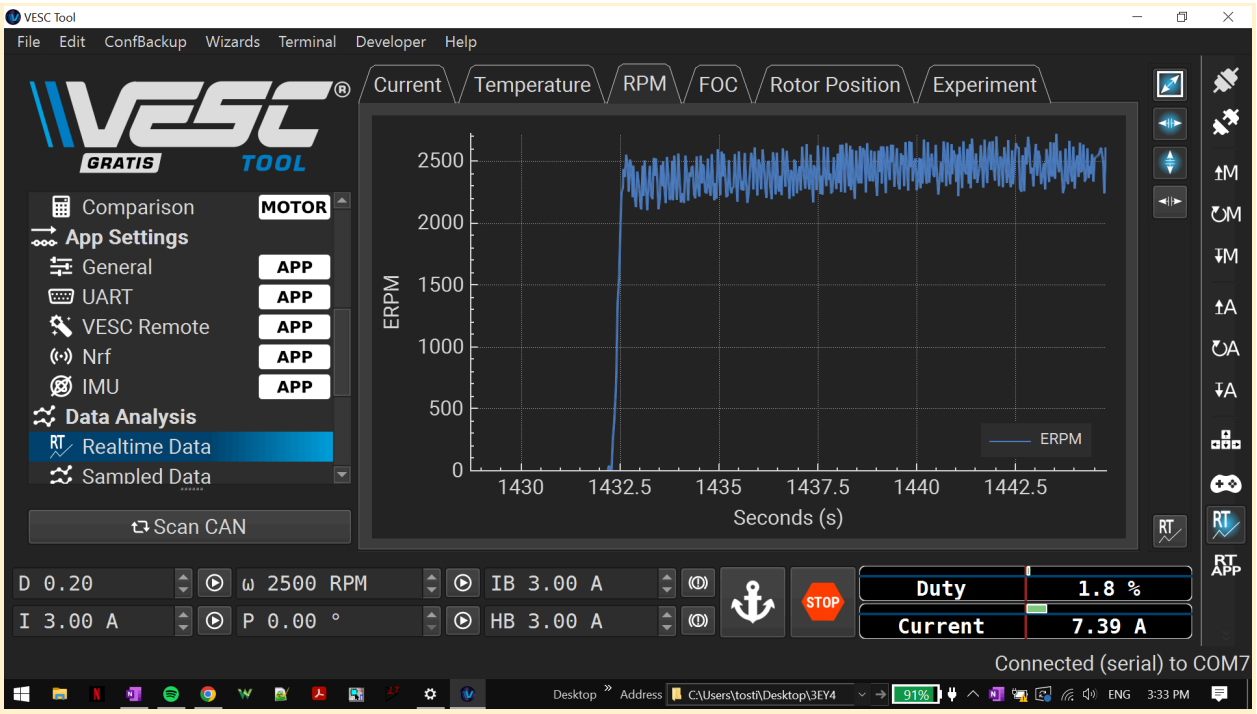
This objective was led by Soham, as he had a remote connection into the VESC. Stefan was responsible for going over the lab manual and instructing the team what to do, and Luke was responsible for compiling all relevant information into the lab manual and answering questions.

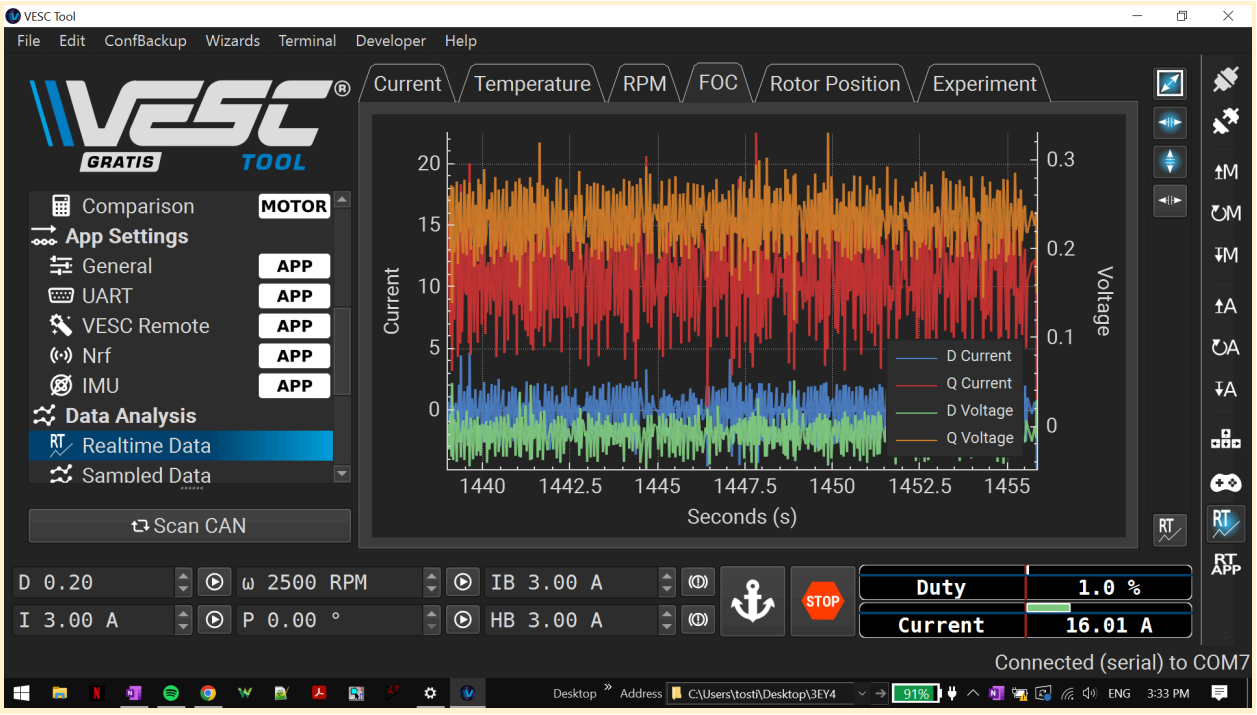
Question 2

PID is a control systems theory which uses a constant of proportionality, a derivative term, and an integral term to achieve a desired output from a system, given an ideal input value. For the McMaster AEV, tuning these PID parameters is crucial for achieving stable, responsive and accurate speed control of the motor.

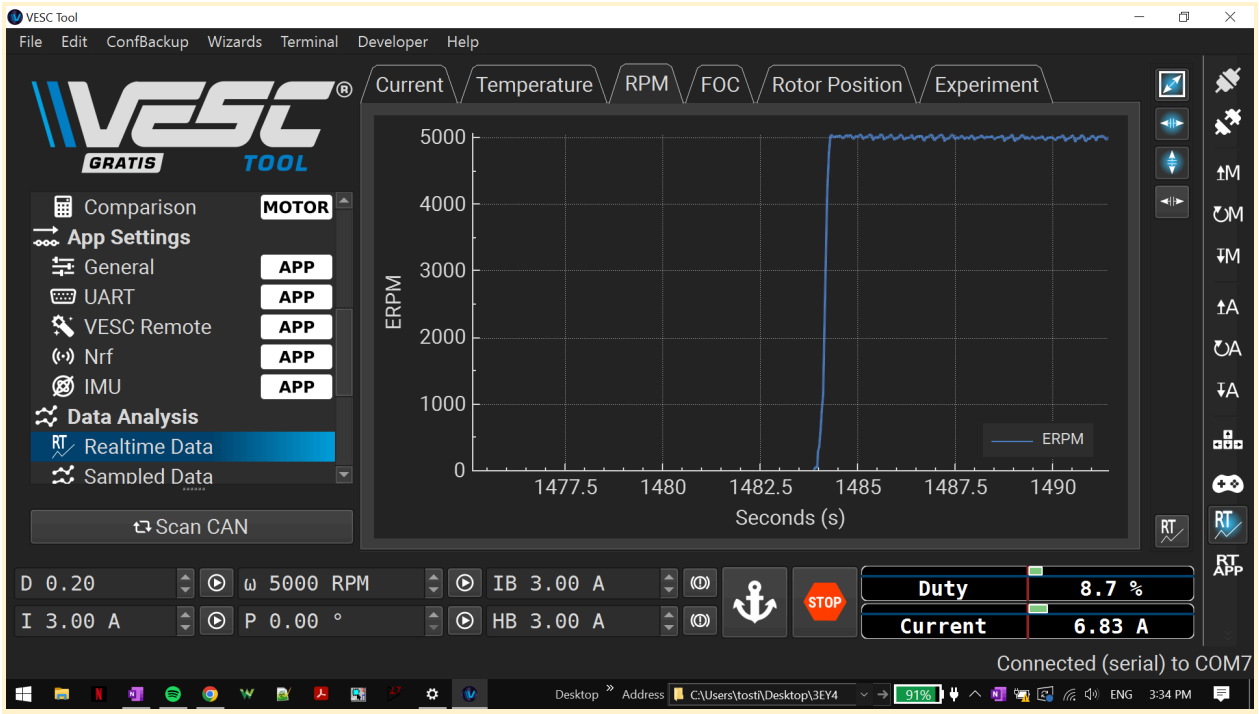
Question 3

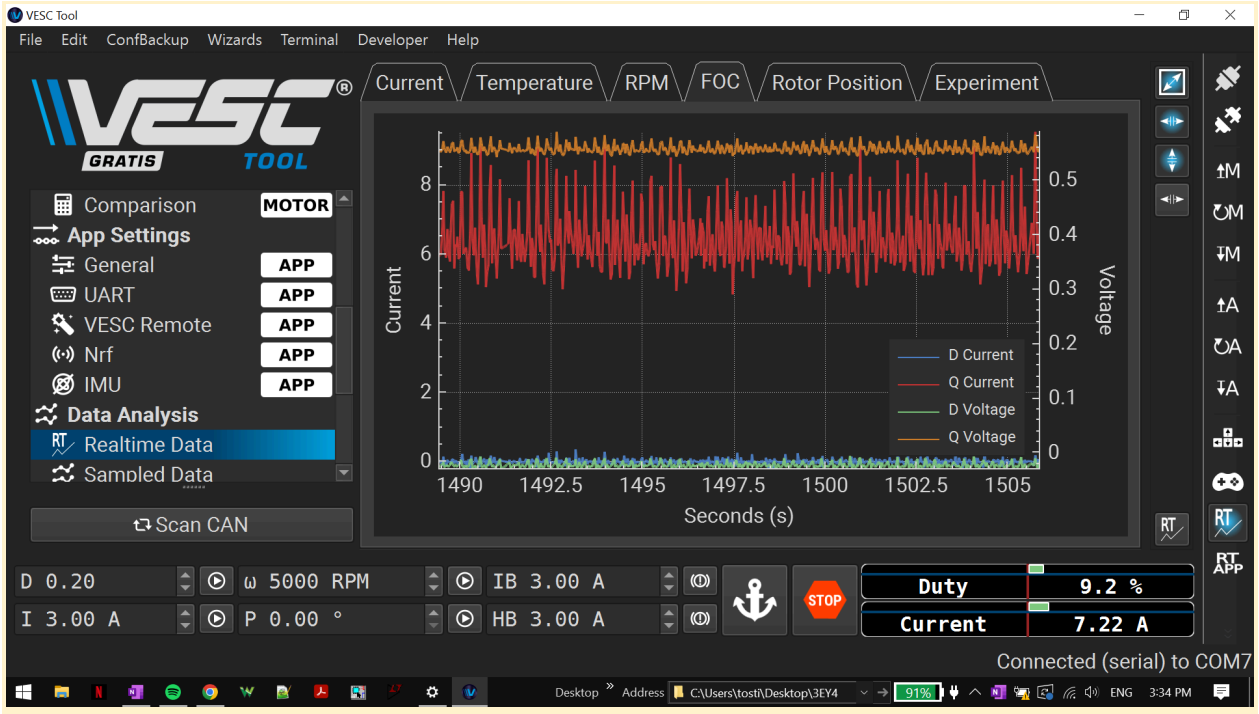
2500 - RPM & FOC graphs



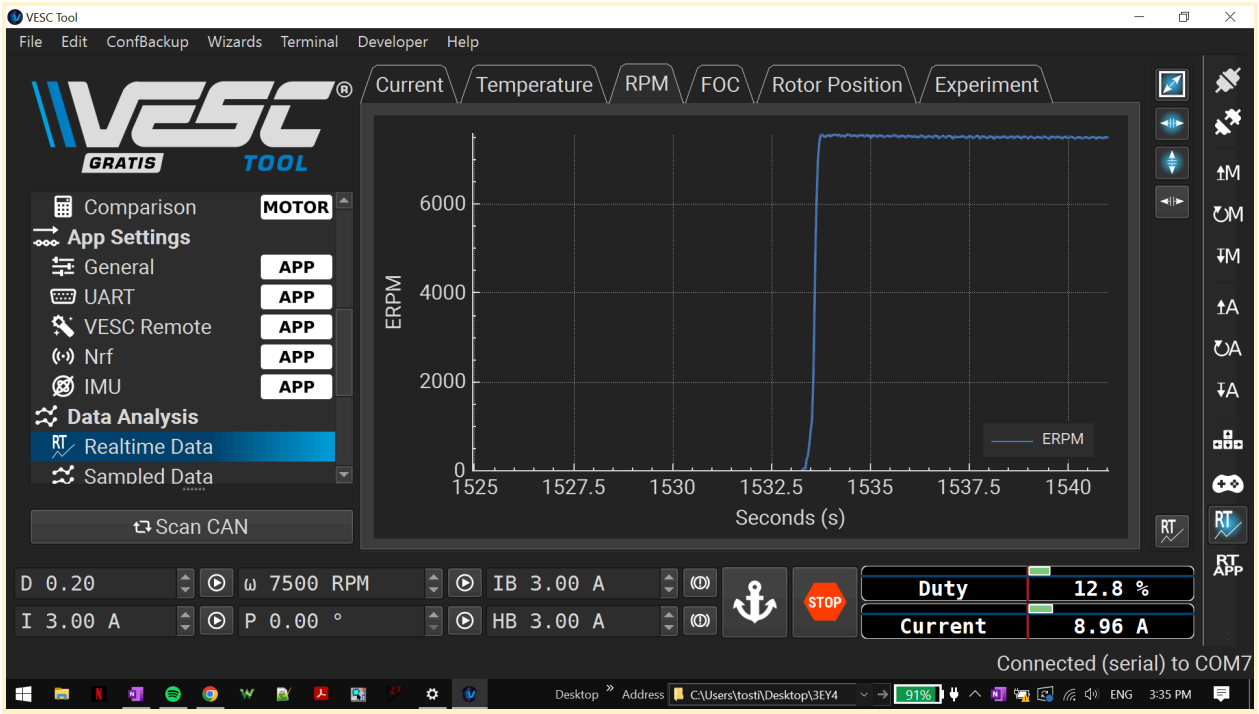


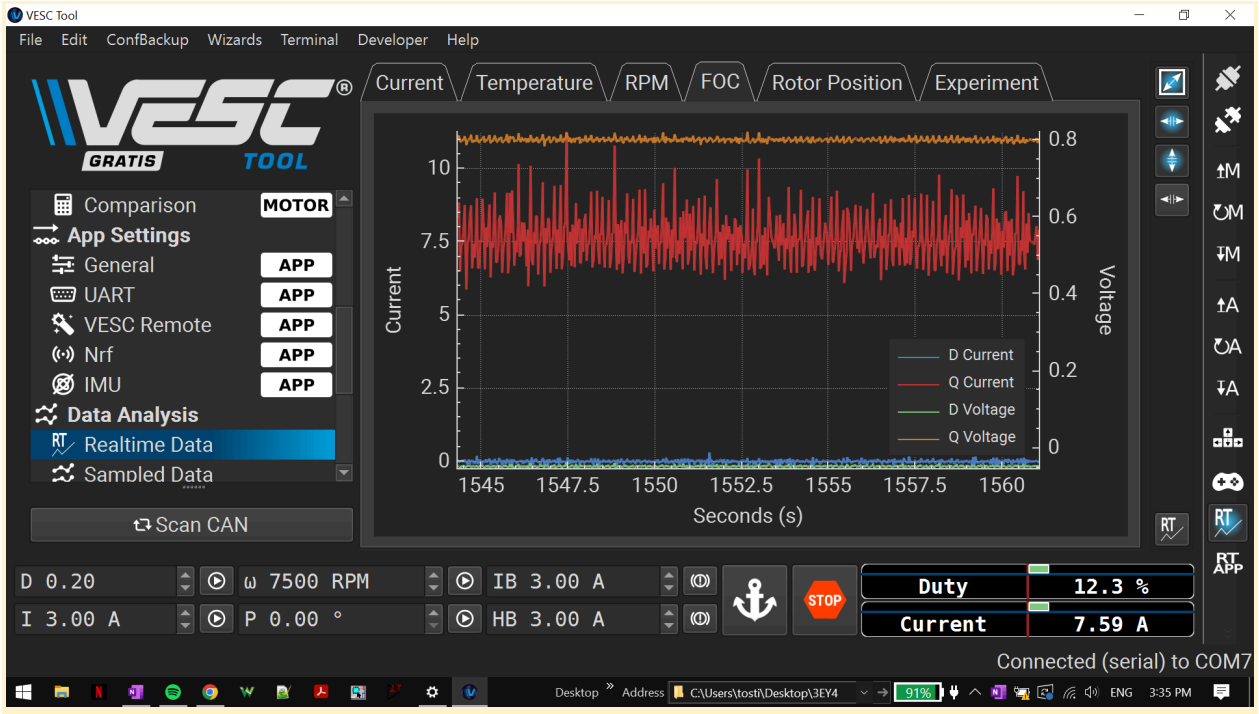
5000 - RPM & FOC graphs



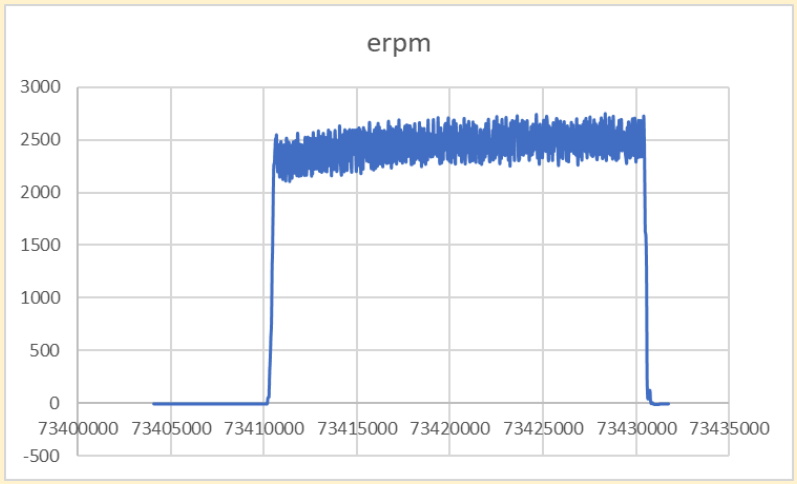


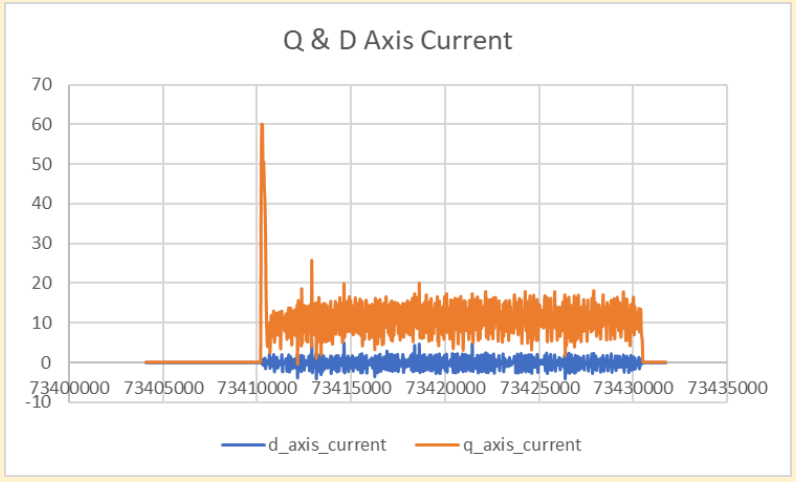
7500 - RPM & FOC graphs

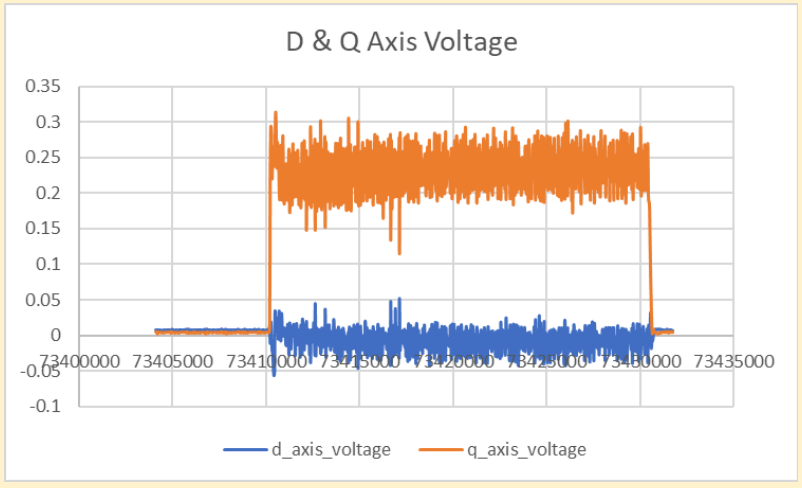




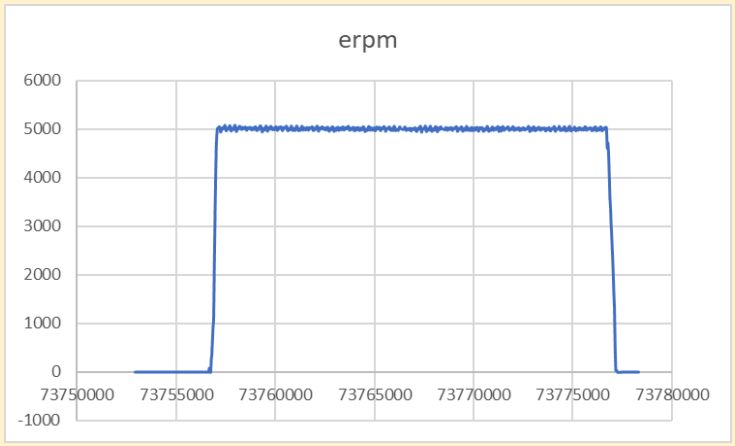
2500 RPM - Excel Plots

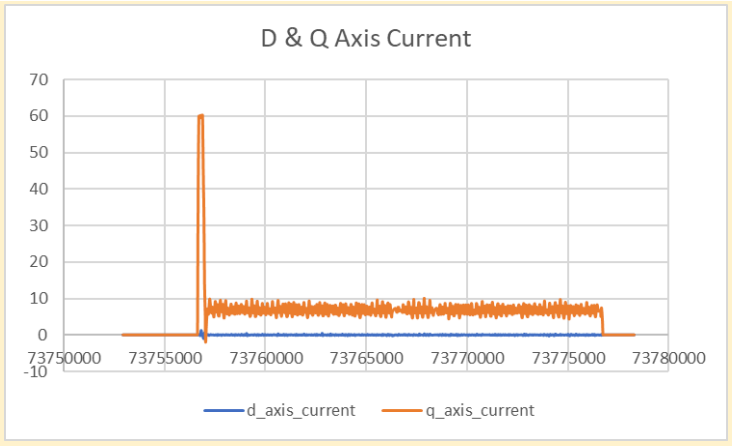


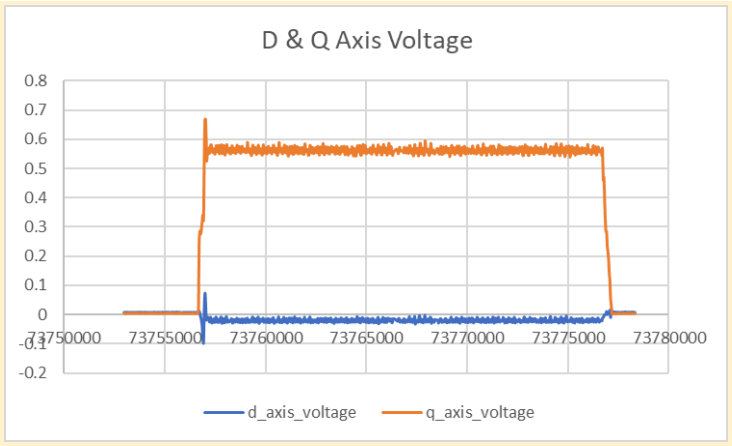




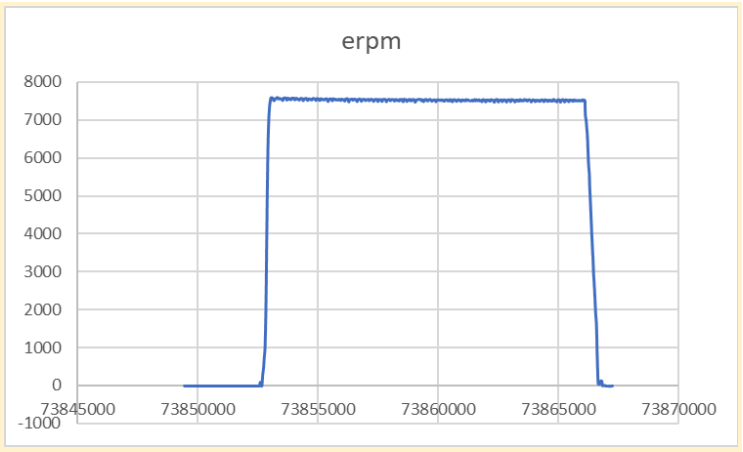
5000 - RPM, D-current, Q-current, D-voltage, Q-voltage

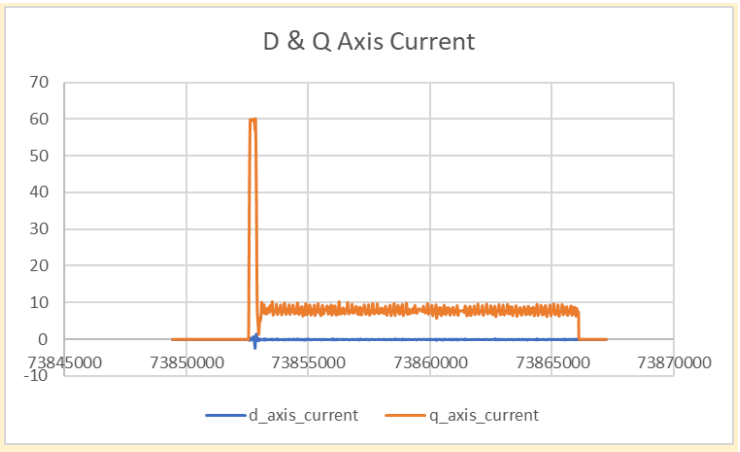


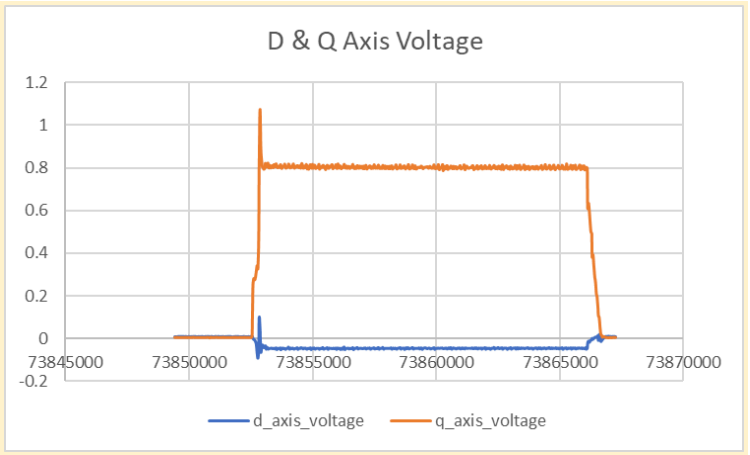




7500 - RPM, D-current, Q-current, D-voltage, Q-voltage

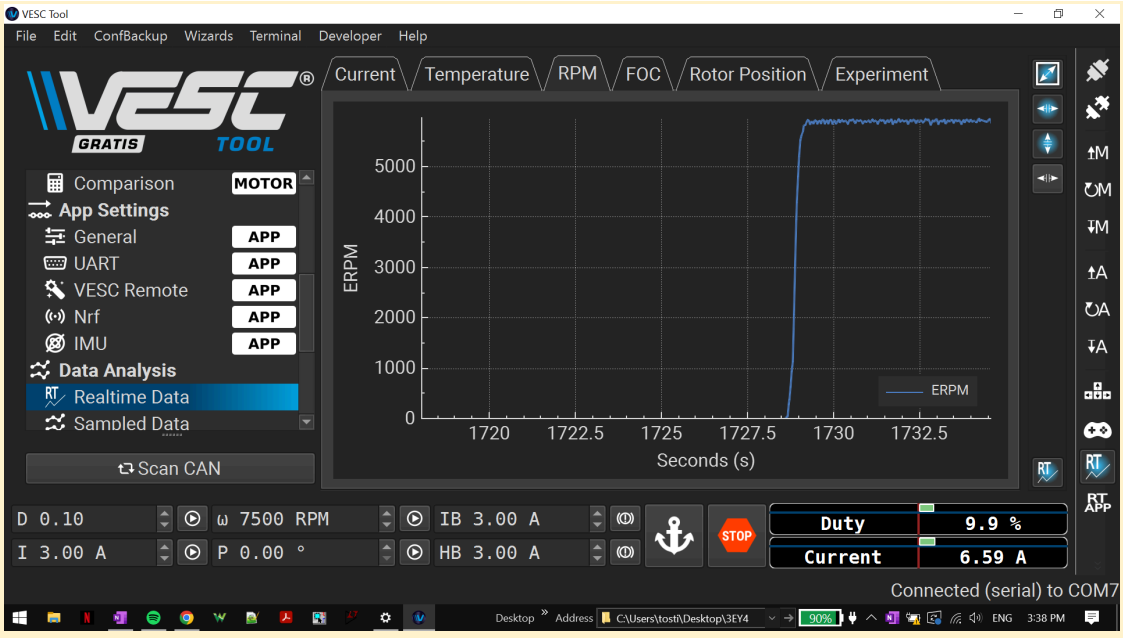


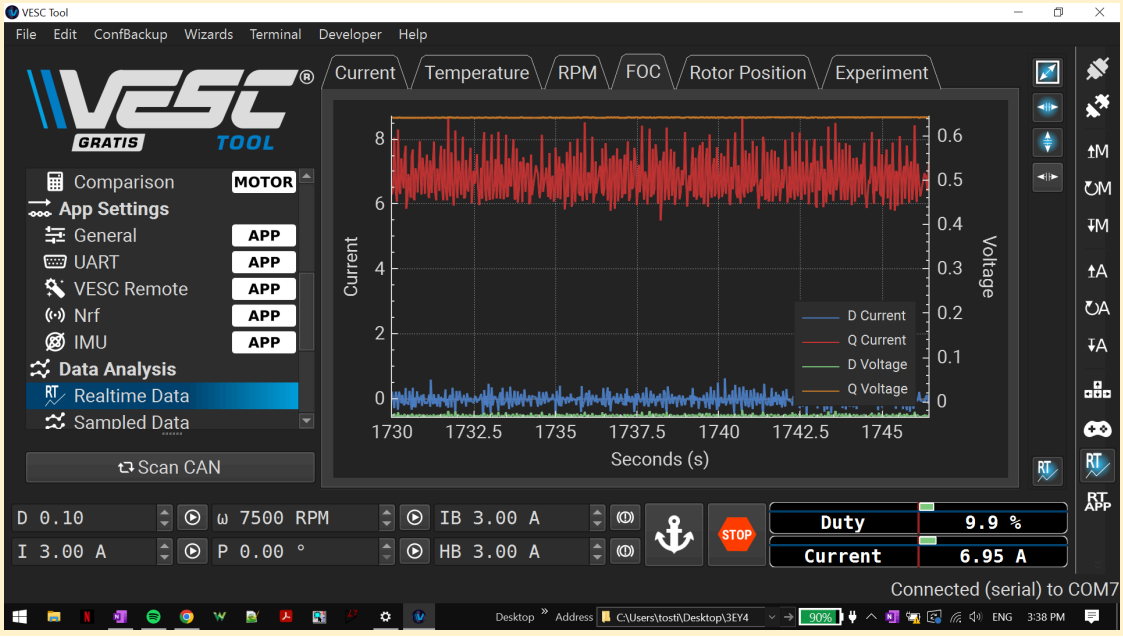




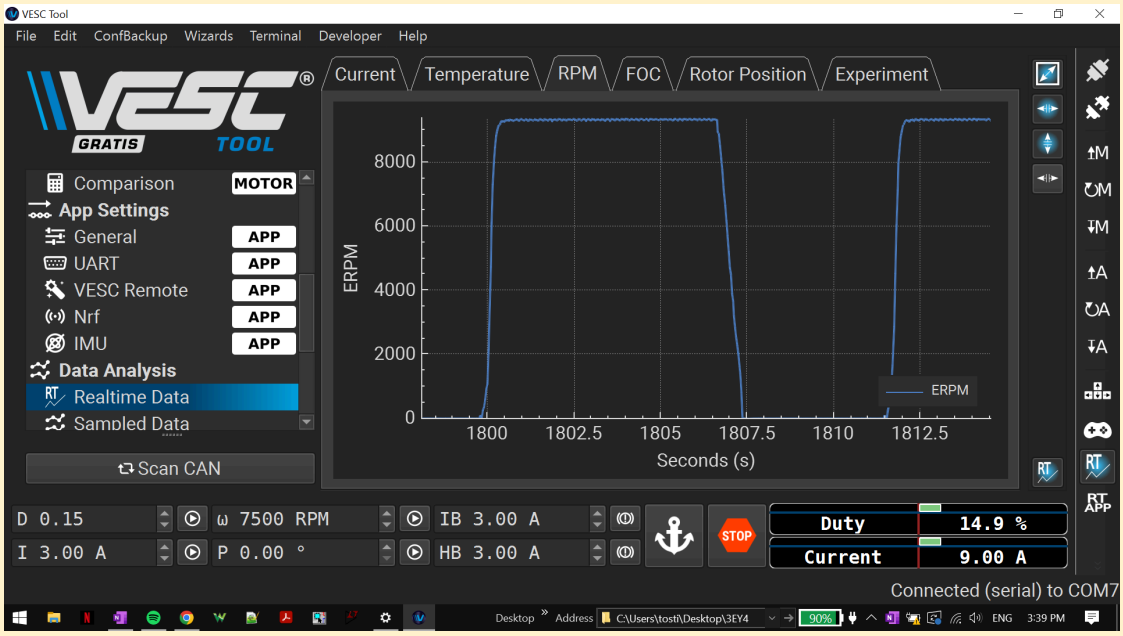
Question 4

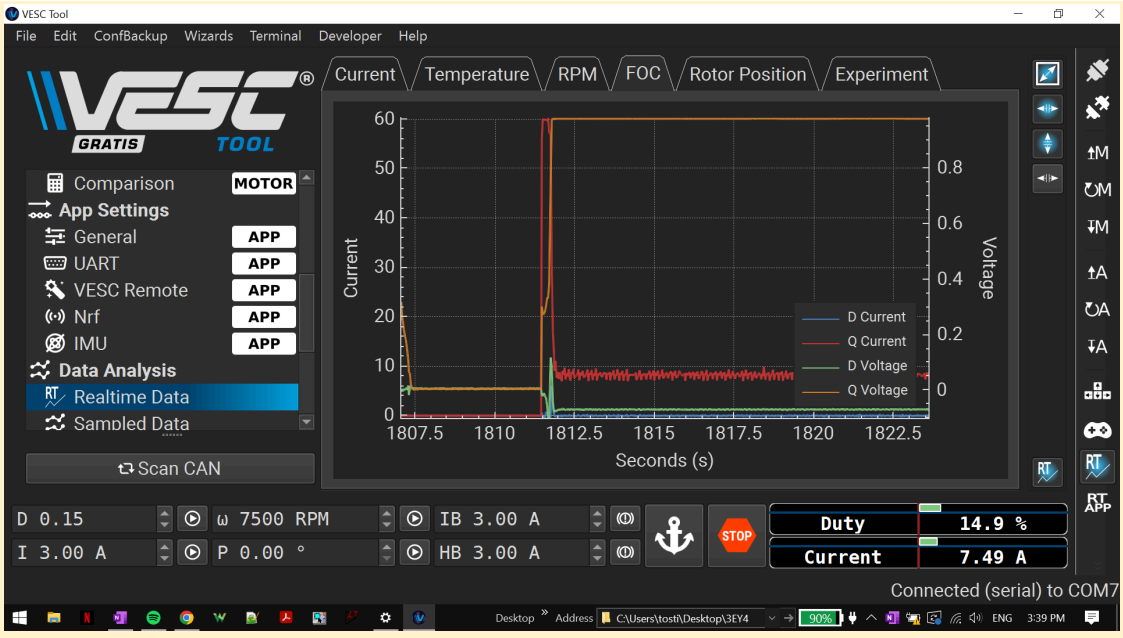
0.1 - RPM & FOC graphs



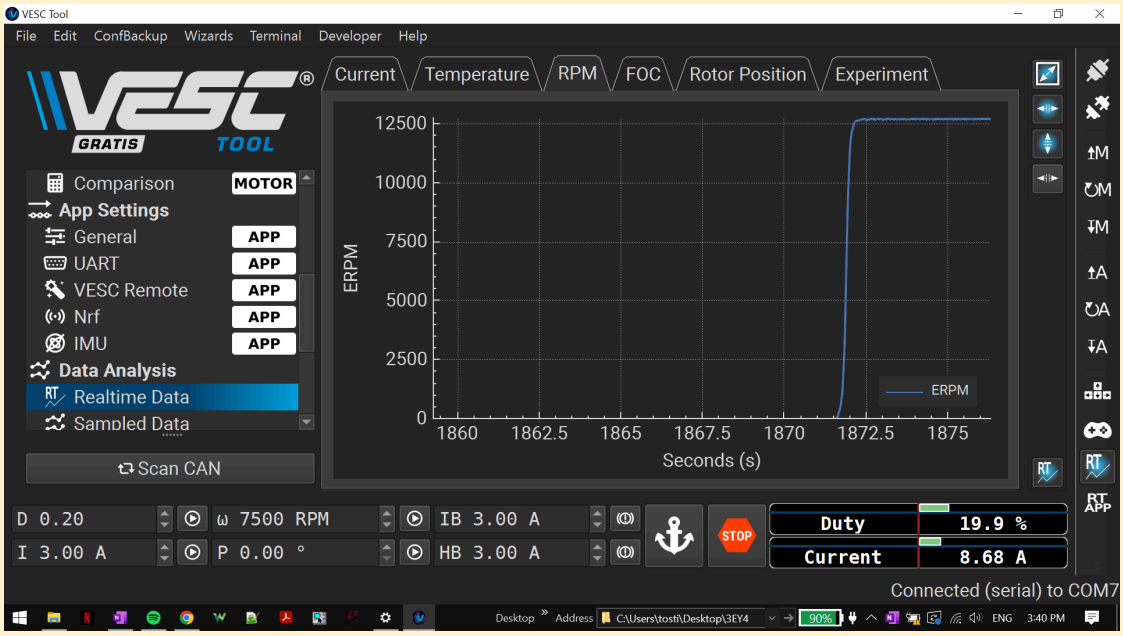


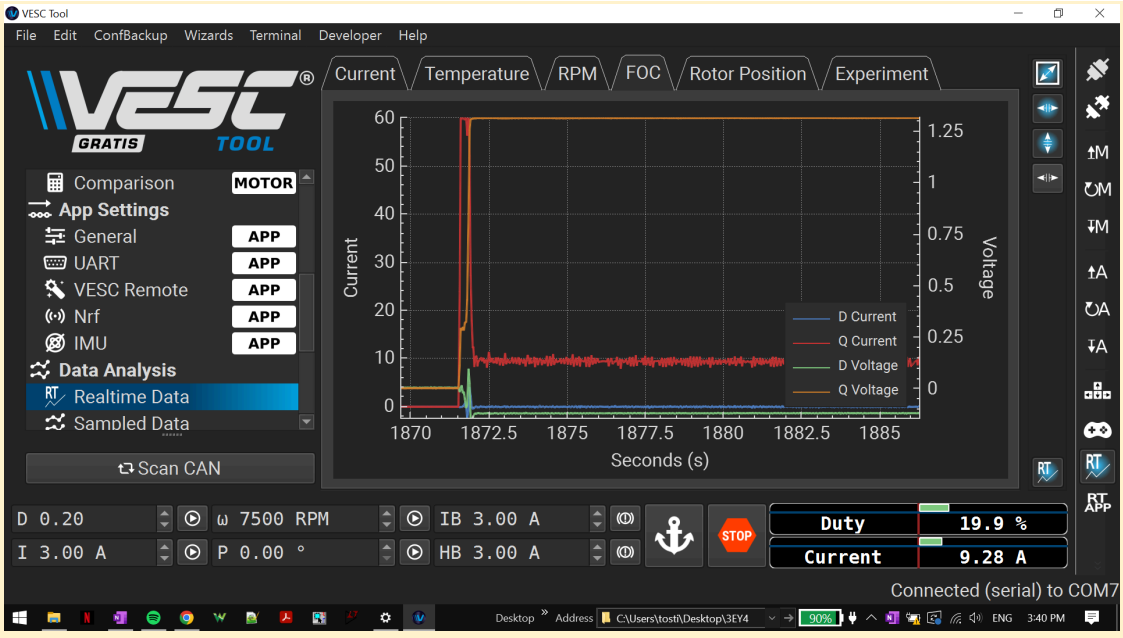
0.15 RPM & FOC graphs



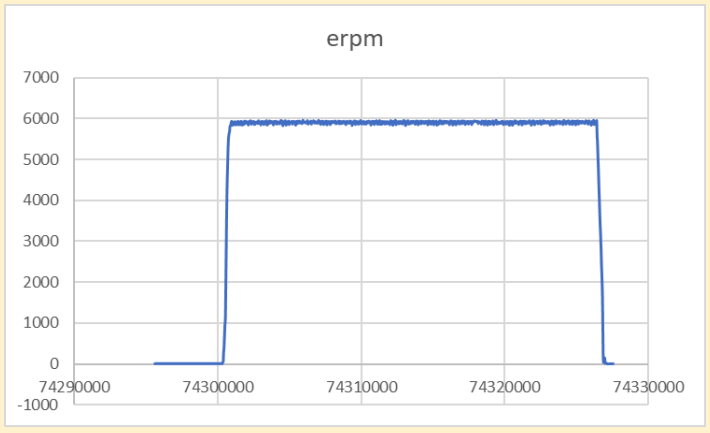


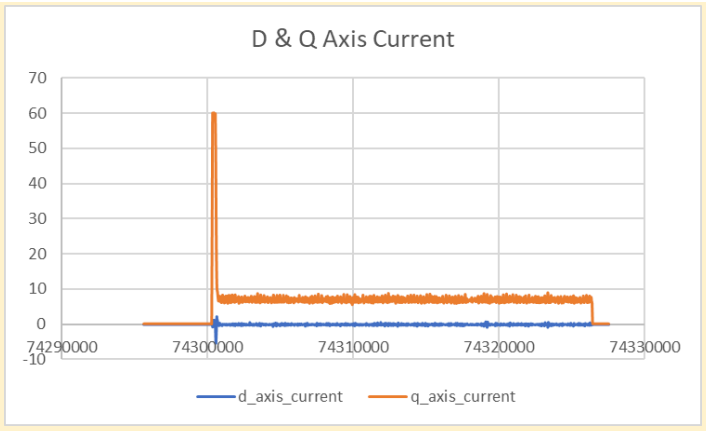
0.2 RPM & FOC graphs

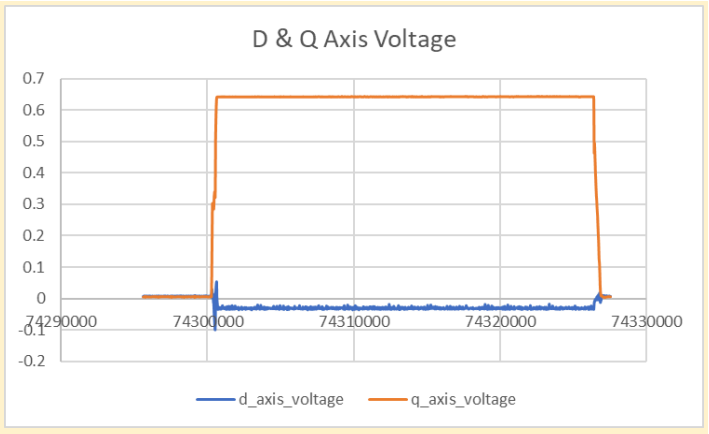




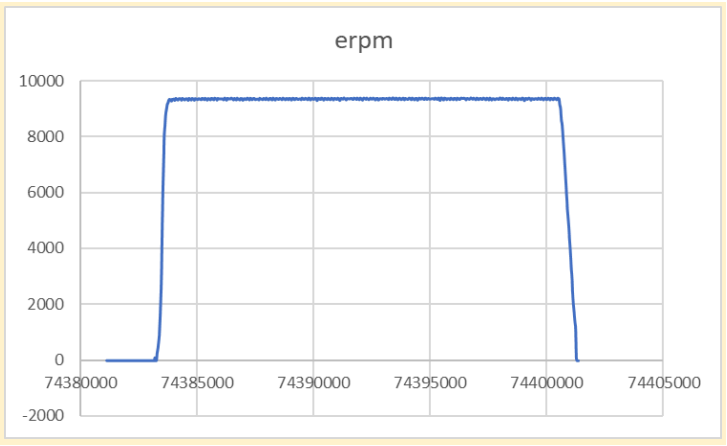
0.1 - RPM, D-current, Q-current, D-voltage, Q-voltage

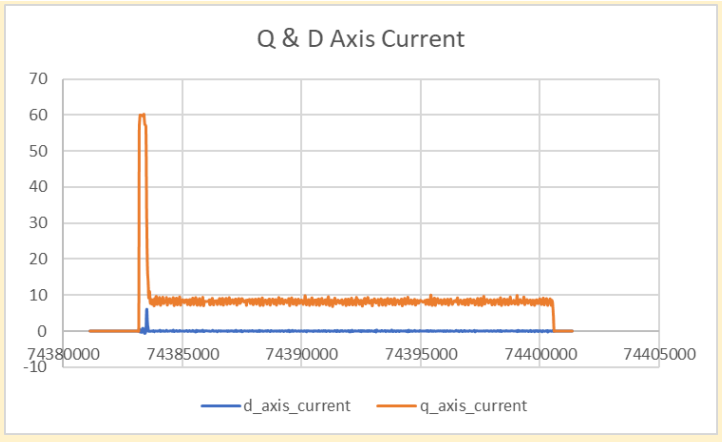


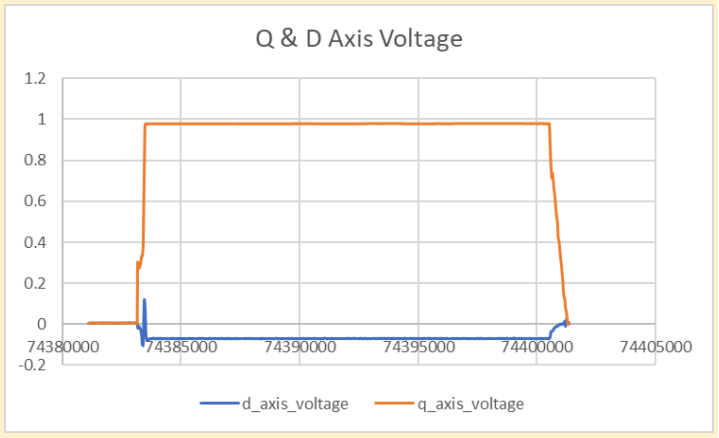




0.15 - RPM, D-current, Q-current, D-voltage, Q-voltage

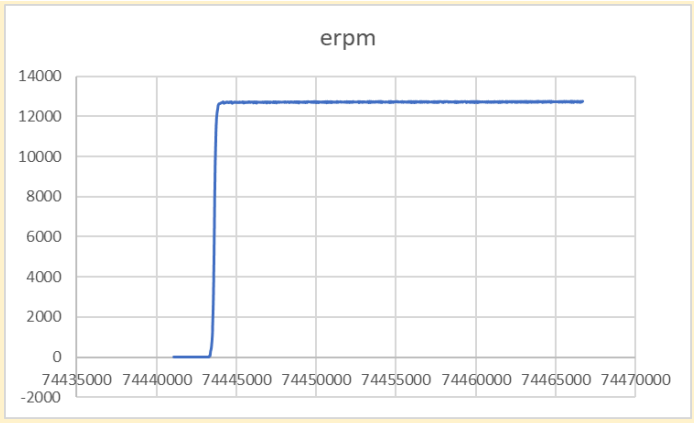


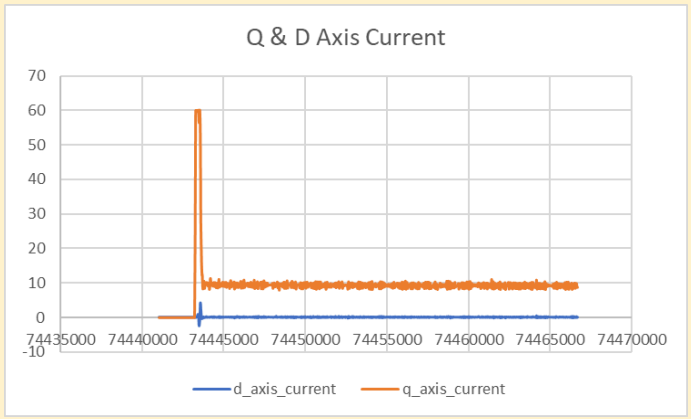


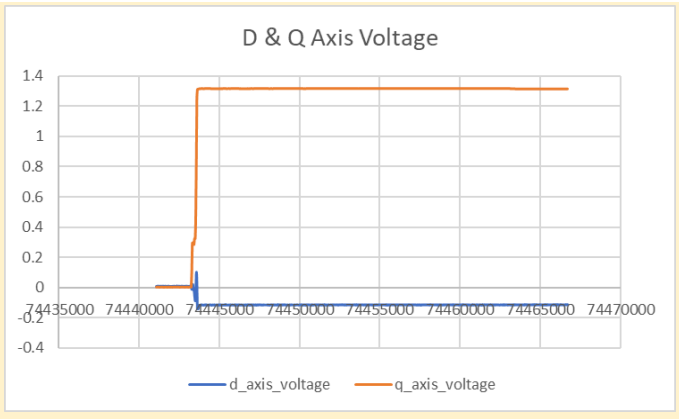


0.2 - RPM, D-current, Q-current, D-voltage, Q-voltage

** For this set of data our group accidentally turned the Real Time Data capture off before stopping the car







Question 5

While running the motor using the speed command versus the duty cycle command, our group mainly noticed that the duty cycle command seemed to control the motor much smoother, and thus made the rotation of the wheels less noisy and turbulent. We can confirm this idea by referring to the voltage, current and speed waveforms above. We can see that the graph of the duty cycle commands are far less noisy than that of the speed control, which confirms our observations.

Question 6

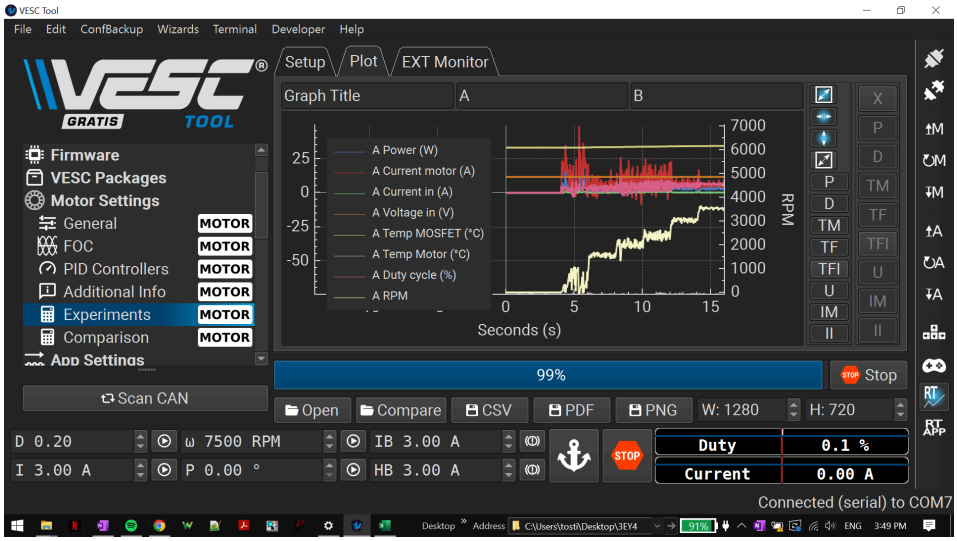
D-axis current is current that is directly aligned with the rotor magnetic field, and it primarily affects the field strength of the motor. D-axis current does not aid in torque production. Q-axis current is 90° out of phase with the rotor's magnetic field. Q-axis current is responsible for torque production in the motor. D-axis current is intentionally set to 0 in order to maximize torque produced by the q-axis current. When we apply current entirely on Q for the no-load case, all flux linkage must be on the d-axis because the excitation is entirely from permanent magnets.

Objective 5

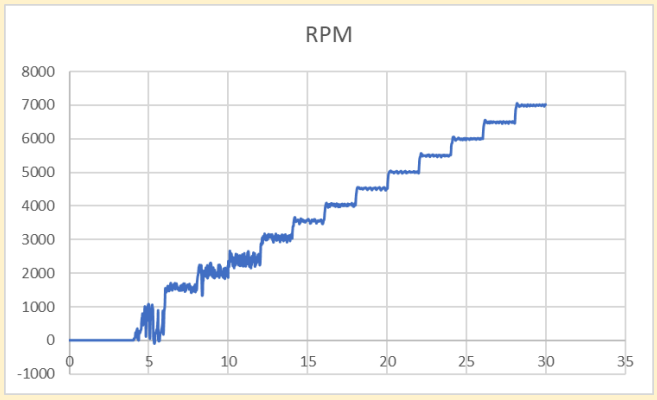
This objective was led by Luke, as he had a remote connection into the VESC. Soham was responsible for going over the lab manual and instructing the team what to do, and Stefan was responsible for compiling all relevant information into the lab manual and answering questions.

Question 7

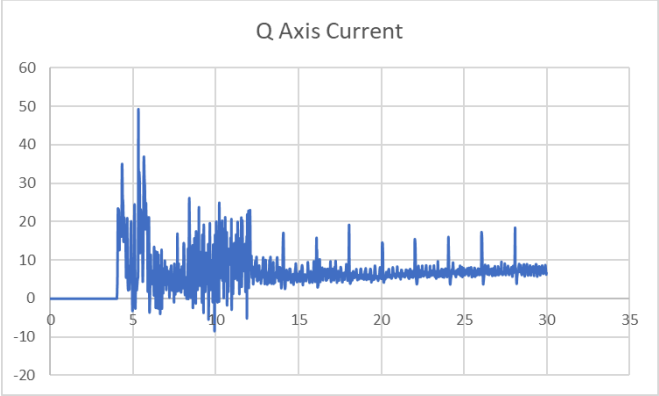
Realtime data tool using the built in VESC tool



RPM plot



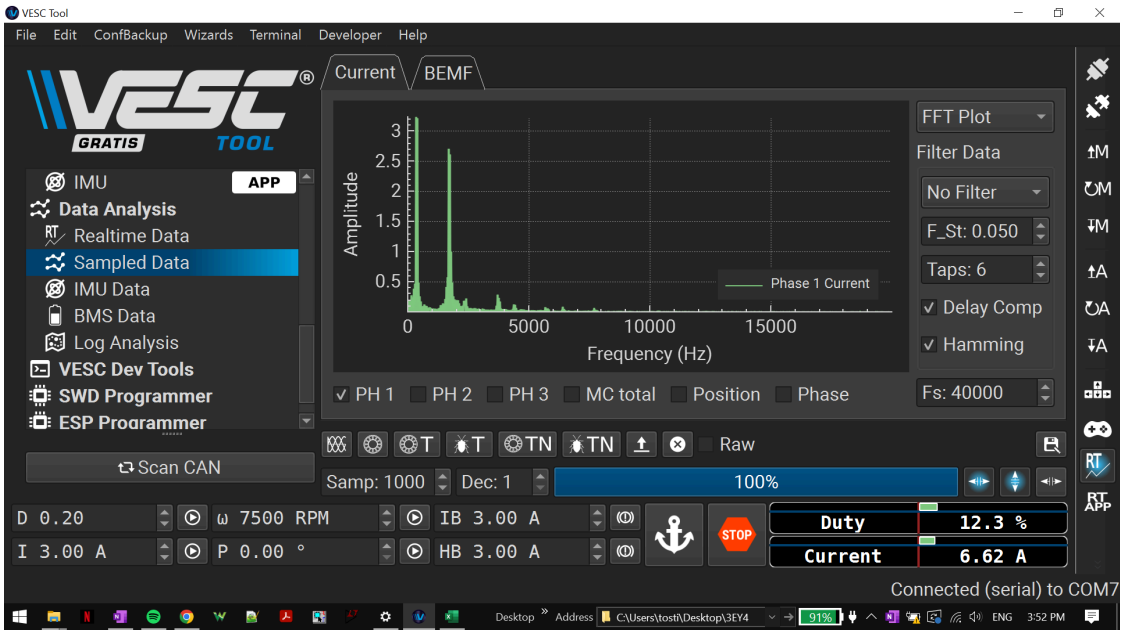
Q-axis current plot



Objective 6

Question 8

FFT plot…



Question 9

An FFT plot is a plot of the frequency spectrum of a signal using the Fast Fourier Transform algorithm. Looking at an FFT plot of phase currents can be helpful in diagnosing underlying problems, because it gives us insight into the harmonics and distortions that may not be evident in the time domain. Specifically, FFT plots can help us with rotor-related frequencies, like slip frequency, as well as stator winding resonance.