3. Pre-Lab Exercises

1. <u>Read</u> the lab handout and answer the following questions.

a. What quantity is typically measured to obtain an indirect measurement of force or torque?

Deformation and Strain

b. What are two reasons for using 4 strain gauges in the lab setup, as shown in Fig. 2?

Increases Sensitivity.

Decreases necessity to over amplify which over amplifies error as well.

2. Referring to Fig. 2, what is the resistance value of R_G that will give a gain of 1005.

0.08kΩ

3. What are the stall torque and no-load speed of a motor both directly proportional to?

Input Voltage

4. Given the stripe pattern shown in Figure 6, how would you convert from the frequency of the signal measured by the optical pickup to the rotational speed of the motor shaft in RPM?

Velocity of Shaft [revolutions/min] = (frequency/number of stripes/gear ratio) * 60

5. Using equation (10), find the maximum power output for a DC motor in terms of the stall torque and no-load speed. What is the rotational speed at which max powers occur?

$$P = -\frac{Ts}{\Omega nl}\Omega^2 + Ts\Omega$$

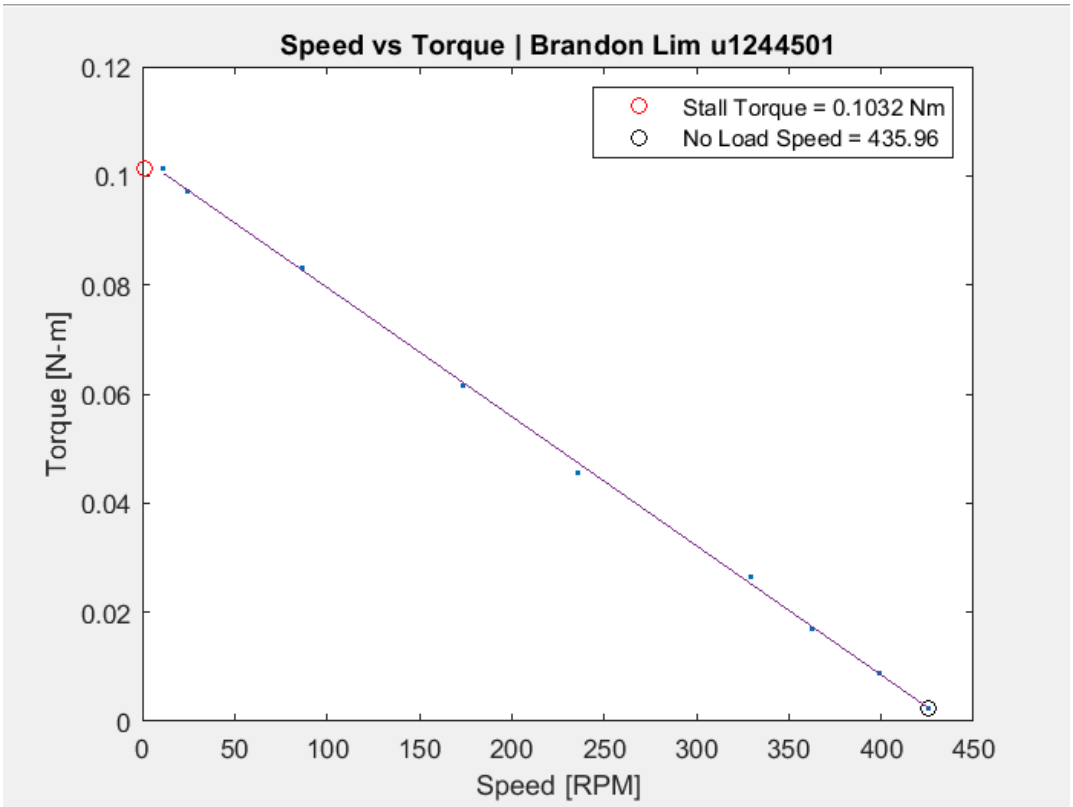
$$\frac{dP}{d\Omega} = 0 = -\frac{2Ts\Omega}{\Omega nl} + Ts$$

$$\Omega = \frac{\Omega nl}{2}$$

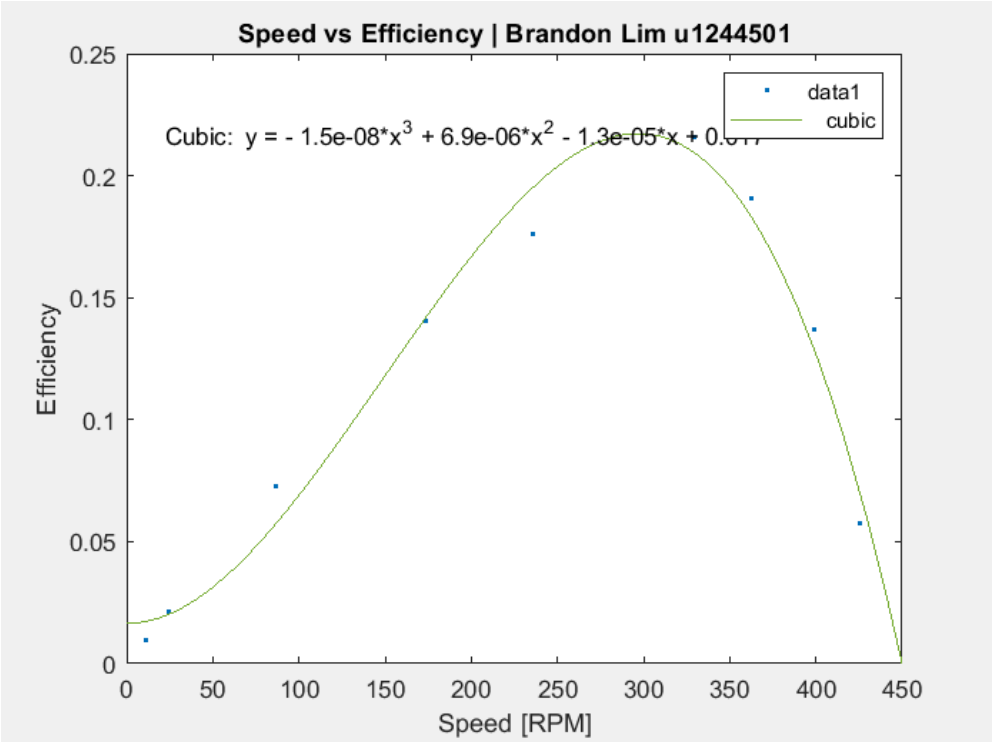
$$P_{max} = -\frac{Ts\Omega nl}{4} + Ts\frac{\Omega nl}{2}$$

6. The *Lab10_motordata.mat* file contains rotational speed (rad/s), measured torque (N-m), motor current (A), and applied voltage (V) from a dynamometer test. Using this data do the following. Be careful of units:

a. Generate a Torque (N-m) vs Speed (RPM) curve, with proper labels. Display the stall torque and no-load speed values on the plot. Attach your plot to the pre-lab.



b. Generate an Efficiency vs Speed (RPM) curve with proper labels. Attach your plot to the pre-lab.



```
%Brandon Lim u1244501
clear, clc, close all
load("Lab10_motordata.mat");

figure
plot(((Speed./(2*pi)).*60),Torque,".")
xlabel("Speed [RPM]")
ylabel("Torque [N-m]")
title("Speed vs Torque | Brandon Lim u1244501")
hold on
plot(Speed(end),Torque(end), "ro")
plot((Speed(1)/(2*pi)*60),Torque(1), "ko")
fit1 = fitlm(((Speed./(2*pi)).*60),Torque)
plot(((Speed./(2*pi)).*60),(0.10321-0.00023674.*(((Speed./(2*pi)).*60))))
hold off
NoLoad = 0.10321/0.00023674
Tstall = 0.10321
legend("","Stall Torque = 0.1032 Nm","No Load Speed = 435.96")

figure
eta = (Torque .* Speed) ./ (Volt .* Current);
plot(((Speed./(2*pi)).*60),eta,".")
xlabel("Speed [RPM]")
ylabel("Efficiency")
title("Speed vs Efficiency | Brandon Lim u1244501")
```