Comparing Drone Motors

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Design Experiment

Lab section: 1
Group: A

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NORTHERN ARIZONA UNIVERSITY
Mechanical Engineering

ABSTRACT

This experiment characterizes the electromechanical performance of three brushless motors—Mad Jenny, Mad Jennington, and Melon Motor—operating as permanent-magnet synchronous generators. Voltage, current, torque, and rotational speed were measured under no-load, constant-resistance, and constant-current conditions using a calibrated dynamometer system. These measurements were used to compute mechanical power, electrical power, efficiency, and Kv. Calibrated sensors with quantified uncertainties provided error-propagated results. Kv values were measured as 158 (Mad Jenny), 189 (Mad Jennington), and 361 (Melon Motor), demonstrating the expected trend that lower Kv motors generate higher voltage per RPM and stronger electromechanical coupling. Kv curves include error bars based on voltage, RPM, and regression uncertainty. Across all tests, voltage scaled linearly with speed, constant-resistance power curves followed the expected parabolic V^2/R trend, and constant-current power curves were linear due to $P = VI$. Efficiency increased with speed in constant-resistance tests and was more irregular in constant-current tests because of higher current-measurement error. Peak electrical power reached 263 W for Mad Jenny, 156 W for Mad Jennington, and 94 W for Melon Motor. Efficiencies exceeded 90% for Mad Jenny and remained below 70% for Melon Motor. Results show a clear inverse relationship between Kv and generator performance, with lower-Kv motors producing higher voltage and power. Overall, Mad Jenny delivered the strongest and most consistent generator behaviour, though optimal motor selection remains application-dependent for NAU's Collegiate Wind Competition turbine design.

INTRODUCTION

Northern Arizona University's (NAU's) Collegiate Wind Competition (CWC) team relies on permanent-magnet synchronous generators (PMSGs) to convert rotor-shaft motion into usable electrical power for their competition wind turbines. A PMSG operates by electromagnetic induction: external mechanical rotation drives permanent magnets past stator windings, inducing a voltage proportional to rotational speed. Two performance characteristics—Kv rating and efficiency—are critical for predicting how well a generator will pair with a wind turbine. Kv represents the PMSG's speed-to-voltage constant (RPM per volt generated). In practice, a lower Kv indicates stronger electromagnetic coupling and typically suggests improved power generation.

The objective of this experiment is to characterize the Kv rating, electrical power output, mechanical power input, and efficiency of three PMSGs—Mad Jenny, Mad Jennington, and Melon Motor—under no-load, constant-resistance, and constant-current conditions, as shown in Figure 1.

(a) Mad Jenny **(b)** Mad Jennington **(c)** Melon Motor

Figure 1: PMSGs being experimented

The purpose of this analysis is to provide the CWC team with validated generator performance data to inform wind turbine design choices. Based on basic electromechanical energy-conversion theory and Ohm's Law, it is hypothesized that lower-Kv PMSGs will exhibit higher efficiency and power production across the tested loading conditions.

Voltage, current, rotational speed, and torque are measured digitally using microcontroller-based sensing. These measurements require conversion to physical quantities before Kv, power, and efficiency can be computed. To simplify the electromechanical model, the analysis assumes steady-state operation, allowing direct application of Ohm's Law to generator behavior; and negligible voltage losses, permitting electrical power to be computed directly from terminal measurements. These assumptions are later assessed by comparing measured and applied load parameters.

Under these assumptions, the following governing equations are defined:

PMSG Kv rating is defined as:

$$\mathrm{Kv} = \frac{\omega}{\mathrm{V}} \tag{1}$$

where Kv is the unloaded RPM per volt rating (RPM/V), ω is the rotational speed (RPM), and V is the open-circuit voltage (V).

PMSG efficiency is defined as:

$$\eta = \frac{P_e}{P_m} \tag{2}$$

where η is efficiency, P_e is the electrical power output (W), and P_m is the mechanical power input (W).

Ohm's Law is defined as:

$$V = IR \tag{3}$$

where V is voltage (V), I is current (A), and R is resistance (Ω).

Equations 1 – 3 provide the basis for comparing PMSG performance across loading conditions and are quantified with the following measurement equations:

Measured analog-to-digital converter (ADC) voltage is defined as:

$$V_{ADC} = \frac{V_{ref}}{2^N} * n \tag{4}$$

where V_{ADC} is the measured ADC voltage (V), V_{ref} is the ADC reference voltage (V), N is the number of bits in the ADC, and n is the digital reading.

Voltage is defined as:

$$V = V_{ADC}\frac{R_1 + R_2}{R_2} \tag{5}$$

where V is the PMSG voltage (V), V_{ADC} is measured ADC voltage (V), and R is resistance within the voltage divider (Ω). Since most ADCs can safely read up to 5 V and the PMSGs will produce more than 5 V, a voltage divider is applied to measure PMSG voltage.

Current is defined as:

$$I = \frac{V_{ADC} - \frac{V_{ref}}{2}}{s} \tag{6}$$

where I is the current (A), V_{ADC} is the measured ADC voltage (V), V_{ref} is the ADC reference voltage (V), and s is the static sensitivity of the current sensor (V/A).

Rotational speed is defined as:

$$\omega = \frac{60 * f}{p * \omega'} \tag{7}$$

where ω is rotational speed (RPM), f is the microcontroller's clock frequency (Hz), p is the prescaler, and w' is the measured cycles per revolution (cycles/rev). The parameters in Equation 7 are part of a timing utility within microcontrollers. Specifically, the prescaler is used to help the microcontroller relate it's clock frequency to the real time, which creates precise timing for rotational speed.

Torque is defined as:

$$T = m * g * r \tag{8}$$

where T is torque (N-mm), m is mass (kg), g is the gravitational constant (m/s^2), and r is the moment arm length (mm). Equation 8 will help determine the reaction torque made from the PMSG by making a calibration curve against the digital measurement of torque.

Mechanical power input is defined as:

$$P_m = T\omega \tag{9}$$

where P_m is the mechanical power input (W), T is the PMSG reaction torque (N-mm), ω is the PMSG rotational speed (rad/s).

Electrical power output is defined as:

$$P_e = VI = \frac{V^2}{R} \tag{10}$$

where, P_e is the PMSG electrical power output (W), V is PMSG voltage (V), I is PMSG current (A), and R is the applied resistance to the PMSG (Ω).

These calculated quantities allow direct comparison of power generation capability and efficiency among the three PMSGs and enable assessment of the hypothesis regarding Kv performance.

The following equations are the general error propagation equations that are used to determine the uncertainty within all calculations.

Weighted average equations are defined as:

$$w = \frac{1}{{u_x}^2} \tag{11}$$

$$\bar{x}_w = \frac{\sum(wx)}{\sum w} \tag{12}$$

$$u_{\bar{x}} = \sqrt{\frac{1}{\sum w}} \tag{13}$$

where w is the weight of a sample's uncertainty, u_x is the sample's uncertainty, x is the sample measurement, x_w is the weighted average, and u_{xw} is the uncertainty of the weight average.

Error propagated uncertainties are defined as:

$$\theta_i = \frac{\partial R}{\partial x_i} \tag{14}$$

$$u_r = \sqrt{\sum \left(\theta_i u_{x_i}\right)^2} \tag{15}$$

where θ_i is the partial derivative equation of the measurement equation with respect to the variable being error propagated, R is the measurement equation, x_i is the error propagated variable, u_{xi} is the error propagated uncertainty, and u_r is the error propagated measurement uncertainty.

Design uncertainty is defined as:

$$u_d = \sqrt{\sum {u_i}^2} \tag{16}$$

where u_d is the design uncertainty and u_i is an uncertainty.

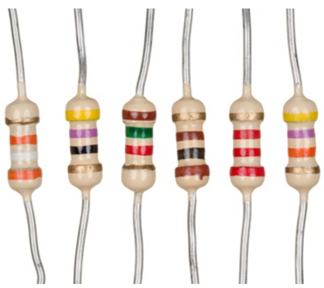
DESIGN

The required components to quantify the performance of the PMSGs are shown in Figure 2.

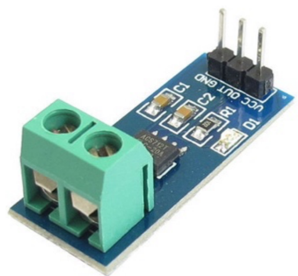
(a) AmpFlow E30-150 Motor

(b) RIGOL DL3201 Programmable DC Electronic Load

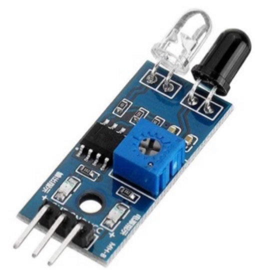
(c) 3 Phase Bridge Rectifier



(d) Resistors

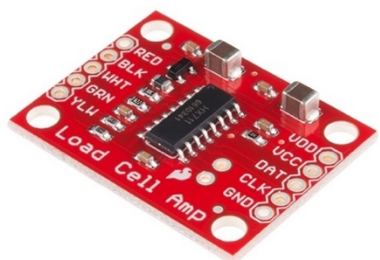


(e) 30 Amp Current Sensor

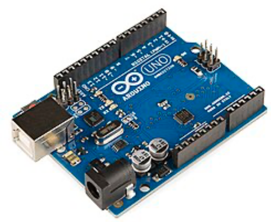


(f) Infrared Sensor

(g) Reaction Torque Transducer

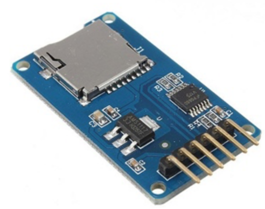


(h) HX711 Load Cell Amplifier



(i) Arduino Uno

(j) Liquid Crystal Display Screen



(k) SD Card Reader

Figure 2: Components of Design

The components in Figure 2 integrate to form the dynamometer-based DAQ system. Figure 3 presents the system-level block diagram, illustrating how each device interfaces with the others to obtain the electrical and mechanical measurements needed to characterize the PMSGs.

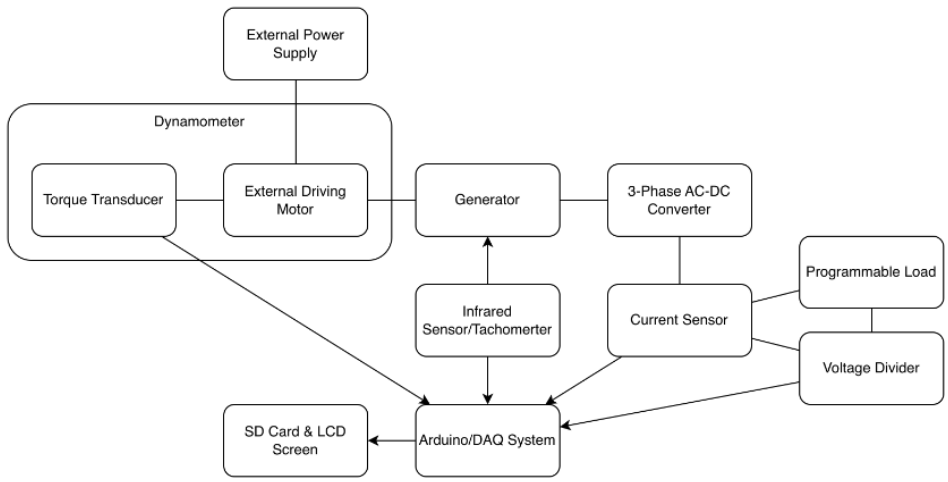


Figure 3: Design System Set-up Block Diagram

The PMSG under test is mechanically coupled to the dynamometer (dyno). The dyno consists of an external motor connected to a reaction torque transducer. The external motor is powered by a dedicated supply and can reach speeds up to 5600 RPM at full throttle. During testing, it drives the PMSG, inducing rotational speed and enabling the generator to produce voltage.

The programmable DC load is connected in parallel with the PMSG output. It provides either a constant resistance or constant current, allowing controlled loading conditions. As the generator supplies electrical power to the load, the resulting electromagnetic torque is transmitted back through the shaft to the torque transducer, enabling measurement of mechanical power.

The PMSG's three-phase AC output is converted to DC using a three-phase bridge rectifier. Under no-load conditions, only voltage and rotational speed are measured. Under constant-resistance or constant-current loading, voltage, current, speed, and torque are all measured.

Each measurement channel is conditioned before entering the DAQ system. The generator voltage passes through a voltage divider to keep the Arduino input within safe limits. Current is sensed using a Hall-effect current sensor that outputs a proportional voltage to the Arduino. Rotational speed is captured by an infrared (IR) sensor aimed at the generator shaft; each detected pass produces a digital pulse. Torque is measured by the reaction torque transducer, which sends an analog signal to the HX711 load-cell amplifier for high-resolution digital conversion.

The Arduino receives all digitized sensor signals, applies the appropriate calibration equations, and computes true voltage, current, speed, and torque values. These processed measurements are displayed on the LCD screen and logged to the SD card for post-processing.

Figure 4 shows the physical implementation of the dyno-integrated DAQ system. Components such as the voltage divider, current sensor, load-cell amplifier, and SD card module are mounted within the DAQ enclosure for organization and reliability.

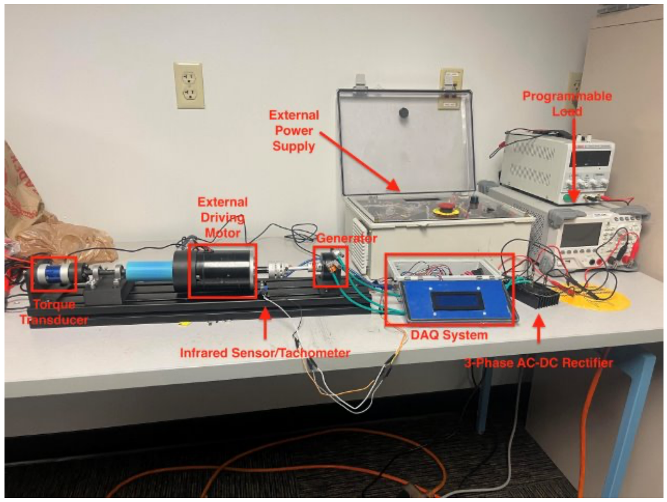


Figure 4: Physical Testing Apparatus

METHOD

With the Arduino, custom firmware processes the raw digital readings obtained from the sensors and converts them into voltage, current, torque, and rotational speed measurements for the PMSG. Because these calculated measurements are not initially calibrated, the voltage, current, and torque channels are individually calibrated.

Voltage and current are calibrated using a power supply with known output values. By applying several known input points, calibration curves are generated for both variables, which are then applied to the Arduino's processed values. Torque is calibrated using a custom moment arm, shown in Figure 5, which allows known weights to be hung at a known radius. This produces known torque values that are compared against the torque transducer's raw output to generate a torque calibration curve.

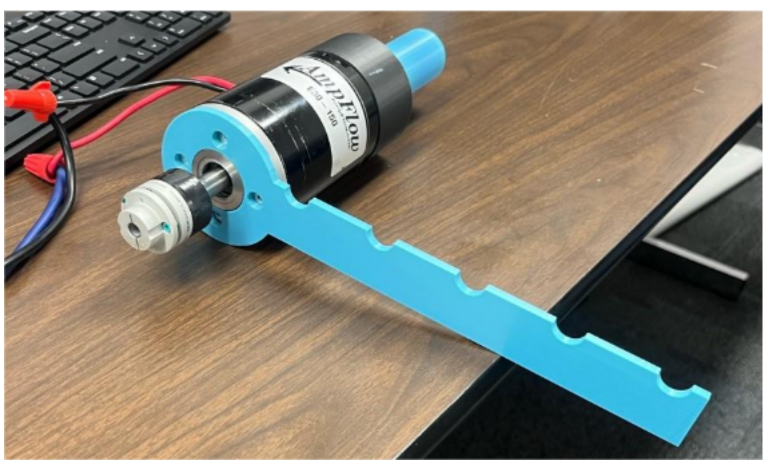


Figure 5: Moment arm on external motor

After calibration curves are established, they are implemented in the Arduino code so that all data displayed and recorded is already converted into calibrated physical units.

For rotational speed measurements, the IR sensor output is verified using a handheld tachometer to ensure consistency and accuracy.

Table 1 summarizes the sources of experimental sensitivity and error that influence the uncertainty calculations for each measurement.

Table 1: Experimental Sensitivities

Voltage	Current	Rotational Speed	Torque
• Quantization error • V_{ref} error • R in voltage divider errors • Calibration curve confidence interval	• Quantization error • Calibration curve confidence interval	• Arduino's clock frequency error • 2% IR sensor accuracy specification	• Quantization error • Calibration curve confidence interval

After calibration and uncertainty sources are defined, the PMSG is connected to the dynamometer and tested through ten input power settings. The external motor is driven from 10% input power and increased in increments of 10% up to 100%. At each setting, five samples are recorded to characterize random error and improve measurement precision.

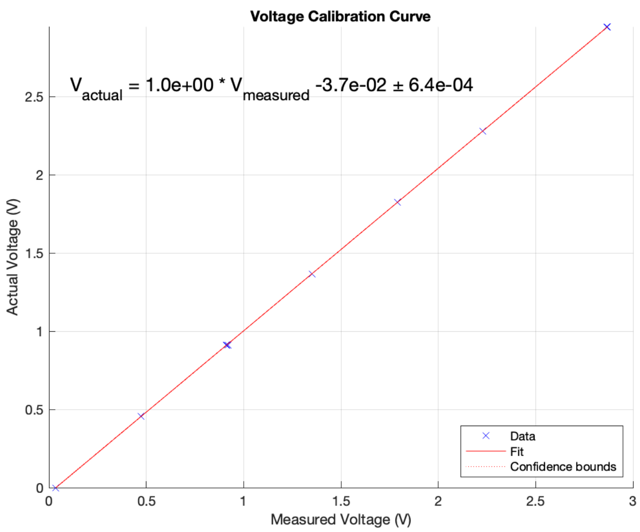
Three experimental configurations are performed:

1. **Unloaded experiment:** No programmable load is applied. A single sweep is performed to determine the generator's Kv rating.
2. **Constant-resistance experiment:** Five full sweeps are performed using resistive loads of 2, 5, 10, 15, and 20 Ω.
3. **Constant-current experiment:** Five full sweeps are performed with constant current loads of 4.2, 4, 3, 2, and 1 A.

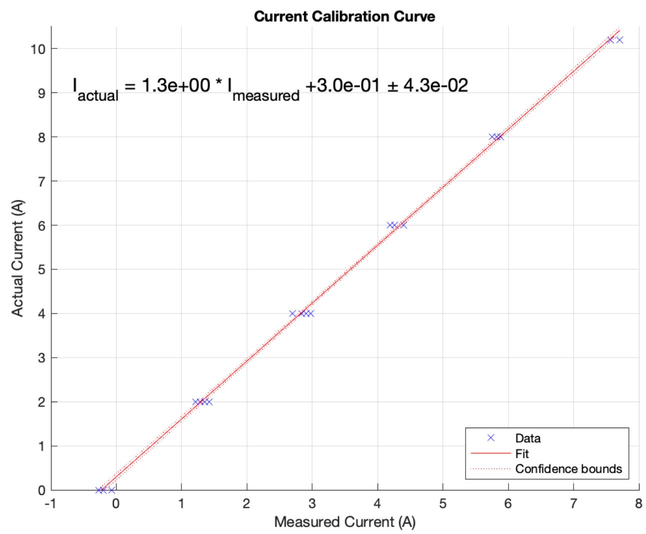
The loaded experiments (constant resistance and constant current) are used to evaluate generator performance, including power input, power output, and overall efficiency under various operating conditions. Once all three experiment types are completed for each motor, the data is post-processed to compare and assess the performance of each generator.

RESULTS

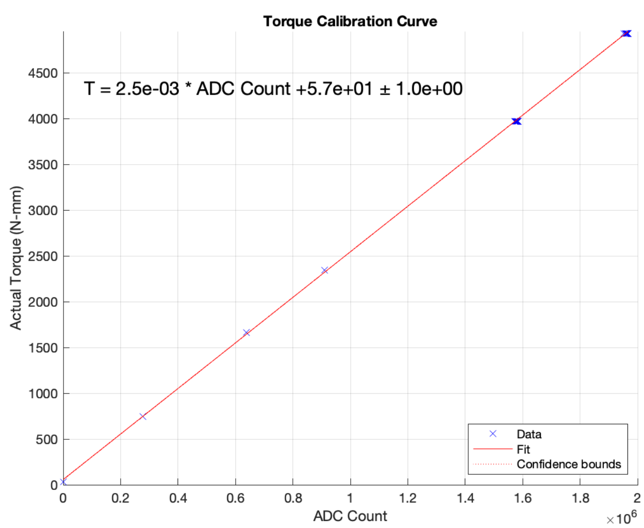
The calibration curves for the measurements are shown in Figure 6 to display the true error of the measurement.



(a) Voltage



(b) Current



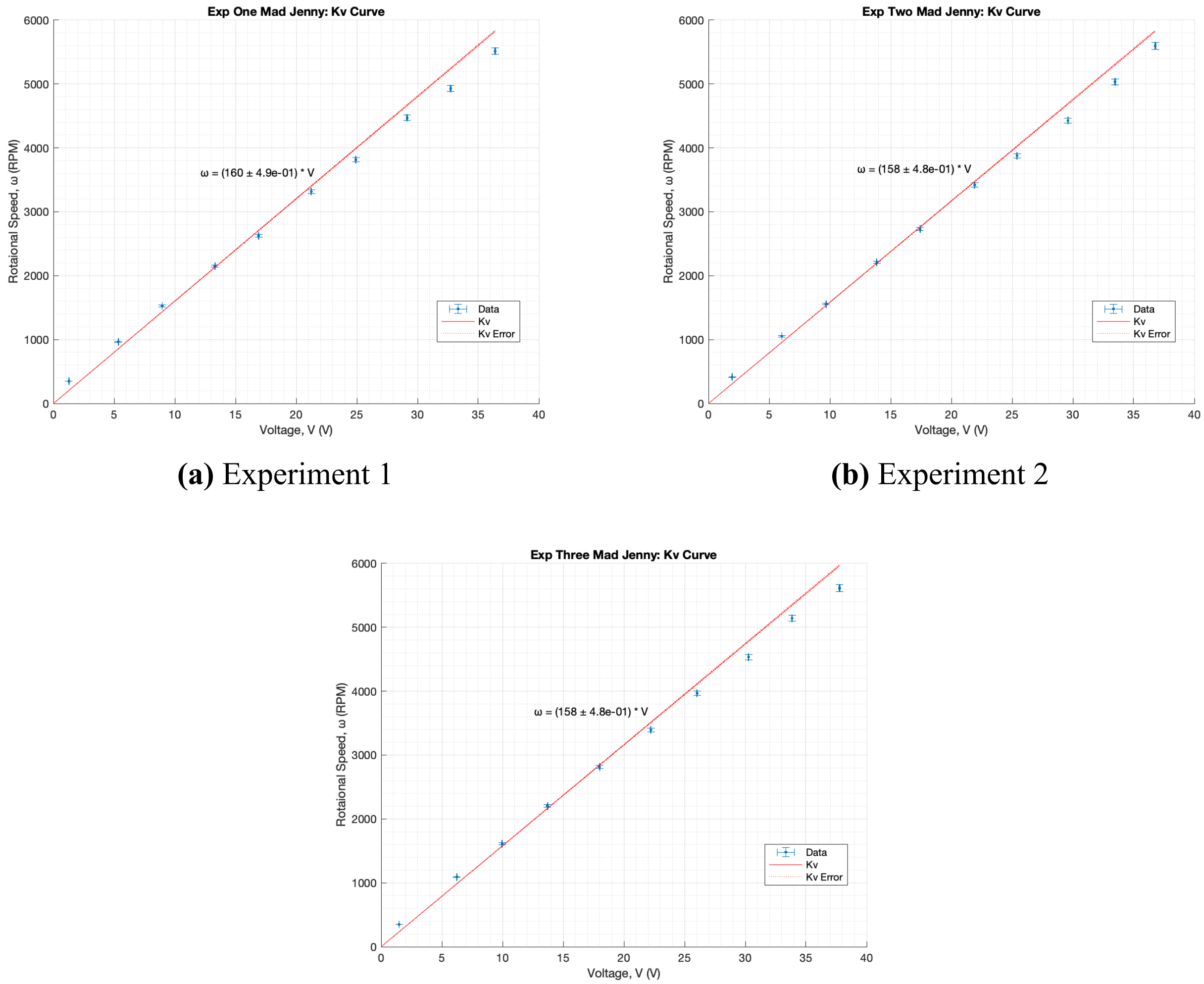
(c) Torque

Figure 6: Calibration Curves

The calibration curves are taken before the experiments and are used to properly adjust the sensors. Based on the graphs, the current calibration curve has the most error.

The following figures are the compiled results of Mad Jenny, Mad Jennington, and Melon Motor. The calibrations, Kv curves, power curves, and efficiency curves are enumerated below.

Mad Jenny



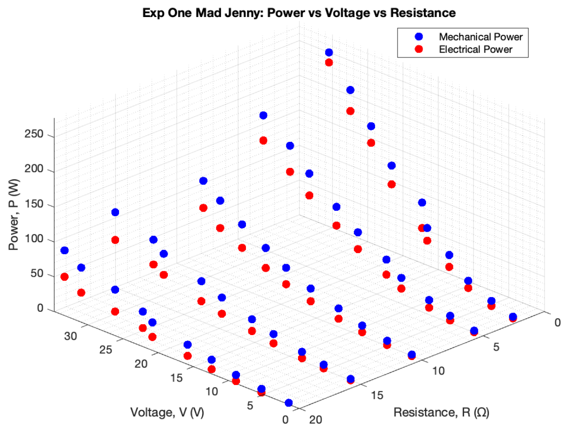
(a) Experiment 1

(b) Experiment 2

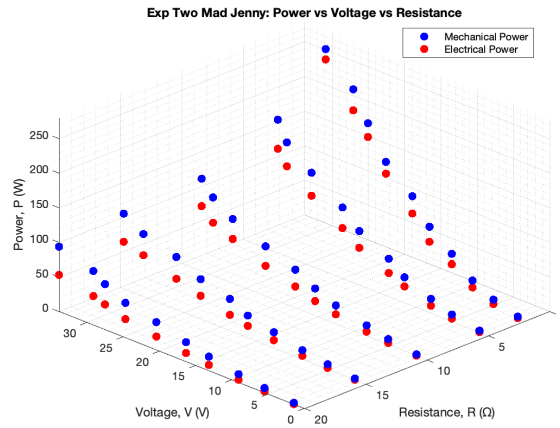
(c) Experiment 3

Figure 7: Mad Jenny Kv Curves

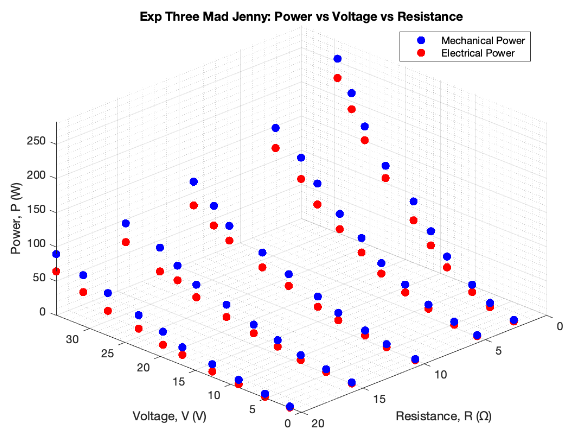
Figure 7 above shows the Kv curves of the Mad Jenny repeat tests. The three curves have very similar behaviors and results showing consistency between tests for the same generator. The error in the curves are also minimal, attributed to the error in the RPM. After averaging, along with obtaining the random error, of each experiment's Kv rating, the Mad Jenny's final Kv curve is 158 ± 0.278.



(a) Experiment 1



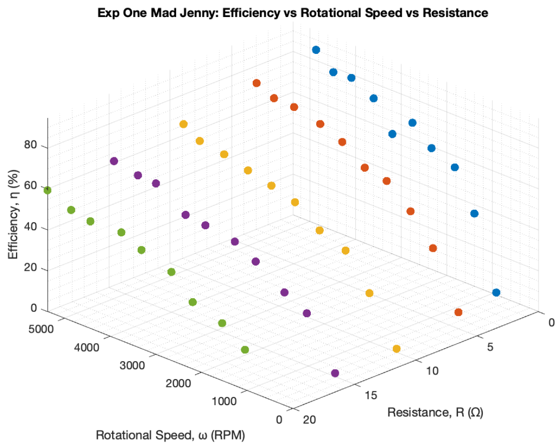
(b) Experiment 2



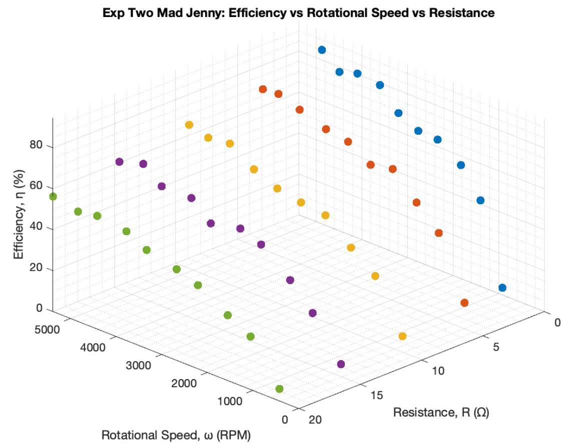
(c) Experiment 3

Figure 8: Mad Jenny Constant Resistance Power Curves

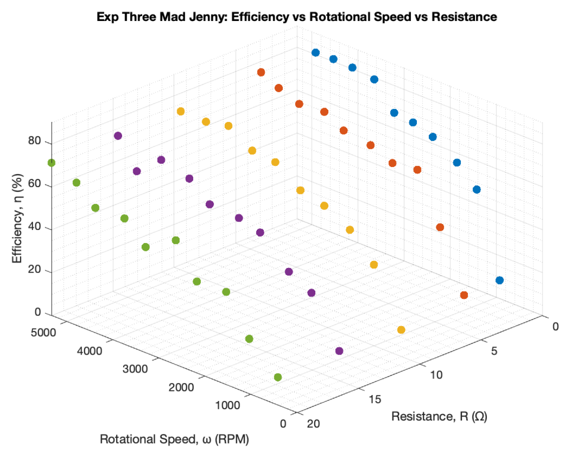
Figure 8 above shows the power curves of Mad Jenny from the constant resistance tests. The results have a parabolic relation that is magnified at the lower resistances. The behavior is also consistent between each repeat test.



(a) Experiment 1



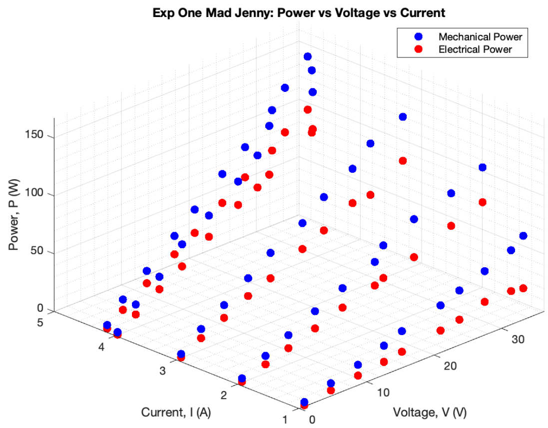
(b) Experiment 2



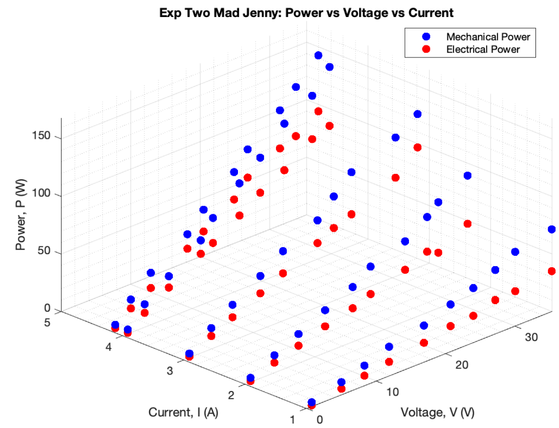
(c) Experiment 3

Figure 9: Mad Jenny Constant Resistance Efficiency Curves

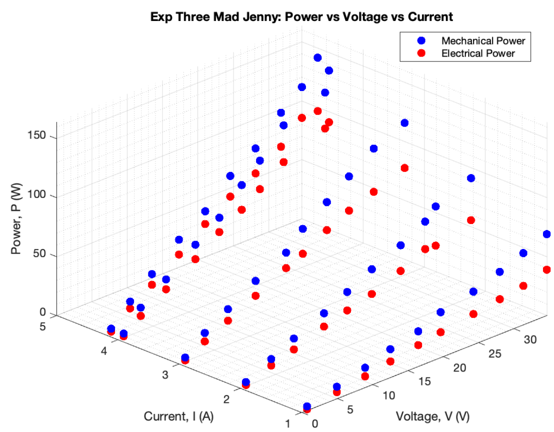
Figure 9 above shows the efficiencies of the constant resistance tests for Mad Jenny. The efficiency of Mad Jenny increases as the RPM increases and as the resistance of the load decreases.



(a) Experiment 1



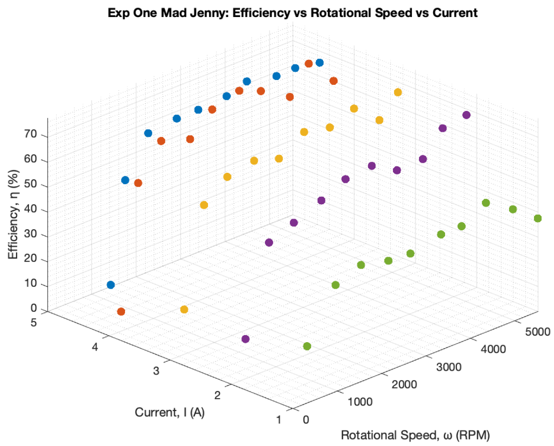
(b) Experiment 2



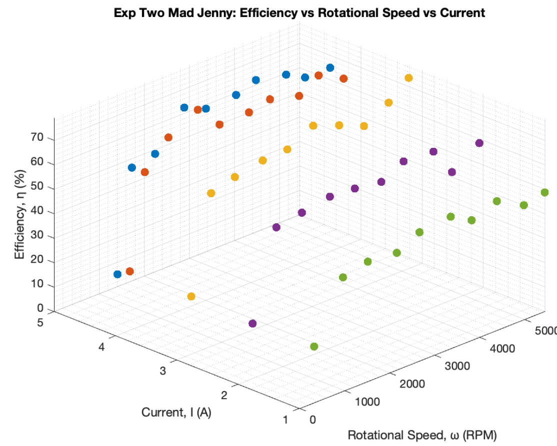
(c) Experiment 3

Figure 10: Mad Jenny Constant Current Power Curves

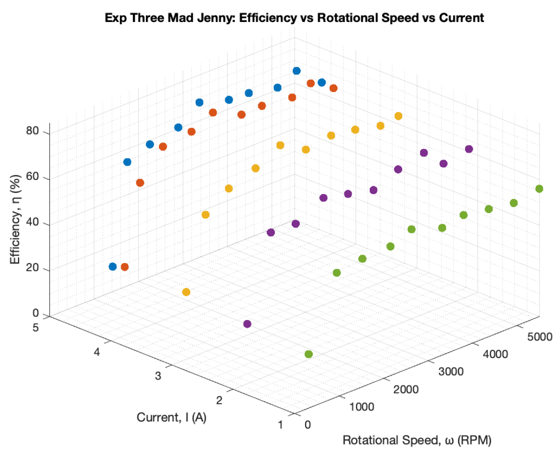
Figure 10 above shows Mad Jenny's constant current power curves. They have linear relations and are consistent between all three repeat tests.



(a) Experiment 1



(b) Experiment 2



(c) Experiment 3

Figure 11: Mad Jenny Constant Current Efficiency Curves

Figure 11 above shows the efficiency curves of the constant current tests for Mad Jenny. The behavior is consistent between the tests, with the higher current resulting in higher efficiency. The curves exhibit some variance at the plateau of the efficiency, varying between higher and lower efficiency. This is error being exhibited in the final result of the efficiency.

Mad Jennington

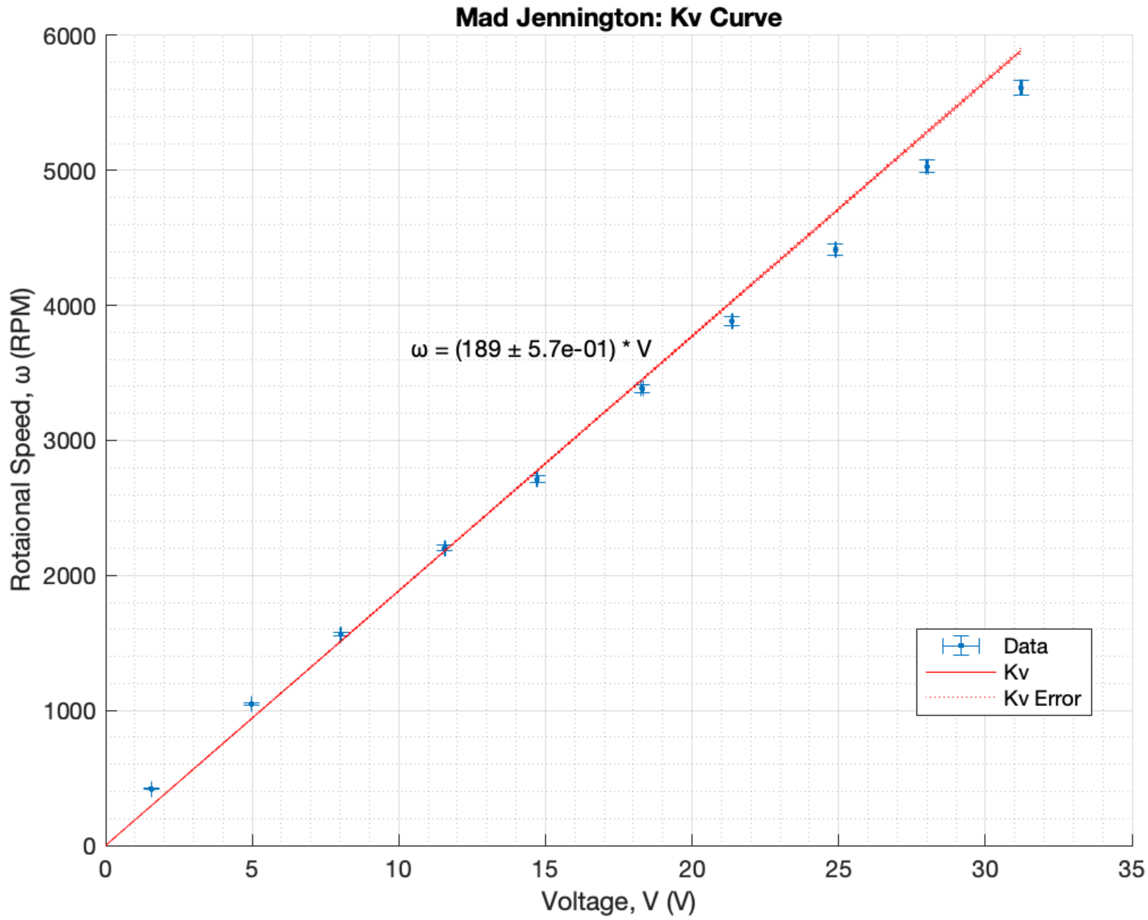
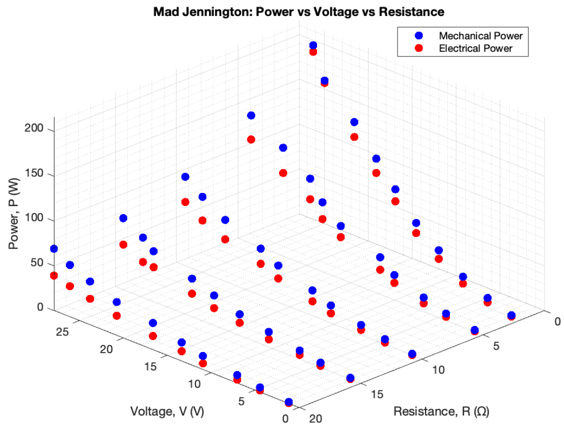
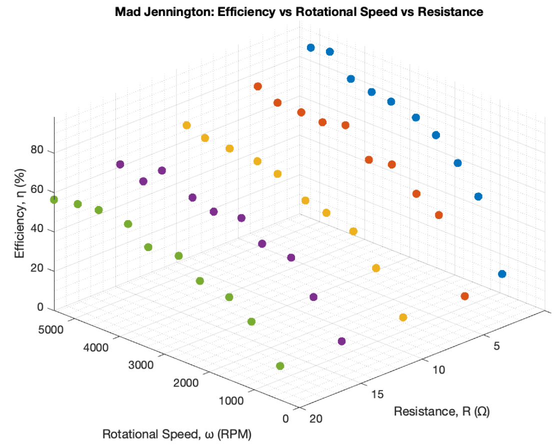


Figure 12: Mad Jennington Kv Curve

Figure 12 above shows the Kv curve for Mad Jennington. The data appears consistent and slightly increases in error as the RPMs increase. The error is minimal based on the points, mainly coming from the RPM.



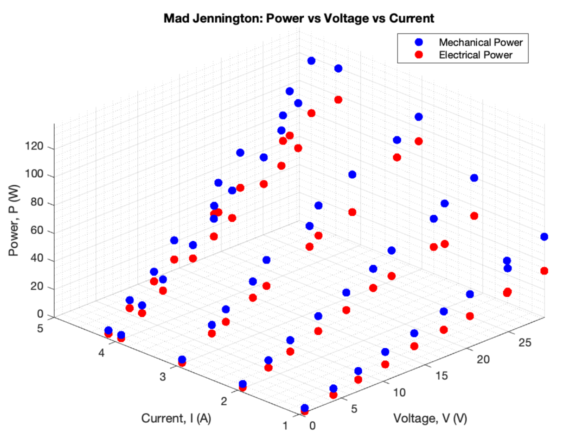
(a) Power Curves



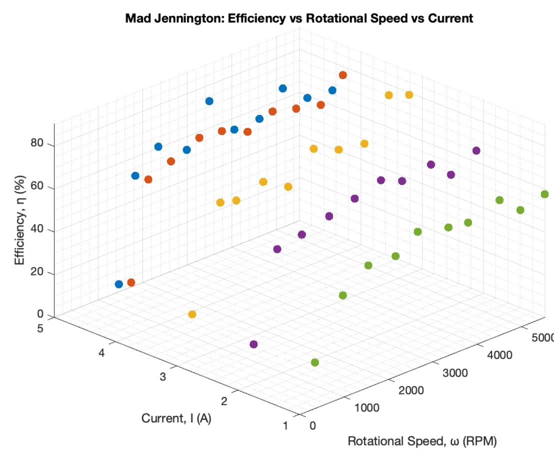
(b) Efficiency Curves

Figure 13: Mad Jennington Constant Resistance Curves

Figure 13 above shows the constant resistance power and efficiency curves for Mad Jennington. The power curves are parabolic, consistent with Mad Jenny's results, and the efficiency curves increase with RPM and resistance.



(a) Power Curves



(b) Efficiency Curves

Figure 14: Mad Jennington Constant Current Curves

Figure 14 above shows the constant current results for Mad Jennington. The power curves are linear, just like Mad Jenny's results, and the efficiency curves still behave erratically once they plateau. This shows the error in the constant current tests is consistent between the different generators.

Melon Motor

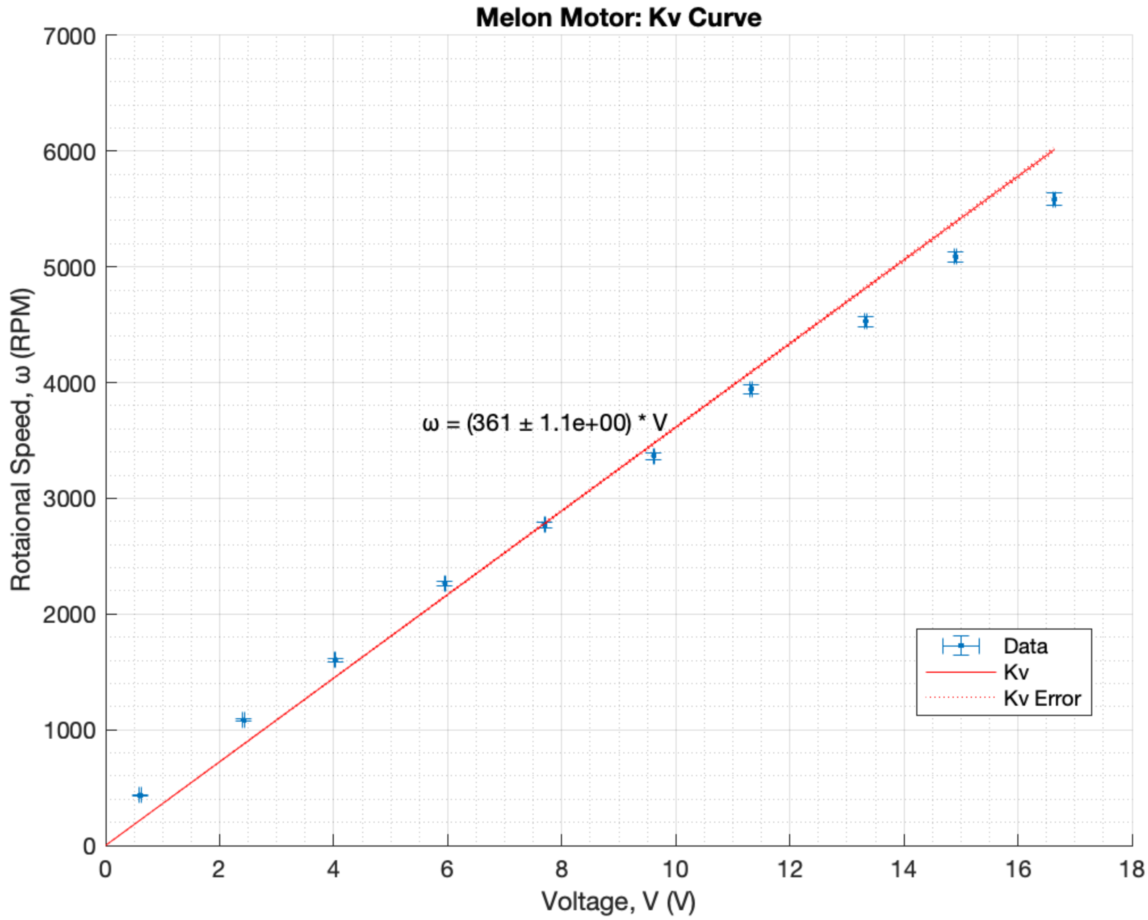
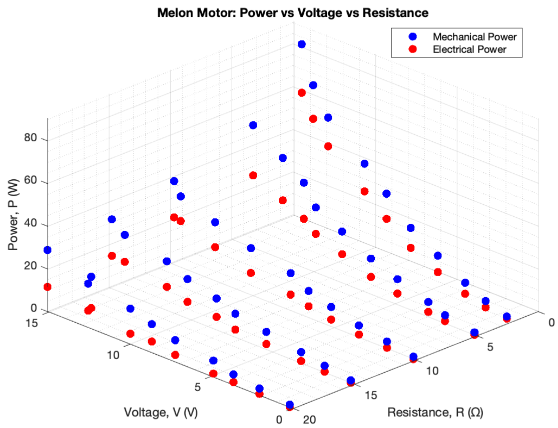


Figure 15: Melon Motor Kv Curve

Figure 15 above shows the Kv curve for Melon Motor. Like the previous Kv curves, the error increases as the RPM increases.

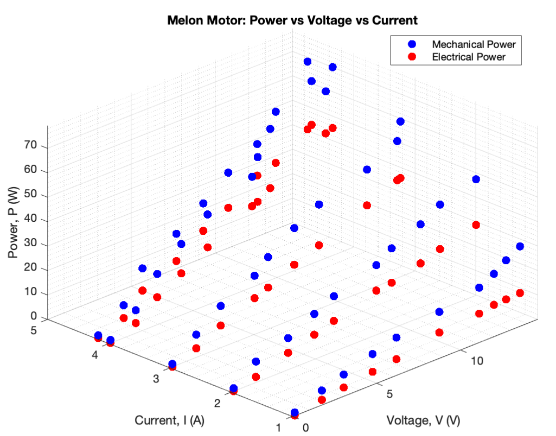


(a) Power Curves

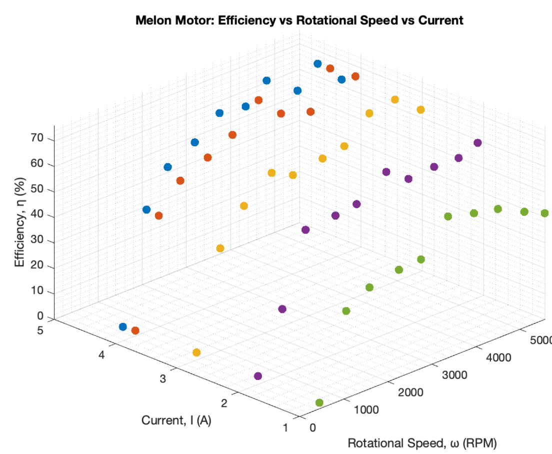
(b) Efficiency Curves

Figure 16: Melon Motor Constant Resistance Curves

Figure 16 above shows the power and efficiency curves for Melon Motor's constant resistance tests. The power curves are parabolic like the other generators, and the efficiency continues to increase with RPM and resistance.



(a) Power Curves



(b) Efficiency Curves

Figure 17: Melon Motor Constant Current Curves

Figure 17 above shows the constant current curves for Melon Motor. The power curves are linear, increasing with increased current, and the efficiency curves continue to show variance at the plateau. All three generators exhibit this error in the final constant current efficiency.

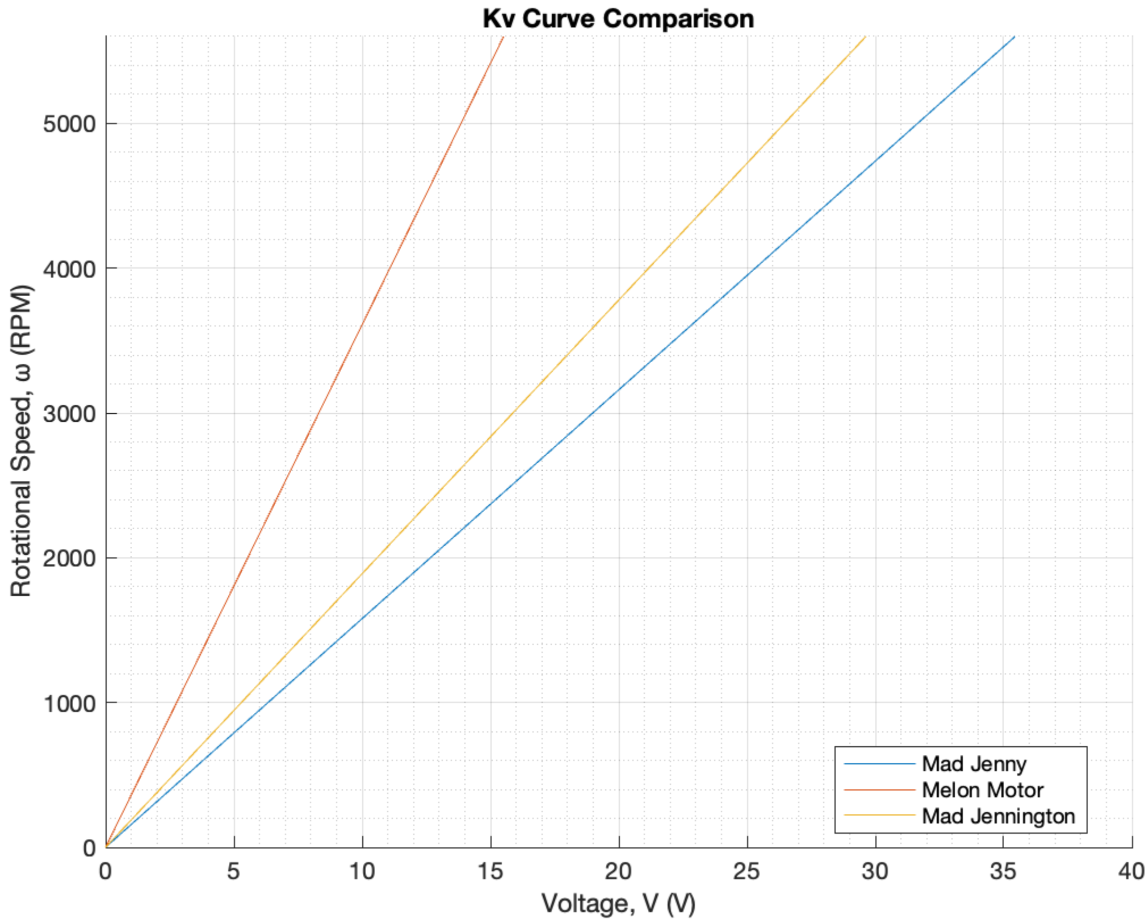
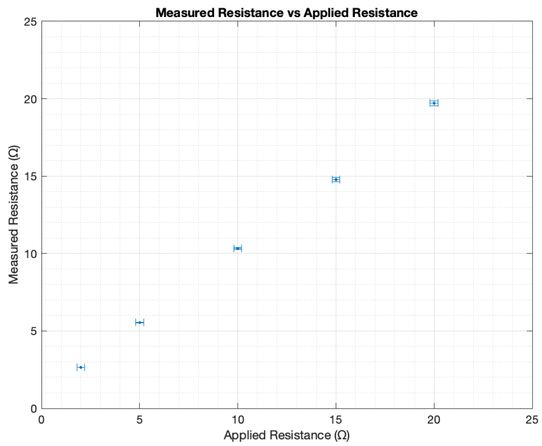
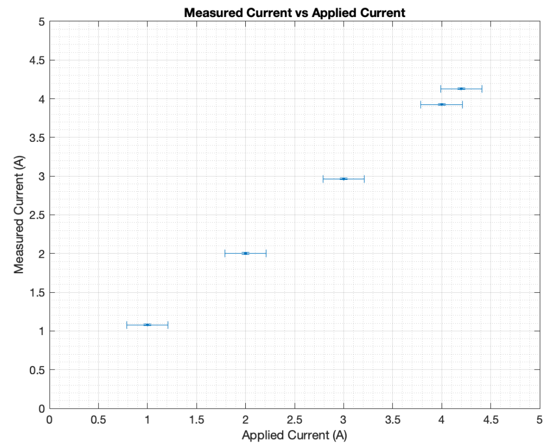


Figure 18: Kv Curve Comparison

Figure 18 shows the three generators Kv overlaid on the same graph. The magnitude in the difference of Kv is clear, showing the similarity between Mad Jenny and Mad Jennington. The stark difference of Melon Motor is also clear, producing fewer volts at the same RPMs as the other two generators.



(a) Measured vs Applied Resistance



(b) Measured vs Applied Current

Figure 19: Measured vs Applied Resistance and Current

Figure 19 shows the respective errors with the resistance and current measurements versus the applied values. The error in the resistance is much less than the error in the current. This error propagates to the efficiency of the constant current and resistance tests resulting in different behaviors between them.

DISCUSSION

Ohm's Law dictates the relation of different electrical variables to electrical power. This is shown in Equation 3, where the relations observed in these experiments include voltage with current resistance. These different relations must hold true when observing the power output from the generators when keeping loads constant. In constant-resistance power curves for each generator, the data points create a parabolic relation between voltage and power. The relation is most prominent when the resistance is smallest, following Equation 3, where resistance is in the denominator. This relation is most easily observed in Figure 6 with Mad Jenny's replicate tests all having a parabolic relation. Based on Equation 3, the relationship with power and current should be linear, and this is observed in all three different generators constant-current power curves. This relation is seen in Figure 8 with all three of Mad Jenny's repeated tests, with higher current resulting in a steeper linear curve. This is because the same voltage is reached across the same RPMs for all generators, and with increased current, the electrical power increases.

The assumptions used throughout this project is that there is steady state operation and no voltage loss. For steady state operation, the assumption is the work input is not changing. This means the power supplied to the motor does not change when data is recorded, meaning the RPM input is in steady state. The no voltage loss assumption means that voltage is not lost to the circuit. In reality, there is voltage loss through wires, resistors, and rectifiers, but the total amount is negligible.

The Kv of a generator is the defining number for how the generator will perform. The Kv of each is found to be 158 for Mad Jenny, 189 for Mad Jennington, and 361 for Melon Motor. The Kv of a generator is found to be inversely related to the electrical power output, where a higher value like Melon Motor's results in a lower power output. This is observed when comparing the three generator's peak electrical power output at a constant current. Melon Motor's max power is 52.2 W at 4.2 amps seen in

Figure 15; Mad Jennington has a max power of 101 W at 4.2 amps in Figure 12; and Mad Jenny has the most power output at 4.2 amps with 121 W in Figure 8. A linear relation between the change in Kv and change in electrical power is also observed. This is seen in the doubling of power output from 52.2 W to 102 W between Melon Motor and Mad Jennington and the approximate halving of Kv from 361 to 189.

To spin the generators to get an electrical power output, a mechanical power input is required. This means there is an efficiency between the two values, work in versus work out. The mechanical power is calculated by Equation 2, taking the RPM and resistive torque at each point. For both types of experiments, the constant resistance and constant current tests, the efficiency curves are logarithmic growth curves. The curves for constant resistance appear to be smoother than constant current. This is seen with constant current curves staggering at the plateau. This inconsistency in the efficiency can be attributed to the error in the measured versus applied current seen in Figure 18. The error in measured versus applied resistance is far less seen in the same figure, correlating to the smoother efficiency graphs seen from the constant resistance tests.

The Mad Jenny appears to be the most viable generator out of the three on hand. After the first test, two more repeat tests were done to further characterize the generator, increasing the sample size of its data. The repeat tests continue to show the performance of the generator with little variation. The Kv results of the three tests are 160, 158, and 158 respectively. The maximum electrical power of the three constant resistance tests are 263 W, 265 W, and 255 W respectively. The maximum electrical power of the three constant resistance tests are 121 W, 119 W, and 119 W respectively.

The data is found to be reliable when comparing the generator's measured Kv to the manufacturer stated Kv. Mad Jenny and Melon Motor, measured to be 158 and 361 Kv respectively, are manufacturer stated to be 160 and 360 respectively. Alternatively, Mad Jennington is measured to have 189 Kv while the manufacturer states a Kv rating of 170. Based on the other two generator readings, the data is confirmed to be accurate, meaning Mad Jennington's Kv is wrong or has changed over time. The error in Kv can be from inaccurate assembly or rating of Mad Jennington from the manufacturer. Another possibility in the error is loss in electric capacity over use and time. Mad Jennington was donated by the CWC team, having been used in previous competition. This means the generator has gone under extensive use over long periods of time. This can lower the capabilities of the generator though a loss in magnetization or electric capacity in the coils. To confirm these theories, a new Mad Jennington would need to be tested to observe the performance of the generator straight from the manufacturer.

To improve upon this design project in the future with more resources, a few of the key sensors will be replaced with higher grade, more reliable alternatives. The IR sensor is difficult to calibrate and get consistent data from. Reflections and sunlight can easily alter the data increasing the error from the sensor. Instead, a Hall effect sensor will be used to get more consistent, less error prone data from. The Hall effect sensor uses a magnet on the dynamometer shaft to sense the rotation with an induced voltage from the magnetic flux passing by the sensor. Only reacting to magnetic impulse greatly reduces the external error. The other sensor to be upgraded is the torque transducer. The sensor reads different torque values at no load or rotation, requiring a tare within the code to get proper torque values. A rotary torque sensor has greater precision and reads the torque with the rotation of the motor shaft, minimizing error at no and low rotational speed.

CONCLUSIONS

This experiment evaluates and characterizes the generator performance of three brushless drone motors and identifies the most suitable generator for the Collegiate Wind Competition turbine system. Output voltage, current, torque, and speed are measured across multiple loading modes, enabling a complete comparison of mechanical power, electrical power, and efficiency. The uncertainty analysis ensures the accuracy of the results and provides confidence that the differences observed between motors reflect real performance differences rather than measurement errors. The relationships between voltage, current, and resistance follow theoretical predictions from Ohm's law, validating the observed trends in power and efficiency. Mad Jenny demonstrates the lowest Kv value at 158, followed by Mad Jennington at 189, and Melon Motor at 361. This is consistent with the higher power output of Mad Jenny, which produced a peak electrical output of 263 W under constant-resistance loading and 121 W under constant-current loading, outperforming the other two motors, as expected with its lower Kv value. Melon Motor's higher Kv value corresponded to lower torque and lower power output with a peak of 94 W under constant-resistance loading and 52 W under constant-current loading. Efficiency analysis indicates that all the motors exhibit logarithmic-growth behavior under constant-resistance tests; however, constant-current efficiency tests reveal more irregular patterns due to the electrical fluctuations that occur at high current settings. Repeated testing of Mad Jenny produced nearly identical results, confirming the measurement consistency and repeatability of the experimental setup. Further comparison with the discussion reveals that the efficiency plateau variations in constant-current tests originate from higher measurement error in applied current, as shown by the mismatch between measured and applied values. Conversely, the smooth constant-resistance efficiency curves reflect the lower error in measured resistance. The analysis also reinforces that Kv is inversely related to power output, demonstrated by the roughly doubled electrical output when Kv is halved between Melon Motor and Mad Jennington. Based on the combined assessment of output power, efficiency, and reliability, Mad Jenny stands out as the most capable and reliable generator for the Collegiate Wind Competition turbine system. These results provide a validated performance foundation for future generator selection and wind-turbine optimization efforts.

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APPENDIX

A. Measurements/Calculations Tables

A.1 Experiement 1 Mad Jenny

A.1.1 No Load

Table A.1.1.1

V (V)	u_V (V)	ω (RPM)	u_ω (RPM)
1.28	0.0119	349	3.22
5.34	0.0134	967	8.92
8.96	0.0158	1530	14.1
13.3	0.0195	2150	19.8
16.9	0.0228	2630	24.2
21.2	0.0272	3320	30.6
24.9	0.0310	3820	35.2
29.1	0.0355	4470	41.2
32.7	0.0394	4930	45.4
36.4	0.0434	5520	50.9

A.1.2 Constant Resistance

Table A.1.2.2

Constant Resistance Load (Ω)									
2		5		10		15		20	
V (V)	uV (V)	V (V)	uV (V)	V (V)	uV (V)	V (V)	uV (V)	V (V)	uV (V)
0.964	0.0119	1.25	0.0119	1.40	0.0120	1.38	0.0120	1.47	0.0120
4.02	0.0128	4.66	0.0131	4.91	0.0132	5.21	0.0134	5.34	0.0134
7.31	0.0146	7.63	0.0149	8.45	0.0154	8.28	0.0153	8.95	0.0158
9.99	0.0166	11.6	0.0179	11.8	0.0181	12.3	0.0186	12.4	0.0187
13.1	0.0193	13.7	0.0198	15.7	0.0217	15.4	0.0214	15.8	0.0218
13.8	0.0200	17.7	0.0237	19.2	0.0252	19.6	0.0256	20.8	0.0267
18.2	0.0241	20.8	0.0267	22.1	0.0281	22.5	0.0286	22.2	0.0282
21.1	0.0271	24.6	0.0307	25.5	0.0316	27.9	0.0342	26.1	0.0323
24.0	0.0301	27.4	0.0336	28.6	0.0350	29.3	0.0358	30.9	0.0374
27.1	0.0333	31.1	0.0377	31.0	0.0375	34.8	0.0416	33.3	0.0401

Table A.1.2.3

Constant Resistance Load (Ω)									
2		5		10		15		20	
I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)
0.313	0.0687	0.154	0.0686	0.029	0.0686	0.029	0.0686	-0.024	0.0685

1.49	0.0695	0.740	0.0690	0.384	0.0688	0.349	0.0688	0.243	0.0687
2.55	0.0702	1.31	0.0694	0.740	0.0690	0.509	0.0689	0.385	0.0688
3.81	0.0710	1.86	0.0697	1.02	0.0692	0.757	0.0690	0.544	0.0689
4.82	0.0717	2.43	0.0701	1.36	0.0694	0.970	0.0692	0.775	0.0690
5.68	0.0723	3.03	0.0705	1.66	0.0696	1.15	0.0693	0.935	0.0691
6.85	0.0730	3.63	0.0709	1.98	0.0698	1.29	0.0694	1.20	0.0693
8.16	0.0739	4.18	0.0713	2.32	0.0700	1.63	0.0696	1.33	0.0694
8.57	0.0742	4.61	0.0715	2.62	0.0702	1.86	0.0697	1.38	0.0694
9.74	0.0750	5.00	0.0718	3.06	0.0705	1.96	0.0698	1.70	0.0696

Table A.1.2.4

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
ω (RPM)	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**
381	3.51	405	3.73	415	3.83	419	3.86	421	3.88
860	7.92	962	8.87	1010	9.30	1040	9.55	1050	9.66
1290	11.9	1450	13.4	1530	14.1	1530	14.1	1550	14.3
1800	16.6	1970	18.2	2100	19.3	2160	19.9	2190	20.2
2220	20.4	2450	22.6	2640	24.3	2610	24.1	2660	24.5
2660	24.5	2950	27.2	3150	29.1	3260	30.0	3310	30.5
3060	28.3	3430	31.6	3670	33.8	3690	34.0	3750	34.6
3550	32.7	4000	36.9	4190	38.6	4340	40.0	4430	40.8
3950	36.4	4440	40.9	4720	43.5	4730	43.6	4850	44.7
4320	39.9	4820	44.4	5080	46.8	5260	48.4	5370	49.5

Table A.1.2.5

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
T (N-mm)	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**
67.3	0.467	56.8	0.467	50.2	0.467	47.3	0.467	45.7	0.467
147	0.467	99.2	0.467	75.3	0.467	65.8	0.467	60.7	0.467
215	0.467	136	0.467	97.3	0.467	83.6	0.467	75.6	0.467

293	0.467	178	0.467	122	0.467	101	0.467	88.4	0.467
351	0.467	213	0.467	143	0.467	116	0.467	101	0.467
413	0.467	251	0.467	168	0.467	134	0.467	116	0.467
470	0.467	284	0.467	188	0.467	149	0.467	128	0.467
526	0.467	321	0.467	212	0.467	167	0.467	143	0.467
571	0.467	352	0.467	232	0.467	182	0.467	155	0.467
613	0.467	380	0.467	251	0.467	196	0.467	167	0.467

Table A.1.2.6

Constant Resistance Load (Ω)									
2		5		10		15		20	
P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)
0.288	0.0647	0.191	0.0856	0.0406	0.0949	0.0347	0.0944	-0.0346	0.0997
5.97	0.279	3.44	0.321	1.90	0.336	1.83	0.358	1.30	0.367
18.5	0.512	9.96	0.529	6.25	0.582	4.21	0.570	3.44	0.615
38.1	0.712	21.5	0.807	12.1	0.815	9.32	0.849	6.64	0.853
63.3	0.945	33.1	0.960	21.4	1.09	14.8	1.06	12.2	1.09
78.5	1.01	53.5	1.25	31.9	1.34	22.5	1.36	19.5	1.44
124	1.34	75.1	1.48	43.8	1.55	29.0	1.56	26.8	1.54
172	1.57	103	1.76	59.1	1.79	45.5	1.94	34.7	1.81
206	1.80	126	1.96	75.1	2.01	54.5	2.05	42.7	2.15
263	2.06	156	2.25	94.5	2.19	68.1	2.43	55.9	2.32

Table A.1.2.7

Constant Resistance Load (Ω)									
2		5		10		15		20	
P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)
2.69	0.0310	2.41	0.0298	2.18	0.0286	2.07	0.0280	2.01	0.0277
13.21	0.129	9.99	0.103	7.96	0.0884	7.14	0.0831	6.66	0.0800
29.0	0.274	20.7	0.204	15.6	0.162	13.4	0.144	12.3	0.136
55.2	0.516	36.8	0.353	26.9	0.268	22.7	0.234	20.3	0.216
81.4	0.758	54.6	0.518	39.6	0.387	31.7	0.319	28.1	0.290
115	1.07	77.6	0.730	55.5	0.534	45.8	0.451	40.2	0.405
151	1.40	102	0.955	72.3	0.691	57.7	0.562	50.3	0.499

196	1.81	134	1.25	92.8	0.880	75.8	0.730	66.1	0.647
236	2.18	163	1.52	114	1.08	90.2	0.863	78.5	0.762
278	2.57	192	1.78	133	1.25	108	1.03	93.8	0.904

Table A.1.2.8

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
η (%)	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**
10.7	2.41	7.94	3.56	1.83	4.35	1.67	4.55	-1.68	4.94
45.2	2.16	34.4	3.23	23.8	4.23	25.6	5.02	19.4	5.51
64.0	1.87	48.1	2.60	40.1	3.75	31.5	4.28	28.0	5.03
68.9	1.44	58.4	2.27	44.9	3.06	41.0	3.77	32.7	4.22
77.6	1.37	60.6	1.85	53.9	2.81	46.7	3.38	43.3	3.90
68.2	1.08	68.9	1.74	57.5	2.48	49.0	3.01	48.3	3.61
82.1	1.17	73.4	1.60	60.4	2.21	50.3	2.76	53.1	3.10
87.8	1.14	76.7	1.49	63.7	2.02	60.0	2.63	52.5	2.79
87.1	1.11	77.1	1.40	65.5	1.87	60.5	2.35	54.3	2.79
94.7	1.15	81.2	1.39	70.7	1.77	62.8	2.33	59.3	2.54

A.1.3 Constant Current

Table A.1.3.1

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
V (V)	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**
0.628	0.0119	0.363	0.0118	0.699	0.0119	0.648	0.0119	0.811	0.0119
2.96	0.0124	3.05	0.0124	3.66	0.0126	4.13	0.0128	4.75	0.0131
6.50	0.0141	6.56	0.0142	7.06	0.0145	7.51	0.0148	8.75	0.0157
10.6	0.0171	9.91	0.0166	10.6	0.0172	11.5	0.0179	12.6	0.0188
13.6	0.0198	13.9	0.0200	13.9	0.0201	15.5	0.0216	15.3	0.0213
17.7	0.0236	18.2	0.0242	18.7	0.0246	20.3	0.0262	21.0	0.0270
21.0	0.0270	21.1	0.0270	21.8	0.0279	21.6	0.0276	23.8	0.0298
25.0	0.0313	22.8	0.0289	26.1	0.0323	26.1	0.0323	27.5	0.0338
26.9	0.0332	29.3	0.0357	28.7	0.0353	31.6	0.0382	31.4	0.0380
30.3	0.0369	29.1	0.0355	33.5	0.0403	36.3	0.0432	33.2	0.0400

Table A.1.3.2

Constant Current Load (A)									
4.2		4		3		2		1	
I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)
0.988	0.0692	0.509	0.0689	0.970	0.0692	0.882	0.0691	1.02	0.0692
3.92	0.0711	3.81	0.0710	2.85	0.0704	1.86	0.0697	0.971	0.0692
4.04	0.0712	3.83	0.0710	2.85	0.0704	1.84	0.0697	0.935	0.0691
3.97	0.0711	3.78	0.0710	2.94	0.0704	1.91	0.0698	0.882	0.0691
3.95	0.0711	3.86	0.0710	2.76	0.0703	1.96	0.0698	0.900	0.0691
3.95	0.0711	3.92	0.0711	2.83	0.0704	1.89	0.0698	0.900	0.0691
4.01	0.0711	3.78	0.0710	2.82	0.0704	1.95	0.0698	0.917	0.0691
3.94	0.0711	3.81	0.0710	2.89	0.0704	1.89	0.0698	1.04	0.0692
4.06	0.0712	3.79	0.0710	2.67	0.0703	2.02	0.0698	0.917	0.0691
4.02	0.0711	3.74	0.0710	2.83	0.0704	2.03	0.0698	0.828	0.0691

Table A.1.3.3

Constant Current Load (A)									
4.2		4		3		2		1	
ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)
323	2.97	279	2.57	319	2.94	320	2.95	327	3.02
647	5.96	663	6.12	766	7.06	849	7.82	967	8.92
1160	10.7	1180	10.9	1290	11.9	1410	13.0	1540	14.2
1810	16.7	1830	16.9	1890	17.5	2030	18.7	2160	19.9
2290	21.1	2330	21.5	2450	22.6	2570	23.7	2650	24.5
2930	27.0	2940	27.1	3020	27.8	3160	29.2	3340	30.8
3390	31.2	3430	31.6	3600	33.2	3730	34.4	3800	35.1
4050	37.4	4080	37.6	4140	38.2	4310	39.8	4350	40.1
4470	41.2	4500	41.5	4710	43.5	4760	43.9	4960	45.7
5020	46.3	5060	46.7	5130	47.3	5300	48.8	5520	50.9

Table A.1.3.4

Constant Current Load (A)

4.2		4		3		2		1	
T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)
108	0.467	78.9	0.467	107	0.467	106	0.467	103	0.467
300	0.467	288	0.467	228	0.467	168	0.467	106	0.467
302	0.467	290	0.467	230	0.467	170	0.467	109	0.467
305	0.467	293	0.467	233	0.467	173	0.467	111	0.467
307	0.467	295	0.467	235	0.467	175	0.467	114	0.467
309	0.467	297	0.467	238	0.467	178	0.467	116	0.467
311	0.467	299	0.467	240	0.467	180	0.467	118	0.467
313	0.467	302	0.467	242	0.467	182	0.467	121	0.467
316	0.467	304	0.467	245	0.467	185	0.467	124	0.467
318	0.467	306	0.467	247	0.467	187	0.467	125	0.467

Table A.1.3.5

Constant Current Load (A)									
4.2		4		3		2		1	
P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)
0.594	0.0441	0.179	0.0253	0.649	0.0484	0.566	0.0458	0.800	0.0559
11.4	0.214	11.4	0.218	10.4	0.259	7.59	0.287	4.59	0.328
26.3	0.466	25.1	0.469	20.1	0.498	13.8	0.522	8.18	0.605
41.8	0.755	37.1	0.703	30.8	0.745	21.8	0.798	11.1	0.870
53.4	0.967	53.6	0.989	38.4	0.981	30.4	1.08	13.7	1.05
69.9	1.26	71.1	1.30	52.8	1.32	38.4	1.42	18.8	1.45
84.3	1.50	79.6	1.50	61.6	1.54	42.0	1.51	21.8	1.64
98.2	1.79	86.7	1.63	75.5	1.84	49.5	1.83	28.6	1.91
110	1.92	111	2.08	76.4	2.03	63.9	2.21	28.9	2.18
121	2.17	108	2.07	94.8	2.37	73.6	2.53	27.2	2.30

Table A.1.3.6

Constant Current Load (A)									
4.2		4		3		2		1	
P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)

3.66	0.0373	2.30	0.0252	3.58	0.0365	3.56	0.0364	3.53	0.0363
20.4	0.190	20.0	0.187	18.3	0.173	14.9	0.143	10.7	0.110
36.9	0.345	35.9	0.336	31.1	0.294	25.1	0.241	17.5	0.178
57.7	0.539	56.2	0.526	46.2	0.436	36.6	0.352	25.1	0.255
73.6	0.688	71.9	0.673	60.4	0.570	47.1	0.452	31.6	0.319
94.8	0.886	91.3	0.854	75.2	0.709	58.8	0.564	40.7	0.409
110	1.03	107	1.00	90.4	0.852	70.2	0.673	47.1	0.472
133	1.24	129	1.20	105	0.990	82.4	0.789	55.2	0.551
148	1.38	143	1.34	121	1.14	92.1	0.880	64.2	0.639
167	1.56	162	1.52	133	1.25	104	0.991	72.5	0.721

Table A.1.3.7

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
η (%)	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**
16.2	1.22	7.75	1.10	18.0	1.36	15.9	1.30	22.6	1.60
56.0	1.17	56.7	1.21	56.8	1.52	50.9	1.99	42.7	3.08
71.2	1.43	69.9	1.46	64.4	1.71	54.9	2.15	46.7	3.49
72.6	1.47	66.1	1.40	66.7	1.73	59.5	2.25	44.1	3.49
72.7	1.48	74.4	1.54	63.6	1.73	64.2	2.38	43.5	3.37
73.6	1.50	77.7	1.60	70.3	1.87	65.4	2.49	46.3	3.60
76.3	1.54	74.1	1.56	68.0	1.82	59.6	2.22	46.3	3.52
73.8	1.51	67.2	1.41	71.8	1.88	60.0	2.29	51.9	3.50
74.1	1.47	77.6	1.63	63.1	1.78	69.3	2.49	45.0	3.42
72.4	1.46	66.7	1.42	71.4	1.91	70.8	2.54	37.4	3.19

A.2 Experiment 2 Mad Jenny

A.2.1 No Load

Table A.2.1.1

V (V)	**u_V (V)**	**ω (RPM)**	**u_ω (RPM)**
1.95	0.0121	414	3.82
6.03	0.0138	1050	9.70
9.68	0.0164	1560	14.3

13.9	0.0200	2210	20.4
17.4	0.0234	2730	25.1
21.9	0.0279	3420	31.5
25.4	0.0315	3880	35.7
29.6	0.0360	4430	40.8
33.5	0.0402	5040	46.4
37	0.0438	5600	51.6

A.2.2 Constant Resistance

Table A.2.2.1

Constant Resistance Load (Ω)									
2		5		10		15		20	
V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)
1.02	0.0119	1.23	0.0119	1.46	0.0120	1.50	0.0120	1.45	0.0120
4.37	0.0129	5.03	0.0133	5.36	0.0134	5.25	0.0134	5.49	0.0135
7.26	0.0146	7.92	0.0151	8.33	0.0154	8.73	0.0157	9.06	0.0159
10.1	0.0167	11.6	0.0179	12.6	0.0188	12.7	0.0189	13.2	0.0193
13.2	0.0194	13.7	0.0199	15.4	0.0214	16.3	0.0222	16.3	0.0223
15.6	0.0216	17.8	0.0237	18.2	0.0241	18.7	0.0246	20.4	0.0263
19.2	0.0251	20.1	0.0261	22.3	0.0283	22.7	0.0288	24.7	0.0308
21.7	0.0276	24.4	0.0305	26.8	0.0330	26.1	0.0323	27.5	0.0337
23.7	0.0298	27.8	0.0340	29.5	0.0359	30.6	0.0372	29.1	0.0355
27.5	0.0337	29.0	0.0354	31.1	0.0376	33.4	0.0402	33.8	0.0406

Table A.2.2.2

Constant Resistance Load (Ω)									
2		5		10		15		20	
I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)
0.349	0.0688	0.243	0.0687	0.118	0.0686	0.0827	0.0686	0.0826	0.0686
1.56	0.0695	0.828	0.0691	0.473	0.0688	0.349	0.0688	0.314	0.0687
2.60	0.0702	1.36	0.0694	0.775	0.0690	0.562	0.0689	0.420	0.0688
4.02	0.0711	2.04	0.0698	1.11	0.0693	0.882	0.0691	0.633	0.0689
4.57	0.0715	2.48	0.0701	1.38	0.0694	1.04	0.0692	0.775	0.0690
5.91	0.0724	3.01	0.0705	1.72	0.0696	1.22	0.0693	0.953	0.0692
6.99	0.0731	3.62	0.0709	1.98	0.0698	1.49	0.0695	1.09	0.0692
8.16	0.0739	4.17	0.0712	2.39	0.0701	1.70	0.0696	1.33	0.0694

8.75	0.0744	4.68	0.0716	2.59	0.0702	1.95	0.0698	1.45	0.0695
9.64	0.0750	5.18	0.0719	3.03	0.0705	2.03	0.0698	1.57	0.0695

Table A.2.2.3

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
ω (RPM)	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**
377	3.48	402	3.71	414	3.82	417	3.84	420	3.88
858	7.91	965	8.90	1010	9.32	1040	9.56	1050	9.70
1290	11.9	1450	13.4	1540	14.2	1530	14.1	1560	14.3
1800	16.6	1980	18.2	2100	19.4	2170	20.0	2210	20.4
2220	20.5	2460	22.7	2640	24.3	2620	24.2	2670	24.7
2660	24.5	2950	27.2	3160	29.1	3270	30.2	3330	30.7
3060	28.2	3440	31.7	3670	33.8	3700	34.1	3770	34.8
3560	32.8	4020	37.0	4200	38.7	4350	40.1	4410	40.7
3950	36.4	4480	41.3	4670	43.1	4750	43.8	4840	44.6
4330	40.0	4820	44.4	5090	46.9	5270	48.6	5380	49.6

Table A.2.2.4

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
T (N-mm)	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**
65.6	0.467	55.6	0.467	49.1	0.467	46.6	0.467	45.2	0.467
146	0.467	98.4	0.467	74.7	0.467	65.3	0.467	60.2	0.467
215	0.467	135	0.467	96.5	0.467	81.4	0.467	73.3	0.467
296	0.467	177	0.467	122	0.467	100	0.467	88.2	0.467
353	0.467	212	0.467	143	0.467	116	0.467	101	0.467
418	0.467	251	0.467	167	0.467	134	0.467	115	0.467
471	0.467	284	0.467	188	0.467	149	0.467	128	0.467
528	0.467	321	0.467	211	0.467	167	0.467	143	0.467
574	0.467	351	0.467	231	0.467	182	0.467	155	0.467
617	0.467	381	0.467	251	0.467	197	0.467	167	0.467

Table A.2.2.5

Constant Resistance Load (Ω)									
2		5		10		15		20	
P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)
0.341	0.0695	0.295	0.0835	0.171	0.0990	0.125	0.103	0.115	0.0995
6.79	0.304	4.15	0.347	2.54	0.369	1.82	0.360	1.71	0.377
18.8	0.510	10.8	0.549	6.45	0.575	4.88	0.601	3.80	0.624
40.7	0.723	23.5	0.808	14.0	0.871	11.2	0.875	8.33	0.907
60.4	0.948	33.9	0.963	21.3	1.07	16.9	1.13	12.6	1.13
91.4	1.13	53.6	1.26	31.1	1.27	22.8	1.30	19.4	1.41
134	1.41	72.6	1.43	44.1	1.56	33.8	1.58	27.0	1.71
177	1.62	102	1.74	64.0	1.88	44.4	1.82	36.5	1.91
207	1.78	130	2.00	76.4	2.07	59.7	2.14	42.0	2.02
265	2.09	150	2.10	93.9	2.19	67.8	2.34	52.9	2.35

Table A.2.2.6

Constant Resistance Load (Ω)									
2		5		10		15		20	
P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)
2.59	0.0302	2.34	0.0292	2.13	0.0282	2.04	0.0277	1.99	0.0276
13.2	0.128	9.95	0.103	7.91	0.0881	7.10	0.0828	6.64	0.0800
29.0	0.274	20.6	0.202	15.6	0.162	13.1	0.142	11.9	0.134
55.7	0.521	36.7	0.352	26.8	0.268	22.7	0.235	20.4	0.217
82.1	0.765	54.6	0.518	39.5	0.386	32.0	0.321	28.3	0.292
116	1.08	77.7	0.731	55.4	0.534	45.8	0.452	40.3	0.406
151	1.40	102	0.959	72.1	0.689	57.7	0.562	50.5	0.501
197	1.82	135	1.26	92.9	0.881	75.8	0.731	65.9	0.645
237	2.20	165	1.53	113	1.07	90.3	0.864	78.3	0.759
280	2.59	192	1.79	134	1.26	109	1.03	93.8	0.904

Table A.2.2.7

Constant Resistance Load (Ω)

2		5		10		15		20	
η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)
13.1	2.68	12.59	3.57	7.97	4.64	6.12	5.04	5.82	5.00
51.6	2.37	41.8	3.51	32.1	4.68	25.6	5.09	25.8	5.69
65.1	1.87	52.4	2.72	41.4	3.71	37.4	4.62	31.9	5.24
73.0	1.47	64.1	2.29	52.2	3.29	49.2	3.88	40.8	4.47
73.5	1.34	62.0	1.86	53.8	2.76	53.0	3.56	44.5	4.01
78.4	1.22	68.9	1.74	56.1	2.35	49.8	2.88	48.2	3.54
88.6	1.25	70.8	1.55	61.0	2.23	58.5	2.80	53.4	3.42
89.8	1.17	75.2	1.47	68.9	2.13	58.5	2.46	55.3	2.95
87.2	1.10	78.9	1.42	67.6	1.94	65.9	2.45	53.7	2.64
94.6	1.15	78.2	1.31	70.2	1.77	62.4	2.23	56.3	2.57

A.2.3 No Load

Table A.2.3.1

Constant Current Load (A)									
4.2		4		3		2		1	
V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)
0.740	0.0119	0.781	0.0119	0.821	0.0119	0.791	0.0119	0.771	0.0119
3.00	0.0124	3.21	0.0125	3.97	0.0128	4.23	0.0129	5.04	0.0133
5.86	0.0137	6.70	0.0142	7.03	0.0145	7.70	0.0149	8.36	0.0154
11.1	0.0176	11.3	0.0177	11.0	0.0175	11.5	0.0179	11.9	0.0182
13.4	0.0196	13.0	0.0193	14.3	0.0204	15.5	0.0215	16.9	0.0229
17.8	0.0238	16.9	0.0229	19.3	0.0252	18.1	0.0240	20.8	0.0267
19.8	0.0258	19.8	0.0259	21.6	0.0276	23.0	0.0291	24.0	0.0301
24.5	0.0306	23.3	0.0294	24.1	0.0303	26.2	0.0325	27.2	0.0335
26.7	0.0330	27.3	0.0337	30.5	0.0370	27.8	0.0342	30.0	0.0366
30.0	0.0365	29.8	0.0363	33.7	0.0405	32.0	0.0388	35.3	0.0422

Table A.2.3.2

Constant Current Load (A)									
4.2		4		3		2		1	
I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)
1.02	0.0692	1.13	0.0693	1.09	0.0692	1.08	0.0692	1.06	0.0692

4.22	0.0713	3.86	0.0710	2.89	0.0704	2.05	0.0699	0.988	0.0692
4.04	0.0712	3.90	0.0711	2.91	0.0704	1.96	0.0698	1.02	0.0692
4.04	0.0712	3.94	0.0711	2.87	0.0704	1.98	0.0698	1.02	0.0692
4.06	0.0712	3.85	0.0710	2.89	0.0704	1.88	0.0697	0.988	0.0692
4.02	0.0711	3.83	0.0710	2.91	0.0704	1.95	0.0698	1.06	0.0692
4.34	0.0714	3.88	0.0711	2.92	0.0704	1.93	0.0698	0.970	0.0692
4.09	0.0712	3.79	0.0710	2.87	0.0704	2.02	0.0698	1.08	0.0692
3.95	0.0711	3.88	0.0711	2.82	0.0704	1.73	0.0697	1.02	0.0692
3.99	0.0711	3.74	0.0710	3.13	0.0706	2.02	0.0698	1.00	0.0692

Table A.2.3.3

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
ω (RPM)	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**
319	2.94	322	2.97	323	2.98	323	2.98	328	3.03
640	5.90	654	6.03	764	7.04	852	7.86	967	8.92
1150	10.64	1180	10.86	1290	11.9	1420	13.1	1520	14.0
1800	16.61	1830	16.87	1910	17.6	2040	18.8	2160	19.9
2280	21.05	2310	21.32	2450	22.6	2600	23.9	2670	24.6
2950	27.22	2970	27.35	3030	27.9	3180	29.3	3360	31.0
3390	31.27	3430	31.65	3610	33.2	3670	33.9	3820	35.2
4060	37.45	4080	37.61	4160	38.3	4340	40.0	4380	40.4
4480	41.33	4510	41.58	4700	43.4	4750	43.8	4980	45.9
5040	46.48	5070	46.71	5150	47.5	5360	49.4	5450	50.2

Table A.2.3.4

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
T (N-mm)	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**
107	0.467	107	0.467	108	0.467	108	0.467	103	0.467
300	0.467	288	0.467	228	0.467	167	0.467	106	0.467
302	0.467	290	0.467	230	0.467	170	0.467	108	0.467

305	0.467	292	0.467	233	0.467	173	0.467	111	0.467
306	0.467	294	0.467	235	0.467	175	0.467	113	0.467
309	0.467	297	0.467	238	0.467	177	0.467	116	0.467
311	0.467	299	0.467	240	0.467	180	0.467	118	0.467
313	0.467	301	0.467	243	0.467	182	0.467	121	0.467
316	0.467	304	0.467	245	0.467	185	0.467	123	0.467
318	0.467	306	0.467	247	0.467	187	0.467	125	0.467

Table A.2.3.5

Constant Current Load (A)									
4.2		4		3		2		1	
P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)
0.747	0.0523	0.864	0.0552	0.867	0.0573	0.822	0.0552	0.809	0.0544
12.5	0.218	12.3	0.231	11.4	0.281	8.65	0.296	4.99	0.349
23.4	0.418	26.0	0.477	20.4	0.496	15.1	0.537	8.48	0.577
45.0	0.795	44.3	0.804	31.6	0.778	22.8	0.804	12.1	0.822
54.4	0.959	49.5	0.925	41.2	1.01	29.0	1.08	16.7	1.17
71.6	1.27	64.3	1.20	55.7	1.36	35.2	1.26	22.0	1.44
86.0	1.42	77.0	1.41	63.1	1.52	44.5	1.61	23.3	1.66
100	1.75	88.3	1.66	69.0	1.70	52.7	1.83	29.3	1.88
106	1.91	106	1.95	85.7	2.15	48.0	1.94	30.3	2.08
119	2.14	111	2.12	104	2.38	63.0	2.25	35.0	2.44

Table A.2.3.6

Constant Current Load (A)									
4.2		4		3		2		1	
P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)
3.59	0.0366	3.61	0.0368	3.67	0.0373	3.65	0.0372	3.53	0.0363
20.1	0.188	19.7	0.185	18.2	0.172	14.9	0.144	10.7	0.110
36.5	0.341	35.8	0.335	31.1	0.294	25.2	0.243	17.2	0.175
57.4	0.537	56.0	0.524	46.6	0.440	36.8	0.354	25.2	0.255
73.3	0.685	71.3	0.667	60.4	0.570	47.5	0.456	31.7	0.320
95.5	0.892	92.2	0.863	75.4	0.711	59.1	0.567	40.8	0.411
110	1.03	107	1.00	90.5	0.853	69.2	0.662	47.3	0.475

133	1.25	129	1.20	106	0.995	82.8	0.792	55.5	0.555
148	1.38	143	1.34	121	1.14	91.8	0.878	64.4	0.642
168	1.57	162	1.52	133	1.26	105	1.00	71.4	0.710

Table A.2.3.7

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
η (%)	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**
20.8	1.48	24.0	1.55	23.6	1.58	22.4	1.53	22.9	1.56
62.1	1.23	62.1	1.31	62.6	1.65	57.9	2.06	46.5	3.29
64.0	1.29	72.5	1.50	65.4	1.71	59.8	2.21	48.9	3.37
78.2	1.56	79.1	1.62	67.7	1.78	61.8	2.26	47.9	3.30
74.3	1.48	69.5	1.46	68.2	1.79	61.1	2.35	52.6	3.73
75.0	1.51	69.7	1.46	73.8	1.93	59.6	2.21	54.0	3.56
77.9	1.48	71.7	1.48	69.7	1.81	64.4	2.41	49.1	3.55
75.3	1.49	68.4	1.44	65.4	1.73	63.5	2.30	52.8	3.44
71.0	1.45	73.6	1.53	71.0	1.90	52.2	2.17	46.8	3.27
71.0	1.44	68.3	1.45	77.9	1.93	59.6	2.22	48.7	3.45

A.3 Experiment 3 Mad Jenny

A.3.1 No Load

Table A.3.1.1

V (V)	**u_V (V)**	**ω (RPM)**	**u_ω (RPM)**
1.48	0.0120	350	3.23
6.24	0.0140	1090	10.1
9.97	0.0166	1610	14.9
13.7	0.0198	2200	20.3
18.0	0.0239	2810	25.9
22.2	0.0282	3390	31.3
26.0	0.0322	3970	36.6
30.3	0.0367	4540	41.8
33.9	0.0406	5140	47.4
37.8	0.0449	5610	51.8

A.3.2 Constant Resistance

Table A.3.2.1

Constant Resistance Load (Ω)									
2		5		10		15		20	
V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)
1.16	0.0119	1.15	0.0119	1.24	0.0119	1.54	0.0120	1.62	0.0120
4.53	0.0130	4.39	0.0130	5.29	0.0134	5.17	0.0134	5.15	0.0133
7.06	0.0145	8.05	0.0152	8.34	0.0154	8.77	0.0157	8.86	0.0158
10.6	0.0172	11.3	0.0177	12.1	0.0184	12.0	0.0183	12.6	0.0189
12.9	0.0191	14.7	0.0208	15.0	0.0211	15.4	0.0214	16.9	0.0228
15.4	0.0214	17.5	0.0235	19.1	0.0251	19.3	0.0252	19.6	0.0256
19.3	0.0253	20.6	0.0266	22.9	0.0289	23.6	0.0296	23.0	0.0291
22.3	0.0283	23.8	0.0298	27.5	0.0338	26.2	0.0324	27.4	0.0337
24.1	0.0302	26.1	0.0323	29.8	0.0362	28.7	0.0351	30.9	0.0374
26.1	0.0323	29.7	0.0361	32.6	0.0393	33.5	0.0403	34.7	0.0416

Table A.3.2.2

Constant Resistance Load (Ω)									
2		5		10		15		20	
I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)
0.420	0.0688	0.278	0.0687	0.189	0.0687	0.171	0.0687	0.136	0.0686
1.72	0.0696	0.846	0.0691	0.509	0.0689	0.438	0.0688	0.296	0.0687
2.76	0.0703	1.54	0.0695	0.882	0.0691	0.580	0.0689	0.544	0.0689
3.86	0.0710	2.00	0.0698	1.17	0.0693	0.953	0.0692	0.633	0.0689
4.97	0.0718	2.48	0.0701	1.47	0.0695	1.11	0.0693	0.899	0.0691
5.92	0.0724	3.21	0.0706	1.88	0.0697	1.31	0.0694	0.953	0.0692
7.06	0.0732	3.78	0.0710	2.09	0.0699	1.56	0.0695	1.22	0.0693
8.05	0.0739	4.24	0.0713	2.46	0.0701	1.93	0.0698	1.33	0.0694
9.00	0.0745	4.93	0.0718	2.71	0.0703	1.86	0.0697	1.61	0.0696
9.74	0.0750	5.36	0.0720	3.03	0.0705	2.28	0.0700	1.87	0.0697

Table A.3.2.3

Constant Resistance Load (Ω)

2		5		10		15		20	
ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)
393	3.62	366	3.37	399	3.68	412	3.80	412	3.80
891	8.22	888	8.19	992	9.14	1020	9.36	1040	9.54
1320	12.2	1380	12.7	1510	13.9	1510	13.9	1540	14.2
1850	17.0	1920	17.7	2070	19.1	2130	19.6	2170	20.0
2270	21.0	2400	22.1	2590	23.9	2590	23.9	2630	24.2
2680	24.7	2980	27.5	3130	28.9	3230	29.7	3290	30.3
3110	28.7	3400	31.3	3630	33.5	3670	33.8	3740	34.5
3590	33.1	3950	36.4	4150	38.3	4280	39.4	4380	40.3
4000	36.9	4390	40.5	4640	42.8	4810	44.3	4790	44.1
4390	40.5	4770	44.0	5190	47.8	5220	48.1	5330	49.1

Table A.3.2.4

Constant Resistance Load (Ω)									
2		5		10		15		20	
T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)
66.3	0.467	45.1	0.467	43.0	0.467	40.8	0.467	39.3	0.467
149	0.467	88.5	0.467	68.4	0.467	59.2	0.467	54.3	0.467
218	0.467	127	0.467	92.9	0.467	77.6	0.467	69.0	0.467
294	0.467	170	0.467	115	0.467	93.6	0.467	82.1	0.467
355	0.467	206	0.467	137	0.467	109	0.467	94.9	0.467
421	0.467	247	0.467	161	0.467	128	0.467	110	0.467
473	0.467	281	0.467	182	0.467	143	0.467	122	0.467
531	0.467	318	0.467	206	0.467	161	0.467	136	0.467
574	0.467	348	0.467	226	0.467	175	0.467	148	0.467
616	0.467	377	0.467	245	0.467	190	0.467	161	0.467

Table A.3.2.5

Constant Resistance Load (Ω)									
2		5		10		15		20	
P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)

0.480	0.079	0.307	0.077	0.225	0.083	0.247	0.105	0.218	0.111
7.76	0.316	3.71	0.302	2.69	0.364	2.26	0.355	1.50	0.353
19.5	0.498	12.38	0.560	7.32	0.575	5.09	0.603	4.79	0.610
41.0	0.756	22.7	0.792	14.1	0.840	11.4	0.831	7.97	0.868
63.8	0.930	36.5	1.03	22.0	1.04	17.0	1.07	15.2	1.16
90.5	1.12	55.9	1.24	35.8	1.34	25.2	1.34	18.6	1.36
136	1.43	77.5	1.47	47.7	1.60	36.6	1.64	28.1	1.60
179	1.66	101	1.70	67.8	1.93	50.5	1.83	36.4	1.90
217	1.82	129	1.88	80.8	2.09	53.3	2.01	49.6	2.15
255	1.99	159	2.15	98.6	2.31	76.5	2.35	64.4	2.43

Table A.3.2.6

Constant Resistance Load (Ω)									
2		5		10		15		20	
P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)
2.73	0.0316	1.73	0.0240	1.80	0.0256	1.76	0.0259	1.70	0.0255
13.9	0.135	8.23	0.0874	7.10	0.0815	6.30	0.0764	5.88	0.0742
30.2	0.285	18.3	0.182	14.7	0.155	12.2	0.135	11.1	0.127
56.8	0.531	34.2	0.329	25.0	0.252	20.9	0.219	18.7	0.202
84.5	0.787	51.8	0.491	37.1	0.364	29.7	0.301	26.1	0.273
118	1.10	77.1	0.725	52.9	0.512	43.1	0.428	37.7	0.383
154	1.43	99.9	0.936	69.3	0.663	54.9	0.537	47.8	0.477
200	1.85	131	1.23	89.3	0.848	72.0	0.696	62.4	0.614
241	2.23	160	1.49	110	1.03	88.2	0.847	74.4	0.725
283	2.62	188	1.75	133	1.25	104	0.991	89.6	0.867

Table A.3.2.7

Constant Resistance Load (Ω)									
2		5		10		15		20	
η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)
17.6	2.92	17.7	4.46	12.6	4.63	13.9	5.95	12.9	6.51
55.8	2.34	45.0	3.71	37.9	5.15	35.9	5.66	25.5	6.00
64.7	1.76	67.6	3.13	49.8	3.94	41.6	4.96	43.2	5.52
72.3	1.50	66.2	2.40	56.3	3.41	54.6	4.02	42.6	4.67

75.4	1.31	70.5	2.11	59.1	2.87	57.5	3.65	58.0	4.50
76.4	1.18	72.4	1.75	67.6	2.61	58.4	3.16	49.3	3.63
88.3	1.24	77.5	1.64	68.8	2.40	66.7	3.06	58.8	3.39
89.8	1.18	76.6	1.48	75.9	2.28	70.3	2.64	58.3	3.10
90.3	1.13	80.3	1.39	73.7	2.04	60.5	2.35	66.7	2.97
90.1	1.09	84.4	1.38	73.9	1.87	73.6	2.37	71.3	2.79

A.3.3 Constant Current

Table A.3.3.1

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
V (V)	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**
0.801	0.0119	0.842	0.0119	0.872	0.0119	0.791	0.0119	0.770	0.0119
3.49	0.0126	3.25	0.0125	3.64	0.0126	4.37	0.0130	4.98	0.0133
6.57	0.0142	6.83	0.0143	6.92	0.0144	7.56	0.0148	8.97	0.0158
10.4	0.0170	11.0	0.0175	10.8	0.0173	11.8	0.0182	12.5	0.0188
14.1	0.0202	14.4	0.0205	15.1	0.0212	15.1	0.0212	16.5	0.0225
17.6	0.0236	17.5	0.0235	17.5	0.0235	18.6	0.0245	19.7	0.0256
21.2	0.0272	20.1	0.0261	20.9	0.0269	22.7	0.0287	24.3	0.0304
24.8	0.0310	23.5	0.0295	24.0	0.0301	26.1	0.0323	28.0	0.0344
27.8	0.0342	29.3	0.0357	27.5	0.0338	27.6	0.0339	31.3	0.0379
30.0	0.0366	29.9	0.0364	31.9	0.0387	32.6	0.0393	34.7	0.0416

Table A.3.3.2

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
I (A)	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**
1.20	0.0693	1.22	0.0693	1.18	0.0693	1.11	0.0693	1.04	0.0692
4.13	0.0712	3.92	0.0711	2.94	0.0704	2.05	0.0699	1.09	0.0692
4.13	0.0712	3.92	0.0711	2.98	0.0705	1.98	0.0698	1.04	0.0692
4.20	0.0713	3.88	0.0711	2.98	0.0705	2.05	0.0699	1.08	0.0692
4.31	0.0713	4.01	0.0711	3.01	0.0705	2.00	0.0698	1.09	0.0692
4.31	0.0713	3.94	0.0711	2.98	0.0705	1.93	0.0698	1.09	0.0692
4.10	0.0712	3.99	0.0711	3.07	0.0705	2.02	0.0698	1.06	0.0692

4.06	0.0712	4.06	0.0712	3.05	0.0705	2.14	0.0699	1.06	0.0692
4.25	0.0713	3.74	0.0710	2.94	0.0704	2.02	0.0698	1.06	0.0692
3.97	0.0711	3.83	0.0710	2.87	0.0704	2.02	0.0698	1.15	0.0693

Table A.3.3.3

Constant Current Load (A)									
4.2		4		3		2		1	
ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)
321	2.96	317	2.92	324	2.99	318	2.94	322	2.97
650	5.99	662	6.10	758	6.99	847	7.81	954	8.79
1160	10.7	1170	10.8	1280	11.8	1410	13.0	1530	14.1
1800	16.5	1820	16.7	1880	17.3	2030	18.7	2160	19.9
2270	20.9	2300	21.2	2440	22.5	2580	23.8	2630	24.3
2930	27.0	2940	27.1	3010	27.8	3150	29.1	3320	30.6
3380	31.2	3400	31.3	3580	33.0	3710	34.2	3800	35.0
4020	37.1	4080	37.6	4120	38.0	4290	39.5	4370	40.3
4450	41.1	4490	41.4	4690	43.2	4730	43.6	4930	45.4
5020	46.3	5010	46.2	5090	46.9	5300	48.8	5500	50.7

Table A.3.3.4

Constant Current Load (A)									
4.2		4		3		2		1	
T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)
102	0.467	102	0.467	101	0.467	100	0.467	97.3	0.467
295	0.467	283	0.467	223	0.467	162	0.467	100	0.467
297	0.467	285	0.467	225	0.467	164	0.467	104	0.467
299	0.467	287	0.467	228	0.467	167	0.467	106	0.467
301	0.467	289	0.467	230	0.467	169	0.467	108	0.467
303	0.467	291	0.467	232	0.467	172	0.467	111	0.467
305	0.467	293	0.467	234	0.467	174	0.467	113	0.467
308	0.467	296	0.467	237	0.467	177	0.467	115	0.467
310	0.467	298	0.467	239	0.467	179	0.467	118	0.467

312	0.467	301	0.467	242	0.467	182	0.467	120	0.467

Table A.3.3.5

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)
0.961	0.0573	1.01	0.0597	1.02	0.0615	0.875	0.0562	0.770	0.0531
14.3	0.252	12.6	0.234	10.6	0.257	8.94	0.306	5.43	0.344
27.0	0.470	26.7	0.487	20.3	0.486	14.9	0.528	9.35	0.621
43.6	0.743	42.4	0.781	32.1	0.764	24.2	0.826	13.5	0.869
60.7	1.01	57.3	1.02	45.5	1.07	30.1	1.06	18.0	1.14
75.5	1.26	68.8	1.25	52.1	1.23	35.8	1.30	21.4	1.36
86.8	1.52	80.1	1.43	64.0	1.48	45.7	1.59	25.9	1.68
100.9	1.77	95.1	1.67	73.1	1.70	56.1	1.83	29.6	1.94
118.3	1.99	109.8	2.09	80.8	1.94	55.5	1.93	33.0	2.17
118.8	2.14	113.8	2.13	90.7	2.26	65.2	2.28	38.9	2.41

Table A.3.3.6

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)
3.44	0.0354	3.37	0.0347	3.43	0.0354	3.34	0.0345	3.28	0.0341
20.1	0.188	19.6	0.184	17.7	0.167	14.4	0.139	10.0	0.103
36.0	0.337	35.0	0.328	30.1	0.285	24.2	0.233	16.7	0.171
56.2	0.525	54.6	0.511	44.8	0.423	35.5	0.342	23.9	0.244
71.5	0.669	69.5	0.651	58.6	0.553	45.8	0.441	29.7	0.303
93.1	0.870	89.7	0.840	73.2	0.690	56.8	0.546	38.4	0.390
108	1.01	104	0.976	87.7	0.828	67.5	0.648	44.9	0.454
130	1.21	126	1.18	102	0.963	79.4	0.761	52.8	0.532
144	1.35	140	1.31	117	1.11	88.7	0.850	60.8	0.610
164	1.53	158	1.47	129	1.21	101	0.965	69.1	0.692

Table A.3.3.7

Constant Current Load (A)									
4.2		4		3		2		1	
η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)
27.9	1.69	29.9	1.80	29.5	1.82	26.1	1.70	23.5	1.64
71.3	1.42	64.2	1.34	60.1	1.56	62.2	2.21	54.3	3.49
75.1	1.48	76.1	1.56	67.6	1.74	61.7	2.26	56.0	3.77
77.6	1.51	77.7	1.61	71.8	1.83	68.3	2.42	56.6	3.69
84.9	1.62	82.4	1.66	77.6	1.97	65.7	2.39	60.4	3.89
81.0	1.55	76.5	1.57	71.2	1.82	63.0	2.36	55.7	3.59
80.5	1.59	76.8	1.55	73.0	1.82	67.8	2.44	57.7	3.80
77.9	1.55	75.3	1.50	71.4	1.79	70.6	2.40	55.9	3.71
81.9	1.58	78.2	1.66	68.7	1.78	62.4	2.26	54.3	3.61
72.5	1.47	72.2	1.51	69.9	1.87	64.4	2.35	56.0	3.53

A.4 Mad Jennington

A.4.1 No Load

Table A.4.1.1

V (V)	u_V (V)	ω (RPM)	u_ω (RPM)
1.56	0.0120	419	3.87
4.97	0.0132	1050	9.67
8.02	0.0151	1560	14.4
11.6	0.0179	2200	20.3
14.7	0.0208	2710	25.0
18.3	0.0242	3380	31.2
21.4	0.0273	3880	35.8
24.9	0.0310	4410	40.7
28.0	0.0343	5030	46.4
31.2	0.0377	5610	51.8

A.4.2 Constant Resistance

Table A.4.2.1

Constant Resistance Load (Ω)

2		5		10		15		20	
V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)
0.944	0.0119	0.933	0.0119	1.08	0.0119	1.14	0.0119	1.18	0.0119
3.66	0.0126	4.20	0.0129	4.18	0.0129	4.54	0.0130	4.45	0.0130
6.45	0.0141	6.74	0.0143	6.89	0.0144	6.91	0.0144	7.03	0.0145
9.21	0.0160	10.1	0.0167	10.3	0.0169	10.4	0.0170	10.9	0.0174
11.8	0.0181	11.7	0.0181	12.4	0.0187	13.7	0.0199	13.3	0.0195
14.1	0.0202	16.2	0.0221	16.3	0.0223	16.6	0.0226	16.6	0.0226
16.3	0.0223	18.2	0.0242	18.3	0.0242	19.1	0.0251	20.7	0.0267
18.8	0.0247	19.6	0.0256	22.3	0.0284	23.5	0.0296	23.8	0.0298
22.2	0.0282	22.7	0.0288	24.9	0.0311	24.7	0.0309	26.1	0.0323
23.5	0.0295	26.4	0.0325	26.9	0.0332	27.0	0.0332	27.9	0.0342

Table A.4.2.2

Constant Resistance Load (Ω)									
2		5		10		15		20	
I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)	I (A)	u_I (A)
0.438	0.0688	0.296	0.0687	0.260	0.0687	0.242	0.0687	0.225	0.0687
1.63	0.0696	0.935	0.0691	0.527	0.0689	0.402	0.0688	0.385	0.0688
2.48	0.0701	1.34	0.0694	0.846	0.0691	0.704	0.0690	0.527	0.0689
3.56	0.0708	1.88	0.0697	1.06	0.0692	0.828	0.0691	0.615	0.0689
4.40	0.0714	2.36	0.0701	1.31	0.0694	1.04	0.0692	0.828	0.0691
5.53	0.0722	2.87	0.0704	1.65	0.0696	1.17	0.0693	0.917	0.0691
6.24	0.0726	3.21	0.0706	1.93	0.0698	1.34	0.0694	1.06	0.0692
7.01	0.0732	3.83	0.0710	2.11	0.0699	1.63	0.0696	1.22	0.0693
8.07	0.0739	4.08	0.0712	2.32	0.0700	1.59	0.0696	1.33	0.0694
8.89	0.0745	4.40	0.0714	2.66	0.0703	1.88	0.0697	1.41	0.0694

Table A.4.2.3

Constant Resistance Load (Ω)									
2		5		10		15		20	
ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)
402	3.70	413	3.81	421	3.88	422	3.89	427	3.94
930	8.57	989	9.12	1022	9.42	1050	9.67	1070	9.82

1390	12.8	1490	13.7	1530	14.1	1550	14.3	1560	14.4
1870	17.3	2030	18.8	2130	19.6	2190	20.2	2210	20.4
2320	21.4	2540	23.5	2590	23.9	2650	24.4	2680	24.7
2870	26.4	3070	28.3	3210	29.6	3270	30.1	3360	31.0
3300	30.4	3580	33.0	3660	33.7	3740	34.5	3810	35.1
3760	34.7	4050	37.3	4280	39.4	4420	40.7	4460	41.1
4230	39.0	4580	42.2	4820	44.5	4830	44.5	4920	45.4
4650	42.9	5010	46.2	5230	48.2	5350	49.3	5450	50.3

Table A.4.2.4

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
T (N-mm)	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**
48.7	0.467	40.4	0.467	36.6	0.467	35.2	0.467	34.0	0.467
111	0.467	72.2	0.467	54.9	0.467	48.3	0.467	44.7	0.467
163	0.467	99.4	0.467	70.9	0.467	60.1	0.467	54.1	0.467
217	0.467	130	0.467	89.1	0.467	73.6	0.467	65.0	0.467
260	0.467	155	0.467	105	0.467	85.2	0.467	74.1	0.467
304	0.467	183	0.467	122	0.467	97.8	0.467	84.7	0.467
339	0.467	206	0.467	137	0.467	109	0.467	93.4	0.467
377	0.467	231	0.467	153	0.467	121	0.467	104	0.467
410	0.467	252	0.467	167	0.467	132	0.467	112	0.467
443	0.467	272	0.467	181	0.467	142	0.467	121	0.467

Table A.4.2.5

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
P_e (W)	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**
0.407	0.0646	0.278	0.0640	0.280	0.0739	0.271	0.0775	0.261	0.0802
5.88	0.254	3.89	0.289	2.17	0.286	1.82	0.312	1.70	0.305
15.9	0.453	9.00	0.467	5.80	0.475	4.86	0.476	3.70	0.484
32.8	0.655	18.9	0.703	10.9	0.714	8.64	0.718	6.69	0.753

51.8	0.844	27.3	0.818	16.2	0.861	14.2	0.950	11.0	0.921
78.1	1.03	46.4	1.14	26.8	1.14	19.3	1.15	15.2	1.15
101	1.19	58.5	1.29	35.3	1.28	25.8	1.33	21.9	1.44
132	1.39	75.1	1.40	47.1	1.56	38.4	1.64	29.1	1.65
179	1.66	92.6	1.62	58.1	1.75	39.4	1.72	34.3	1.81
209	1.77	116	1.89	71.1	1.89	50.3	1.88	39.1	1.94

Table A.4.2.6

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
P_m (W)	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**
2.05	0.0273	1.75	0.0259	1.61	0.0254	1.55	0.0251	1.52	0.0252
10.8	0.109	7.48	0.0842	5.87	0.0737	5.31	0.0709	4.98	0.0695
23.6	0.228	15.5	0.160	11.3	0.128	9.73	0.117	8.82	0.111
42.4	0.402	27.7	0.274	19.8	0.210	16.9	0.189	15.1	0.176
63.0	0.592	41.3	0.401	28.4	0.291	23.7	0.254	20.8	0.232
91.4	0.855	58.8	0.562	41.1	0.410	33.5	0.347	29.8	0.320
117	1.09	77.1	0.732	52.3	0.514	42.5	0.432	37.2	0.390
148	1.38	98.1	0.926	68.7	0.667	56.2	0.561	48.4	0.497
182	1.69	121	1.14	84.4	0.813	66.7	0.659	57.9	0.586
216	2.00	143	1.34	99.2	0.950	79.7	0.780	69.1	0.691

Table A.4.2.7

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
η (%)	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**
19.9	3.17	15.9	3.66	17.3	4.59	17.5	5.00	17.2	5.28
54.5	2.41	52.0	3.91	36.9	4.90	34.3	5.89	34.0	6.14
67.4	2.02	58.3	3.08	51.1	4.23	49.9	4.93	41.9	5.51
77.2	1.71	68.2	2.63	55.1	3.65	51.1	4.29	44.3	5.02
82.1	1.55	66.0	2.08	57.2	3.09	60.0	4.06	52.8	4.46
85.3	1.38	78.9	2.08	65.1	2.84	57.7	3.50	51.1	3.90
86.2	1.30	75.8	1.82	67.5	2.53	60.6	3.19	58.9	3.91
88.7	1.25	76.5	1.60	68.4	2.37	68.2	2.99	60.1	3.46

98.4	1.29	76.7	1.53	68.8	2.18	59.0	2.65	58.9	3.18
96.6	1.21	81.0	1.52	71.6	2.03	63.0	2.44	56.4	2.86

A.4.3 Constant Current

Table A.4.3.1

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
V (V)	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**
0.659	0.0119	0.710	0.0119	0.669	0.0119	0.587	0.0119	0.669	0.0119
3.19	0.0125	3.20	0.0125	4.22	0.0129	3.66	0.0126	4.10	0.0128
6.10	0.0139	5.70	0.0136	5.89	0.0138	6.27	0.0140	7.06	0.0145
8.51	0.0155	9.28	0.0161	9.12	0.0160	9.61	0.0164	10.3	0.0169
13.3	0.0195	11.8	0.0181	10.7	0.0172	13.0	0.0192	13.8	0.0199
13.8	0.0200	14.0	0.0201	15.9	0.0219	16.2	0.0222	17.3	0.0233
16.4	0.0224	17.7	0.0237	17.0	0.0229	18.4	0.0243	20.4	0.0264
21.5	0.0275	19.8	0.0259	21.0	0.0270	23.4	0.0295	24.9	0.0310
22.3	0.0285	21.9	0.0280	26.3	0.0326	24.7	0.0309	24.8	0.0310
24.9	0.0311	26.6	0.0330	28.9	0.0354	28.2	0.0346	29.3	0.0357

Table A.4.3.2

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
I (A)	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**
1.02	0.0692	1.11	0.0693	0.988	0.0692	0.953	0.0692	0.953	0.0692
4.24	0.0713	4.01	0.0711	3.15	0.0706	2.04	0.0698	1.02	0.0692
4.17	0.0712	4.06	0.0712	3.01	0.0705	2.05	0.0699	1.15	0.0693
4.18	0.0713	4.06	0.0712	3.01	0.0705	2.05	0.0699	1.11	0.0693
4.26	0.0713	4.04	0.0712	2.96	0.0704	2.05	0.0699	1.18	0.0693
4.13	0.0712	3.97	0.0711	2.99	0.0705	2.16	0.0699	1.13	0.0693
4.13	0.0712	3.99	0.0711	3.12	0.0706	2.07	0.0699	1.08	0.0692
4.15	0.0712	3.99	0.0711	2.87	0.0704	2.00	0.0698	1.15	0.0693
4.13	0.0712	3.99	0.0711	3.28	0.0707	1.86	0.0697	1.13	0.0693
4.06	0.0712	4.16	0.0712	3.21	0.0706	2.05	0.0699	1.15	0.0693

Table A.4.3.3

Constant Current Load (A)									
4.2		4		3		2		1	
ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)
355	3.28	356	3.28	350	3.23	352	3.25	351	3.23
725	6.68	742	6.84	983	9.06	883	8.14	979	9.03
1240	11.5	1250	11.5	1340	12.4	1440	13.2	1550	14.3
1890	17.4	1890	17.4	1950	18.0	2050	18.9	2170	20.0
2390	22.1	2400	22.1	2510	23.2	2630	24.2	2670	24.6
2960	27.2	2980	27.5	3080	28.4	3220	29.7	3360	30.9
3520	32.5	3540	32.6	3650	33.6	3700	34.1	3800	35.0
4050	37.3	4070	37.5	4230	39.0	4350	40.1	4510	41.5
4600	42.4	4630	42.7	4780	44.0	4800	44.2	4980	45.9
5160	47.6	5120	47.2	5240	48.3	5370	49.5	5530	50.9

Table A.4.3.4

Constant Current Load (A)									
4.2		4		3		2		1	
T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)
83.1	0.467	83.5	0.467	82.1	0.467	81.5	0.467	80.5	0.467
246	0.467	236	0.467	187	0.467	137	0.467	85.6	0.467
246	0.467	236	0.467	188	0.467	138	0.467	87.3	0.467
247	0.467	237	0.467	190	0.467	140	0.467	89.3	0.467
248	0.467	238	0.467	191	0.467	142	0.467	90.9	0.467
250	0.467	240	0.467	193	0.467	144	0.467	92.9	0.467
252	0.467	242	0.467	195	0.467	145	0.467	94.4	0.467
253	0.467	244	0.467	197	0.467	147	0.467	96.3	0.467
255	0.467	245	0.467	198	0.467	149	0.467	97.9	0.467
256	0.467	246	0.467	200	0.467	151	0.467	99.5	0.467

Table A.4.3.5

Constant Current Load (A)									
4.2		4		3		2		1	
P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)	P_e (W)	u_{Pe} (W)
0.671	0.0470	0.772	0.0503	0.639	0.0468	0.556	0.0420	0.632	0.047
12.9	0.226	12.8	0.233	13.2	0.299	7.41	0.255	4.18	0.283
25.2	0.436	22.9	0.407	17.6	0.415	12.7	0.436	8.08	0.488
35.1	0.605	37.5	0.662	27.1	0.640	19.5	0.667	11.4	0.711
56.4	0.949	47.3	0.840	31.7	0.758	26.5	0.905	16.1	0.952
56.3	0.982	55.3	0.995	47.5	1.12	34.7	1.13	19.5	1.20
67.7	1.17	70.6	1.26	53.0	1.20	38.0	1.28	22.0	1.41
89.1	1.54	78.7	1.42	60.2	1.48	46.9	1.64	28.8	1.73
91.0	1.60	86.5	1.56	86.7	1.87	46.0	1.73	27.9	1.72
101	1.78	110	1.91	92.1	2.05	57.7	1.97	33.3	2.03

Table A.4.3.6

Constant Current Load (A)									
4.2		4		3		2		1	
P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)	P_m (W)	u_{Pm} (W)
3.09	0.0334	3.11	0.0336	3.01	0.0326	3.01	0.0327	2.96	0.0322
18.7	0.176	18.3	0.173	19.3	0.184	12.6	0.124	8.78	0.0941
32.0	0.302	31.0	0.292	26.5	0.253	20.8	0.205	14.2	0.151
48.8	0.459	47.0	0.443	38.7	0.369	30.1	0.295	20.3	0.215
62.2	0.585	59.9	0.565	50.2	0.479	39.0	0.382	25.4	0.268
77.4	0.728	74.9	0.706	62.3	0.594	48.4	0.473	32.6	0.343
92.7	0.872	89.7	0.845	74.4	0.709	56.3	0.549	37.6	0.393
107	1.01	104	0.978	87.0	0.828	67.1	0.654	45.4	0.473
123	1.15	119	1.12	99.1	0.943	74.9	0.729	51.0	0.530
138	1.30	132	1.24	109	1.04	84.8	0.825	57.6	0.596

Table A.4.3.7

Constant Current Load (A)				
4.2	4	3	2	1

η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)	η (%)	u_η (%)
21.7	1.54	24.7	1.64	21.2	1.57	18.5	1.41	21.3	1.62
69.4	1.38	69.8	1.43	68.3	1.68	58.6	2.10	47.6	3.26
78.7	1.55	74.1	1.49	66.3	1.69	60.9	2.17	56.9	3.49
71.9	1.41	79.8	1.60	70.1	1.79	64.5	2.30	56.2	3.56
90.6	1.75	78.8	1.59	63.1	1.63	68.0	2.41	63.5	3.81
72.6	1.44	73.7	1.50	76.2	1.94	71.7	2.44	59.9	3.72
73.1	1.44	78.6	1.59	71.2	1.75	67.5	2.37	58.5	3.81
82.9	1.63	75.6	1.54	69.2	1.83	69.8	2.53	63.2	3.86
74.0	1.48	72.7	1.48	87.4	2.06	61.4	2.38	54.7	3.42
72.9	1.46	82.7	1.64	83.8	2.04	68.0	2.42	57.6	3.58

A.5 Melon Motor

A.5.1 No Load

Table A.5.1.1

V (V)	u_V (V)	ω (RPM)	u_ω (RPM)
0.608	0.0119	432	3.98
2.42	0.0122	1080	9.97
4.03	0.0128	1600	14.8
5.95	0.0138	2270	20.9
7.70	0.0149	2770	25.6
9.62	0.0163	3370	31.0
11.3	0.0177	3940	36.4
13.3	0.0195	4530	41.7
14.9	0.0209	5090	46.9
16.6	0.0226	5580	51.5

A.5.2 Constant Resistance

Table A.5.2.1

Constant Resistance Load (Ω)									
2		5		10		15		20	
V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)	V (V)	u_V (V)
0.424	0.0118	0.150	0.0118	0.129	0.0118	0.210	0.0118	0.190	0.0118

1.73	0.0120	1.96	0.0121	1.76	0.0120	1.82	0.0121	2.05	0.0121
2.98	0.0124	2.99	0.0124	3.48	0.0126	3.26	0.0125	3.65	0.0126
4.66	0.0131	4.88	0.0132	5.18	0.0134	5.40	0.0135	4.89	0.0132
6.33	0.0140	6.51	0.0141	6.57	0.0142	7.30	0.0146	7.23	0.0146
7.81	0.0150	8.28	0.0153	7.68	0.0149	8.46	0.0155	8.67	0.0156
9.17	0.0160	9.90	0.0166	10.1	0.0168	10.2	0.0168	9.98	0.0167
11.4	0.0178	10.6	0.0172	12.3	0.0186	11.5	0.0179	12.6	0.0188
12.3	0.0186	11.9	0.0183	14.4	0.0205	14.1	0.0202	12.4	0.0187
13.0	0.0192	13.7	0.0199	14.8	0.0209	14.9	0.0210	15.1	0.0211

Table A.5.2.2

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
I (A)	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**
0.154	0.0686	0.207	0.0687	0.207	0.0687	0.172	0.0687	0.154	0.0686
0.775	0.0690	0.491	0.0689	0.278	0.0687	0.225	0.0687	0.314	0.0687
1.34	0.0694	0.757	0.0690	0.420	0.0688	0.331	0.0688	0.349	0.0688
1.95	0.0698	1.06	0.0692	0.651	0.0690	0.473	0.0688	0.331	0.0688
2.43	0.0701	1.24	0.0693	0.828	0.0691	0.491	0.0689	0.456	0.0688
3.14	0.0706	1.61	0.0696	0.988	0.0692	0.722	0.0690	0.615	0.0689
3.67	0.0709	1.82	0.0697	1.02	0.0692	0.757	0.0690	0.491	0.0689
4.18	0.0713	2.16	0.0699	1.29	0.0694	0.953	0.0692	0.633	0.0689
4.70	0.0716	2.32	0.0700	1.50	0.0695	1.06	0.0692	0.793	0.0690
5.25	0.0720	2.48	0.0701	1.50	0.0695	1.04	0.0692	0.775	0.0690

Table A.5.2.3

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
ω (RPM)	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**	**ω (RPM)**	**u_ω (RPM)**
442	4.08	445	4.10	446	4.11	449	4.14	452	4.17
1060	9.80	1080	9.92	1090	10.1	1100	10.1	1110	10.2
1540	14.2	1580	14.6	1610	14.8	1620	14.9	1620	14.9
2160	19.9	2230	20.5	2260	20.8	2280	21.0	2280	21.0
2650	24.4	2700	24.9	2740	25.3	2780	25.7	2800	25.8

3270	30.1	3370	31.0	3430	31.6	3370	31.1	3390	31.2
3690	34.0	3830	35.3	3910	36.1	3920	36.1	3960	36.5
4330	40.0	4500	41.5	4470	41.2	4500	41.4	4530	41.8
4780	44.1	4940	45.5	5030	46.4	5070	46.7	5060	46.6
5340	49.2	5490	50.6	5470	50.4	5520	50.9	5560	51.2

Table A.5.2.4

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
T (N-mm)	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**	**T (N-mm)**	**u_T (N-mm)**
21.2	0.467	25.1	0.467	25.4	0.467	24.4	0.467	24.3	0.467
38.5	0.467	33.1	0.467	29.3	0.467	27.6	0.467	26.6	0.467
56.1	0.467	41.6	0.467	33.9	0.467	30.7	0.467	29.1	0.467
73.9	0.467	50.7	0.467	39.2	0.467	34.6	0.467	32.2	0.467
89.2	0.467	58.7	0.467	43.7	0.467	37.9	0.467	34.8	0.467
106	0.467	67.9	0.467	49.0	0.467	41.6	0.467	37.8	0.467
120	0.467	75.6	0.467	53.6	0.467	44.9	0.467	40.3	0.467
135	0.467	84.3	0.467	58.8	0.467	48.8	0.467	43.4	0.467
147	0.467	91.7	0.467	63.2	0.467	52.0	0.467	46.0	0.467
162	0.467	99.8	0.467	68.4	0.467	56.2	0.467	49.5	0.467

Table A.5.2.5

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
P_e (W)	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**
0.0184	0.0125	0.0304	0.0106	0.0241	0.00879	0.0136	0.00710	0.0224	0.00937
1.30	0.116	0.961	0.135	0.465	0.118	0.399	0.123	0.644	0.141
3.92	0.204	2.24	0.204	1.43	0.236	1.08	0.224	1.27	0.251
9.04	0.325	5.12	0.336	3.33	0.355	2.56	0.372	1.59	0.333
15.3	0.444	8.03	0.451	5.37	0.451	3.59	0.503	3.29	0.498
24.5	0.553	13.3	0.576	7.54	0.529	6.09	0.583	5.27	0.595
33.3	0.649	18.0	0.689	10.3	0.698	7.76	0.707	4.94	0.684

47.7	0.816	22.8	0.742	15.8	0.853	10.9	0.795	7.97	0.867
57.8	0.886	27.6	0.836	21.7	1.00	14.9	0.976	9.75	0.854
67.9	0.940	33.8	0.963	22.2	1.03	15.4	1.03	11.5	1.04

Table A.5.2.6

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
P_m (W)	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**
0.980	0.0235	1.17	0.0243	1.19	0.0244	1.15	0.0244	1.15	0.0246
4.28	0.0653	3.73	0.0629	3.36	0.0618	3.18	0.0613	3.10	0.0614
9.07	0.113	6.87	0.0999	5.71	0.0947	5.20	0.0924	4.93	0.0914
16.7	0.187	11.8	0.154	9.27	0.140	8.25	0.135	7.69	0.132
24.7	0.262	16.6	0.202	12.6	0.177	11.1	0.170	10.2	0.166
36.3	0.371	23.9	0.275	17.6	0.233	14.7	0.213	13.4	0.207
46.3	0.463	30.4	0.337	22.0	0.279	18.4	0.256	16.7	0.247
61.1	0.602	39.7	0.428	27.5	0.335	23.0	0.305	20.6	0.292
73.6	0.718	47.4	0.500	33.3	0.393	27.6	0.355	24.4	0.334
90.7	0.876	57.3	0.593	39.2	0.449	32.5	0.403	28.8	0.380

Table A.5.2.7

Constant Resistance Load (Ω)									
2		**5**		**10**		**15**		**20**	
η (%)	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**
1.83	1.26	2.59	0.911	2.03	0.743	1.19	0.621	1.94	0.815
30.3	2.76	25.7	3.64	13.8	3.52	12.5	3.88	20.8	4.57
43.3	2.32	32.7	3.02	24.9	4.15	20.7	4.33	25.8	5.10
54.0	2.04	43.2	2.89	35.9	3.86	31.0	4.53	20.7	4.34
61.9	1.91	48.3	2.78	42.8	3.64	32.5	4.58	32.2	4.91
67.4	1.67	55.7	2.49	42.7	3.05	41.4	4.02	39.4	4.48
71.9	1.58	59.2	2.36	47.1	3.24	42.1	3.88	29.5	4.12
78.0	1.54	57.4	1.97	57.5	3.18	47.7	3.52	38.7	4.24
78.6	1.43	58.1	1.87	65.1	3.11	54.2	3.61	40.1	3.55
74.7	1.26	58.8	1.79	56.7	2.71	47.2	3.22	40.0	3.65

A.5.3 Constant Current

Table A.5.3.1

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
V (V)	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**	**V (V)**	**u_V (V)**
0.109	0.0118	0.109	0.0118	0.150	0.0118	0.150	0.0118	0.140	0.0118
1.63	0.0120	1.62	0.0120	1.57	0.0120	1.48	0.0120	1.76	0.0120
2.74	0.0123	2.89	0.0124	3.03	0.0124	3.40	0.0125	3.06	0.0124
4.77	0.0132	4.33	0.0129	5.05	0.0133	4.95	0.0132	4.78	0.0132
6.37	0.0140	5.90	0.0138	5.86	0.0138	6.12	0.0139	6.20	0.0139
7.86	0.0151	8.55	0.0155	7.41	0.0147	8.65	0.0156	8.76	0.0157
9.59	0.0163	8.88	0.0158	8.89	0.0158	9.56	0.0163	11.1	0.0176
10.7	0.0173	9.63	0.0164	11.7	0.0181	11.3	0.0177	12.0	0.0183
12.8	0.0191	12.9	0.0192	13.5	0.0197	12.4	0.0188	12.7	0.0190
12.6	0.0190	13.3	0.0195	13.7	0.0199	14.6	0.0208	13.6	0.0197

Table A.5.3.2

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
I (A)	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**	**I (A)**	**u_I (A)**
0.189	0.0687	0.243	0.0687	0.242	0.0687	0.260	0.0687	0.207	0.0687
2.53	0.0702	2.52	0.0702	2.41	0.0701	1.69	0.0696	1.15	0.0693
4.50	0.0715	3.92	0.0711	3.03	0.0705	2.02	0.0698	1.15	0.0693
4.11	0.0712	3.99	0.0711	3.01	0.0705	2.05	0.0699	1.11	0.0693
4.22	0.0713	4.02	0.0711	2.99	0.0705	2.07	0.0699	1.06	0.0692
4.17	0.0712	3.88	0.0711	3.01	0.0705	2.09	0.0699	1.20	0.0693
4.27	0.0713	3.95	0.0711	2.94	0.0704	1.98	0.0698	1.06	0.0692
4.09	0.0712	3.95	0.0711	2.98	0.0705	1.96	0.0698	1.09	0.0692
4.15	0.0712	3.95	0.0711	2.98	0.0705	2.00	0.0698	1.06	0.0692
4.25	0.0713	3.90	0.0711	2.98	0.0705	2.02	0.0698	1.01	0.0692

Table A.5.3.3

Constant Current Load (A)									
4.2		4		3		2		1	
ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)	ω (RPM)	u_ω (RPM)
449	4.14	453	4.18	453	4.18	453	4.17	454	4.18
986	9.09	985	9.08	988	9.11	1000	9.25	1060	9.79
1470	13.5	1470	13.6	1530	14.1	1530	14.1	1590	14.7
2080	19.2	2090	19.3	2150	19.8	2210	20.4	2260	20.8
2640	24.3	2650	24.5	2630	24.3	2690	24.8	2760	25.4
3230	29.8	3250	29.9	3310	30.5	3360	31.0	3370	31.1
3710	34.2	3760	34.6	3800	35.0	3860	35.6	3960	36.5
4410	40.6	4430	40.8	4370	40.3	4450	41.0	4500	41.5
4870	44.9	4870	44.9	4950	45.6	5000	46.1	5100	47.0
5410	49.9	5440	50.2	5530	51.0	5430	50.1	5560	51.3

Table A.5.3.4

Constant Current Load (A)									
4.2		4		3		2		1	
T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)	T (N-mm)	u_T (N-mm)
24.6	0.467	25.5	0.467	25.5	0.467	25.2	0.467	25.3	0.467
90.3	0.467	90.2	0.467	90.2	0.467	80.6	0.467	52.4	0.467
139	0.467	134	0.467	107	0.467	80.3	0.467	52.8	0.467
138	0.467	132	0.467	107	0.467	80.0	0.467	52.9	0.467
138	0.467	133	0.467	107	0.467	80.3	0.467	53.3	0.467
138	0.467	133	0.467	107	0.467	80.8	0.467	53.7	0.467
138	0.467	133	0.467	107	0.467	81.2	0.467	54.1	0.467
138	0.467	133	0.467	108	0.467	81.6	0.467	54.5	0.467
139	0.467	134	0.467	108	0.467	81.9	0.467	54.8	0.467
140	0.467	135	0.467	110	0.467	83.4	0.467	56.1	0.467

Table A.5.3.5

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
P_e (W)	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**	**P_e (W)**	**u_{Pe} (W)**
0.0191	0.00758	0.0247	0.00775	0.0356	0.0107	0.0382	0.0108	0.0271	0.00955
4.10	0.118	4.04	0.117	3.75	0.113	2.20	0.0963	1.98	0.121
12.3	0.203	11.1	0.209	9.11	0.216	6.85	0.238	3.49	0.211
18.9	0.335	17.0	0.309	14.8	0.352	10.0	0.343	5.25	0.327
26.9	0.458	23.4	0.419	17.0	0.405	12.5	0.426	6.57	0.429
32.3	0.559	33.0	0.609	22.1	0.520	18.0	0.605	10.5	0.607
40.7	0.686	33.9	0.623	26.0	0.626	18.8	0.665	11.8	0.770
43.0	0.756	37.5	0.682	34.6	0.827	22.0	0.787	13.0	0.830
52.7	0.914	50.9	0.922	40.0	0.954	24.7	0.867	13.3	0.879
51.5	0.891	52.0	0.951	40.3	0.968	28.8	1.02	13.6	0.938

Table A.5.3.6

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
P_m (W)	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**	**P_m (W)**	**u_{Pm} (W)**
1.16	0.0244	1.21	0.0248	1.21	0.0248	1.20	0.0247	1.20	0.0248
9.33	0.0986	9.30	0.0983	9.33	0.0987	8.47	0.0922	5.82	0.0747
21.4	0.210	20.7	0.204	17.1	0.175	12.9	0.140	8.79	0.112
30.0	0.295	29.0	0.287	24.0	0.245	18.5	0.202	12.5	0.160
38.1	0.374	36.8	0.364	29.5	0.301	22.6	0.247	15.4	0.196
46.6	0.458	45.1	0.445	37.1	0.378	28.4	0.310	19.0	0.240
53.6	0.527	52.2	0.515	42.7	0.435	32.8	0.357	22.4	0.283
63.9	0.627	61.7	0.609	49.2	0.502	38.0	0.412	25.7	0.323
70.6	0.693	68.1	0.672	56.0	0.570	42.9	0.465	29.3	0.367
79.2	0.777	76.9	0.757	63.5	0.645	47.5	0.512	32.7	0.406

Table A.5.3.7

Constant Current Load (A)									
4.2		**4**		**3**		**2**		**1**	
η (%)	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**	**η (%)**	**u_η (%)**
1.64	0.655	2.04	0.642	2.95	0.889	3.19	0.903	2.24	0.793

43.9	1.34	43.5	1.34	40.1	1.29	25.7	1.19	34.1	2.13
57.3	1.10	53.8	1.14	53.1	1.37	53.1	1.94	39.7	2.46
62.8	1.28	58.7	1.21	61.8	1.60	54.1	1.95	42.0	2.68
70.5	1.39	63.7	1.30	57.6	1.50	55.3	1.98	42.7	2.84
69.0	1.38	73.3	1.53	59.5	1.53	63.4	2.23	55.3	3.28
75.9	1.48	64.6	1.35	61.0	1.59	57.2	2.12	52.6	3.50
67.2	1.36	60.7	1.26	70.0	1.82	57.9	2.17	50.5	3.29
74.6	1.49	74.7	1.54	71.4	1.85	57.6	2.12	45.4	3.06
64.7	1.30	67.6	1.41	63.4	1.66	60.6	2.24	41.7	2.92

A.6 Load Measurement Comparisons

Table A.6.1: Constant Current Comparison

Applied Current (A)	**Measured Current (A)**
4.20 ± 0.212	4.13 ± 0.0120
4.00 ± 0.212	3.93 ± 0.0120
3.00 ± 0.212	2.97 ± 0.0119
2.00 ± 0.211	2.00 ± 0.0118
1.00 ± 0.211	1.08 ± 0.0112

Table A.6.2: Constant Resistance Comparison

Applied Resistance (Ω)	**Measured Resistance (Ω)**
2.00 ± 0.2	2.64 ± 5.80e-3
5.00 ± 0.2	5.54 ± 2.24e-2
10.0 ± 0.2	10.3 ± 7.04e-2
15.0 ± 0.2	14.8 ± 0.130
20.0 ± 0.2	19.7 ± 0.164