Unit 1 Report: Circuits, Laws, and Equipment

Name:

NetID:

Usual bench partner:

Section AB/BB:

0 1 2 3 4 5 6 7

8 9 A B C D E F

Reflections

Review your lab 1 procedure. You should find that in addition to gaining experience with the multi-meter and the power supply, you modeled the motor as a resistor and witnessed that the NiMH battery is definitely not an ideal voltage source.

Review your lab 2 prelab and procedure. You gained an introduction to the use of MATLAB as a tool for analysis (one aspect of scientific computing). You learned to connect switches and to use resistors as current-limiting devices to slow your motor. Out of necessity, you learned to utilize networks of resistors to accomplish this goal. Each of your two resistor networks had an equivalent resistance designed to achieve the proper wheel speed and also a power rating high enough that they would not result in circuit failure. As an engineer-in-training, you learned to validate your design through measurements taken using your benchtop hardware.

Review your lab 3 prelab and procedure. As you learned about Kirchhoff's laws, you also found that smaller "tweaks" in your resistor network could lead to better speed control. You found that in a controlled system, time-varying signals cannot be purely analyzed using DC analysis tools. In this introduction to the oscilloscope, you found that the oscilloscope provides a window into the time-varying behavior of your circuits. You also continued your engineer-in-training practice by validating Kirchhoff's laws on your own car.

Review your lab 4 prelab and procedure. The extension of Kirchhoff's laws to voltage-divider circuits allowed us to design a cloud-detector. We gained valuable practice in reading datasheets for electronic components and we learned to connect a DIP-packaged IC to our breadboard, supplying it with "power and ground". While the prelab consisted of "blind, hobbyist-style" work, the laboratory environment allowed us to gain insight into the time-varying behavior of the cloud-detector circuit via the oscilloscope. We learned more about the *triggering* operation of the oscilloscope which is central to our understanding of the information it provides us. We move away from current-limiting resistors. Instead, we use a MOSFET transistor as a motor switch that is controlled by a voltage-divider circuit. A single resistive device, the potentiometer, provides a great way to quickly adjust wheel speed while the MOSFET itself provides a large increase in power efficiency.

Notes:

Unit 1 Report

You are asked to now provide a report for the unit of this lab that includes **laboratory exercises 1 through 4**. Your report has no minimum or maximum length, but you are expected to give a well-formatted report containing thoughtful evaluations as well as measured data and plots in support of your report (see Graphical Representation of Data below). In particular, your report should touch upon these aspects:

- The efficiency, η, of the current-limiting design for motor-speed control (reference Experiment #3, Figure 10). Solve the numeric value of η.
- The efficiency, η, of the MOSFET-based design for motor-speed control (reference Experiment #4, Figure 6). Solve the numeric value of η.
- Compare the "zeroth-order" resistive model, R_m, of the motor to the Thevenin Model(s) (Experiment #1, Question 9 vs. Experiment #1, Question 11).
- The agreement (or disagreement) of actual measurements taken to confirm Kirchhoff's laws.
- The use of the equipment: Ohmmeter, voltmeter, ammeter, power supply, battery, oscilloscope.
- The modules you completed and their learning objectives.

Just do your best and feel free to discuss these topics with classmates, but **do not just copy answers** or you will be penalized for plagiarism.

Graphical Representation of Data

How can we depict our measurements in a manner that is easy to read, understand, and draw conclusions from? We can use **graphs**! But we must take care when creating a graph in order to avoid ambiguity. Well-measured data, when poorly plotted, can lead to erroneous conclusions and be very confusing to someone reading your report. Even your future self will likely have difficulty interpreting your own report.

Graphs (and charts) are very concise and useful methods of depicting a large amount of data. This portion of the lab outlines the necessary components for an informative graph. You will be required to draw a few graphs by had, but most will be produced using a powerful computing platform – MATLAB. So, in addition to an introduction to "good plotting habits", you will get a quick introduction to plotting graphs using MATLAB. **MATLAB** is *a high-level programming language and computing environment* that has become a very common tool among engineers. It is important that you get comfortable with it early in your academic career.

Notes:

Plotting Graphs

Below are the details that are necessary when plotting a graph. Without these details, a person reading your lab report might not understand what your graph means and you will not receive full credit.

Title/Caption

The title of your graph should give the reader an idea of *what* is plotted and *why* it matters. In a lab course like ECE110, it should be made clear which step (or question) in the procedure is being addressed by the graph.

Example caption:

Figure 6: The IV characteristic of a DC motor with a linear curve fit to the region after turn-on.

Axes labels and Units

The labels for your axes should tell the reader what physical quantity is being plotted. Calling your axes x and y is uninformative and is considered inadequate in a quantitative experimental setting. Common labels in ECE110 include *time (in seconds)* as the horizontal axis and *voltage (in Volts)* as the vertical axis or *voltage (V)* as the horizontal axis and *current (mA)* as the vertical axis. Always, where appropriate, include the units in the axis label.

Axes scales

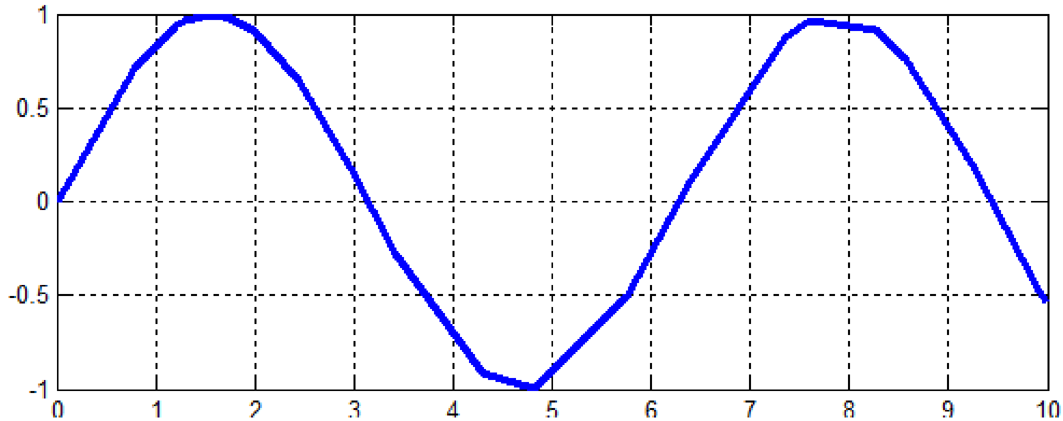
The scale of your axes is usually depicted by *labeling three or more divisions* with a numerical value. Sometimes your scale will be integer-valued and in other cases it might not be. Keep in mind that the scale of your graph should be chosen to show critical detail. If you choose a scale too large, the plot will be too small and the reader will have a hard time seeing important aspects of the curve.

Legend/plot labels

Legends are necessary when you have multiple curves on one graph. Each plot should be clearly labeled so that is clear what data are represented by each curve on your graph.

Notes:

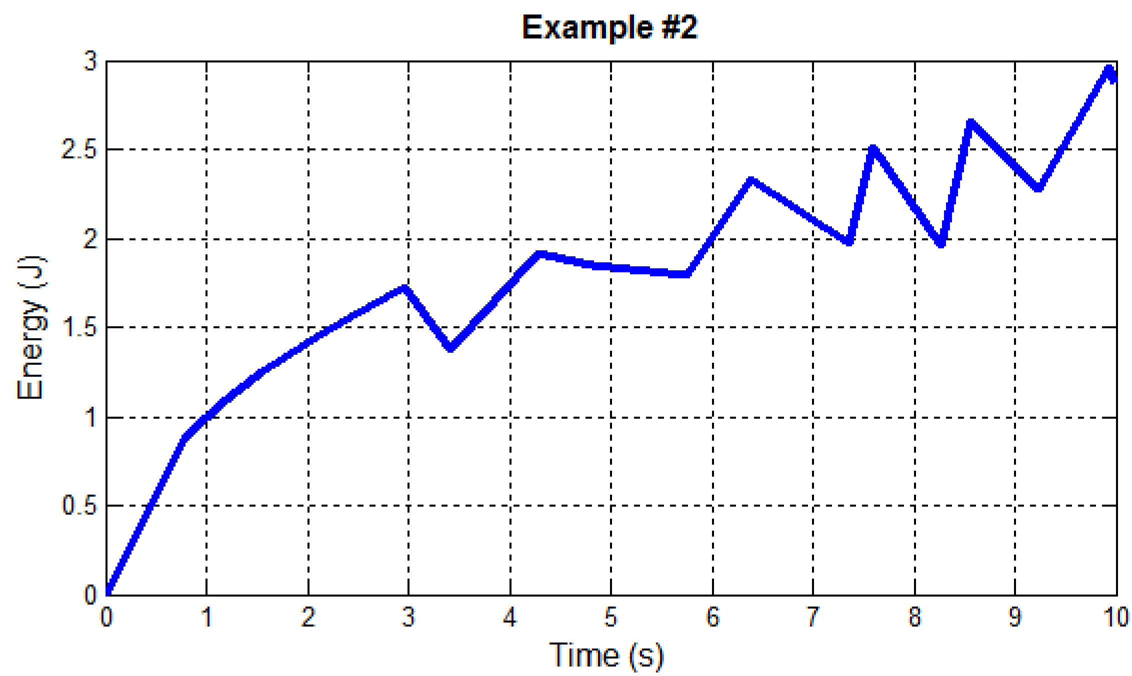
Below are some examples of graphs generated with various data sets. Identify whether each graph is acceptable or not. If you feel a graph is inadequate, clearly state why. This is a good time to discuss your thoughts with your classmates.



Question 1: What is wrong with the graph above? Consider the key features of a good graph described earlier.

No title or caption, no axes labels, no units

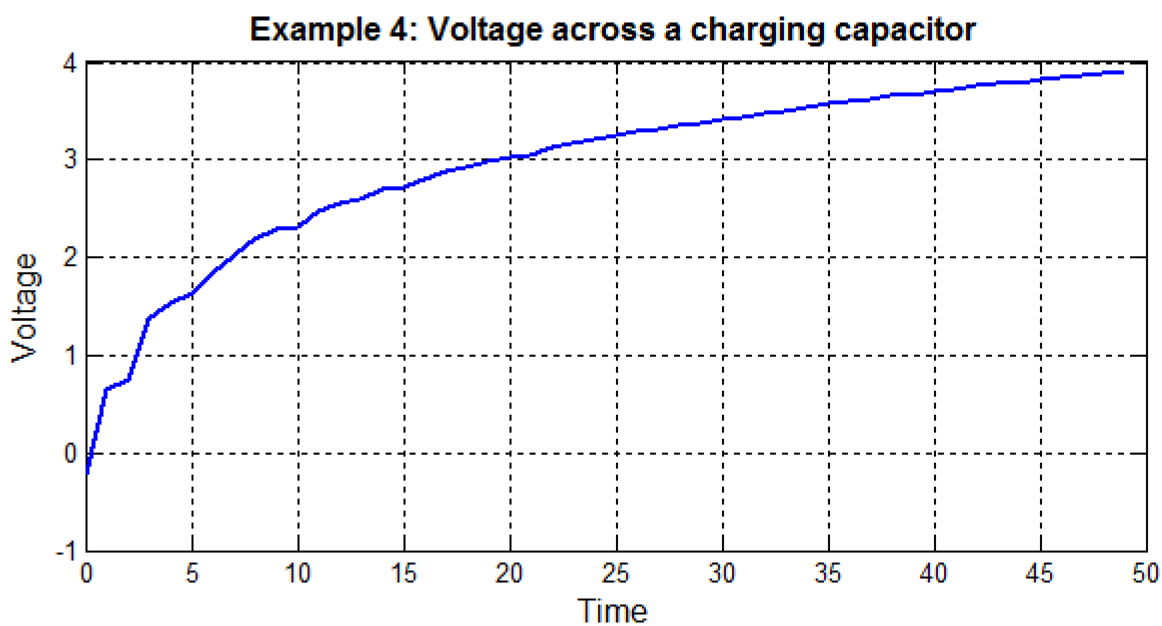
Notes:



Question 2: What is wrong with the graph above?

Title does not tell us anything about the data. A more-descriptive title and/or caption is needed.

Notes:



Question 3: What is wrong with the graph above?

No units