**Title**

**Author1, Author2, and Author3(if applicable)**

Major1,2,3

Minor1 and Minor2 and Minor3 (if applicable)

**ABSTRACT**

{ This is the template for your lab report. ONE REPORT PER TEAM. The grade for each team member depends on the quality of his/her individual portion of the report (e.g. circuit design and testing) as well as the shared sections (e.g. Project Description). Except for section headings (e.g. ABSTRACT), delete all instructions and replace with your own text. Margins are 1-inch all around. Each page should have a header and page number. All text is in Times New Roman font with a line-spacing of 1.5. The title is bold-faced, 18 pt, and centered. The main body text is in 11 pt font. The author names are bold-faced and centered. The author information is also centered. The abstract should be short (a dozen sentences or so). It summarizes the overall goal of your lab work and what you actually did. The last sentence or two should describe your opinion on how you benefited from the lab (e.g. the design process, circuit debugging). }

**1. PROJECT DESCRIPTION**

* NOTE: Delete these bullets! Your report should be written in paragraph format.
* In a few sentences, describe the basic idea of your project (i.e. what it does) in layman’s terms.
* In a few sentences, describe the broader impact of your project topic (i.e. who would benefit and what particular industry).
* Include a block diagram of your system. Make sure to include the system input (e.g. knob position) and output (e.g. LED brightness). Briefly describe the function of each block, and identify who worked on which block component.
* Do NOT put any technical details or design requirements here – that is for the next section.

**2. CIRCUIT DESIGN**

{ Each student must write a separate section describing his/her circuit design. For example, Student 1 writes Section 2.1 while Student 2 writes Section 2.2. }

**2.1 {Name of circuit and student}**

**2.1.1 Design Requirements**

* This is where you provide quantitative information regarding your circuit. Examples include the power supply, input signal amplitude, PWM output frequency, range of duty cycle, or pulse duration, LED current, etc. Some design requirements will be pretty specific, while others less so (that’s OK for this project). No component values! Just discuss the circuit requirements that will guide your design process.

**2.1.2 Description of Final Circuit**

* Provide a Multisim schematic of your FINAL circuit. If your circuit design significantly changed from your preliminary design, that is perfectly OK and you can describe that evolution in a later sub-section.
* Provide a paragraph with a QUALITATIVE (i.e. no numbers) description of how your final circuit works. Pretend like you are describing your circuit to another electrical engineer (i.e. someone who is familiar with op amps, transistors, coupling capacitors). **Demonstrate that you understand the PURPOSE of various features of your circuit.** For example, why include a resistor above and below the potentiometer? What is the purpose of each op amp in the triangle wave generator? What is the comparator doing to produce the PWM output? Why use a high-side or low-side transistor switch?

**2.1.3 Design Calculations**

* This is where you write about how you came up with component values. The rationale is just as important as the result! In other words, make sure to describe your STRATEGY in choosing component values. For example, what did you have to consider when choosing the resistors that go above and below the potentiometer?
* You DO NOT need to type every single calculation for every component. Just type in the most important equation(s) needed, and then describe the final values.

**2.1.4 Circuit Simulation**

* Provide a simulation of your circuit. Your input source (e.g. function generator) in Multisim should be similar to what you used in lab to test your breadboard circuit. That way you can eventually compare the simulation and experimental data!

**2.1.5 Design Evolution**

This is where you describe any modifications made to your circuit design. Some projects required more design changes than others. Make sure to describe how each design modification addressed a design flaw that you observed during prototyping. For example, the triangle wave generator with op amps had some issues.

**2.2 {Name of next circuit and student}**

**2.2.1 Design Requirements**

**2.2.2 Description of Final Circuit**

**2.2.3 Design Calculations**

**2.2.4 Circuit Simulation**

**2.2.5 Design Evolution**

**2.3 {Name of next circuit and student}**

**2.3.1 Design Requirements**

**2.3.2 Description of Final Circuit**

**2.3.3 Design Calculations**

**2.3.4 Circuit Simulation**

**2.3.5 Design Evolution**

**3. CIRCUIT TESTING AND DATA ANALYSIS**

{Each student must write a separate section describing his/her circuit testing. For example, Student 1 writes Section 3.1 while Student 2 writes Section 3.2. The final awesome demo with everything connected comes last.}

**3.1 {Name of circuit and student}**

* Describe the testing procedure (input test source, measurement method, etc.)
* Include important scope waveforms, multimeter measurements, and calculations. Where appropriate, try to reduce your figure sizes to show two plots side by side to conserve paper.
* If you came up a little short in satisfying a particular design requirement (this is not unusual), explain how you might revise your circuit to improve its performance.

**3.2 {Name of next circuit and student}**

**3.3 {Name of next circuit and student}**

**3.4 System Demonstration**

* Describe the testing procedure of the combined circuits.
* Include important scope waveforms, multimeter measurements, calculations, links to YouTube vidoes, etc.. Where appropriate, try to reduce your figure sizes to show two plots side by side to conserve paper.
* Include a photo of your soldered circuits (keep images small to save ink/toner).

**4. DISCUSSION**

This is more of a self-reflection section. Lots of stuff happened along the way -- you had to do calculations, simulations, and circuit debugging. You probably had to iterate the entire design process a few times. What did you find the most challenging about the circuit design process? Also comment on any observations of weird circuit behavior. For example, the servo motors produced significant unwanted feedback in the PWM output – perhaps a totem-pole driver could buffer the comparator output from the servos?

**5. CONCLUSIONS**

Overall, did your project work (if not completely, that is perfectly OK)? Did it satisfy some or all of the design requirements? Were there significant discrepancies between theory, simulation, and experiment? What lessons did you learn about the design/testing process?