**Title**

**Author1 and Author2 (if applicable)**

Major1,2

Minor1 and Minor2 (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. audio signal from phone) and output (e.g. sound from a speaker). 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 and frequency range, output voltage amplitude, distance between optical transmitter and receiver, speaker impedance, range of heart rate values, LED currents, etc. Some design requirements will be pretty specific, while others less so (that’s OK for this particular project).

**2.1.2 Description of Final Circuit**

* Provide a Multisim schematic of your FINAL circuit. If your circuit design fundamentally changed from your preliminary design (e.g. inserted a voltage buffer), 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 use a voltage divider with a bypass capacitor? Why use a coupling capacitor? Why is the photodetector oriented one way and not the other? Why attach a resistor to the microphone? How does the summing op amp work?

**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 a coupling capacitor?
  + One notable exception to this “rule” is the voltage dividers. Most projects did not have any requirements for the voltage divider. Therefore, we used 100 kohm resistors since: (1) power dissipation is low (under 1 mW) (2) example circuits in data sheets often use 100 kohm resistors. The second reason is not very convincing, but it is true!
* 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 showing the frequency response of your circuit. Your input source (e.g. function generator in series with a resistor) in Multisim should be similar to what you used in lab. That way you can eventually compare the simulation and experimental frequency plots!

**2.1.5 Design Evolution**

This is where you describe any modifications made to your circuit design. Some projects required a more drastic change in design than others. Buma feels bad about being away for a week and not having time to fully vet the initial circuit designs. ☹ Nevertheless, make sure to describe how each design modification addressed a design flaw that you observed during prototyping. For example, some circuits experienced problems with large electrolytic capacitors as input coupling capacitors – how did the circuit modification get around this annoying reality?

**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 { If you needed the LM386 amplifier, whoever built this circuit should write this short section}**

**2.3.1 Design Requirements**

* Not many requirements here (power supply and speaker impedance).
* No gain requirements, so the default Gain = 20 was fine.

**2.3.2 Description of Final Circuit**

* Circuit schematic (e.g. cut and paste from the LM386 data sheet).
* If you made any modifications (e.g. input coupling capacitor) should be described here.

{No circuit simulation needed for the LM386 amplifier. ☺}

**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 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.

**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 (e.g. speaker distortion, unreliable potentiometer, the need for power supply bypass capacitors).

**5. CONCLUSIONS**

Overall, did your project work? Did it satisfy the design requirements? Were there significant discrepancies between theory, simulation, and experiment? What lessons did you learn about the design/testing process?