Lab Report: Title

The lab report should be written assuming the reader is familiar with the lecture material and has read the lab handout. You might need to paraphrase some of the content in the handout in your own words to demonstrate understanding. In previous courses, students often describe their code at a low level in a lab report. In this course, we challenge students to prepare reports that demonstrate the student's understanding of the course *content*. The report should focus on the high-level implementation and evaluation aspects of the assignment. Details about the actual code should be in the code comments.

Each report should include an introduction and conclusion, along with a section on the alternative design, testing strategy, evaluation, and work distribution. The final lab report can also include an optional section on optimizations. Your report should look like a report with paragraphs and prose. Avoid subsections unless there is a very compelling reason to include them.

Use this overleaf template, but remove all the instruction text from the template before you submit it. **There is a strict 6 page page limit.** Most high-quality reports require around four pages of actual text with another one or two pages of figures, plots, and tables. You should interleave your figures, plots, and tables in the main body text where appropriate. Do not place all of your figures, plots, and tables at the end. All figures must be legible. Avoid scanning hand-written figures and do not use a digital camera to capture a hand-written figure. When including code is appropriate, do not use screen captures. Instead, cut and paste the code into your report and format it appropriately. Here is an example of how to write a code snippet:

```
1 module and_gate(input a, b, output y);
2 assign y = a & b;
3 endmodule
```

1 Introduction (1 paragraph maximum)

All reports must start with an introduction. Students must summarize the purpose of the lab. Why are we doing this assignment? How does it connect to the lecture material? There are often many purposes. Think critically about how the assignment fits into the other labs. Students can paraphrase from the handout as necessary. Students must include a sentence or two that describes at a very high-level their baseline and alternative design. The introduction should be brief but still provide a good summary of the lab.

2 Alternative Design

Students must describe their alternative design and their implementation. Students must include a datapath diagram or a block diagram and possibly an FSM diagram for the alternative design. Consider a paragraph that provides an overview of your design, before doing a deep dive into the details of one or two interesting aspects of the design. Think critically about what are the key items to mention in order for the reader to understand how the

alternative design works. We do not want a detailed description of your baseline design, but selectively comparing the alternative design to your baseline may provide useful context. Examples are usually great to include here to illustrate how the alternative design works. Students are encouraged to describe how their design incorporates specific design patterns and principles discussed in lecture and the discussion section, but be specific. Simply saying the design exhibits modularity, hierarchy, encapsulation, regularity, and/or extensibility is not sufficient; be specific and explain *how* the design exhibits these design principles. Do not include detailed information about Verilog signals or code; your lab report should be at a higher level. If you include waveforms or line traces then you must annotate them so that the reader can understand what they mean. This section will likely be about one page. **Remember that you must provide a balanced discussion between what you implemented *and* why you chose that implementation.**

3 Testing Strategy

Describe the testing framework provided for testing your design. Describe the overall testing strategy (e.g., ad-hoc vs. assertion testing, directed vs. random testing, black-box vs. white-box testing, value vs. delay testing, unit vs. integration testing, and usage of reference models). Simply saying the group used unit testing is not sufficient; be specific and explain *why* you used a specific testing strategy. Students must explain at a high-level the kind of directed tests cases they implemented and why they used these test cases. Consider including a table with a test case summary, or some kind of quantitative summary of the number of test cases that are passing. (Here is an example of how you can cite Table 1 in your text.) Provide a compelling, evidence-based argument that there design is functionally correct.

Table 1: Table Example. Note how table captions come before figure captions.

Implementation	unit	unit
A	number	number
B	number	number
C	number	number

We recommend students start this section with a short paragraph that provides an overview of your *strategy* for testing (so how all of the testing fits together). Then you might have one paragraph for each kind of testing. Each paragraph starts with the "why" (why that kind of testing) and then goes on to the "what" (what did you actually test using that kind of testing). Then you can end with a paragraph that pulls it all together and tries to make a compelling case for why you believe your design is functionally correct. Do not include the actual test code itself; your lab report should be at a higher level. If you include waveforms line traces then you must annotate them so that the reader can understand what they mean (i.e., what corner case does the waveform or line trace illustrate?). For lab 4, you will also need to discuss your *software* testing strategy in addition to your *hardware* testing strategy. This section will likely be about one page. **Remember to provide a balanced discussion between how you tested your design *and* why you chose that testing strategy and test cases.**

4 Optimizations

For lab 4, students can include a dedicated section to discuss any software or hardware optimizations they experimented with. We suggest dedicating a paragraph to each optimization. Start by motivating what overhead the optimization is focusing on, then discuss how the optimization can mitigate this overhead, and finally discuss the details of how the optimization was implemented in your implementations. Students should discuss optimizations even if the optimization did not actually improve performance. Do not quantitatively evaluate your optimizations in this section. This section may just be a single paragraph, or could be several paragraphs. **This section is optional. Students can still earn full credit without this section.**

5 Evaluation

Students must report their simulation results using an appropriate mix of text, tables, and plots. Do not simply include the raw data. A plot is almost always helpful. (Here is an example of how you can cite Figure 5 in your text.) You must include some kind of analysis of the results: Why is one design better or worse than another? Can you predict how the results might change for other designs or parameters? What can we learn from these results? Students must include some kind of qualitative analysis of the impact of the alternative design on cycle time (i.e., clock frequency), area, and energy. Simply saying one design uses more area or energy is not sufficient; be specific and explain *why* one design might use more area or energy. We recommend students start with the performance analysis and then have three (possibly short?) paragraphs: one each on area, energy, and cycle time. This is where your qualitative analysis comes in on these important metrics. This section will probably be one of the longer (and most important) sections. **Remember to provide a balanced discussion between what the results are *and* what those results mean.**

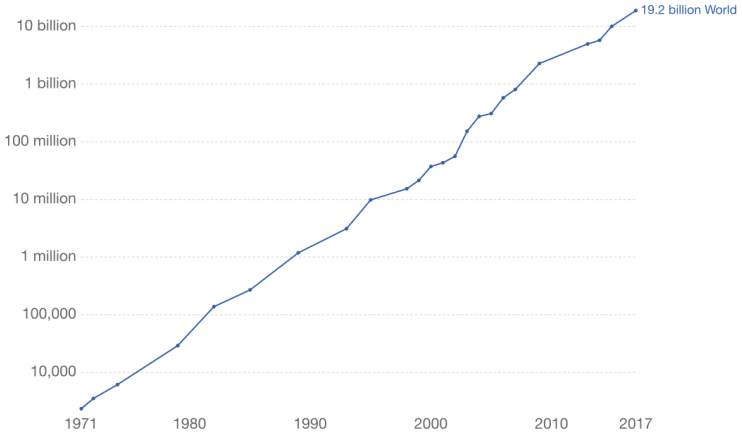

Figure 1: Figure Example. Note how figure captions come after the figure content. Source: Our World in Data. https://ourworldindata.org/grapher/transistors-per-microprocessor

6 Conclusion

All reports end with a conclusion. Students must include a brief qualitative *and* quantitative overview of the evaluation results (Which implementation performed best? By how much? On which inputs?). Students must include some high-level conclusions they can draw from their qualitative and quantitative evaluation. Do not over-generalize. Can you predict how the results might change for other inputs? What can we learn from these results? Which design should we use in the future? If it depends, explain why it depends.

7 Work Distribution (1 paragraph maximum)

Students must include a one paragraph description of which student did what work. It is perfectly fine if one students does more work; the key is to transparent and honest about the work distribution across students. Also state how you used generative AI for (1) coding, (2) testing, and (3) the preparation of the lab report.

If you have room, feel free to include extra material to help demonstrate your understanding. For example, you could include a particularly clever test case in the testing strategy section. You could include a pen-and-paper example to illustrate how your baseline design or alternative design works. Be sure to highlight "extra" work you did in your design, testing, or evaluation. If you tried two different alternative designs, discuss them in the alternative design section and use them to create a richer comparative analysis in the evaluation section. If you used a new kind of testing technique (e.g., randomly generating different mixed instruction sequences) highlight that in the testing strategy. If you added an interesting new evaluation input, highlight that in your evaluation section. There are many creative things you can do to set your report apart!

Important: Although you may use generative AI tools in this class, your lab report must demonstrate your understanding of the material covered in this assignment and course. You cannot earn full credit if you use generic statements that aren't specific to our class content. Implausibly advanced discussions or conclusions that do not demonstrate your authentic understanding of course concepts will result in point deductions far worse than leaving a section blank. If the course staff questions whether you understand what you have submitted, the instructor will invite you to a technical conversation about your report. Unless you relish awkward conversations, please ensure it doesn't come to that.