EGR 270
Fundamentals of Computer Engineering
File: EGR270SampleLab

Lab Report Format

Each lab report submitted should contain the following four sections:
1) Title Page
2) Preliminary Work
3) Laboratory Results
4) Discussion/Conclusion

Title Page

The Title Page should contain the following items as a minimum: Lab Number, Lab Title, your name, the course number and name, and the semester.

Preliminary Work

Even though the Preliminary Work is checked at the beginning of each class, it must also be included in the lab report where it will be graded in detail. Be sure to make the Preliminary Work as readable as possible by including all given information or instructions and by explaining your steps.

Preliminary Work will often require schematics. All schematics should be drawn in PSPICE. Pinouts for all Integrated Circuits (IC's) are also typically required. Pinouts can be obtained from the Pinouts document on the course website. Pinouts are also readily available online from sites such as Jameco (www.jameco.com).

Laboratory Work

Clearly present the results of all testing performed in lab. List any changes to the design or the schematic. Also see the lab guide for additional requirements for this section.

Discussion/Conclusion

Clearly and specifically state whether the objectives of the lab were accomplished. Did the circuits tested produce the expected results and what design principles were verified by these results? What did you prove or verify in the lab? Discuss any significant design changes. Also see the lab guide for additional requirements for this section.

Refer to the **Sample Lab** and the **Sample Lab Report** on the following pages. Include all sections indicated in each report. Reports should be presented neatly and professionally. Use proper grammar, employ good writing style, and make the reports as readable as possible. Readability of reports is greatly enhanced by simple techniques such as:

- stating what you are about to show or adding comments at various points when you display your results
- adding titles or headings before equations, graphs, tables, etc.

Sample Lab Guide

EGR 270
Fundamentals of Computer Engineering
File: SAMPLE_LAB.DOC

Lab # ?? (Sample Lab)

2-bit Adder/Subtractor with Carry-in/Borrow-in

A. Objectives

The objective of this laboratory is the design and realization of adding and subtracting circuits using combinational switching circuits.

B. Introduction

It is expected that the student reviews those topics relating to modeling switching functions using Karnaugh Maps and Boolean algebra. The student should also review the function definitions of NAND and XOR (exclusive-OR) gates.

C. Preliminary Work

1. Construct the truth table for a 2-bit (logic variables B and A) binary adder/subtractor with a carry-in/borrow-in input. An input logic signal called X is to control the circuit to perform either addition or subtraction as follows:
   - if X = 0, perform the addition B + A
   - if X = 1, perform the subtraction B - A

   Inputs to the circuit include B, A, and X as described above, as well as Ci/Bi, the carry-in/borrow-in bit. The circuit should compute the result, referred to as SUM/DIF and the carry-out/borrow-out, referred to as Co/Bo.
2. Use K-maps and Boolean algebra to simplify the equations in minimal SOP formfor each output signal.
3. Further simplify the equations using XOR gates if possible.
4. Draw the schematic using PSPICE. Be sure to include switches for all inputs and LEDs for all outputs. No simulation is required for this circuit.
5. Include pinouts for all IC's used.

D. Laboratory Work

1. Construct your circuit from the PSPICE schematic. Note any changes.
2. Test your circuit, filling in a truth table prepared for recording the circuit response for all possible input combinations.
3. Demonstrate proper circuit operation to the instructor.

Sample
Lab
Report

Lab # ?? (Sample Lab)

<u>2-bit Adder/Subtractor with Carry-in/Borrow-in</u>

By: John Doe
Partner: Joe Smith

EGR 270
Fundamentals of Computer Engineering
Spring 20??

Preliminary Work

Clearly label each section of the report.

1. The truth table shown below is for a 2-bit binary adder/subtractor with a carry-in/borrow-in input. The inputs and outputs are described as follows:

Always include instructions (or a summary). Present the work clearly so that the report is easy to follow.

Inputs:

B, A — binary inputs
Ci/Bi — carry input or borrow input
X — input to indicate whether the circuit is to perform addition or subtraction

Outputs:

SUM/DIFF = B + A if X = 0
= B - A if X = 1
Co/Bo — carry output or borrow output

Inputs				Outputs	
X	Ci/Bi	B	A	SUM/DIFF	Co/Bo
0	0	0	0	0	0
0	0	0	1	1	1
0	0	1	0	1	0
0	0	1	1	0	0
0	1	0	0	1	1
0	1	0	1	0	1
0	1	1	0	0	0
0	1	1	1	1	1
1	0	0	0	0	0
1	0	0	1	1	0
1	0	1	0	1	0
1	0	1	1	0	1
1	1	0	0	1	0
1	1	0	1	0	1
1	1	1	0	0	1
1	1	1	1	1	1

2. Shown below are the Kmaps and logic equations (in minimal SOP form) for the two output signals: SUM/DIFF and Co/Bo.

BA \ XCi/Bi	00	01	11	10
00	0	1	1	0
01	1	0	0	1
11	0	1	1	0
10	1	0	0	1

Kmap for SUM/DIFF

BA \ XCi/Bi	00	01	11	10
00	0	1	0	0
01	1	1	1	0
11	0	1	1	1
10	0	0	1	0

Kmap for Co/Bo

$$\text{SUM/DIFF} = \text{Ci/Bi} \bullet \overline{B} \bullet \overline{A} + \overline{\text{Ci/Bi}} \bullet \overline{B} \bullet A + \text{C/B} \bullet B \bullet A + \overline{\text{Ci/Bi}} \bullet B \bullet \overline{A}$$ (minimal SOP)

$$\text{Co/Bo} = \text{Ci/Bi} \bullet A + \overline{X} \bullet \text{Ci/Bi} \bullet \overline{B} + X \bullet B \bullet A + \overline{X} \bullet \overline{B} \bullet \overline{A} + X \bullet \text{Ci/Bi} \bullet B$$ (minimal SOP)

3. Further simplify the equations using XOR gates if possible.

$$\text{SUM/DIFF} = \text{Ci/Bi} \bullet \left(\overline{B} \bullet \overline{A} + B \bullet A\right) + \overline{\text{Ci/Bi}} \bullet \left(\overline{B} \bullet A + B \bullet \overline{A}\right)$$

$$\text{SUM/DIFF} = \text{Ci/Bi} \bullet \left(\overline{B \oplus A}\right) + \overline{\text{Ci/Bi}} \bullet (B \oplus A)$$

$$\boxed{\text{SUM/DIFF} = \text{Cin/Bin} \oplus (B \oplus A)}$$ (final minimized result)

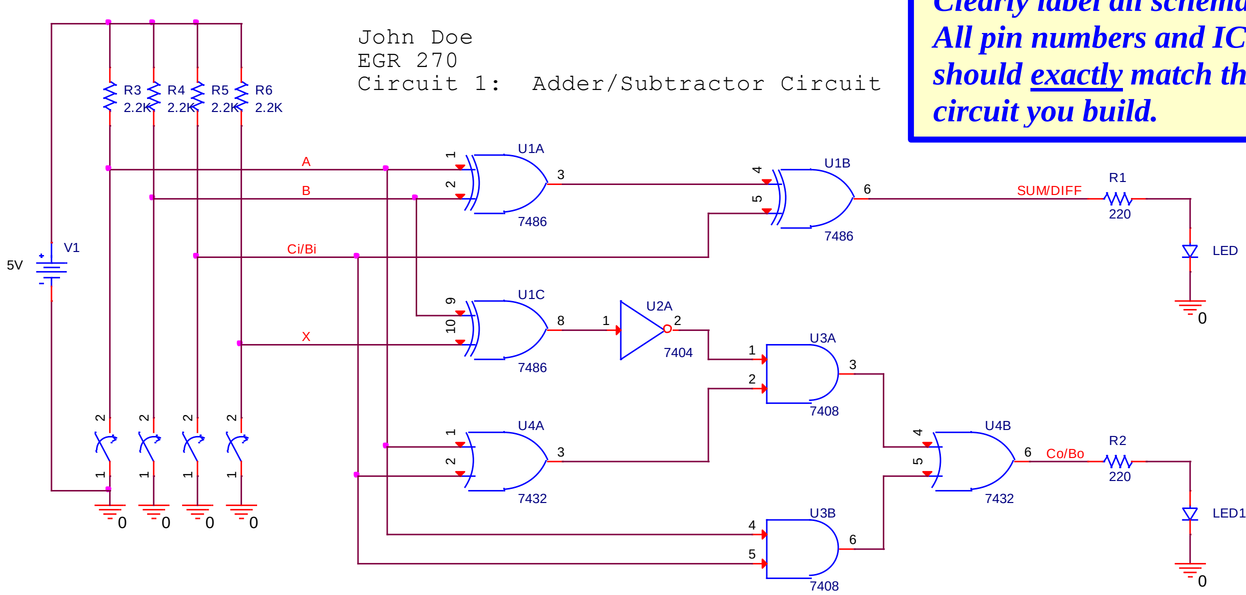
$$\text{Cout/Bout} = A \bullet \left(\overline{X} \bullet \overline{B} + X \bullet B\right) + \text{Cin/Bin}\left(\overline{X} \bullet \overline{B} + X \bullet B\right) + \text{Cin/Bin} \bullet A$$

$$\text{Cout/Bout} = (A + \text{Cin/Bin}) \bullet \left(\overline{X \oplus B}\right) + \text{Cin/Bin} \bullet A$$

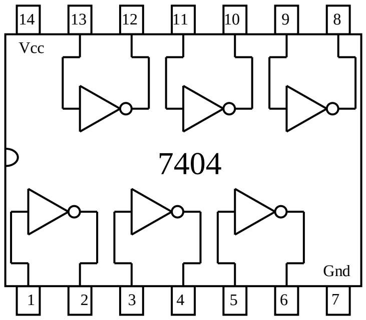
$$\boxed{\text{Co/Bo} = (A + \text{Ci/Bi}) \bullet \left(\overline{X \oplus B}\right) + \text{Ci/Bi} \bullet A}$$ (final minimized result)

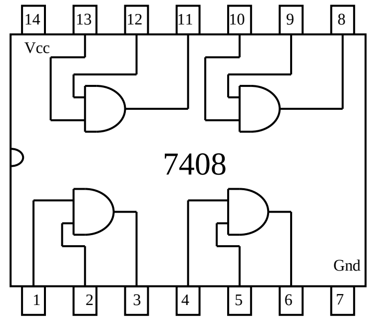
4. Draw the schematic using PSPICE. Be sure to include switches for all inputs and LEDs for all outputs. No simulation is required for this circuit.

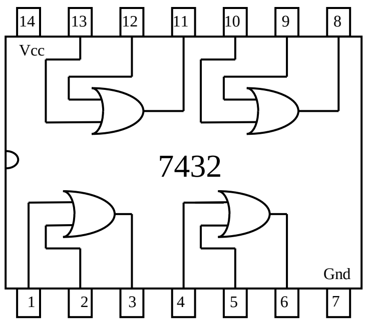
Clearly label all schematics. All pin numbers and ICs should <u>exactly</u> match the circuit you build.

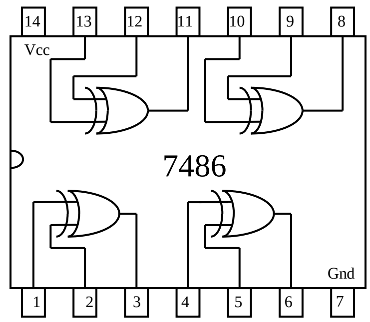


5. Include pinouts for all IC's used.









Pinouts are available in the Pinouts document on the course website or online from sites such as Jameco Electronics (www.jameco.com).

Laboratory Work

1. The adder/subtractor circuit was constructed according to the PSPICE schematic. No changes were needed.

2. The circuit was tested for all 16 input switch combinations. An output of 1 (HIGH) was indicated by the corresponding LED being lit and a 0 (LOW) was indicated by the LED not being lit.

Inputs				Outputs	
X	Cin/Bin	B	A	SUM/DIF F	Cout/Bout
0	0	0	0	0	0
0	0	0	1	1	1
0	0	1	0	1	0
0	0	1	1	0	0
0	1	0	0	1	1
0	1	0	1	0	1
0	1	1	0	0	0
0	1	1	1	1	1
1	0	0	0	0	0
1	0	0	1	1	0
1	0	1	0	1	0
1	0	1	1	0	1
1	1	0	0	1	0
1	1	0	1	0	1
1	1	1	0	0	1
1	1	1	1	1	1

Always show all measured data. It is not sufficient to say that "the circuit worked correctly" or that "the measured results matched the predicted results." Show all measured the data and clearly introduce or label all items.

Discussion/Conclusion

The truth table generated from testing the adder/subtractor circuit is identical to the truth table generated in the Preliminary Work, therefore the design of the Adder/Subtractor Circuit has been validated. No problems occurred and no design modifications were required.

Be specific about what you have proven or demonstrated. It is not sufficient to say that "the lab went fine" or "everything worked correctly." Discuss any problems or discrepancies.