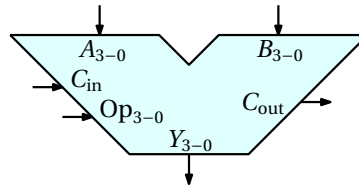


ECE 150 Digital Logic Design, Fall 2023
Project 1: 4-bit Arithmetic Logic Unit
Due October 4th 2023

Using any of the following ICs in JLab, *gates, muxes, demuxes, decoders*, implement a 4-bit Arithmetic Logic Unit (ALU) as a combinatorial logic circuit (no memory circuitry or sequential logic). Your ALU must accept two 4-bit words as input (A, B), a 4-bit op-code (Op) and output a single 4-bit word (Y).



Your ALU must be able to perform the following operations:

- (Op = 0000) No-op ($Y = A$)
- (Op = 0001) Binary Addition ($Y = A + B$)
- (Op = 0010) Binary Subtraction ($Y = B - A$, in two's complement)
- (Op = 0011) Logical Shift of A (ex. if $A = 0101$, then $Y = 101C_{in}$)
- (Op = 0100) Bitwise OR ($Y = A + B$)
- (Op = 0101) Bitwise AND ($Y = AB$)
- (Op = 0110) Bitwise NOT ($Y = \bar{A}$)
- (Op = 0111) Bitwise XOR ($Y = A \oplus B$)

You will demonstrate the correct output of your circuit at the beginning of class on the due-date, and submit a typed PDF report.

Circuit Requirements:

- Provide inputs A_{3-0} , B_{3-0} , and Op_{3-0} via three 4-input DIP switches (active-high) from left to right.
- Use no more than four breadboards.
- Use red wire for 5V and black for ground.
- Display your outputs on LEDs.

Report Requirements:

- Introduction: restate the problem in your own words
- Methods: detail how you arrived at your implementation. You must include,
 - truth-table(s)
 - a derivation of your final implemented expressions (boolean algebra or K-map)
 - logic diagram(s)
- Implementation: detail your circuit, including,
 - a picture of your circuit with labeled ICs and labeled subcircuits.
- Conclusion:
 - What are the pros and cons of your design?

Grading:

- Correct circuit operation (demo) (40 pts)
- Report (60 pts)

Additional Considerations:

- Circuit
 - Can you combine ALUs with a classmate to create an 8-bit ALU? (+5 pts to project)
 - (+3 pts to project) ($Op = 1000$) Arithmetic Shift of A (in two's complement)
 - * ex. if $A = -3_{10}$, then $Y = -6_{10}$
 - Neatness (color coding, right-angles only, no crossing wires) (+2/100 pts to midterm exam)
 - Number of ICs used (+5/+3/+1 points to midterm for fewest chips used, ranked by class).
- Report
 - Consistent typesetting
 - Schematics and diagrams done in CAD (or hand-drawn EXTREMELY NEATLY)
 - Correct use of technical terms
 - All Figures, Images, and Tables have captions and are referenced in the text

You may find it helpful to make use of simulation software, such as Logisim or Logisim-Evolution.