CDA 4203L Spring 2025
Computer System Design Lab
Lab 1 – Schematic Capture
Lab Date: Jan. 28
Report Due Date: Feb. 7 on Canvas

**This is an individual assignment. No teaming allowed. No demonstration is needed.
No hardware is needed, use ISE as instructed.**

Before this lab please: (a) read installation guide and install ISE, (b) read Tutorial_Lab1.pdf.

Objectives: To learn and practice schematic entry and simulation.
Problem: Implement an ALU (Arithmetic Logic Unit) satisfying the following functional requirements. You should complete schematic capture tutorial (Tutorial_Lab1.pdf), before you start on this lab.

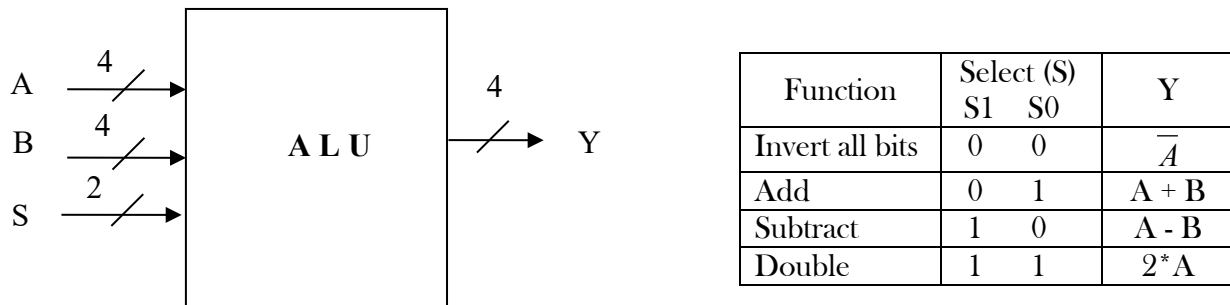| Function	Select (S) S1 S0		Y
Invert all bits	0	0	$\overline{A}$
Add	0	1	A + B
Subtract	1	0	A - B
Double	1	1	2*A

Figure 1: ALU Port Interface and Function Table

Implement your design in two's complement signed system, discard the end-round carry. Do not use the cases that lead to overflow, i.e., adding two positive or adding two negative numbers (sometimes), and subtracting a positive and a negative number and vice versa (sometimes).
-   Invert example: 1101 will be 0010
-   Add example: 0110 (which is +6) + 0001 (which is +1)=0111 (+7)
-   Add example: 0111 (which is +7) + 0001 (which is +1) gives 1000 (-8), <u>overflow</u>
-   Add example: 1111 (-1) + 0111 (+7) = 0110 (+6)
-   Subtract example: 1111 (-1) – 1110 (-2) = 0001 (+1)
-   Subtract example: 0001 (+1) – 1000 (-8), gives 1001, <u>overflow</u>

1. (10 pts) Design and create a schematic of the ALU using ISE Schematic Entry tool.
2. (10 pts) Create a test bench and use it to test the ALU functionality. Include at least two test vectors per 4 functions in the table above.

Deliverables: A concise report that includes your design and simulation results.

Report Organization (A template is provided on Canvas –Lab 1 Report Template.docx):
- □ Cover sheet
- □ ALU schematic, you need to show the top level and also inside of all your blocks including full adder, MUX, etc. You need to show screenshots of all the blocks and the details inside.
- □ Brief description of your design
- □ Simulation waveforms
- □ Feedback: Hours spent, Exercise difficulty (Easy, Medium, Hard)

Important:
- □ Do not discard your design. It will be used as starting point for subsequent lab exercise(s).
- □ You need to submit your report on Canvas in PDF format. No hardcopy is needed.