EEE 304 – Digital Electronics Laboratory
Jan 2023 Level-3 Term-2
Final Project Demonstration

4 Bit ALU (Arithmatic Logic Unit)

SUBMITTED BY – GROUP 01

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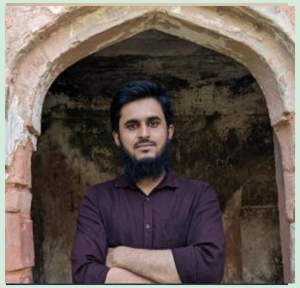

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Outline

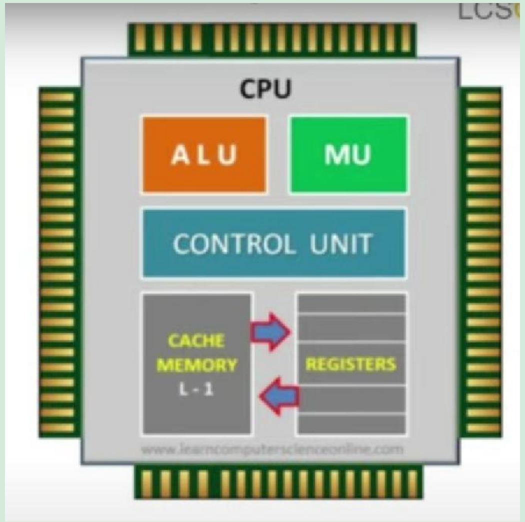
1. Summary
2. Introduction
3. Design
4. Implementation
5. Analysis and Evaluation
6. References

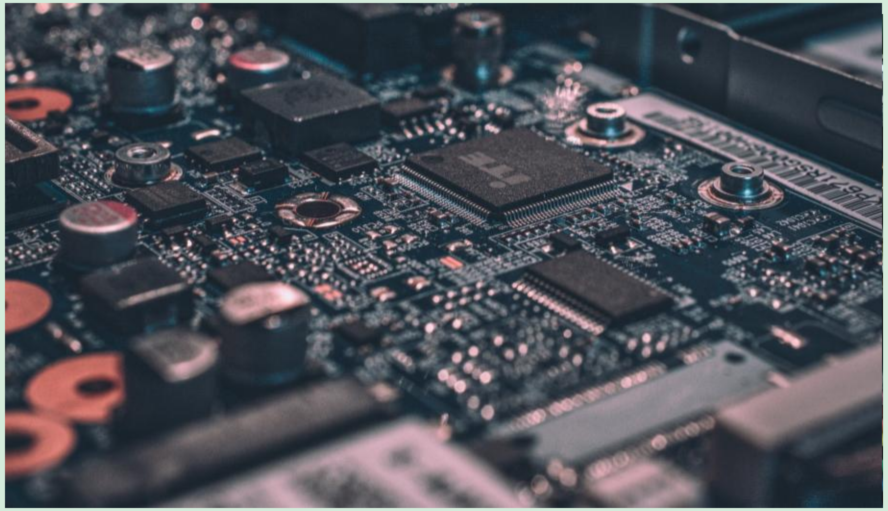
1. Abstract

- An Arithmetic Logic Unit (ALU) is a fundamental component of a computer's central processing unit (CPU) responsible for performing arithmetic and logical operations on data.
- A 4-bit ALU operates on 4-bit data at a time.
- Our ALU can perform 4 arithmetic operations : addition, subtraction, multiplication, division & 4 bitwise operations: AND, OR, NOT, XOR
- It shows output on 7 segment display & stores the result back in registers.

2. Introduction

An ALU (Arithmetic Logic Unit) is a crucial component of a computer's CPU (Central Processing Unit). It is necessary because it performs fundamental arithmetic and logical operations on binary data. The development of the ALU was driven by the need to perform arithmetic and logical operations efficiently in electronic computing devices. It emerged as an essential component of computers to facilitate data processing, computation, and program execution, enabling the growth and evolution of computing technology.





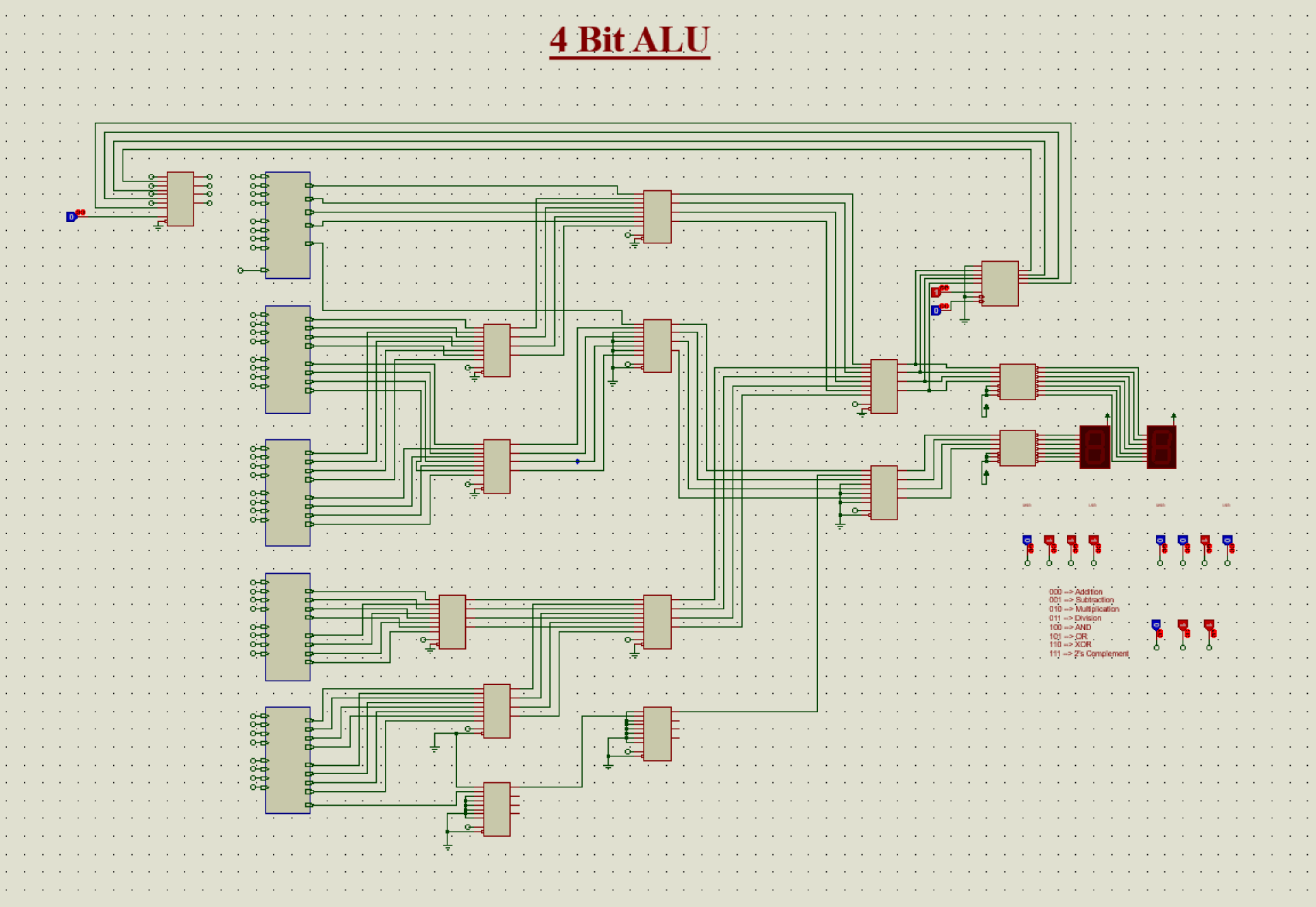
3.1 Design: Methods

Components:

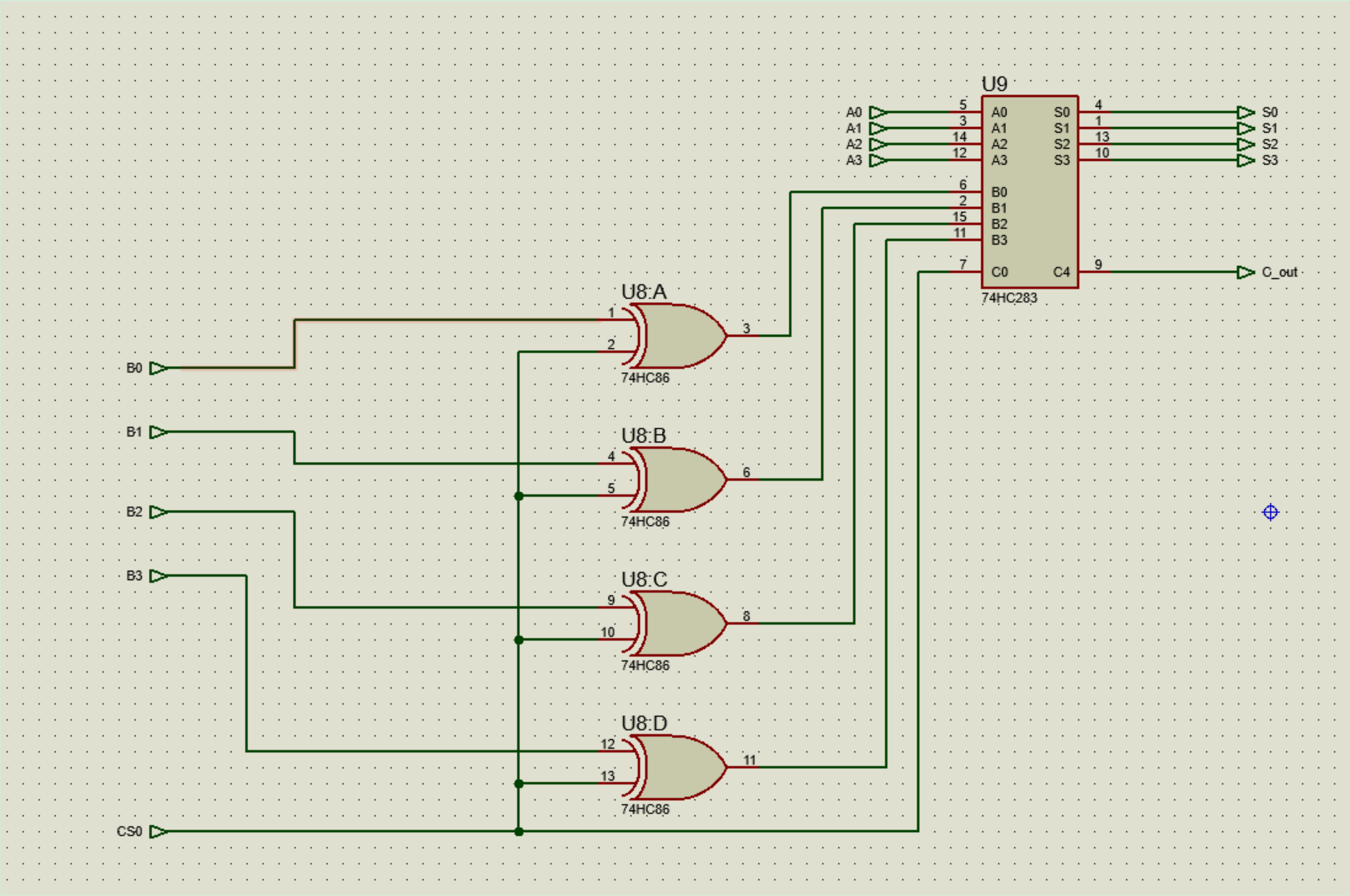
- 7404 (NOT gate)
- 7408 (AND gate)
- 7432 (OR gate)
- 7486 (XOR gate)
- 74283 (Adder)
- 74157 (MUX)
- 7495 (Register)
- 7447 (Decoder)
- 7 Segment Display
- Breadboard
- Jumper Wire
- Stapler Wire
- 5V Adapter
- 9V Battery
- Battery Clip
- Buck Module
- Switch
- Breadboard Power Supply
- 74595 (Register)
- 7476 (JK Flip-Flop)
- 7474 (D Flip-Flop)

Software: Proteus Professional

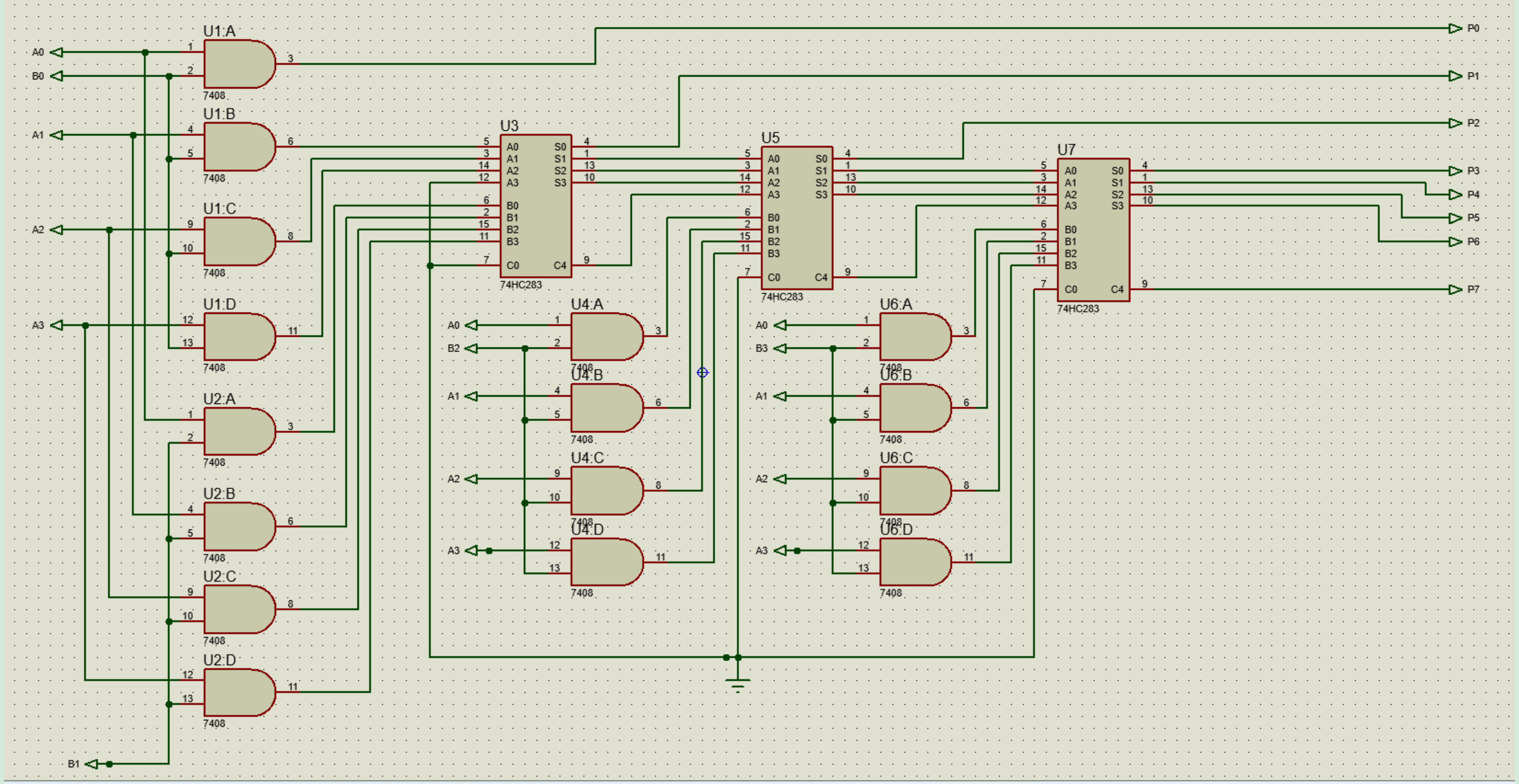
3.2 Circuit Diagram



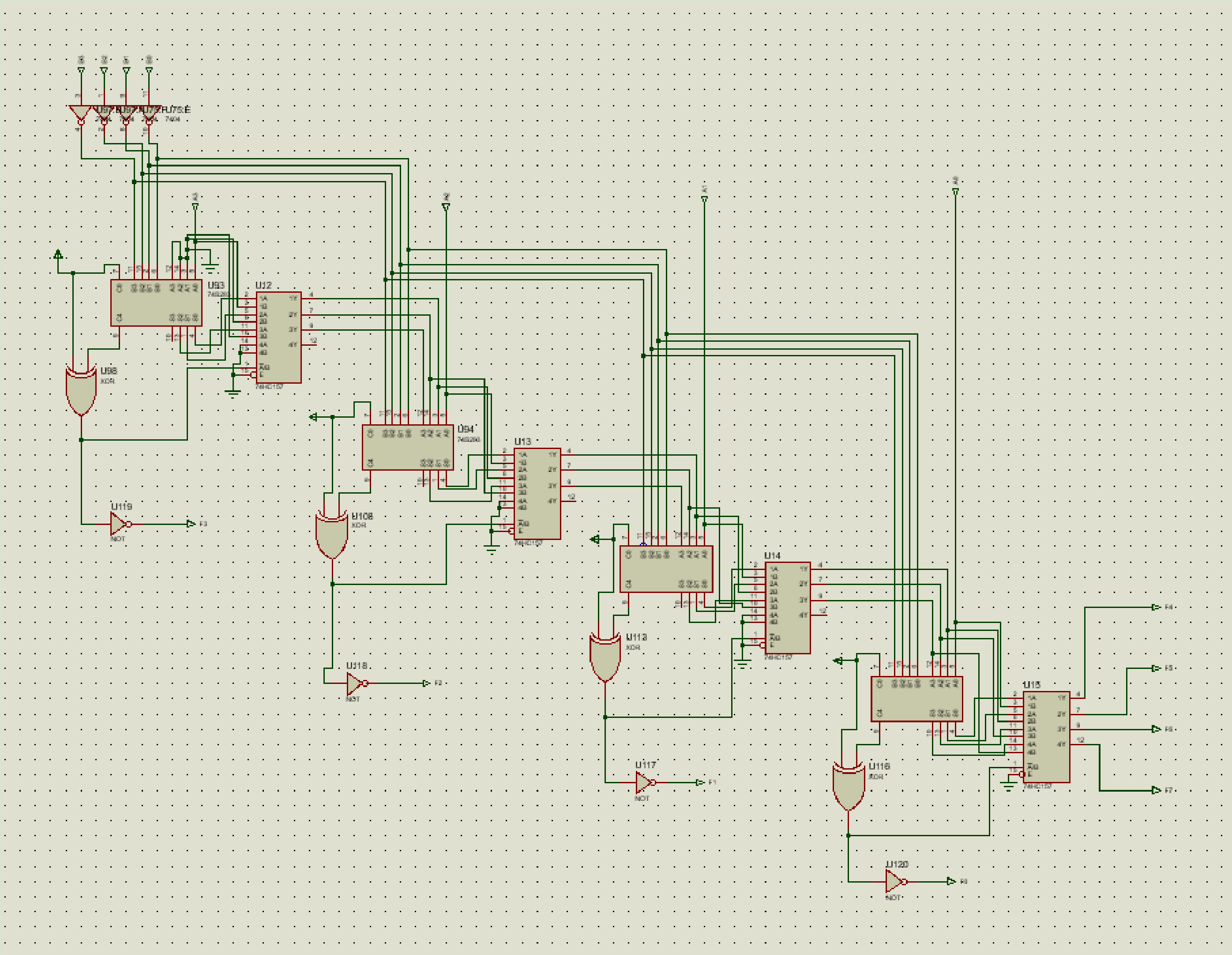
3.2 Circuit Diagram: Addition-Subtraction Block



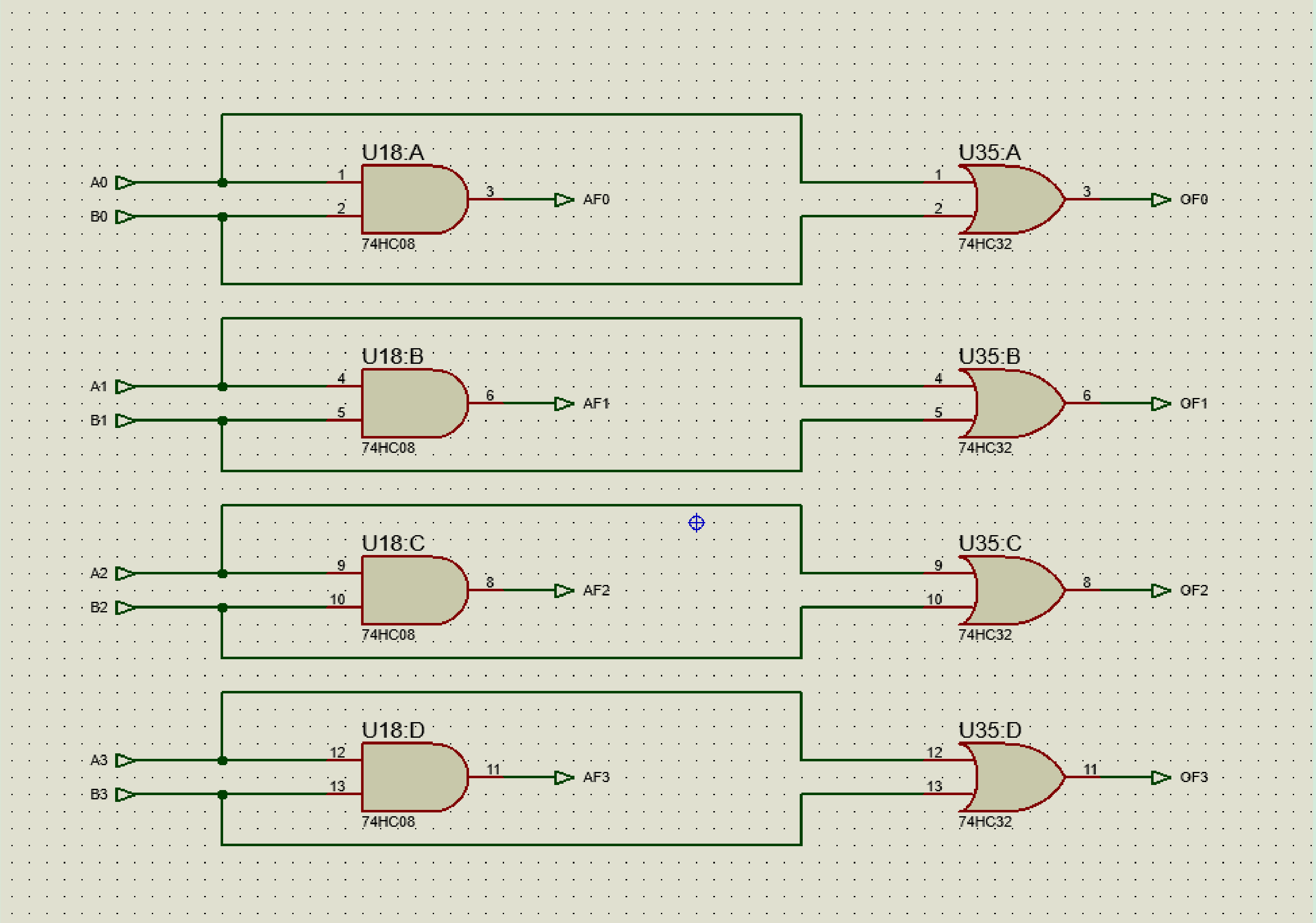
3.2 Circuit Diagram: Multiplication Block



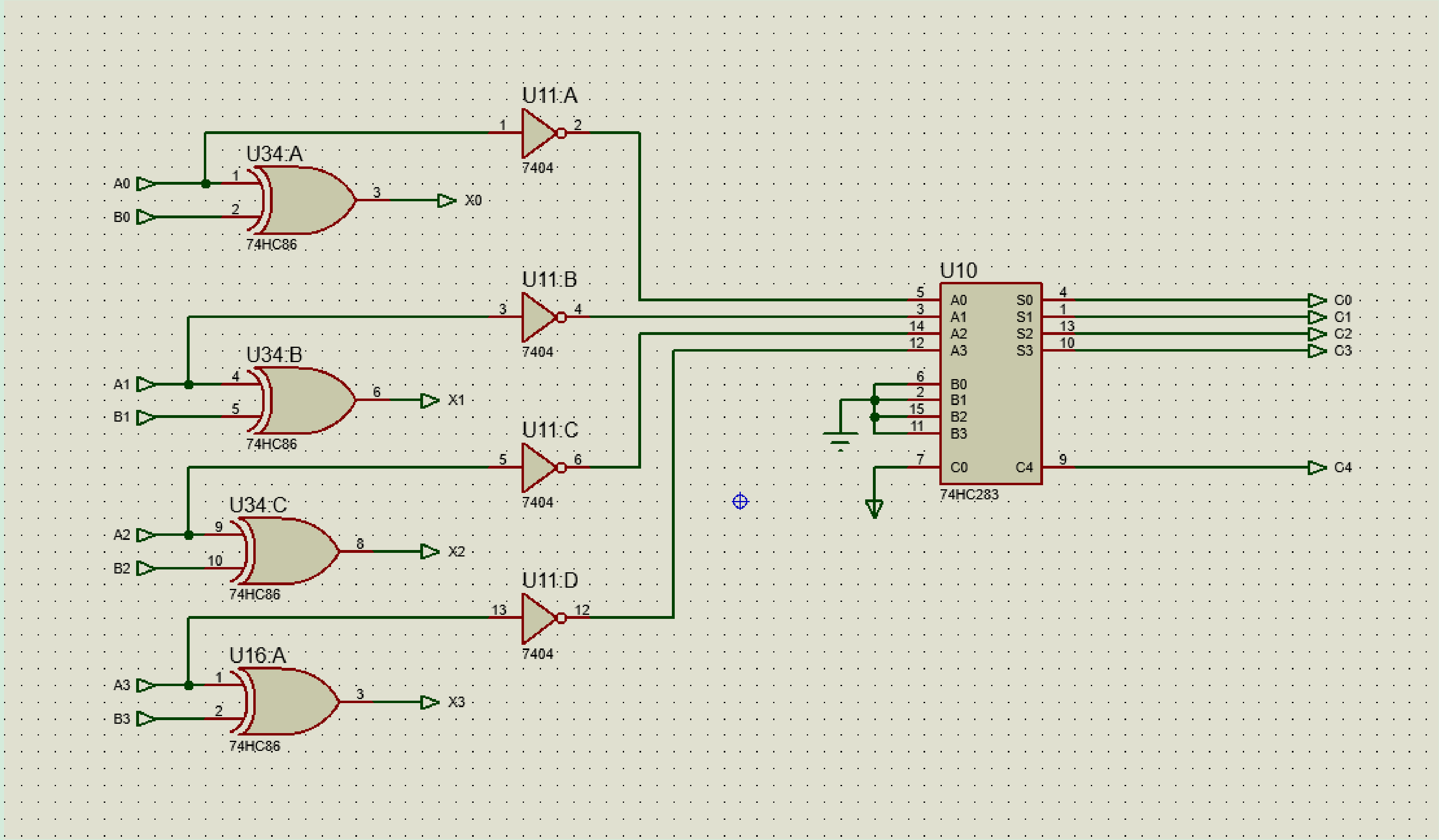
3.2 Circuit Diagram: Division Block



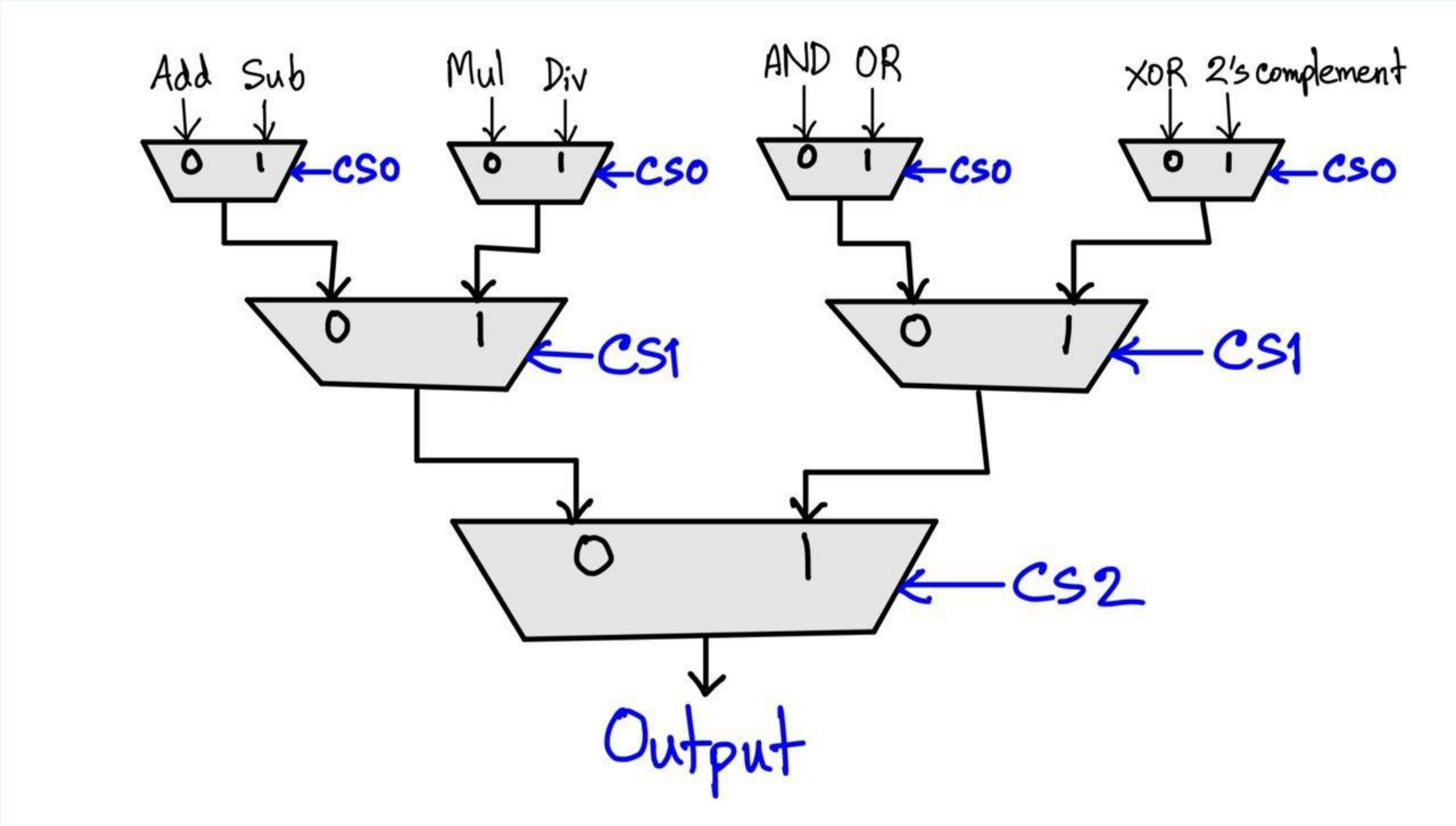
3.2 Circuit Diagram: AND-OR Block



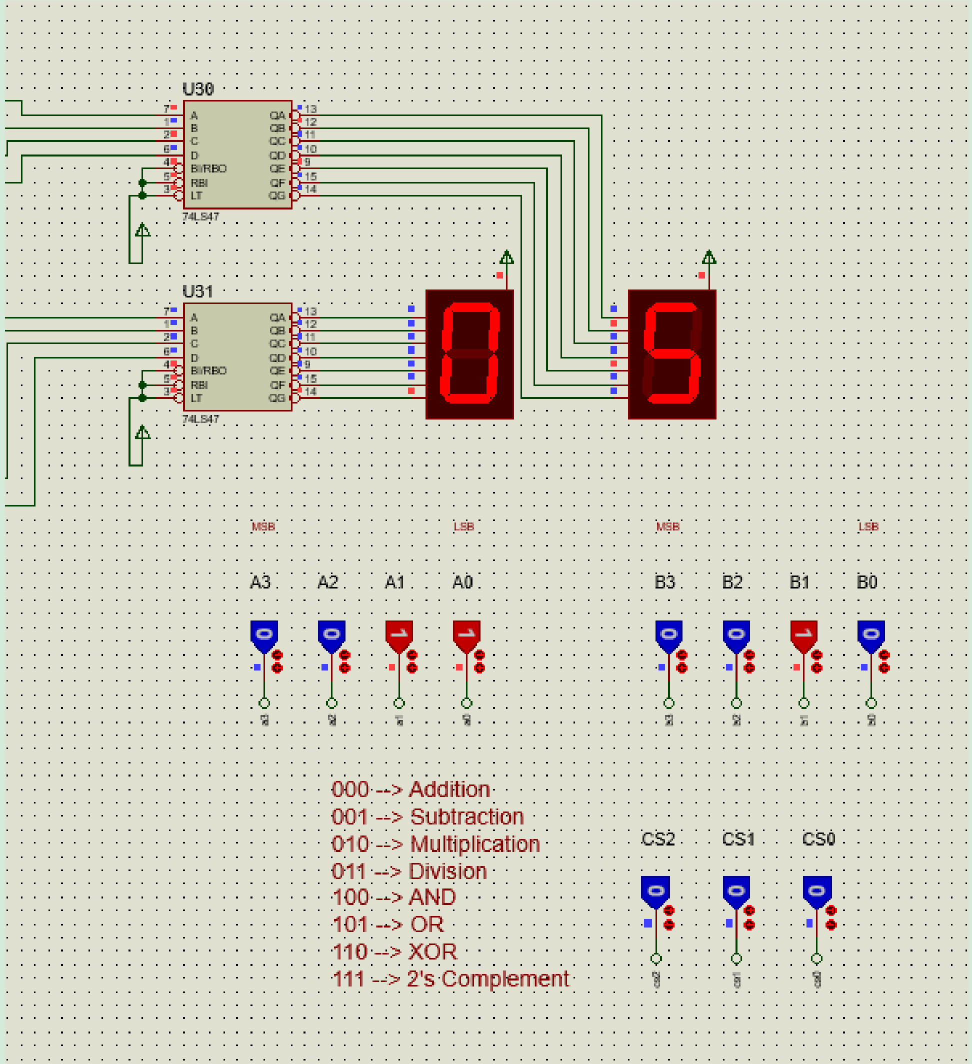
3.2 Circuit Diagram: XOR, 2's compliment Block

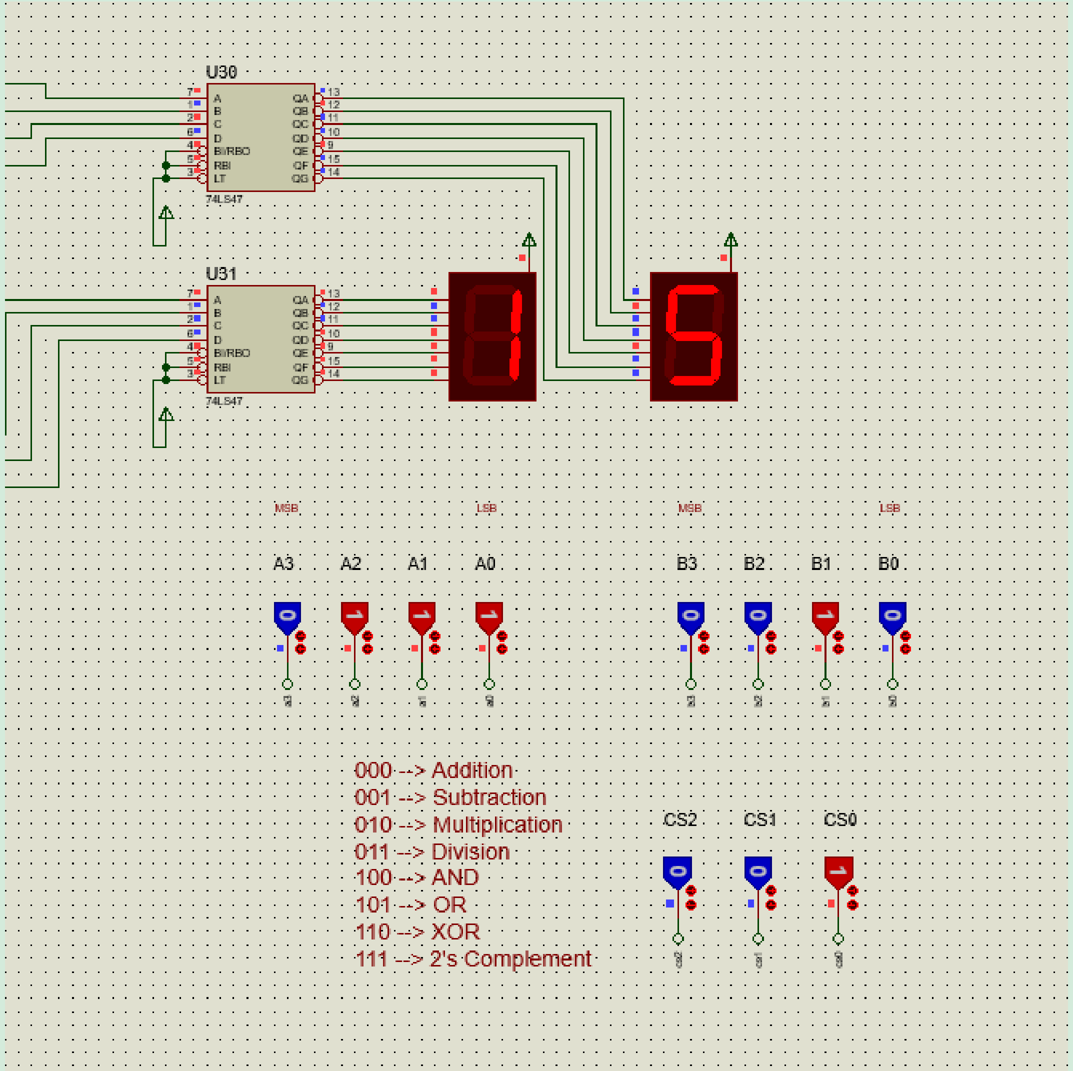


3.2 Circuit Diagram: Operations Design with Control Signal

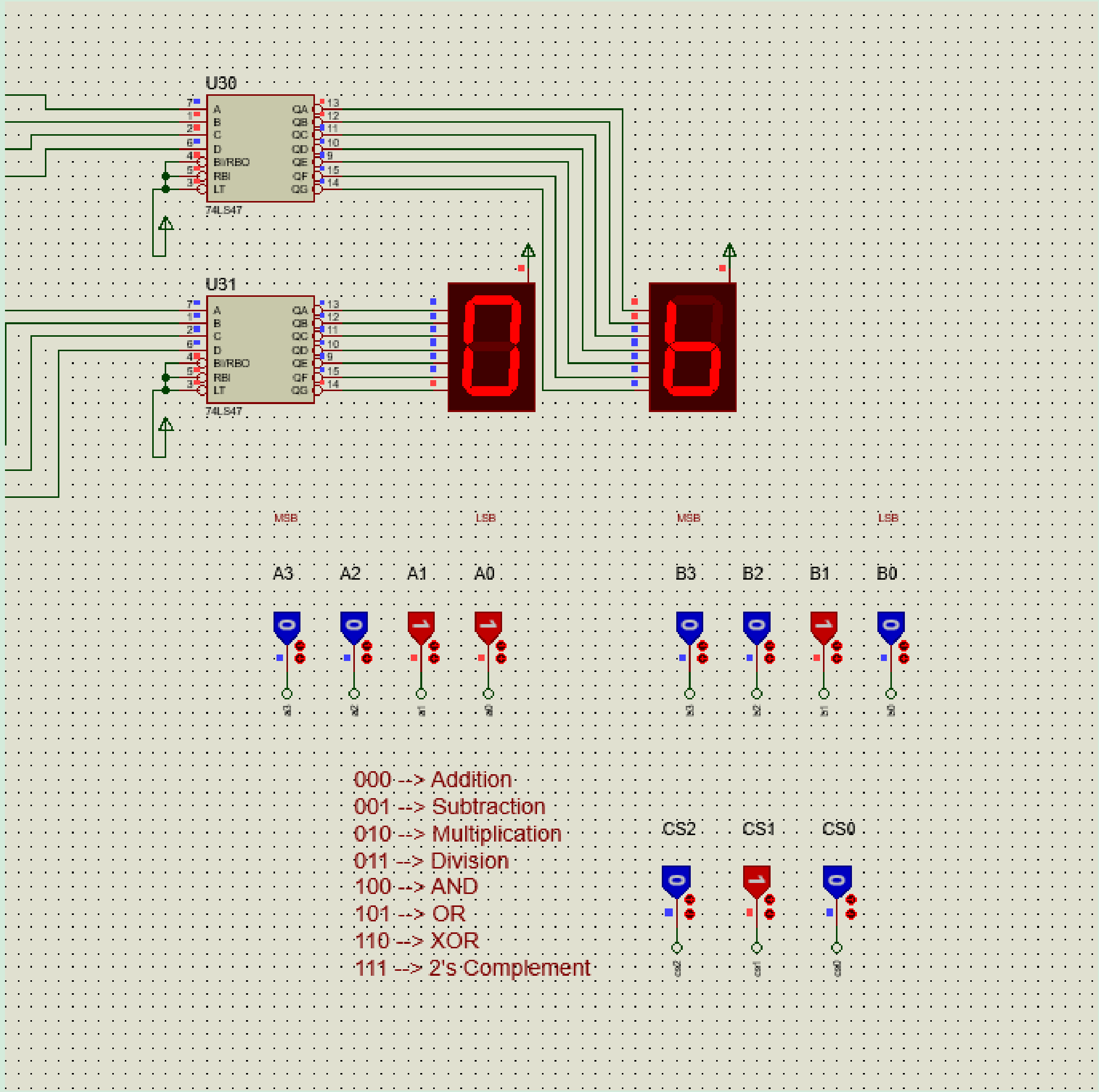


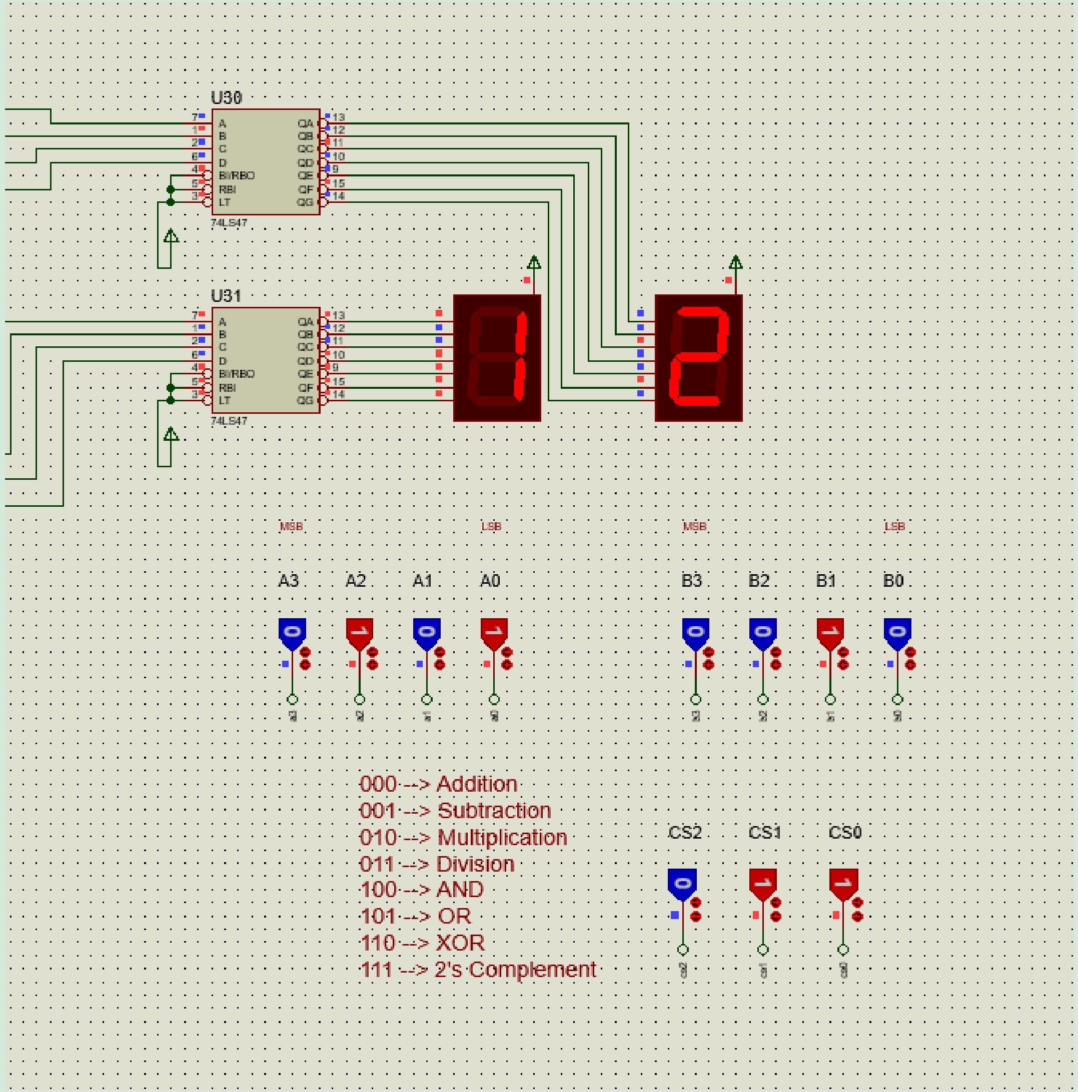
3.3 Simulation: Addition , Subtraction



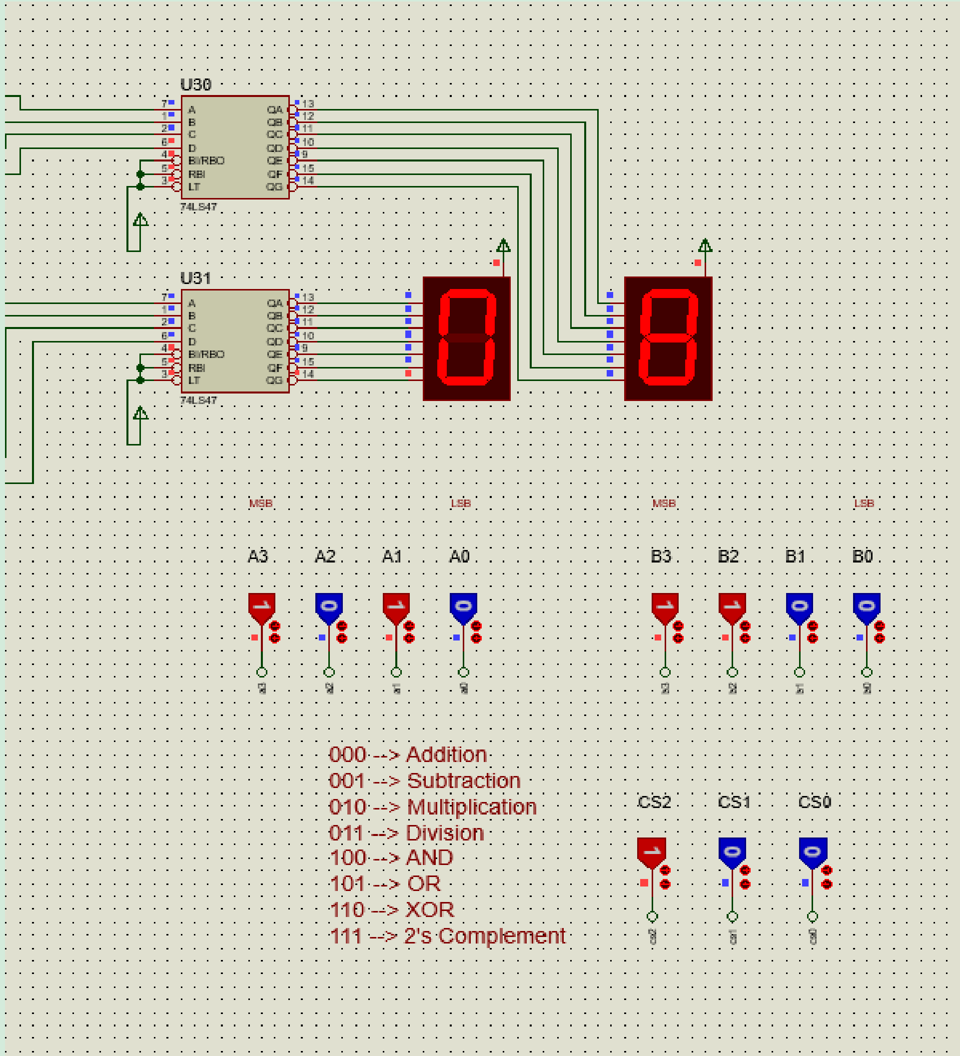


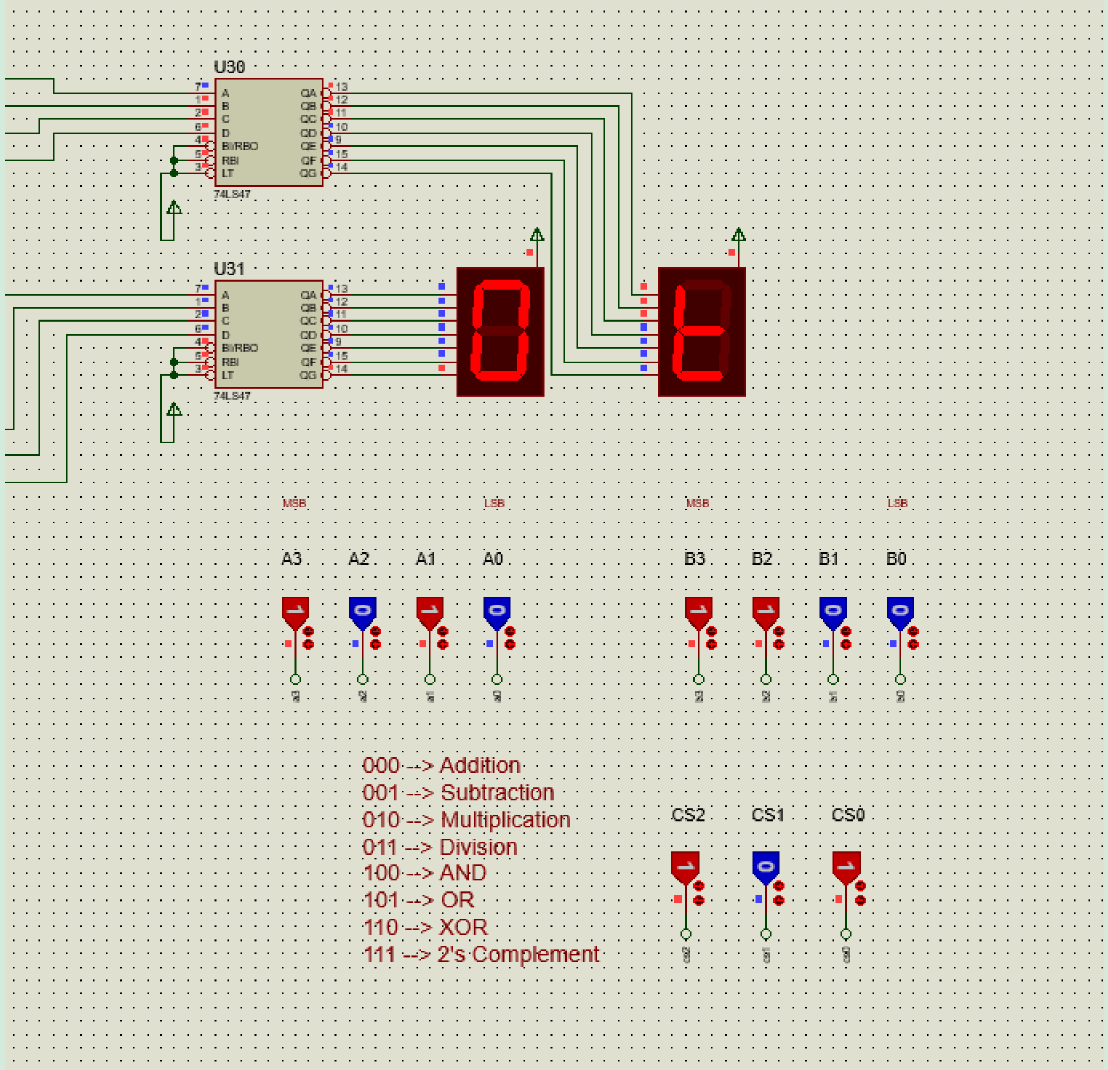
3.3 Simulation: Multiplication, Division



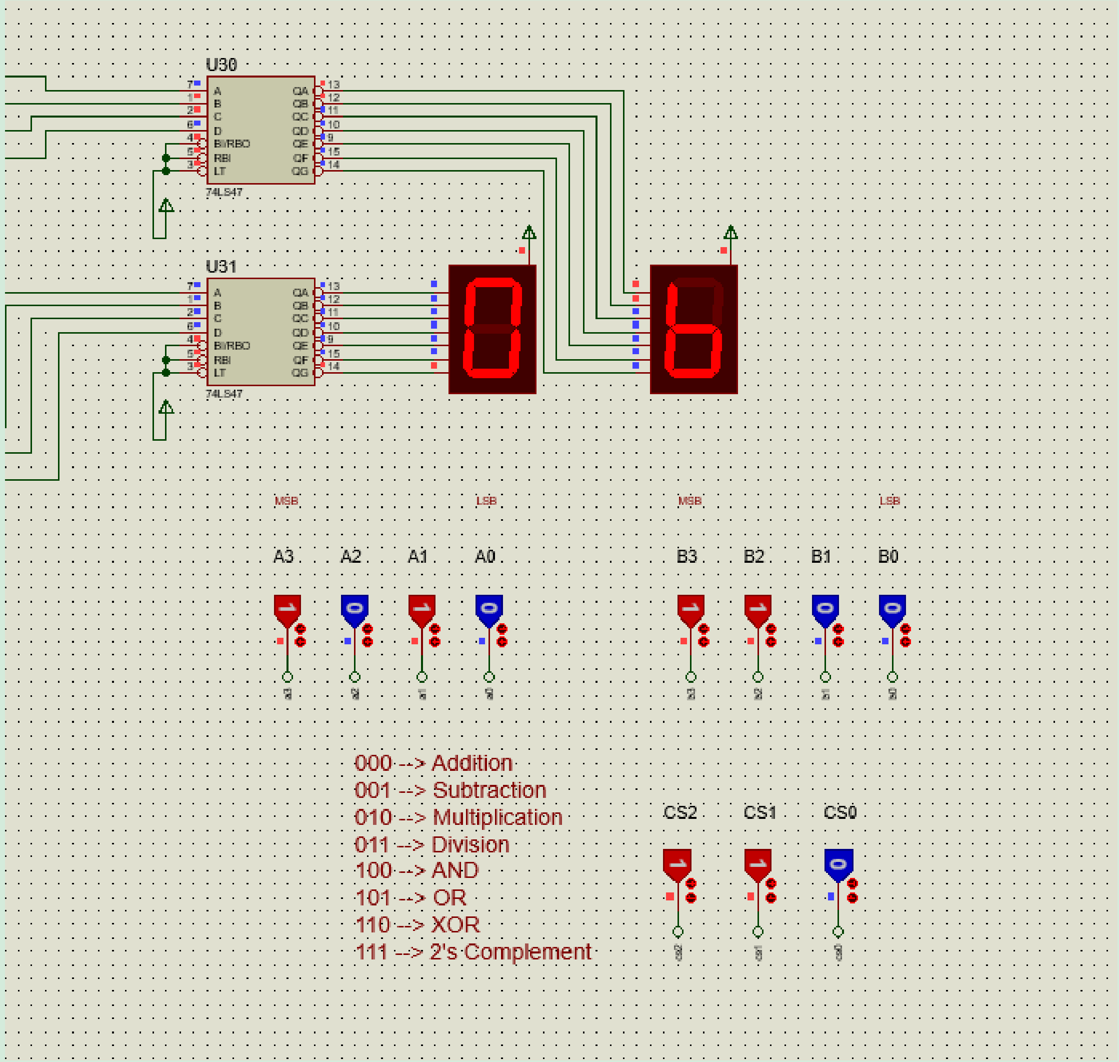


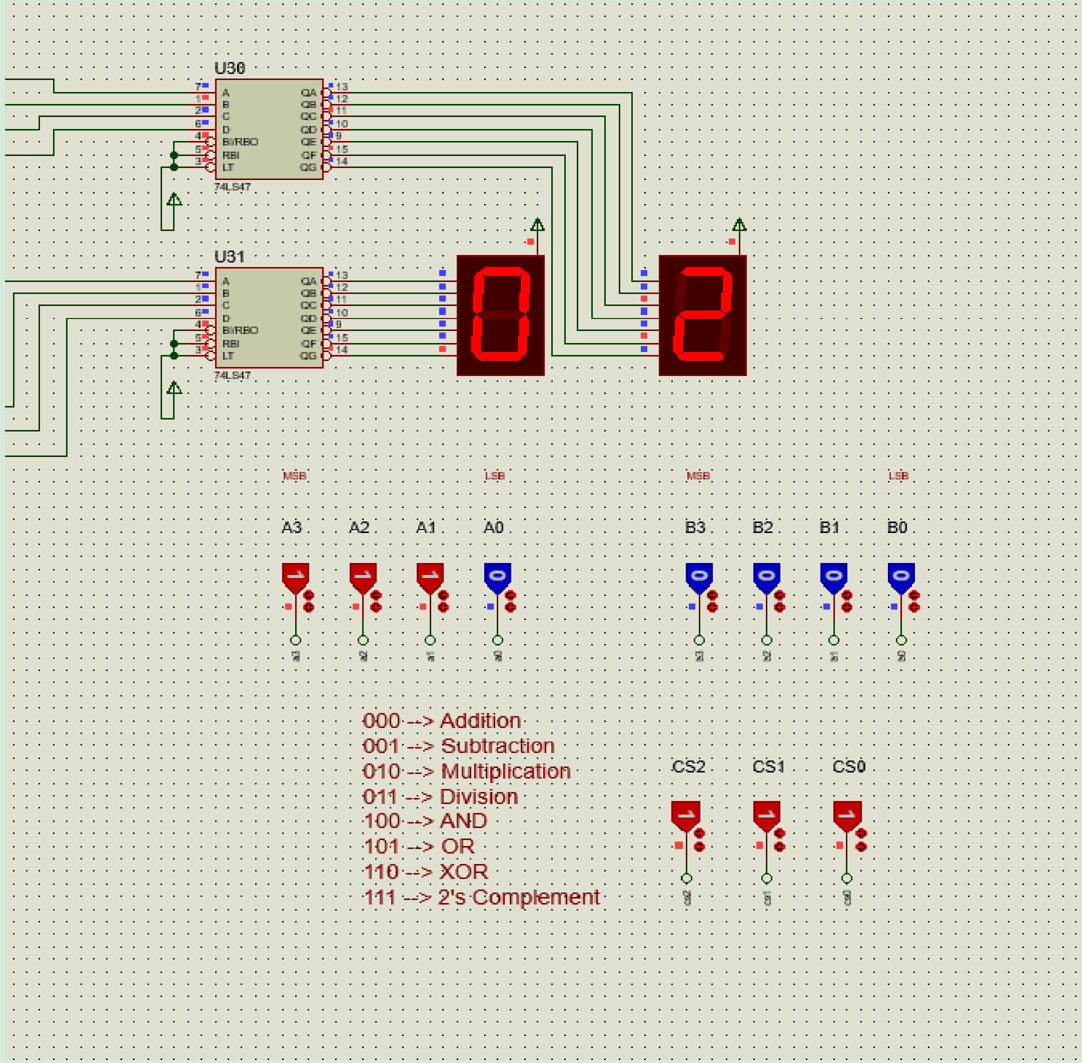
3.3 Simulation: AND , OR



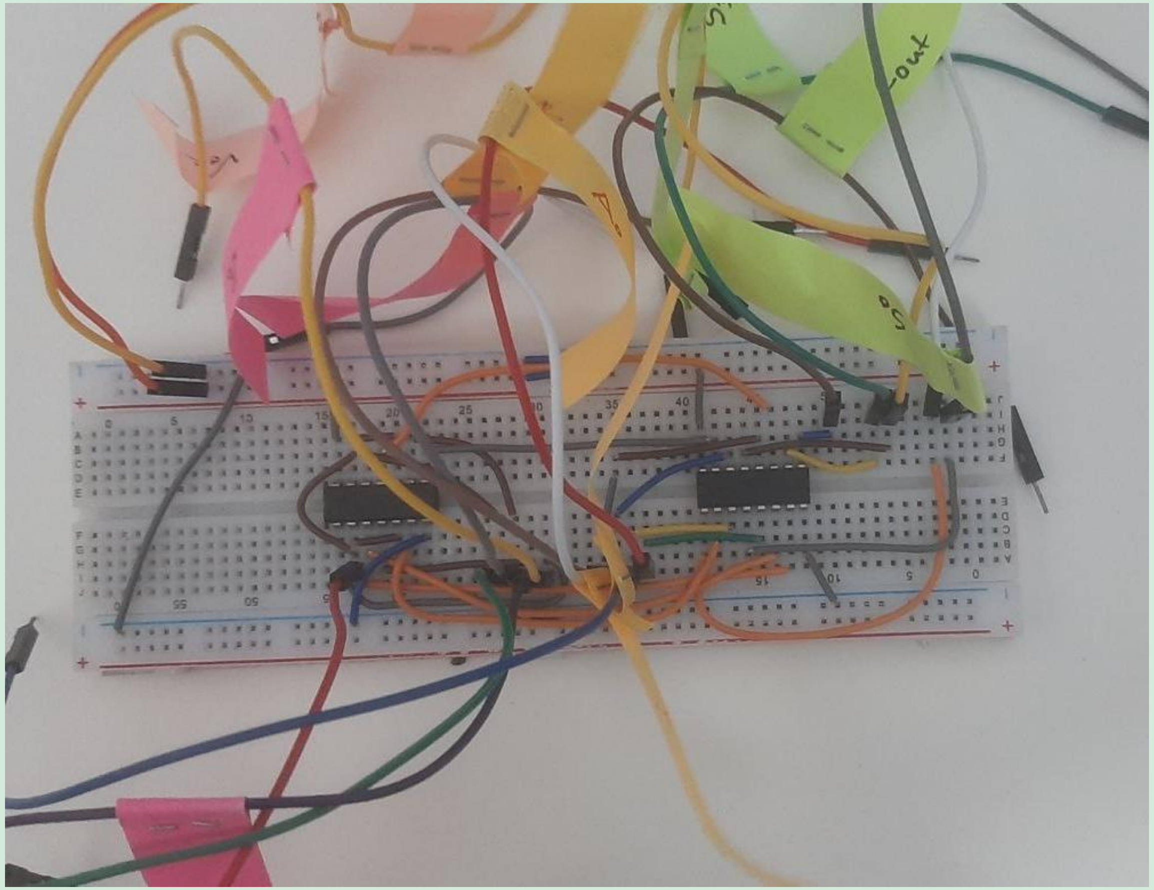


3.3 Simulation: XOR, 2's Compliment

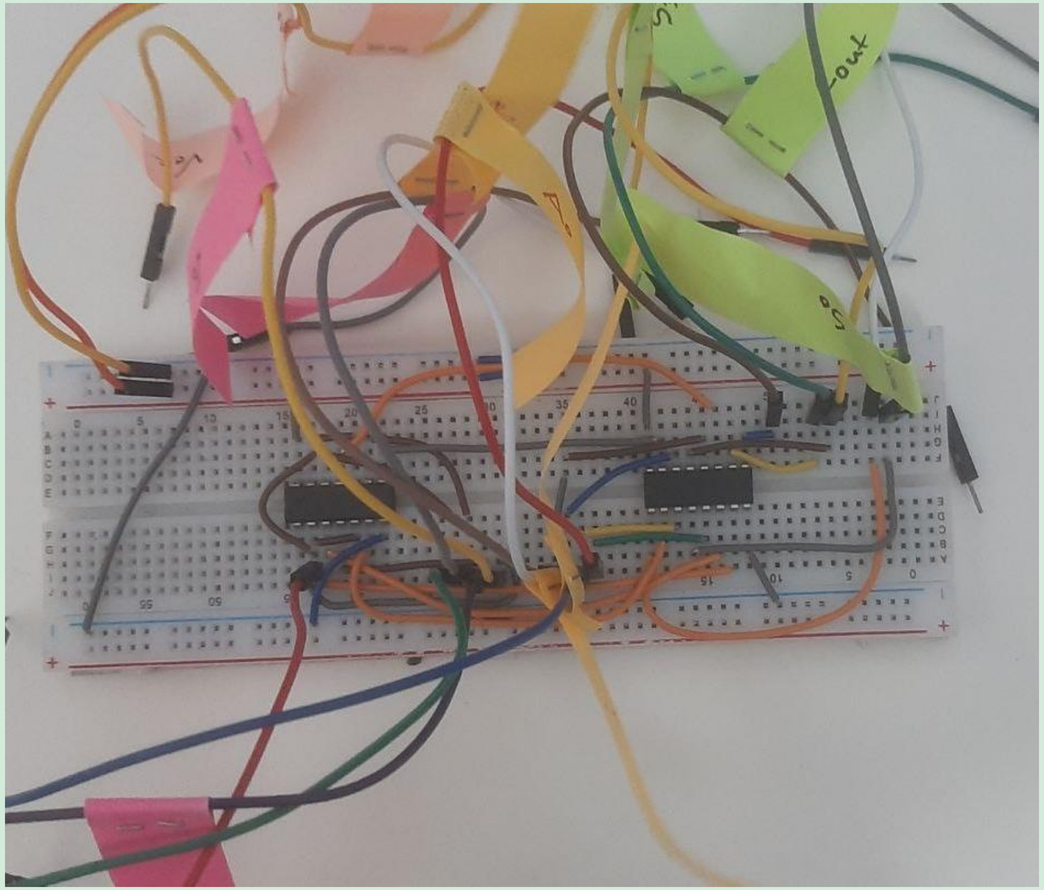




4. Implementation

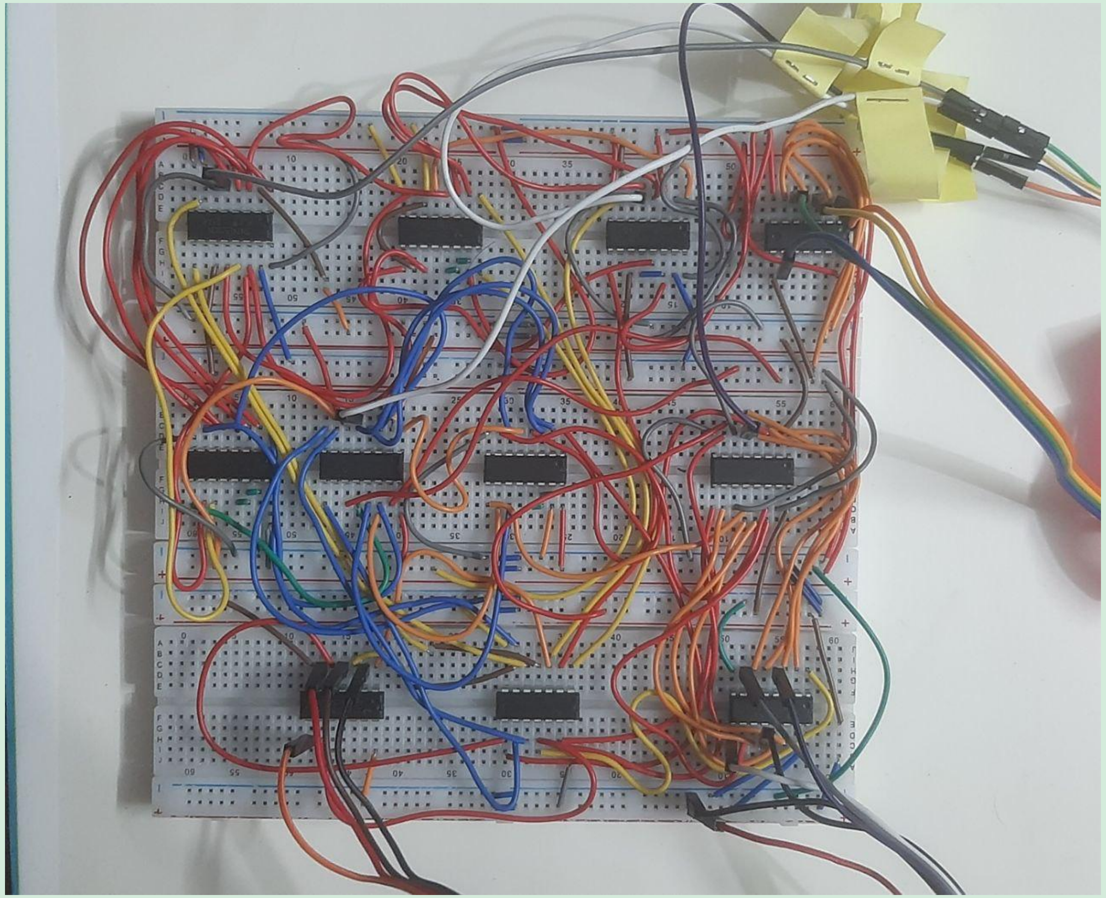


Addition, Subtraction

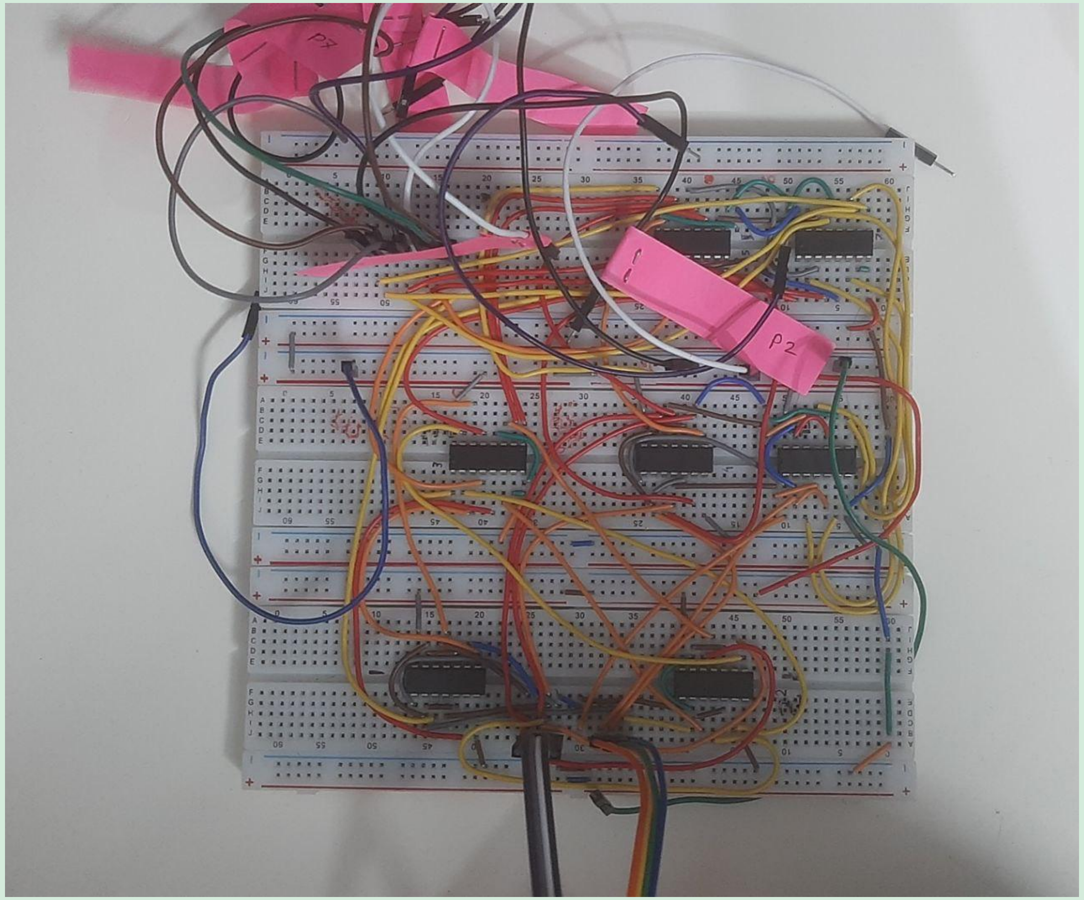


AND, OR

4. Implementation

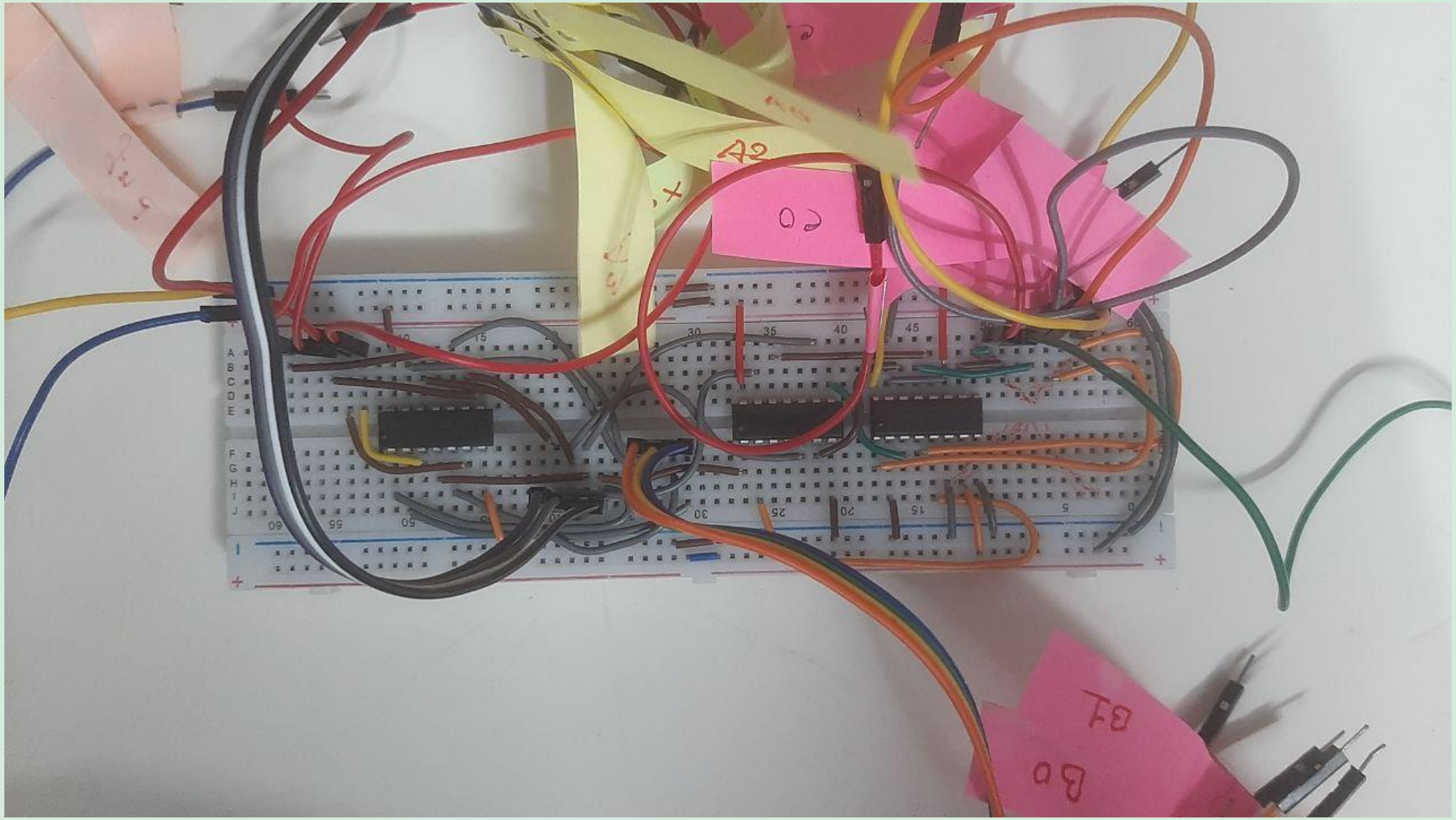


Division



Multiplication

4. Implementation



XOR, 2’s Complement

5.1 Cost Analysis

Component	Quantity	Cost
7404 (NOT gate)	12	360
7408 (AND gate)	18	360
7432 (OR gate)	10	180
7486 (XOR gate)	12	300
74283 (Adder)	30	1350
74157 (MUX)	48	1800
7495 (Register)	4	180
7447 (Decoder)	12	380
7 Segment Display	14	112
Breadboard	23	2990
Jumper wire	18 set	1440
Stapler wire	10 set	1500
5V adapter	3	1740
9V Battery	6	300
Battery clip	6	60
Buck Module	3	240
Switch	20	100
Breadboard Power supply	2	220
74595 (Register)	2	40
7476 (JK Flip-Flop)	4	180
7474 (D Flip-Flop)	6	180
Grand Total		14012

5.2 Limitations

- Switch was not used for input as the voltage drop across the switch was affecting the outputs.

- We couldn't find BCD to Hexa-decimal decoder in the market so we couldn't show A-F characters in display, rather special characters were displayed in our 7447 decoder.

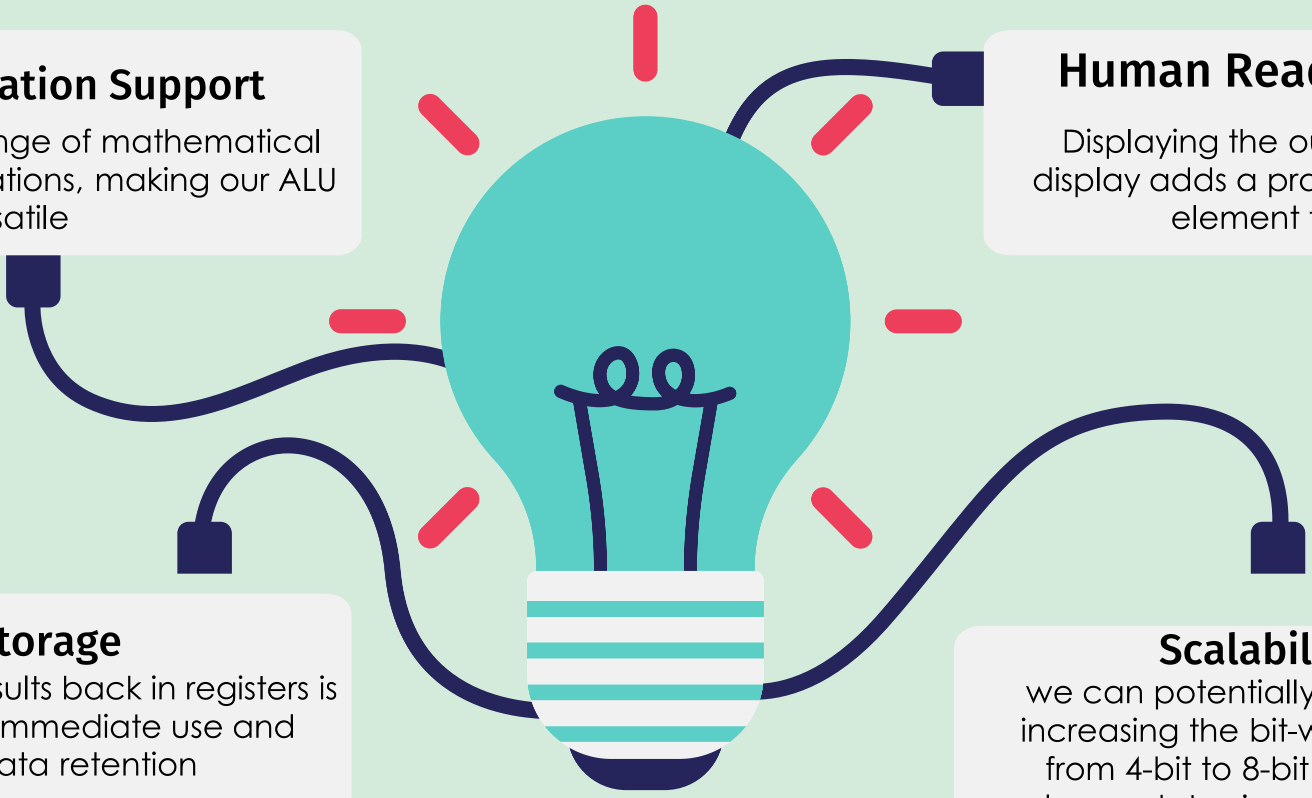
5.3 Novelty

Diverse Operation Support

allows for a wide range of mathematical and logical computations, making our ALU versatile

Human Readable Output

Displaying the output on a 7-segment display adds a practical and user-friendly element to your project



Result Storage

The ability to store results back in registers is valuable for both immediate use and long-term data retention

Scalability

we can potentially scale our project by increasing the bit-width of our ALU (e.g., from 4-bit to 8-bit or 16-bit) to handle larger data sizes, which is a common design consideration in CPU architectures

5.4 Practical Considerations of the Design

01

Hardware Selection

Choosing appropriate electronic components, necessary processing power and input/output capabilities to handle our project's requirements

02

Accuracy and Precision

Precision is crucial, especially for calculations involving division and multiplication

03

Cost Constraints

Keeping an eye on budget and try to optimize component selection to meet our project's requirements without unnecessary expenses.

04

Testing and Validation

Rigorously testing ALU's operations to ensure accuracy and reliability

5.5 Evaluation of the Sustainability

01

Energy Efficiency

Using low-power components and implementing power-saving techniques not only conserves energy but also extends the lifespan of batteries or reduces electricity consumption

02

Longevity

Ensure that the electronic components and circuits used are of high quality and have a long operational life

03

Repairability

Keeping an eye on budget and try to optimize component selection to meet our project's requirements without unnecessary expenses.

04

Materials Selection

We chose components that have have a lower environmental footprint.

6.1 Individual Contribution of Each Member

Sheikh Abu Al Raihan Evan

Contribution in buying components, implementing hardware, debugging, Report writing

Kazi Abid Hasan

Contribution in software simulation, implementing hardware, debugging, Integrating all team members

Md. Hasnat Karim

Contribution in implementing hardware, software simulation, Report writing

Md. Nahid Mustafa

Contribution in buying components, debugging, helping others, preparing slides

6.2 Mode of Team Work and Diversity

We, all the four members of our team, worked in a structured way and cooperated each other. One member coordinated the whole task & other member did their assigned task. Here are some moments we worked together.

6.3 Logbook of Project

Circuit Design & Simulation — Week 5-7

Week 8 — Bought all necessary components

Circuit Implementation — Week 9-11

Week 12-13 — Testing, Debugging & Verification

7. References

- https://www.electronics-tutorial.net/Mini-Projects/Four-bit-Arithmetic-Logical-Unit/
- https://www.youtube.com/watch?v=Ohp81M5dTPg
- https://vlab.amrita.edu/?sub=3&brch=81&sim=604&cnt=1
- https://www.ijert.org/design-and-implementation-of-4-bit-alu-for-low-power-using-adiabatic-logic-based-on-finfet
- https://www.instructables.com/8-bit-ALU-Arithmetic-Logic-Unit/

THANKS!

Any questions?