

EE 214: Digital Circuits Laboratory

LAB - 5

Roll No.: 200010003

- **Aim:** Design and Implementation of *Half-Subtractor* circuit using logic gates, and *4-bit Adder-Subtractor* circuit using a full adder.
- **Summary of the experiment:**
 1. Creation of truth table for Half-Subtractor, and obtaining boolean expressions for Difference (D) and Borrow (B).
 2. Design and Implementation of the Half-Subtractor using XOR, NOT, and AND gates.
 3. Design and Implementation of a 4-bit Adder/Subtractor circuit (that uses 2's complement method) using a full adder.
- **Problem Statement:**
 1. Design and implement a Half-Subtractor circuit using a minimum number of 2-input gates.
 2. Familiarize 74LS83 IC and implement a controlled 4-bit Adder/Subtractor circuit which is controlled by signal CTRL using 74LS83 and minimum number of 2-input gates. (CTRL: 0 for Addition and 1 for Subtraction)
- **Components used:** IC 7408, 7404, 7486, 7483, 1 kilo-ohm resistor array, DIP switches, LED displays, breadboard, power supply.
- **Design Procedure, Circuit Diagrams and Snapshots:**

(attached below)

- **Results and Discussions:**

1. We constructed a truth table for a Half-Subtractor. Then, we derived the boolean expression for it, and implemented it using the AND, NOT, and XOR logic gates. The outputs obtained were Difference (D) and Borrow (B).
2. We modified a full-adder into a 4-bit Adder-Subtractor circuit by adding XOR gates at B-inputs, and keeping a CTRL that controls whether the adder obtains B, or 2's complement of B. Keeping $C_0 = \text{CTRL}$ ensures that for CTRL = 1, we add 1 to the 1's complement of B, hence obtaining its 2's complement. Also, when CTRL = 0, it makes the XOR gates behave as buffers, and simply allows B to pass.
3. Subtraction of B from A is the same as adding A to the 2's complement of B. We kept this in mind during the design.

- **Conclusion:**

We designed and implemented a Half-Subtractor circuit using the basic/special logic gates (AND, NOT, XOR), and verified the outputs obtained using the truth table. We also implemented a 4-bit Adder/Subtractor circuit using IC 7483 (Full Adder), and utilized 2's complement method with the help of XOR gates.