ALU Design

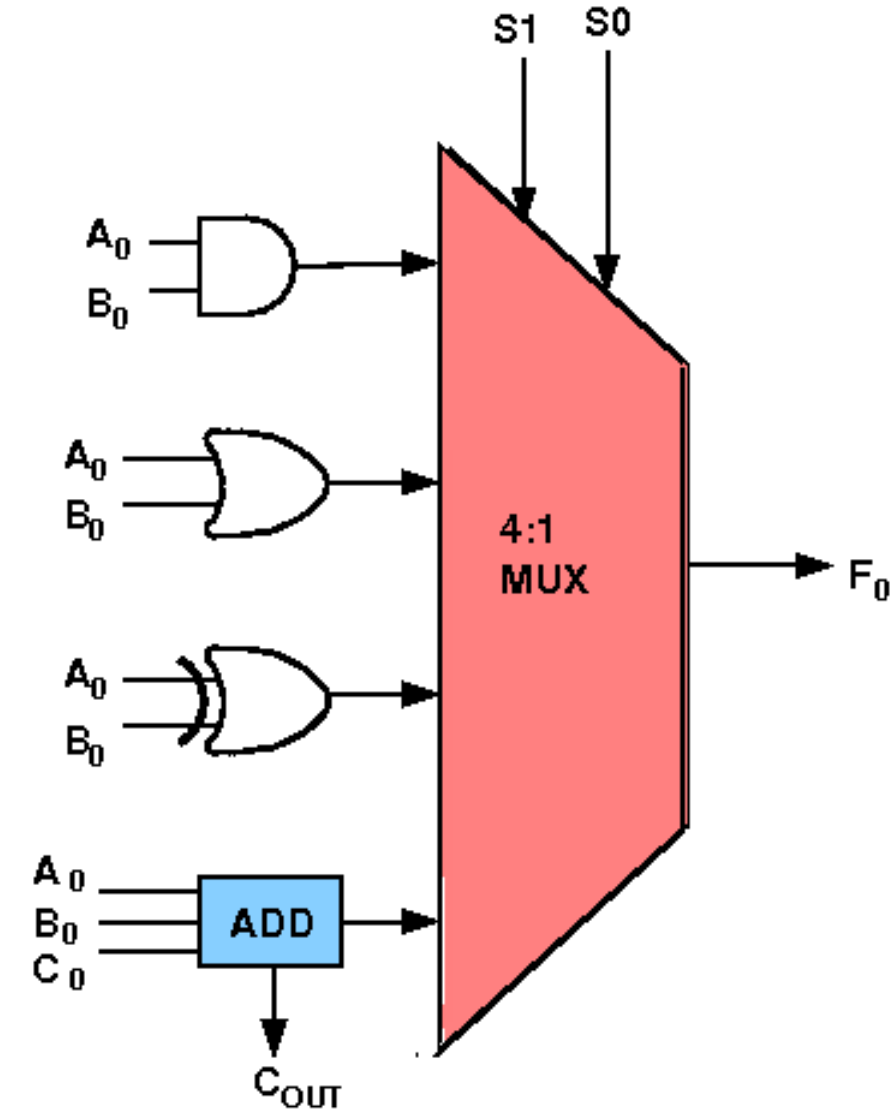## Sparsh Mittal

Example 1

- The circuit functionality of a 1 bit ALU is shown here, depending upon the control signal S_1 and S_0 the circuit operates as follows:

- $S_1 = 0$, $S_0 = 0$, the output is **A And B**,
- $S_1 = 0$, $S_0 = 1$, the output is **A Or B**,
- $S_1 = 1$, $S_0 = 0$, the output is **A Xor B**,
- $S_1 = 1$, $S_0 = 1$, the output is **A Add B**.

6. An ALU (Arithmetic Logic Unit) is a combinational circuit that performs arithmetic operations and is an important part of any processor. Design an ALU that takes two 3 bit inputs ($A_2A_1A_0$ and $B_2B_1B_0$) and computes the sum, difference or product based on a control signal (M_1M_0) as follows:

$M_1M_0=00 \rightarrow A+B$ (addition)
$M_1M_0=01 \rightarrow A-B$ (subtraction)
$M_1M_0=10 \rightarrow B-A$ (subtraction)
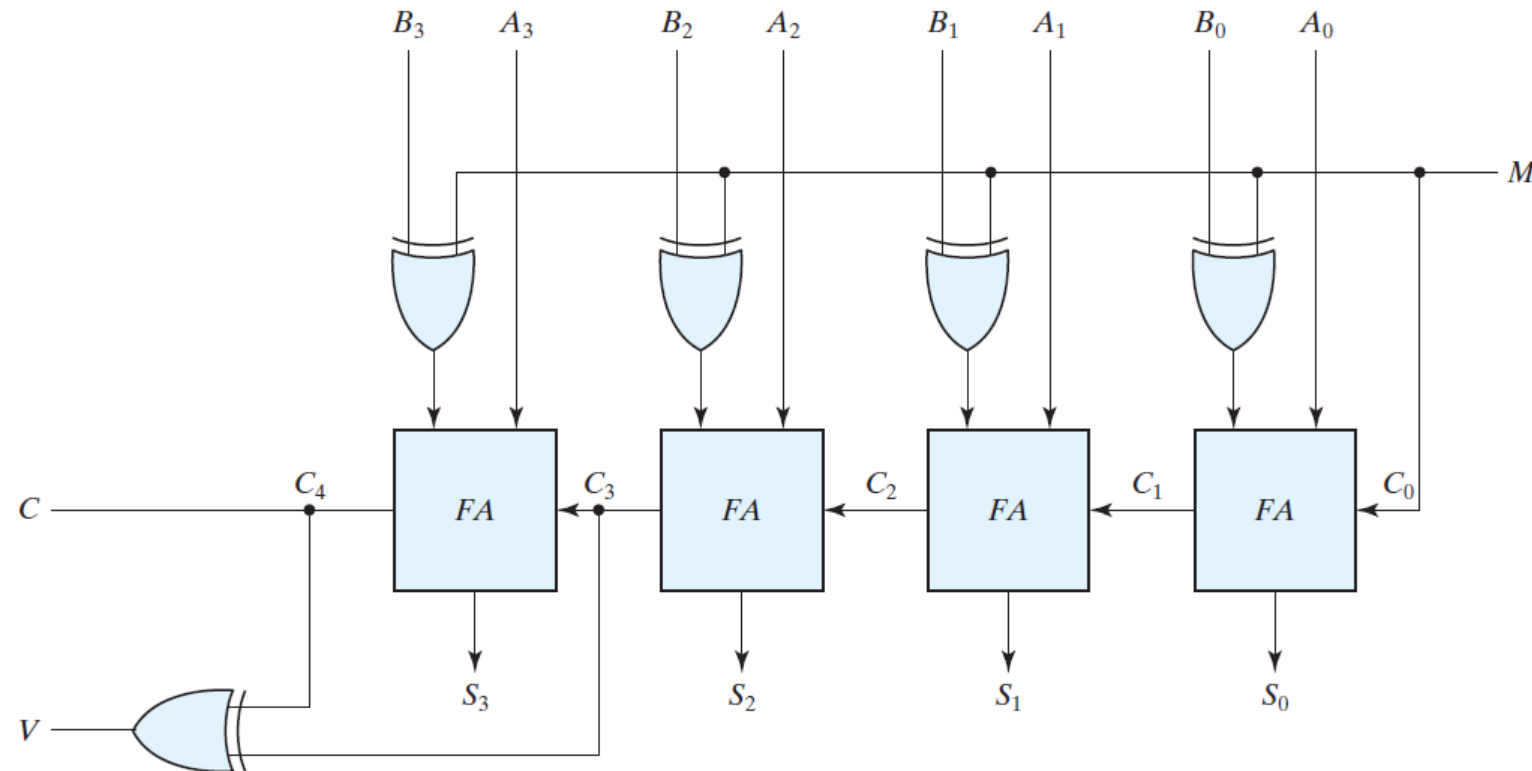$M_1M_0=11 \rightarrow A.B$ (multiplication)

8 marks

[Hint: Use the modular approach to make it easier to design]
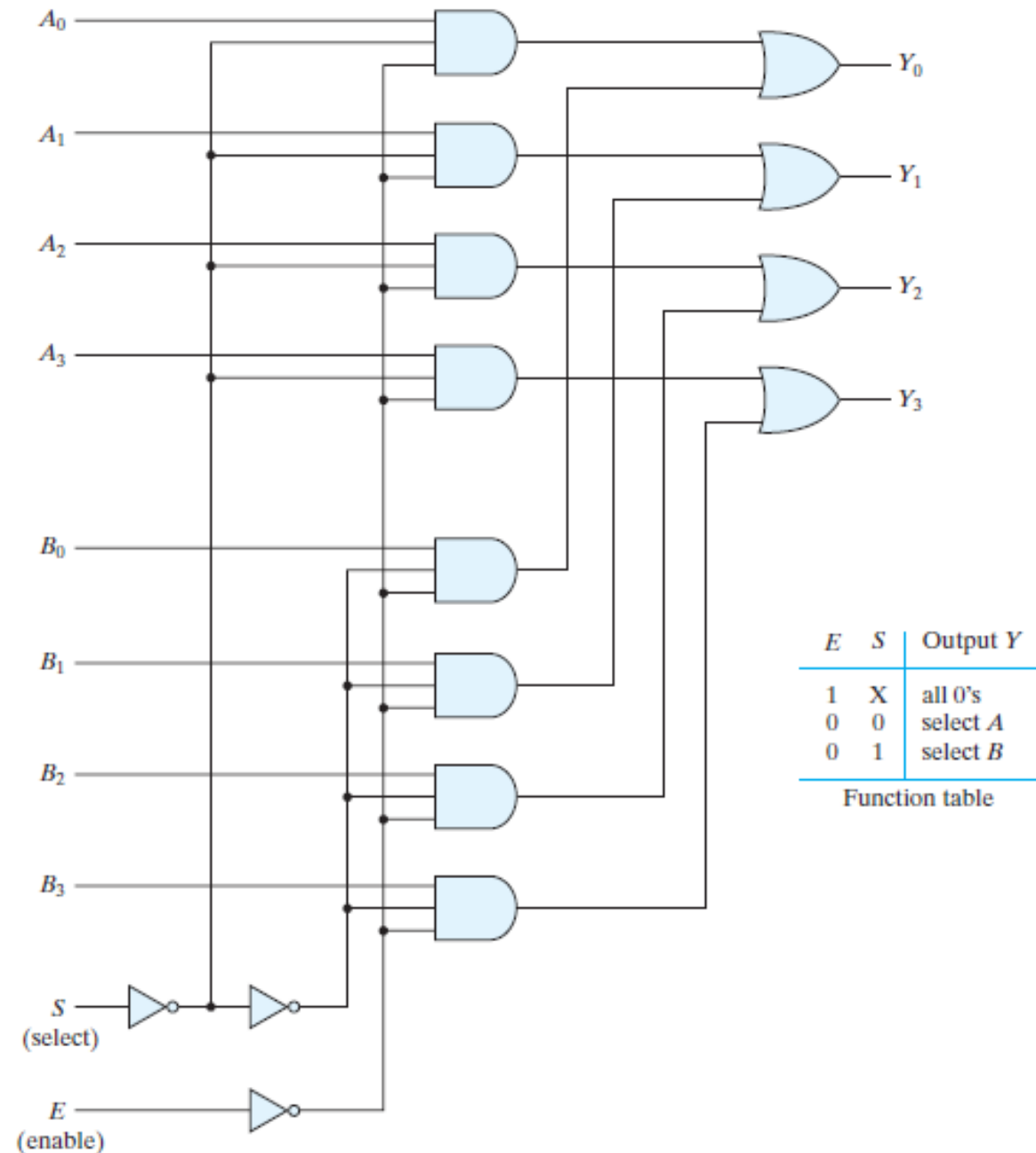
Single circuit for add and subtractor

- The mode input M controls the operation.

- $M = 0$, circuit is adder

- $M = 1$ ➜ subtractor.

- $M = 1$ ➜ $B \oplus 1 = B'$ and $C_0 = 1$. ➜ B inputs are all complemented and a 1 is added through the input carry.
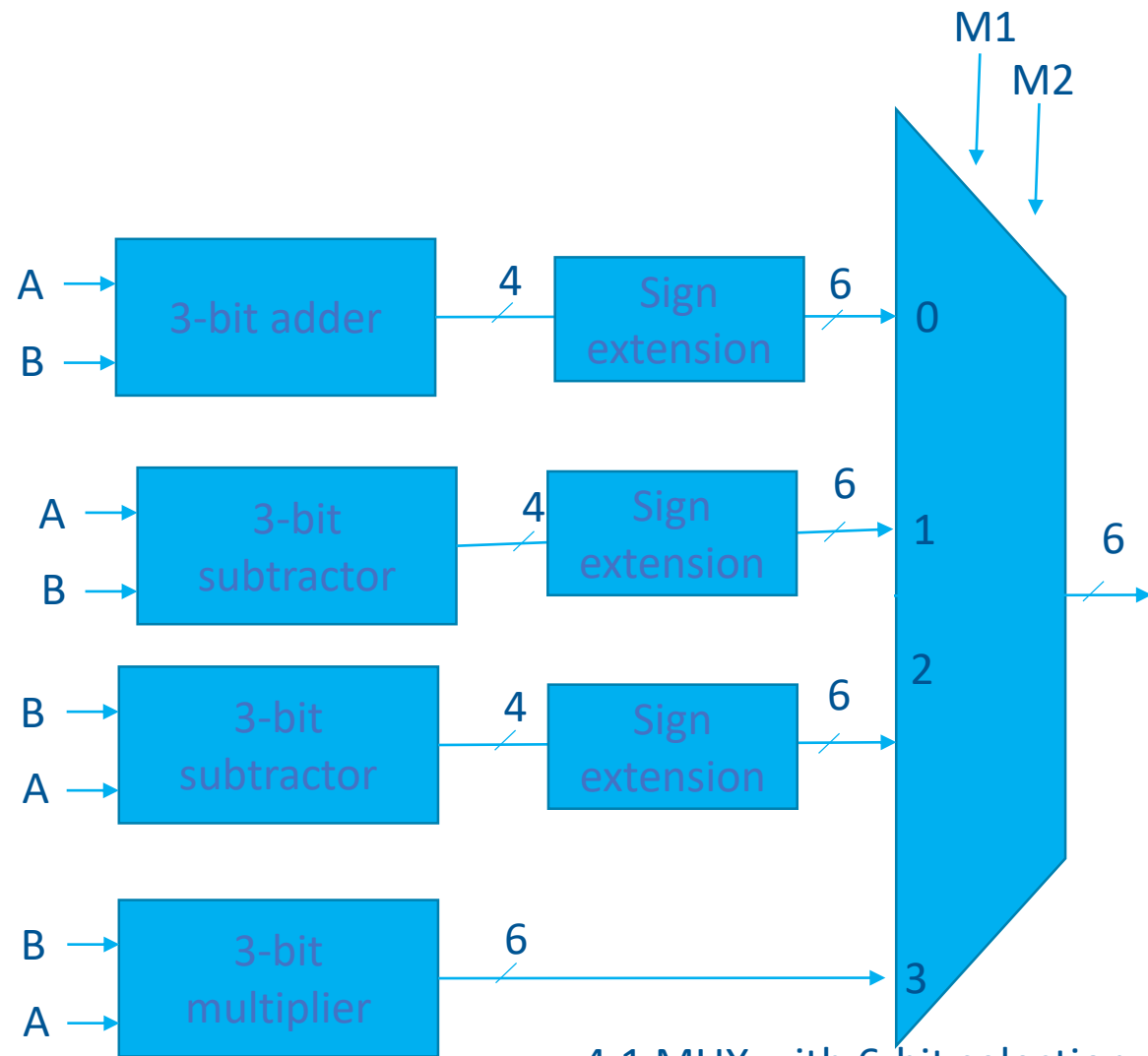
- V= for overflow detection

Four-bit adder–subtractor (with overflow detection)

Multiple-bit selection

- Common selection inputs can be used to provide multiple-bit selection logic.

- This circuit has four MUXes, each capable of selecting one of two input lines.

- Output Y0 can be selected to come from either input A0 or input B0 and so on.

- Input selection line S selects one of the lines in each of the four MUXes.

- Circuit is enabled using Enable signal

E	S	Output Y
1	X	all 0's
0	0	select A
0	1	select B

Function table

4:1 MUX with 6-bit selection