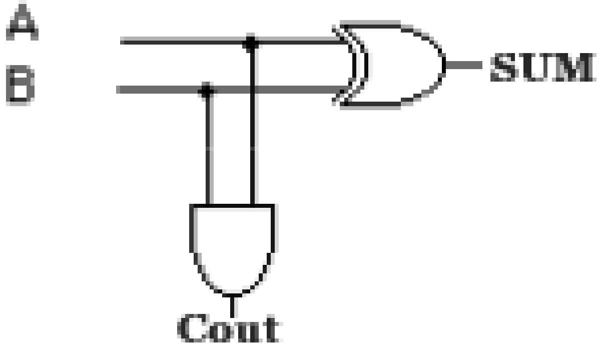
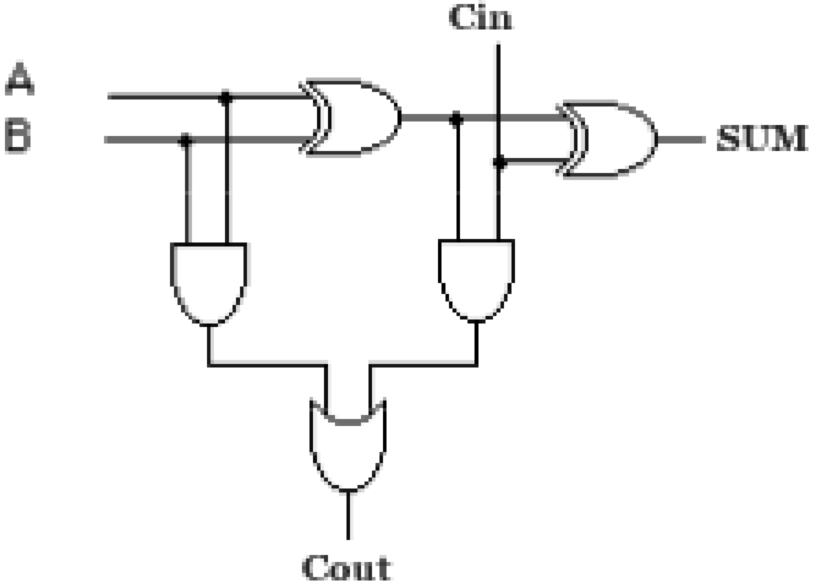
CS 240 Lab 4
Adders and ALU

Half-Adder – adds two one-bit values



A	B	Sum	Cout
0	0		
0	1		
1	0		
1	1		

Full Adder – incorporates a carry-in



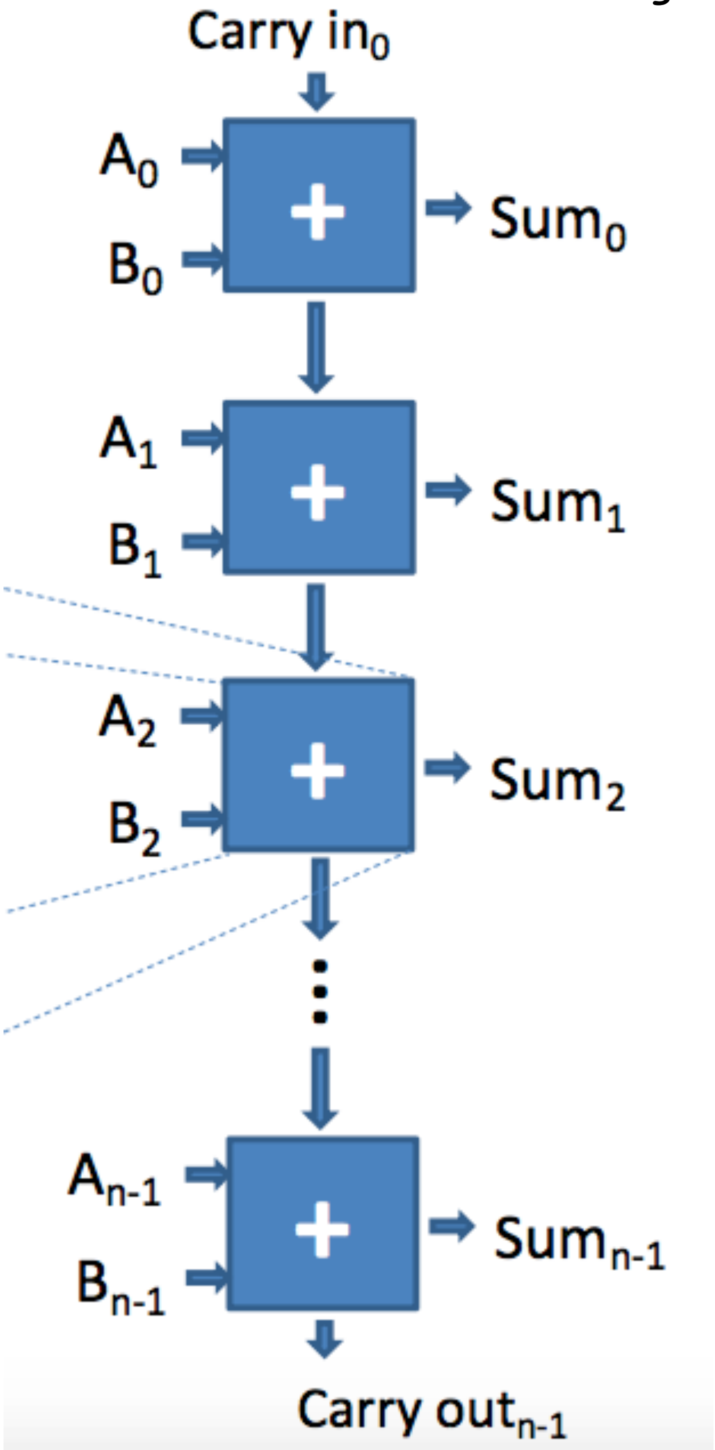
A	B	Cin	Sum	Cout
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

$\mathrm{Sum} = A \oplus B \oplus \mathrm{Cin}$

$\mathrm{Cout} = AB + (A \oplus B)\mathrm{Cin}$

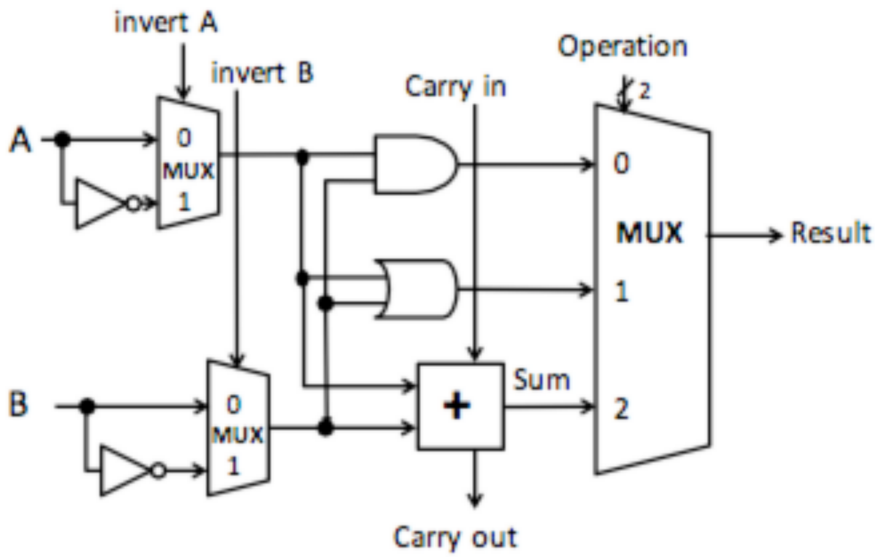
n-bit adder = n 1-bit adders

Carry-out of each adder = Carry-in of the adder for next two most significant bits being added



ALU

Want to be able to select whether the ALU will produce the bitwise AND, OR, and sum as a result.



add (**A + B + Cin**),
AND (**A AND B**),
OR (**A OR B**),

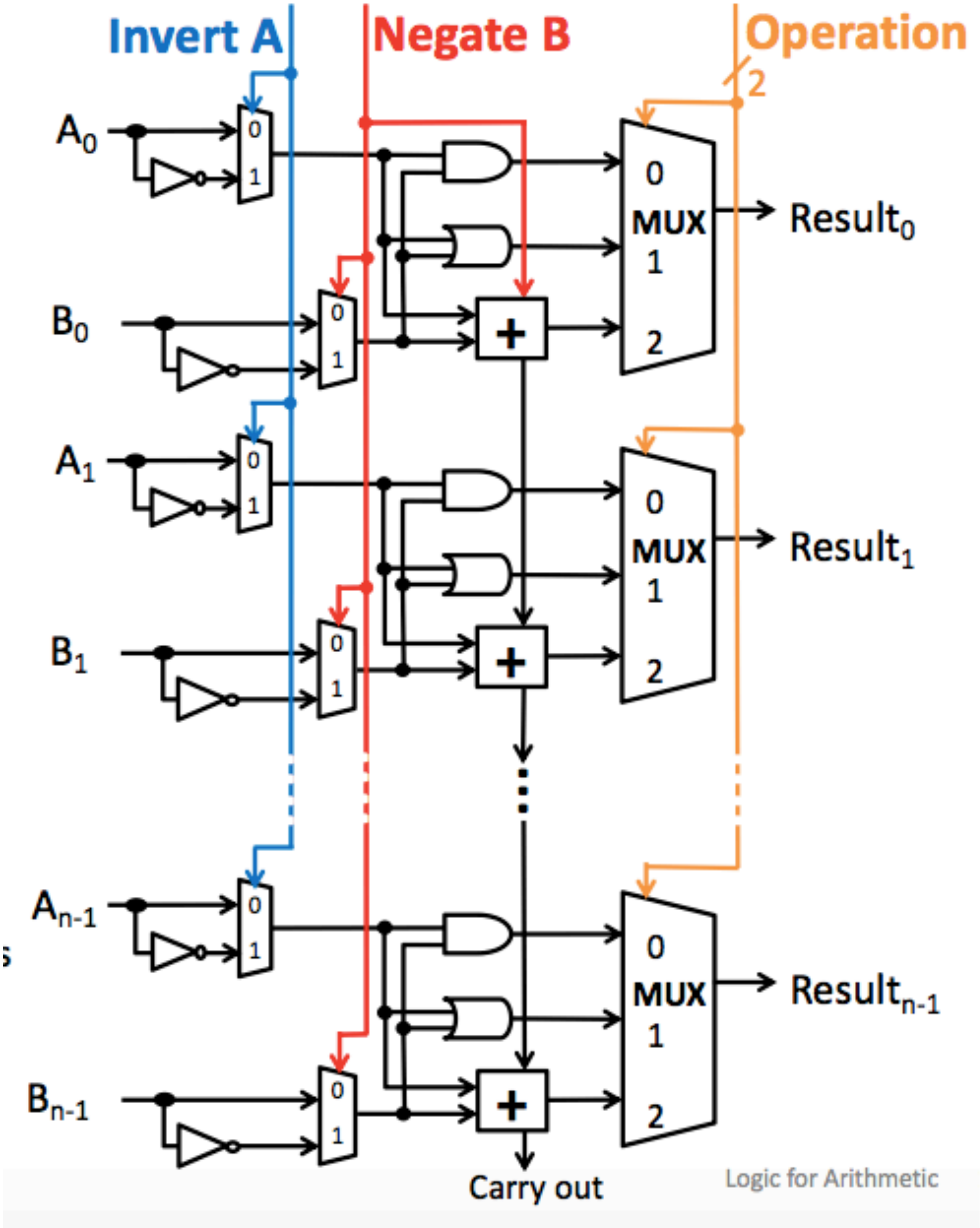
Adding the ability to choose whether to invert A or B provides additional operations:

sub (invert **B**, **Cin** = 1, **A + B + Cin**)

NOR (invert a, invert b, a AND b)

invA	invB	Cin	Op1	Op0	Result
0	0	N/A	0	0	A AND B
0	0	N/A	0	1	A OR B
0	0	0/1	1	0	A + B
0	1	1	1	0	A – B
1	1	N/A	0	0	A NOR B

n-bit ALU


Invert A
Negate B
Operation
2
A$_0$
B$_0$
A$_1$
B$_1$
A$_{n-1}$
B$_{n-1}$
0
1
0
MUX
1
2
Result$_0$
Result$_1$
Result$_{n-1}$
Carry out
Logic for Arithmetic