Repo Link: https://github.com/KaedenOndrus/CIS310-HW1

CIS-310 HW1

1.1.) Truth table for 3-input AND gate:

| X | Y | Z | Output |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 0 |
| 1 | 1 | 1 | 1 |

Truth table of AND → OR gate


| X | Y | Z | Output |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

1.2.) Nand A=1 B=0 C=1 D=1 **Output = 1**

:D

2.1) $(A + A \cdot B) = A$

$(A \cdot (B+C) + 0 \cdot C) = AB + AC + BC$

2.2) $(A \cdot (B+C) + B \cdot C)$

| A | B | C | OUT |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

=

$AB + AC + BC$

| A | B | C | OUT |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 0 | 1 | 0 |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

3.1)

| AB \ CD | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 1 | X | 1 |
| 01 | X | 0 | X | X |
| 11 | X | X | 1 | X |
| 10 | X | X | X | X |

3.2) $X = \overline{B}\,D + C$

Part 4.)

$P_0$:

| $A_1A_0$ \ $B_1B_0$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 |
| 01 | 0 | 1 | 1 | 0 |
| 11 | 0 | 1 | 1 | 0 |
| 10 | 0 | 0 | 0 | 0 |

$P_0 = A_0 B_0$

$P_1$:

| $A_1A_0$ \ $B_1B_0$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 |
| 01 | 0 | 0 | 1 | 1 |
| 11 | 0 | 1 | 0 | 1 |
| 10 | 0 | 1 | 1 | 0 |

$P_1 = \bar{A}_1 A_0 B_1 + A_0 B_1 \bar{B}_0 + A_1 \bar{B}_1 B_0 + A_1 \bar{A}_0 B_0$

$P_2$:

| $A_1A_0$ \ $B_1B_0$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 |
| 01 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 0 | 1 |
| 10 | 0 | 0 | 1 | 1 |

$P_2 = A_1 \bar{A}_0 B_1 + A_1 B_1 \bar{B}_0$

$P_3$:

| $A_1A_0$ \ $B_1B_0$ | 00 | 01 | 11 | 10 |
|---|---|---|---|---|
| 00 | 0 | 0 | 0 | 0 |
| 01 | 0 | 0 | 0 | 0 |
| 11 | 0 | 0 | 1 | 0 |
| 10 | 0 | 0 | 0 | 0 |

$P_3 = A_1 A_0 B_1 B_0$

4.2)

Full Adder

| A | B | out | carry |
|---|---|---|---|
| 0 | 0 | 0 | 0 |
| 0 | 1 | 1 | 0 |
| 1 | 0 | 1 | 0 |
| 1 | 1 | 0 | 1 |

Out:

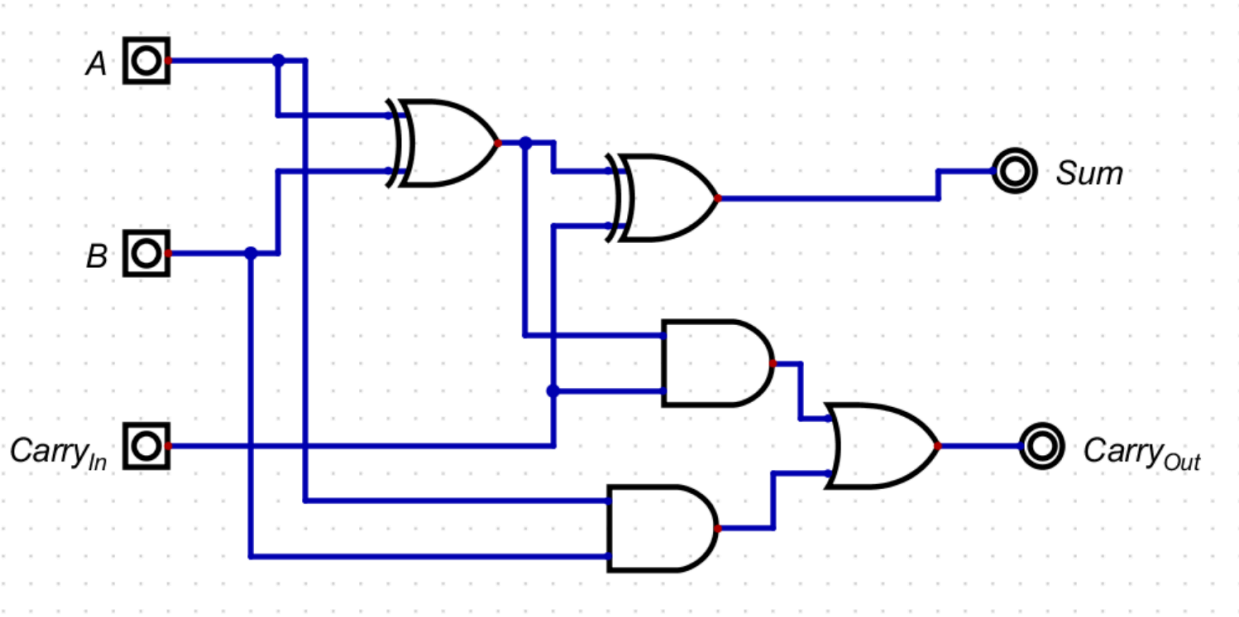
| A \ B | 0 | 1 |
|---|---|---|
| 0 | 0 | 1 |
| 1 | 1 | 0 |

Carry:

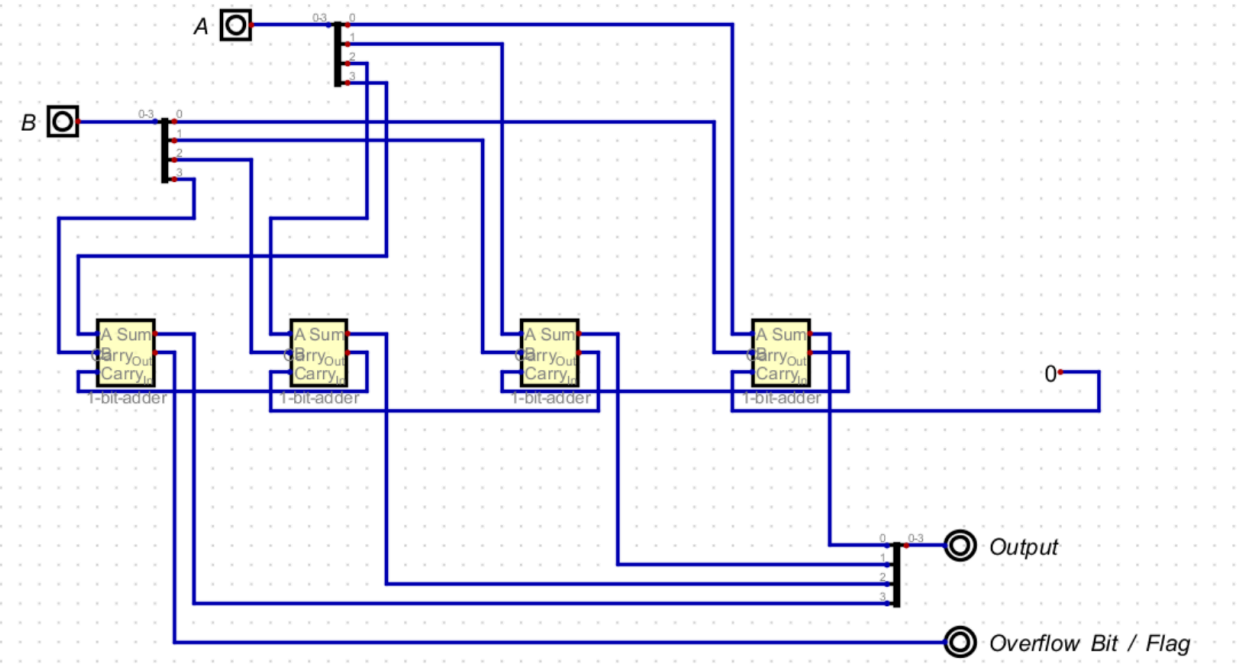
| A \ B | 0 | 1 |
|---|---|---|
| 0 | 0 | 0 |
| 1 | 0 | 1 |

$Out = \bar{A} B + A \bar{B}$ $\quad carry = AB$

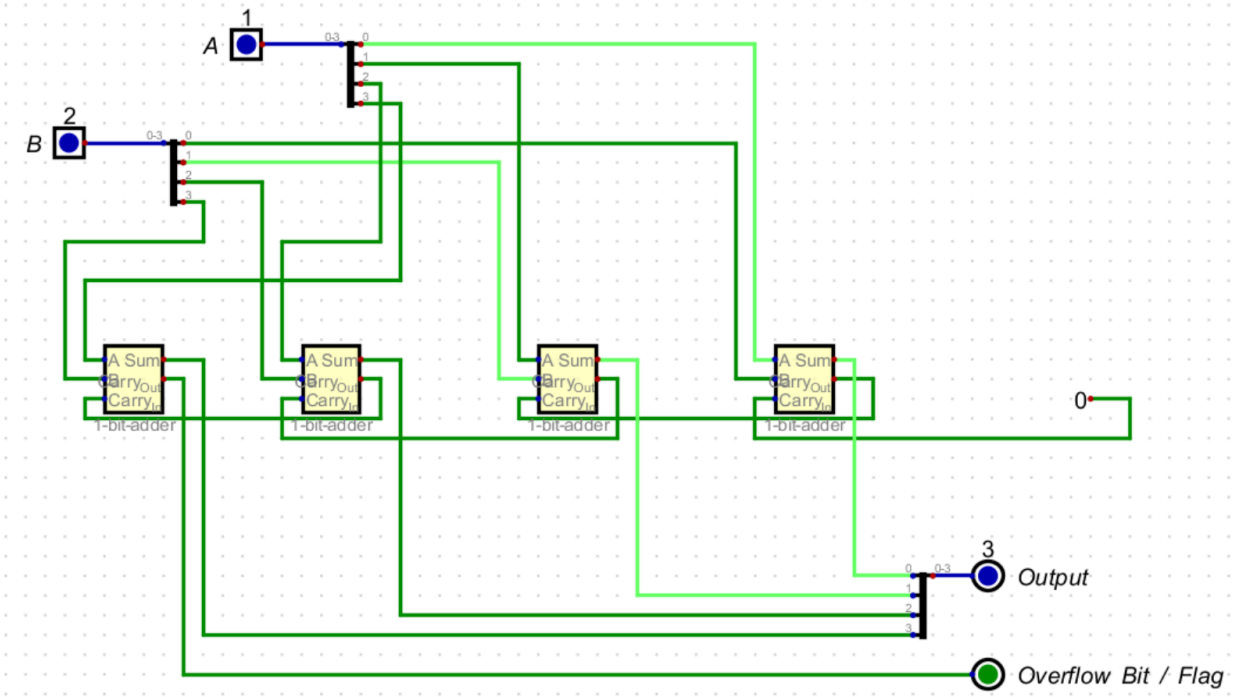
One-Bit Adder

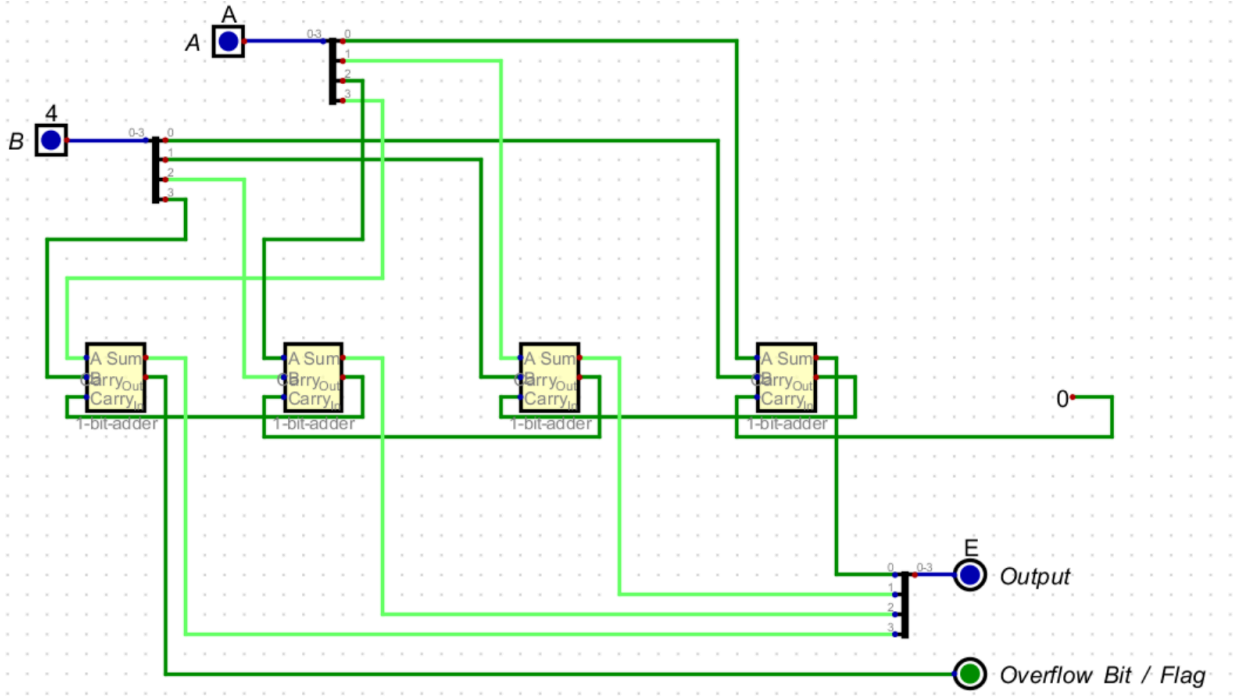


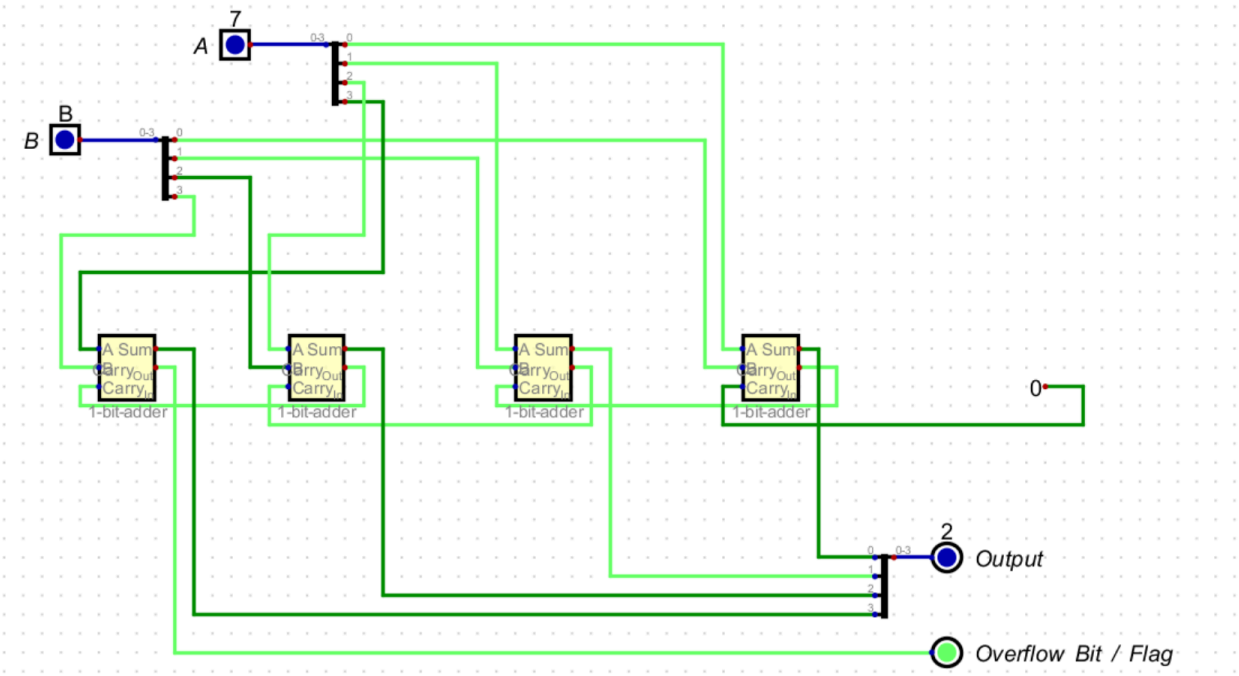

4-Bit Adder




4-Bit Adder Test cases:


A
1
B
2
A Sum
Carry_Out
Carry_In
1-bit-adder
0
3
Output
Overflow Bit / Flag


A
A
B
4
A Sum
Carry_Out
Carry_In
1-bit-adder
0
E
Output
Overflow Bit / Flag


A
7
B
B
A Sum
B
CarryOut
CarryIn
1-bit-adder
1-bit-adder
1-bit-adder
1-bit-adder
0
2
Output
Overflow Bit / Flag