ECE216: Digital Electronics Laboratory

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Experiment 2

Aim: To design a circuit for Full adder and full subtractor using X-OR and basic gates

1. **Apparatus Required: -** IC 7486, IC 7432, IC 7408, IC 7400, IC 7404 etc.

XOR OR AND NAND NOT

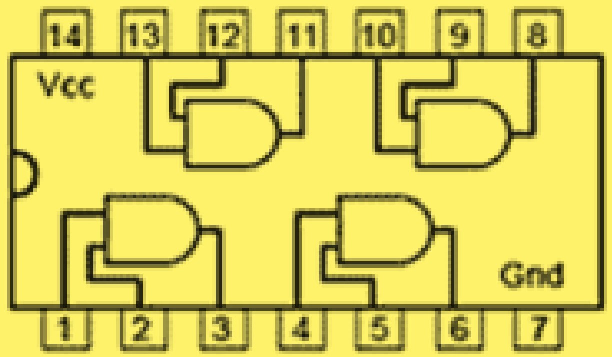
2. **Learning objective**:

    a) How to realize the functionality full adder.

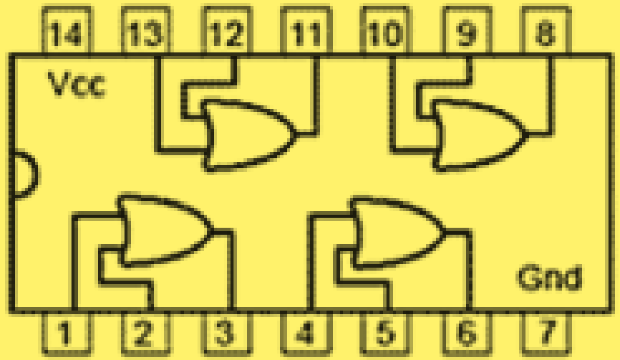
3. **Theory:**

1) Using X – OR and Basic Gates to implement full Adder:

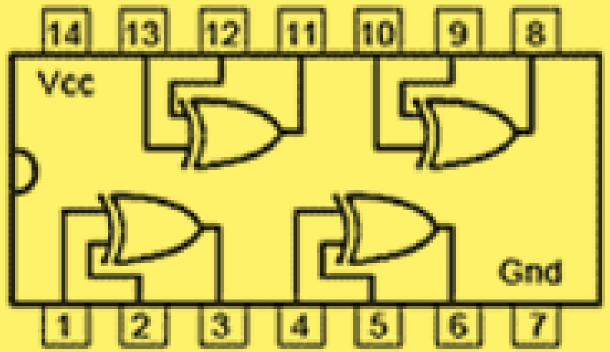
A full adder adds binary numbers and accounts for values carried in as well as out. A one-bit full adder adds three one-bit numbers, often written as A, B, and Cin ; A and B are the operands, and Cin is a bit carried in from the next less significant stage. The full-adder is usually a component in a cascade of adders, which add 8, 16, 32, etc. binary numbers. The circuit produces a two-bit output sum typically represented by the signals Count and S.
In this implementation, the final OR gate before the carry-out output may be replaced by an XOR gate without altering the resulting logic. Using only two types of gates is convenient if the circuit



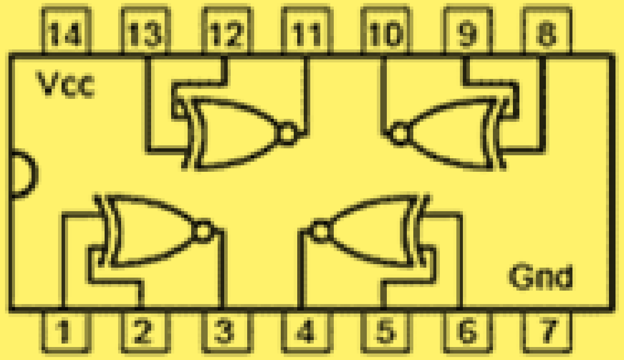
7408 Quad 2 input
AND Gates



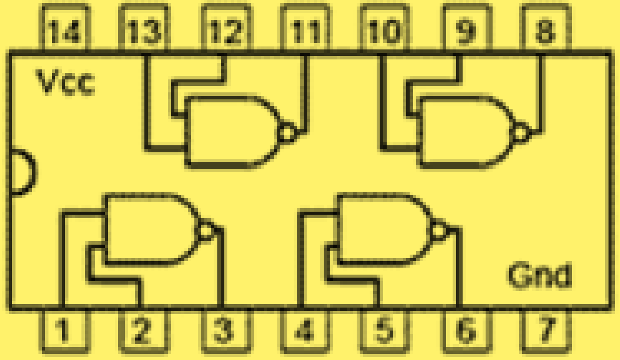
7432 Quad 2 input
OR Gates



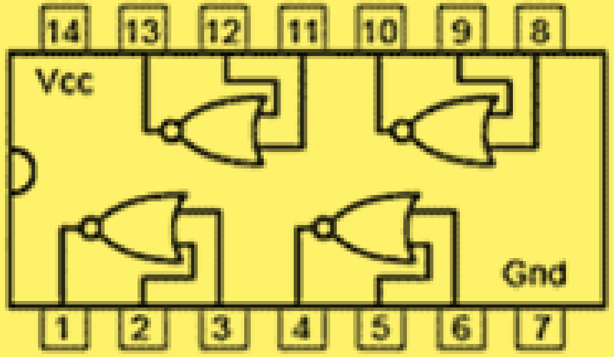
7486 Quad 2 input
XOR Gates



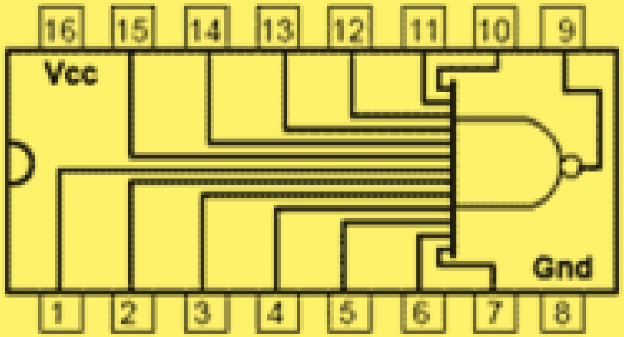
747266 Quad 2 input
XNOR Gates



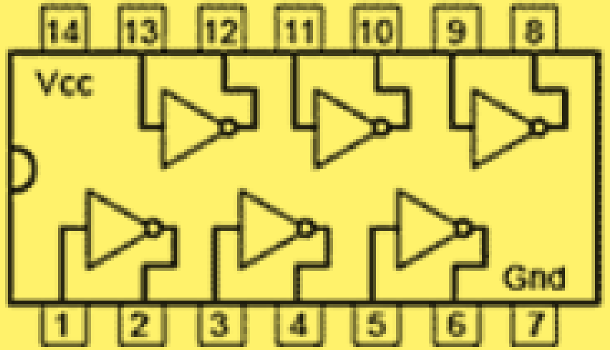
7400 Quad 2 input
NAND Gates



7402 Quad 2 input
NOR Gates



74133 Single 13 input
NAND Gate



7404 Hex NOT Gates
(Inverters)

Half Adder

It can add 2, 1-bit binary number

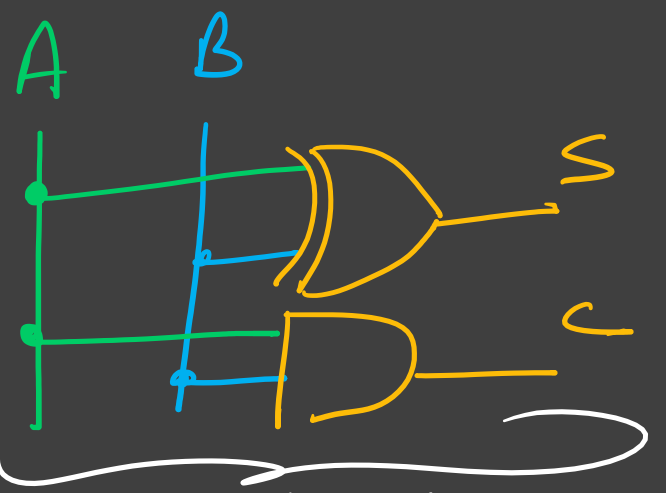
i/p: A, B — o/p: S, C

	A	B	S	C
0	0	0	0	0
1	0	1	1	0
2	1	0	1	0
3	1	1	0	1

SOP

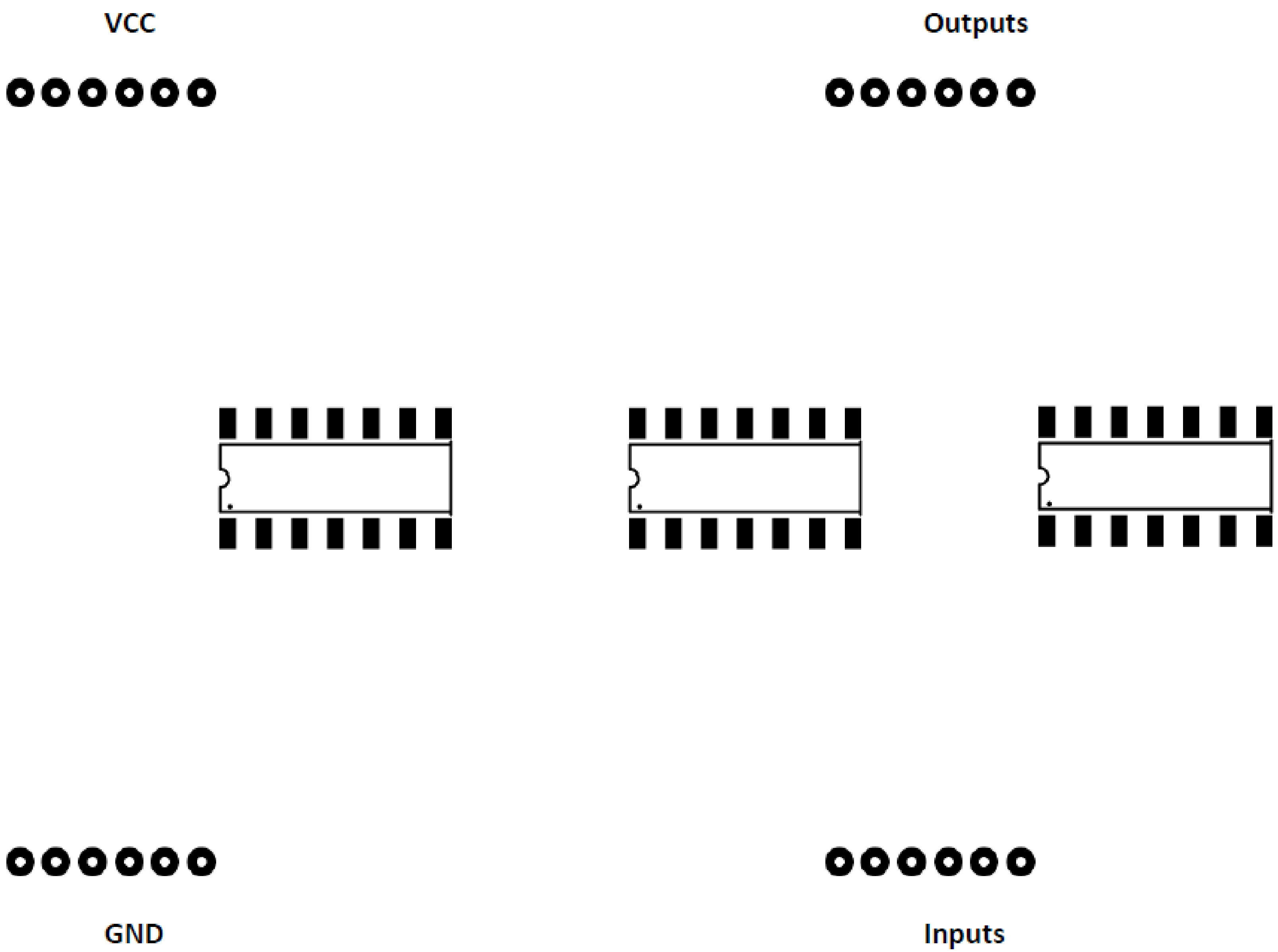
$$S = \bar{A}B + A\bar{B} = A \oplus B$$

$$C = AB$$



half adder

Draw Bread Board Connection diagram:

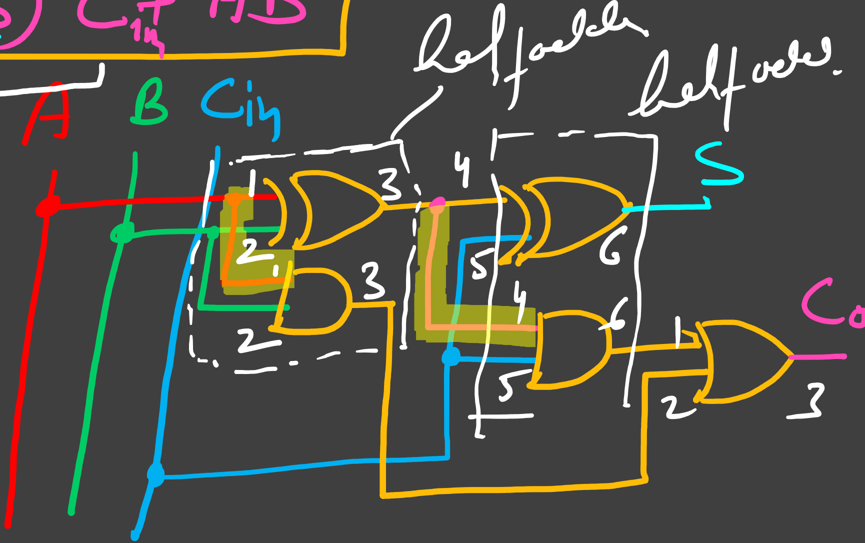


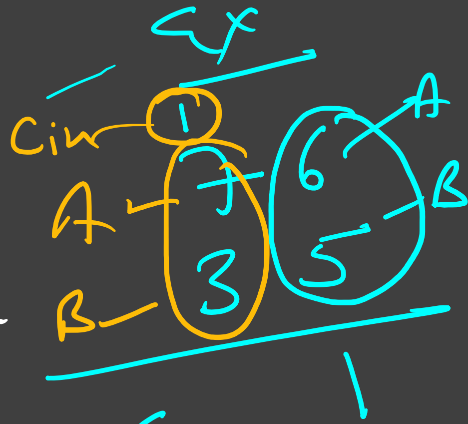
Full Adder

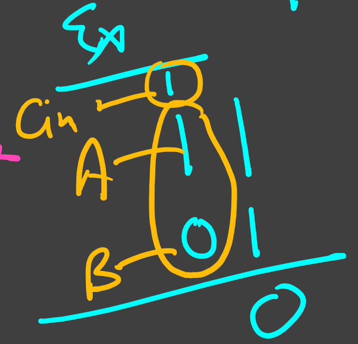
It can add 2, 1-bit Binary numbers, considering previous carry $(A+B+C_{in})$

	A	B	C_{in}	S	C_{out}
0	0	0	0	0	0
1	0	0	1	1	0
2	0	1	0	1	0
3	0	1	1	0	1
4	1	0	0	1	0
5	1	0	1	0	1
6	1	1	0	0	1
7	1	1	1	1	1

$$C_{out} = \bar{A}BC_{in} + A\bar{B}C_{in} + AB\bar{C}_{in} + ABC_{in}$$
$$= (\bar{A}B + A\bar{B})C_{in} + AB(\bar{C}_{in} + C_{in})$$
$$\boxed{C_{out} = (A \oplus B)C_{in} + AB}$$



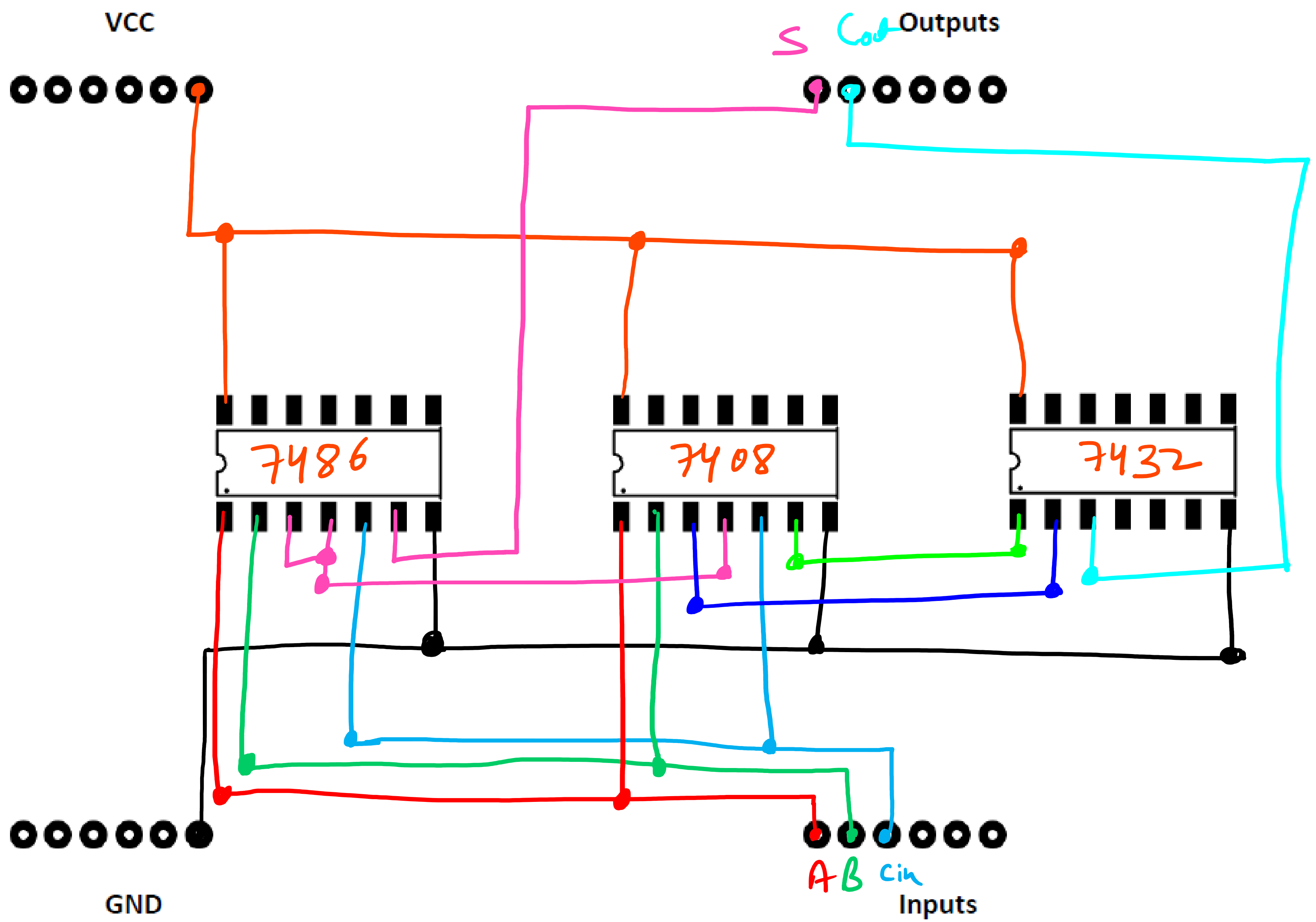




$$\boxed{S = \bar{A}\bar{B}C_{in} + \bar{A}B\bar{C}_{in} + A\bar{B}\bar{C}_{in} + ABC_{in}}$$
$$= (\bar{A}B + A\bar{B})\bar{C}_{in} + (\bar{A}\bar{B} + AB)C_{in}$$
$$= (A \oplus B)\bar{C}_{in} + \overline{A \oplus B}\, C_{in} = \boxed{(A \oplus B) \oplus C_{in}}$$

$$f_1\bar{f}_2 + \bar{f}_1 f_2$$

Draw Bread Board Connection diagram:



Half Subtractor

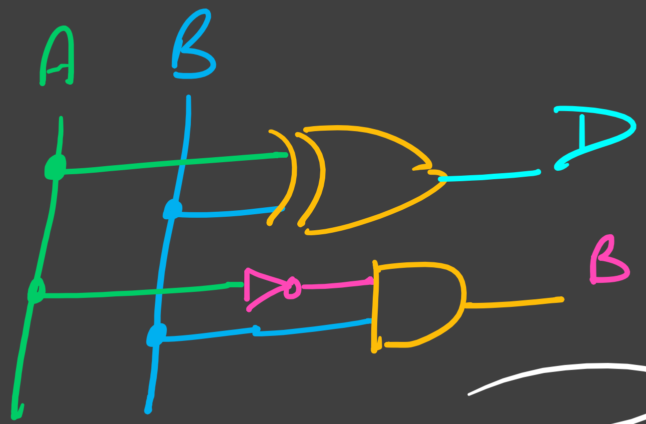
It can subtract 2, 1-bit binary numbers

$A - B$

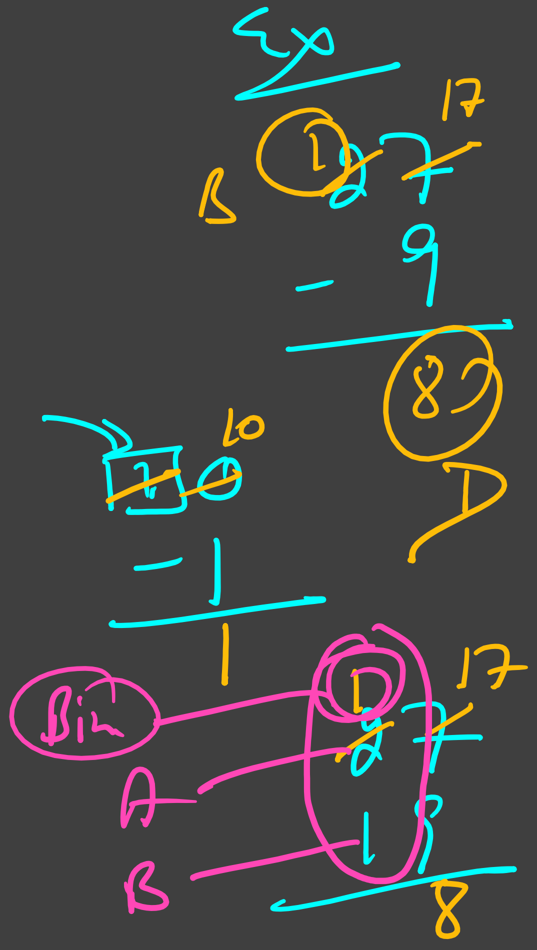
A	B	D	B
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

$$D = \bar{A}B + A\bar{B} = A \oplus B$$

$$B = \bar{A}B$$

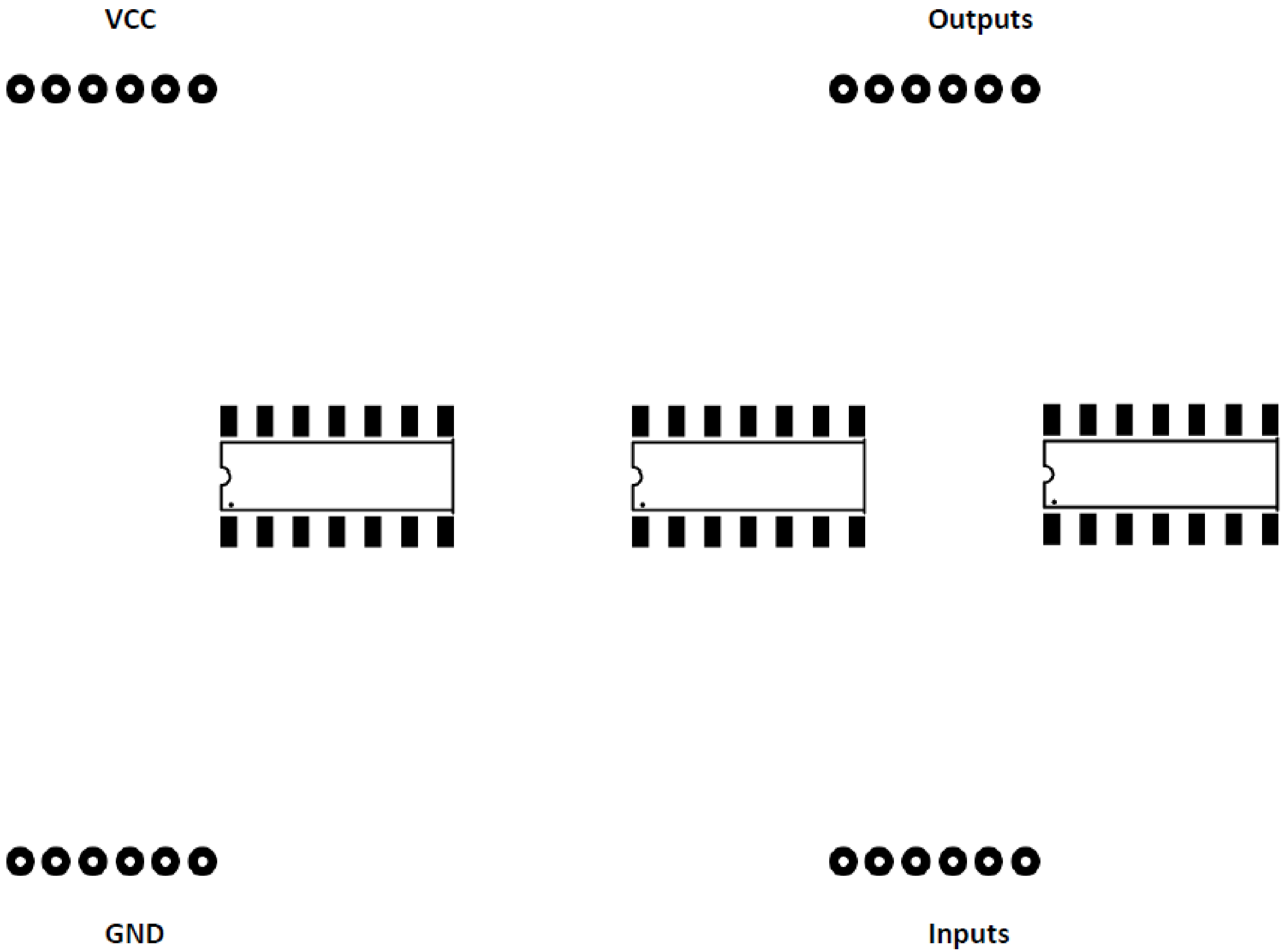


Half substractor



$\boxed{A - B - Bin}$

Draw Bread Board Connection diagram:



Full Subtractor

	A	B	Bin	D	Bout
0	0	0	0	0	0
1	0	0	1	1	1
2	0	1	0	1	1
3	0	1	1	0	1
4	1	0	0	1	0
5	1	0	1	0	0
6	1	1	0	0	0
7	1	1	1	1	1

$D = A \oplus B \oplus Bin$

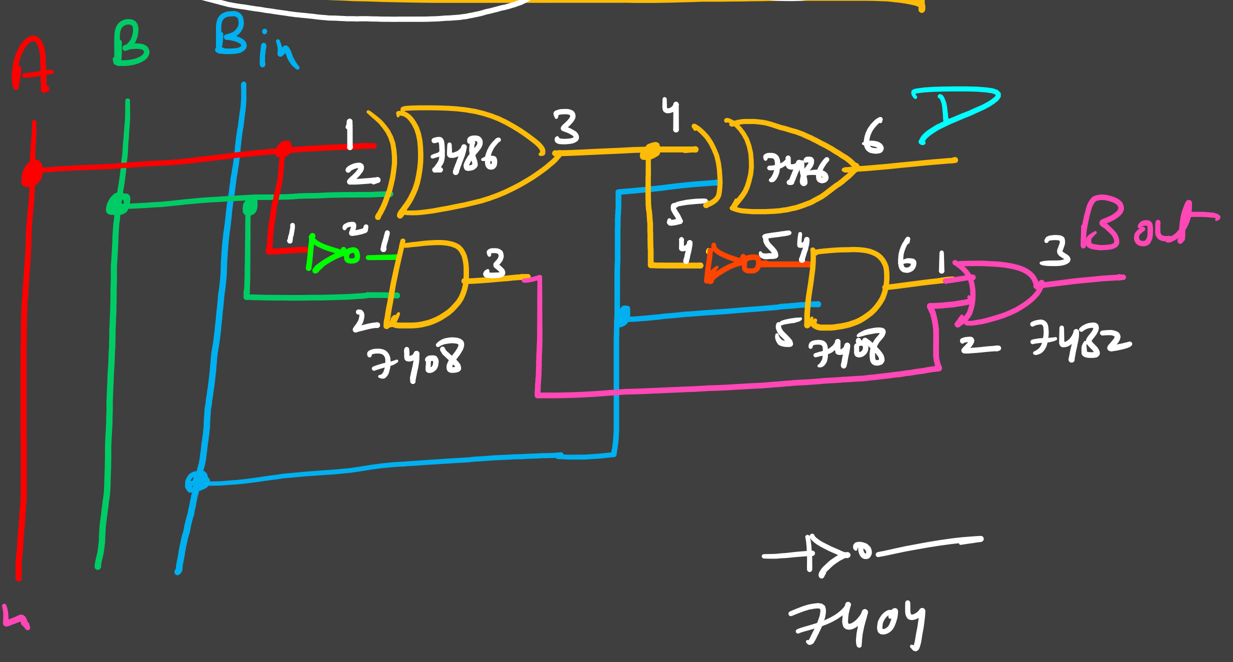
$Bout = \bar{A}\bar{B}\,Bin + \bar{A}B\,\overline{Bin} + \bar{A}B\,Bin + AB\,Bin$

It can add 2 1-bit bin number considering the borrow down

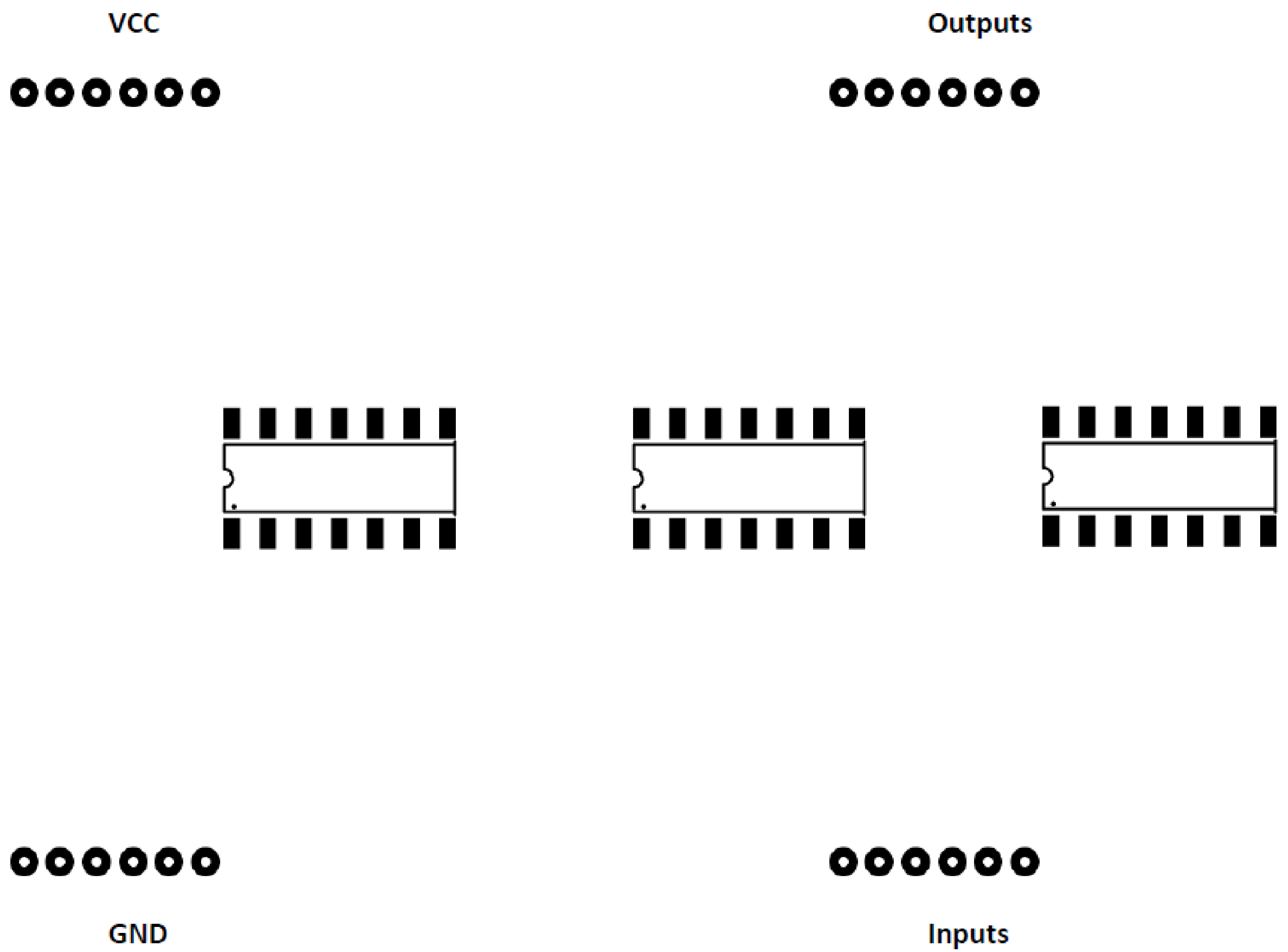
$(A - B) - Bin$

$Bout = (\bar{A}\bar{B} + AB)Bin + \bar{A}B(\overline{Bin} + Bin)$

$\boxed{Bout = \overline{A \oplus B}\,Bin + \bar{A}B}$



Draw Bread Board Connection diagram: for full Sustraction (HW)



7486
7408
7432
7404

Test 2 — 8th Feb 2021

Google form

- MCQ / Three short answer questions — 10 Marks
- Writeup / BA design — 10 Marks
- Simulation — 10 Marks