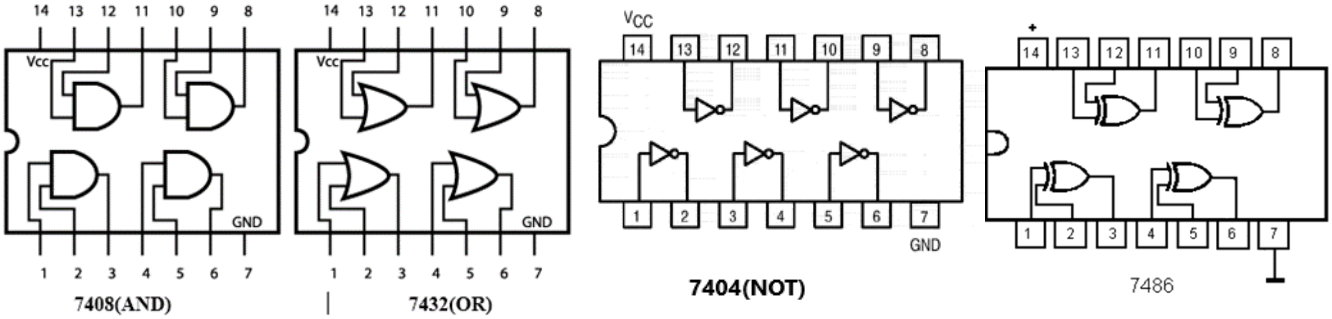
Lab 3 1-bit Adder, Subtractor

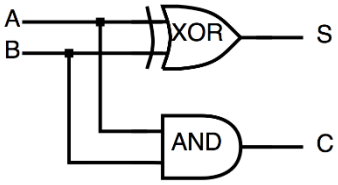
The objective of this lab is to build circuits to perform 1-bit addition and subtraction.

Equipment: Elenco Digital/Analog Trainer X-150,Chip**s:** 74HCT**08** Quad 2-input **AND gate**, 74HCT**32** Quad 2-input **OR gate**, 74HCT**04inverter**, 74HCT**86** Quad 2-input **XOR gate.**



Procedure

1. **Half Adder**: ahalf adder is an electronic circuit that performs **the addition of two single binary digits** and provide the output plus a carry value. It has two inputs, called A and B, and two outputs S (sum) and C (carry). The circuit uses an XOR logic gate and an AND logic gate.Write the Boolean equations for S and C, built the half adder on the breadboard and record the outputs on the table.

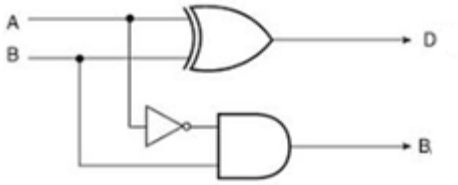


S = _____

C = _____

A	B	C	S
0	0		
0	1		
1	0		
1	1		

2. **Half Subtractor**: a half subtractor is circuit for subtracting two binary numbers. The circuit below is used to **subtract two single bit binary numbers** A and B. The D(difference) and B (borrow) are two output states of the half subtractor. Write the Boolean equations for D and B, built the half subtractor on the breadboard and record the outputs on the table.



D = _____

B = _____

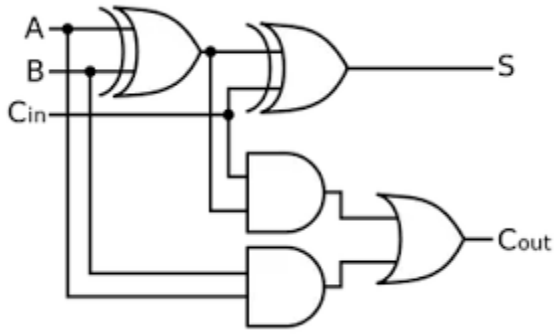
A	B	B	D
0	0		
0	1		
1	0		
1	1		

3. **Full adder:**

A circuit that **adds a column of three bits** is called a full-adder. Let A and Bbe the two data bits to be added andCinthe input carry. The output bits will be S for the sum bit and Cout for the output carry. The summation is shown symbolically below, together with the table giving the outputs for each input combination. Fill in each row of the table by writing in binary the sum of the three bits A + B + Cin, using 0 = 00, 1 = 01, 2 = 10, and 3 = 11.

A
B
+ Cin
C S

A	B	Cin	Cout	S
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		



The full-adder circuit is shown above using two XOR gates, two AND gates, and one OR gate. Write the Boolean equations for C and S based on the given diagram and build the circuit on the breadboard to verify if it can perform addition correctly by applying all eight combinations of logic LOW and HIGH levels to the three inputs using three switches.

C = S =

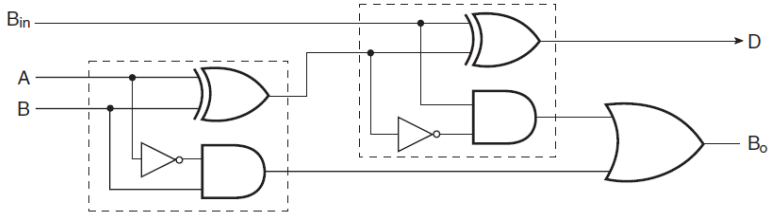
When your circuit is working, ask me to check your work.

Homework: Build a 1-bit subtractor

Derive the truth table for 1-bit full subtractor (X - Y - Bin), and then build the subtractor on TinkerCadusing the given logic diagram.Include the equation, truth table, logic diagram, screenshot of circuit and link in your lab report. Again you can use the given CSC 347 Tinkercad starterto build the circuit. Log into Tinkercad, copy and paste the following link to your web browser https://www.tinkercad.com/things/19XqriP2dMF. Click on the button of "Copy and Tinker" on the right to make a copy).

D = Bout =

A	B	Bin	Bout	D
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		



Lab report submission

Lab report is needed for this lab. Please follow the guidelines and sample report on the Blackboard when you are writing your lab report. Click on **Lab 3 Report Submission** to submit your report. It is due one week after the lab is done.