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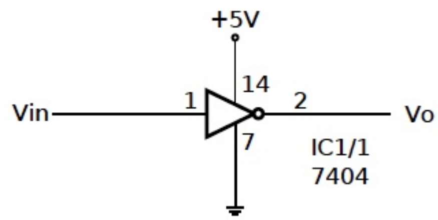
Name: .... Student ID: ....

Laboratory 2

NOT-Gate, AND-Gate and OR-Gate

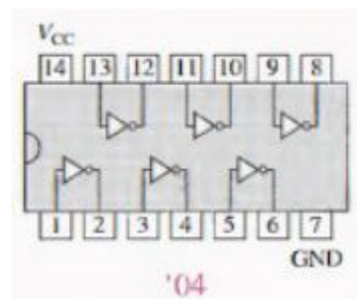
1. NOT-Gate

1.1 Connect the circuit as shown in the following figure:

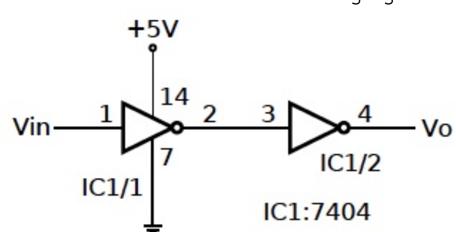


1.2 Connect the input pin (V_{in}) to the terminal as shown in the following table. Use the digital multi-meter to measure the output voltage (V_o).

V_{in}	V_o (V)
+5V	light off
GND	light on



1.3 Connect the circuit as shown in the following figure:



1.4 Connect the input pin (V_{in}) to the terminal as shown in the following table. Use the digital multi-meter to measure the output voltage (V_o).

V_{in}	V_o (V)
+5V	light on
GND	light off

1.5 What can be concluded if

a) 2 NOT-gates are connected in series

b) 3 NOT-gates are connected in series

c) 4 NOT-gates are connected in series

d) Write the Boolean expressions for all the above cases

a) The logic will be same as when it has no NOT gate due to those 2 NOT gates' negation cancelled each other.

b) The first 2 NOT gates cancelled each other like case a) and left the 3rd NOT gate inverse the signal

c) The logic will be same as when it has no NOT gate due to those 4 NOT gates' negation cancelled each other.

d)

	Case a	Case b	Case C
5V	1	0	1
GND.	0	1	0

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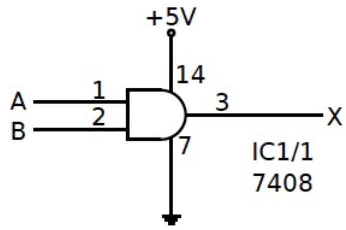
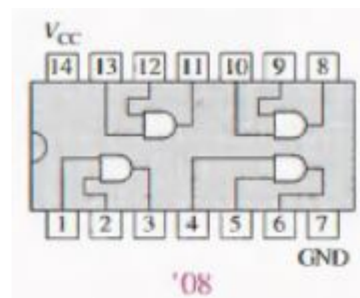
2. AND-Gate

2.1 Connect the circuit as shown in the following figure:

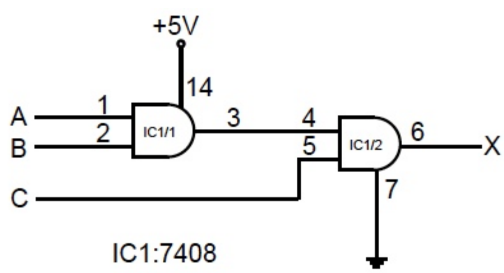


2.2 Use the logic switch to supply input signals to the input pin as specified. Connect the output pin to the logic monitor and record the results for each combination of the inputs in the following table.

A	B	X
0	0	0
0	1	0
1	0	0
1	1	1



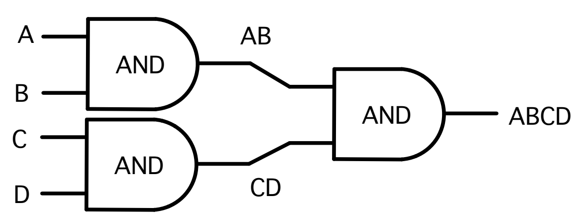
2.3 Connect the circuit as shown in the following figure:



2.4 Use the logic switch to supply input signals to the input pin as specified. Connect the output pin to the logic monitor and record the results for each combination of the inputs in the following table.

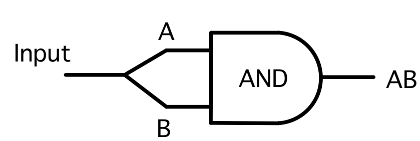
A	B	C	X
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	1

2.5 How to use 2-inputs AND gate to produce 4-inputs AND gate? Explain and draw a circuit.



2.6 If both inputs of AND-gates, A and B, are connected together. Explain the behavior of the output X.

The logic will follow from the initial input because A and B have the same logic.



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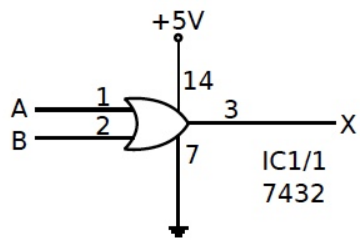
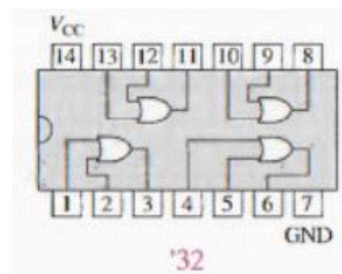
3. OR-Gate

3.1 Connect the circuit as shown in the following figure:

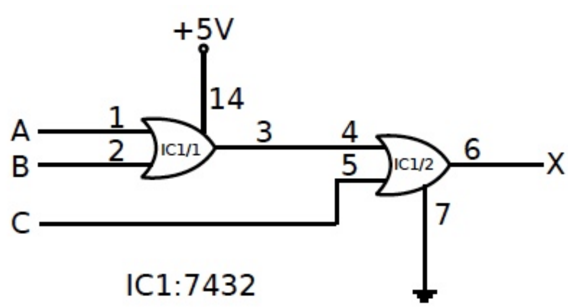


3.2 Use the logic switch to supply input signals to the input pin as specified. Connect the output pin to the logic monitor and record the results for each combination of the inputs in the following table.

A	B	X
0	0	0
0	1	1
1	0	1
1	1	1



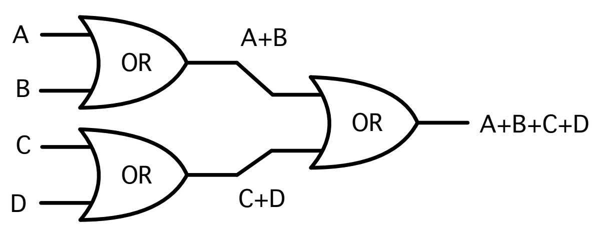
3.3 Connect the circuit as shown in the following figure:



3.4 Use the logic switch to supply input signals to the input pin as specified. Connect the output pin to the logic monitor and record the results for each combination of the inputs in the following table.

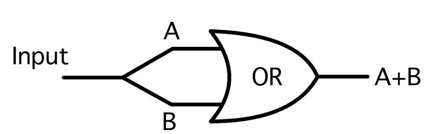
A	B	C	X
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

3.5 How to use 2-inputs OR gate to produce 4-inputs OR gate? Explain and draw a circuit.



3.6 If both inputs of OR-gates, A and B, are connected together. Explain the behavior of the output X.

The logic will follow from the initial input because A and B have the same logic.



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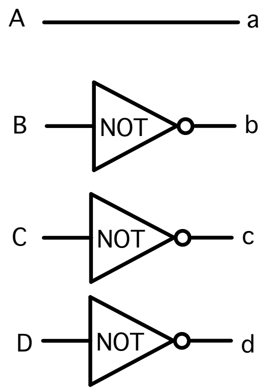
4. Assignments

4.1 Develop a circuit that converts the 4-bits positive input numbers in sign-magnitude representation into negative number with the same magnitude in 1's complement representation.

INPUT OUTPUT abcd

No.	Sign Magnitude	1's Complement
-0	1000	1111
-1	1001	1110
-5	1101	1010
-7	1111	1000



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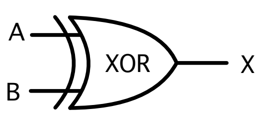
4.2 Given the following truth table. Implement the corresponding logic circuit

A	B	X	
0	0	0	
0	1	1	1
1	0	1	2
1	1	0	



$$X = \overset{1}{\bar{A}B} + \overset{2}{A\bar{B}} = A \oplus B$$

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4.3 Implement the circuit that accepts the input as BCD code of decimal number 0-9. The output of the circuit should be connected to LED D0. In case the input is greater than 3 and can be divided by 2, D0 should turn on otherwise it should be off.

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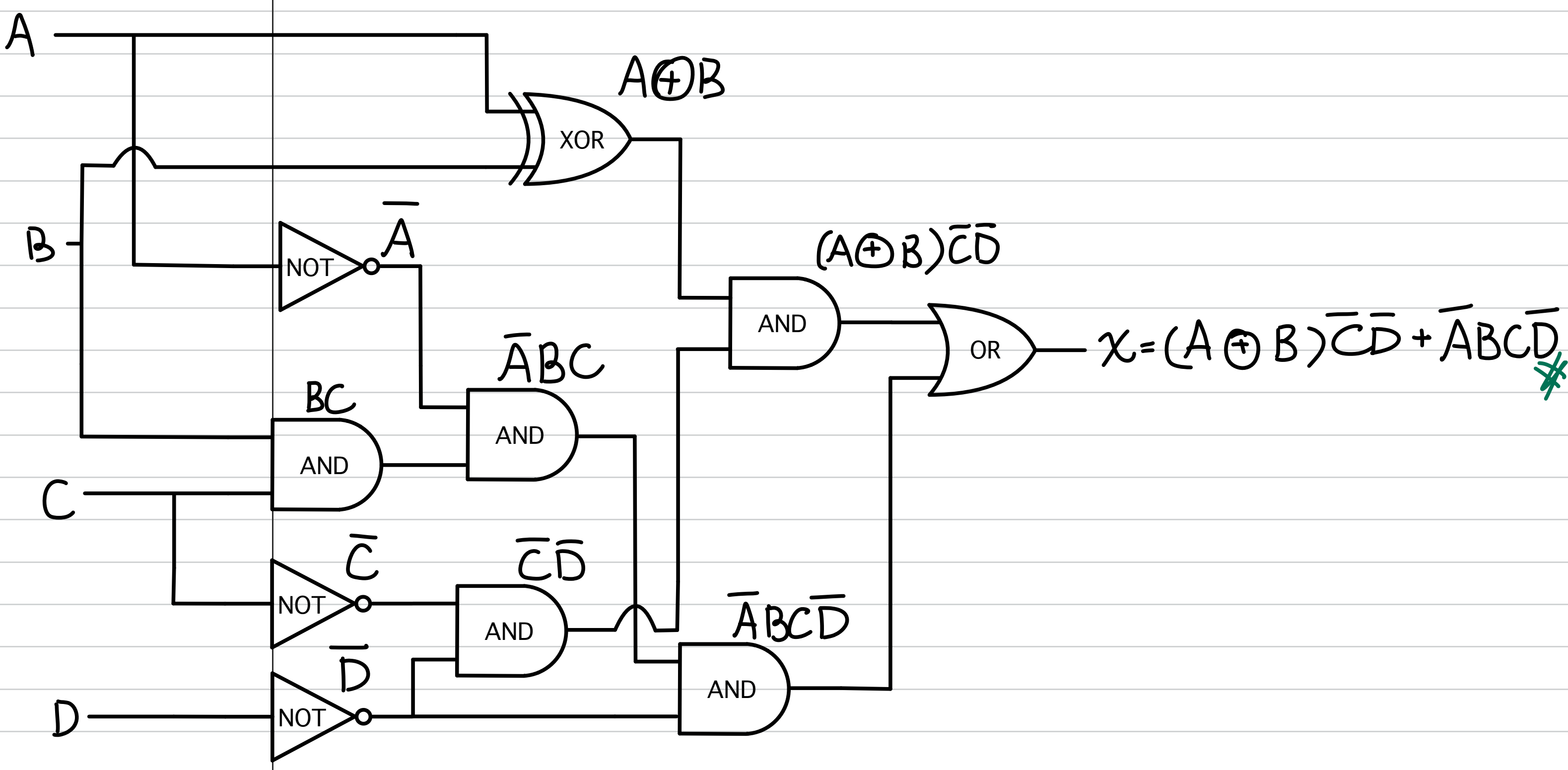
4.3	A	B	C	D	x
0	0	0	0	0	0
1	0	0	0	1	0
2	0	0	1	0	0
3	0	0	1	1	0
4	0	1	0	0	1 — ①
5	0	1	0	1	0
6	0	1	1	0	1 — ②
7	0	1	1	1	0
8	1	0	0	0	1 — ③
9	1	0	0	1	0

By SOP: $x = \underbrace{\bar{A}B\bar{C}\bar{D}}_{①} + \underbrace{\bar{A}BC\bar{D}}_{②} + \underbrace{A\bar{B}\bar{C}\bar{D}}_{③}$

$x = (\bar{A}B + A\bar{B})\bar{C}\bar{D} + \bar{A}BC\bar{D}$

$x = (A \oplus B)\bar{C}\bar{D} + \bar{A}BC\bar{D}$



4.5 A simple logic is required to light an LED (D0 and D1) for car safety. There are three sensors involved. The first is force sensor. This is the sensor used to detect whether the seat is occupied or not. If the seat is occupied the sensor gives a HIGH signal and LOW otherwise. The second sensor detect seat belt fastening. In case the seat belt is fastened, the sensor provides a LOW signal and HIGH otherwise. Finally, the gear sensor that detects whether the gear is in 'P' position or not. It gives LOW signal if the gear is in 'P' position, and HIGH otherwise. Develop a circuit such that LED D0 is lighten up when the seat is occupied and at least one of the other two sensors provides LOW signal while LED D1 is lighten up when the seat is occupied, the seat belt is fasten and the gear is in 'P' position.

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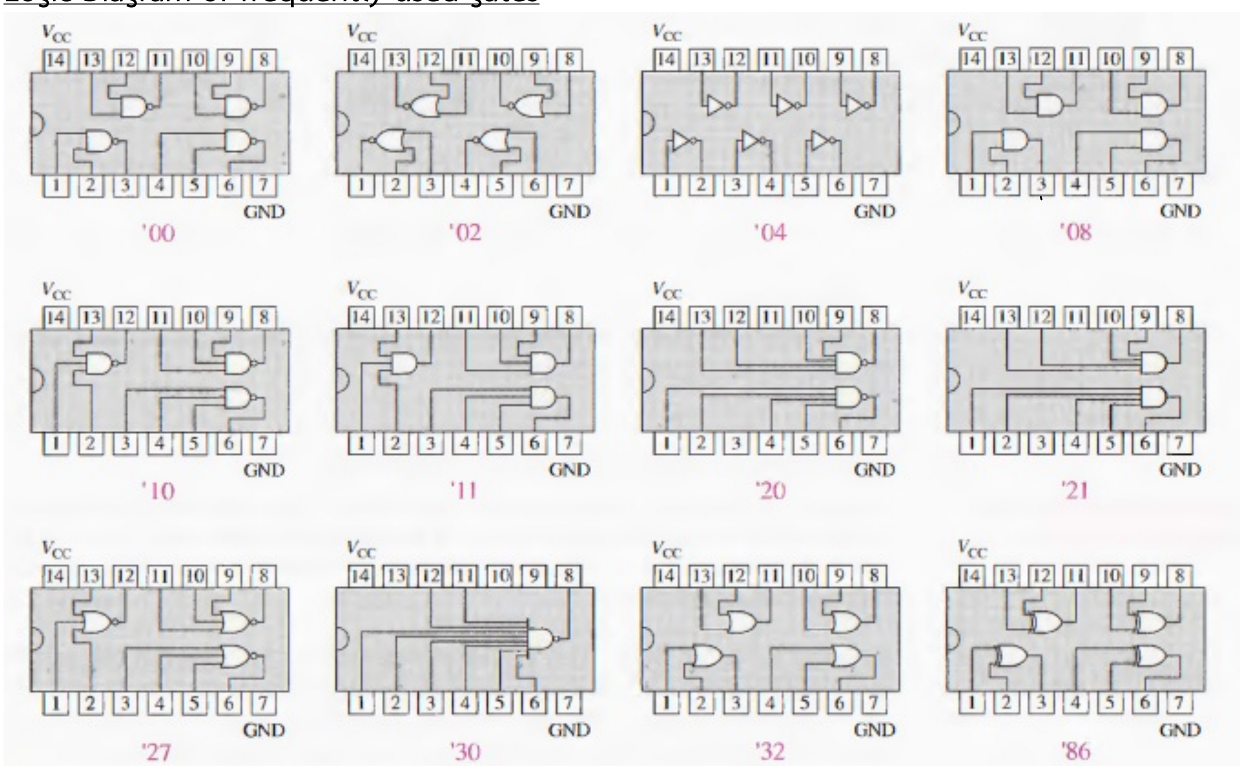
Logic Diagram of frequently used gates



4.5

$F \begin{cases} \text{occupied} = 1 \\ \text{unoccupied} = 0 \end{cases}$ $S \begin{cases} \text{not fastened} = 1 \\ \text{fastened} = 0 \end{cases}$ $G \begin{cases} \text{not } P = 1 \\ P = 0 \end{cases}$ $D_0, D_1 \begin{cases} \text{light on} = 1 \\ \text{light off} = 0 \end{cases}$

F	S	G	D_0	D_1
0	0	0	0	0
0	0	1	0	0
0	1	0	0	0
0	1	1	0	0
1	0	0	0	1 (1)
1	0	1	1 (1)	0
1	1	0	1 (2)	0
1	1	1	1 (3)	0

$$\begin{aligned} D_0 &= \underset{①}{F\bar{S}G} + \underset{②}{FS\bar{G}} + \underset{③}{FSG} \\ &= F(\bar{S}G + S\bar{G}) + FSG \\ &= F(S \oplus G) + FSG \\ &= F[(S \oplus G) + SG] \end{aligned}$$

$$D_1 = F\bar{S}\bar{G}$$