Digital Design LAB

Experiment # 1

Basic Logical Functions and Gates

Eng. Waleed Y. Mousa

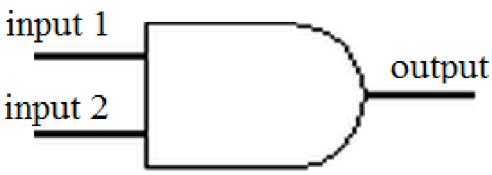
1. Objectives:

- To study AND, OR, INV, NAND, NOR and X-OR gates.
- To study the representation of these functions by truth tables, logic diagrams and Boolean algebra.

2. Theory:

Truth Table: Representation of the output logic levels of a logic circuit for every possible combination of levels of the inputs. This is best done by means of a systematic tabulation.
Number of possibility is $2^{(\text{NO. of input})}$

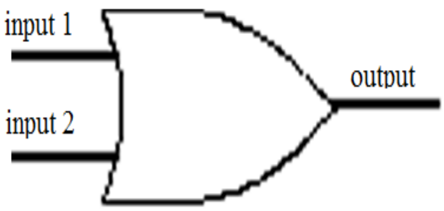
AND: A multi-input circuit in which the output is 1 only if all inputs are1.



STATE	INPUTS		OUTPUTS
	A	B	F
0	0	0	0
1	0	1	0
2	1	0	0
3	1	1	1

In Boolean expression, F= AB

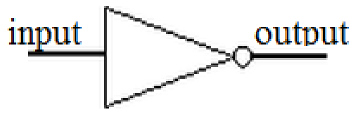
OR : A multi-input circuit in which the output is 1 when any input is 1.



STATE	INPUTS		OUTPUTS
	A	B	F
0	0	0	0
1	0	1	1
2	1	0	1
3	1	1	1

In Boolean expression, F = A+B

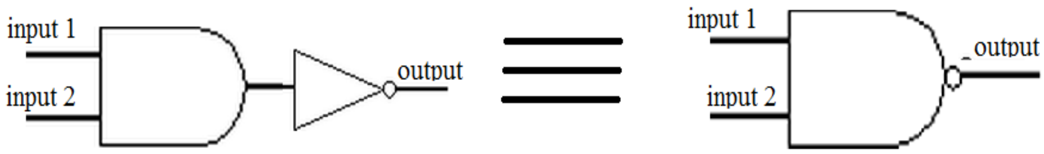
INV: The output is 0 when the input is 1, and the output is 1 when the input is 0.



STATE	INPUTS	OUTPUTS
	A	F
0	0	1
1	1	0

In Boolean expression, F= $\overline{A}$

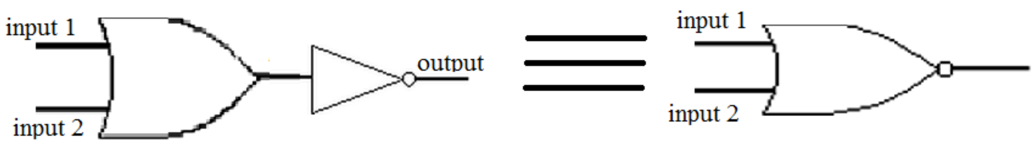
NAND: AND followed by INVERT.



STATE	INPUTS		OUTPUTS
	A	B	F
0	0	0	1
1	0	1	1
2	1	0	1
3	1	1	0

In Boolean expression, F= $\overline{AB}$

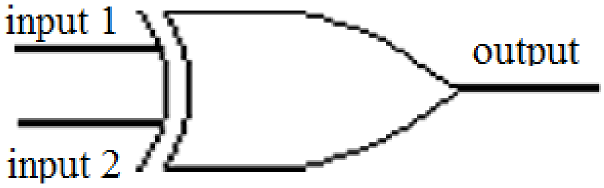
NOR: OR followed by INVERT.



STATE	INPUTS		OUTPUTS
	A	B	F
0	0	0	1
1	0	1	0
2	1	0	0
3	1	1	0

In Boolean expression, F= $\overline{A+B}$

X-OR: The output of the Exclusive –OR gate, is 0 when it's two inputs are the same and its output is 1 when its two inputs are different.

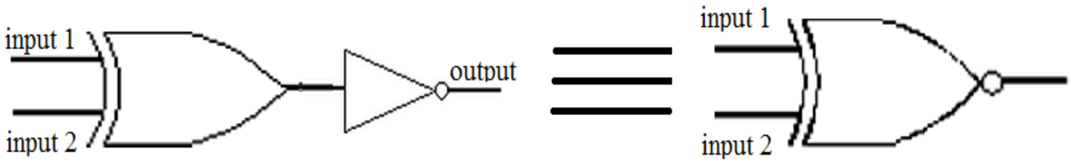


STATE	INPUTS		OUTPUTS
	A	B	F
0	0	0	0
1	0	1	1
2	1	0	1
3	1	1	0

When A=B, the output F=0.
When A≠B, the output F=1.
In Boolean expression, $F= A \oplus B$
The output F of an XOR is equal to $A \oplus B=A'B + AB'$. XOR gates can be constructed using NOT, AND , and OR gates.

NOTE: these truth tables are based on "positive" logic where positive voltage represents "1" and negative voltage represents "0". In case negative logic is used the output will be reversed.

XNOR: XNOR equal to XOR followed by NOT; (A XNOR B) = not (A XOR B).



STATE	INPUTS		OUTPUTS
	A	B	F
0	0	0	1
1	0	1	0
2	1	0	0
3	1	1	1

3. Lab Work:

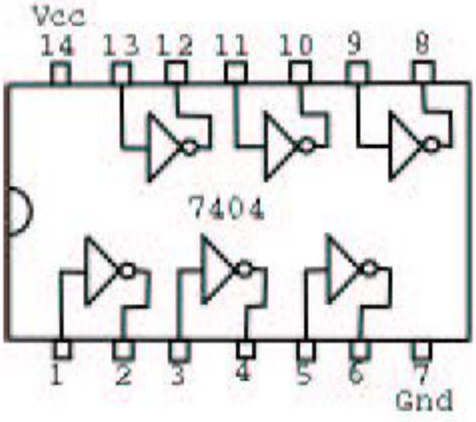
- **Requirements:**

1. ICs 7400(NAND), 7402(NOR), 7404(NOT), 7408(AND), 7432(OR), 7486(XOR), LED.
2. TTL switches for inputs and LED for the output.

- **Prelab:**
  1. Derive the truth table and draw a schematic diagram for each experimental part.
  2. Write out a logical expression for the output for each circuit connection in your experiment.

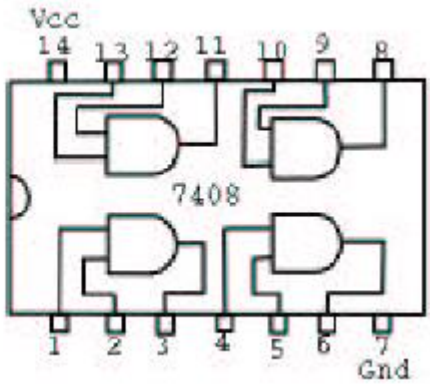
Part 1: NOT Gate

- Connect the following circuits and do the Prelab requirements.



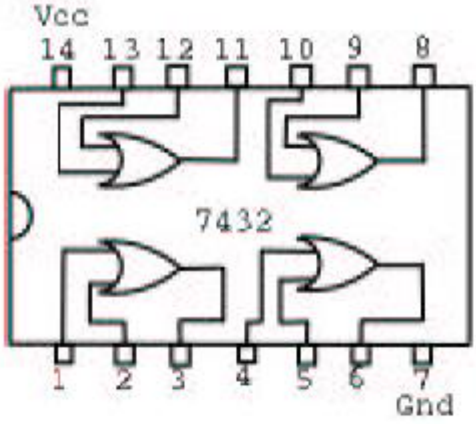
Part 2: AND Gate

- Connect the following circuits and do the Prelab requirements.



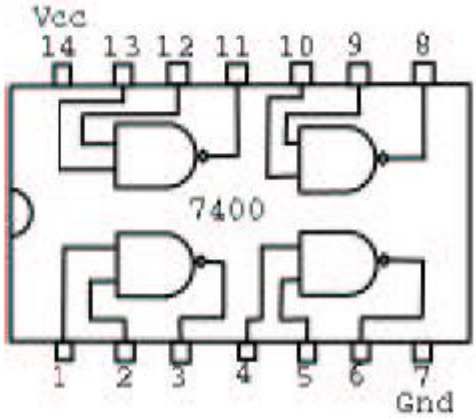
Part 3: OR Gate

- Connect the following circuits and do the Prelab requirements.



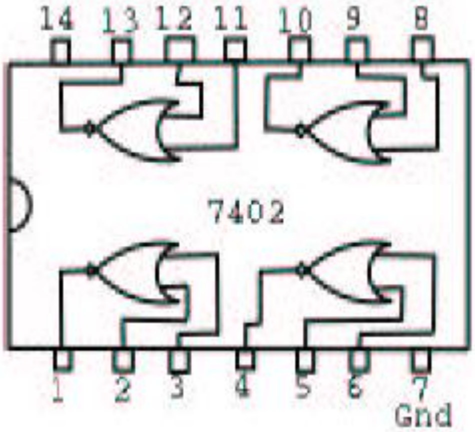
Part 4: NAND Gate

- Connect the following circuits and do the Prelab requirements.



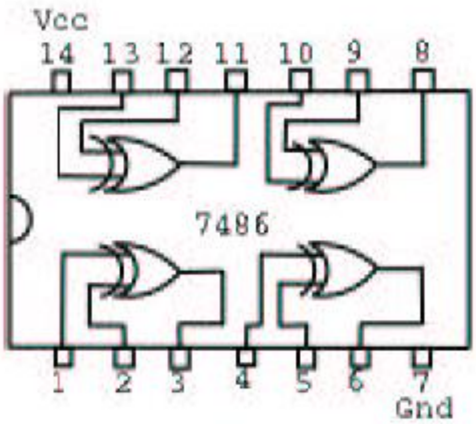
Part 5: NOR Gate

- Connect the following circuits and do the Prelab requirements.



Part 6: X-OR Gate

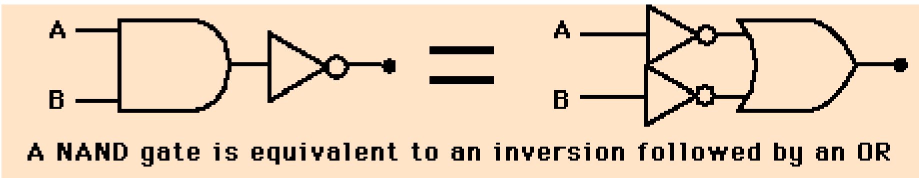
- Connect the following circuits and do the Prelab requirements.

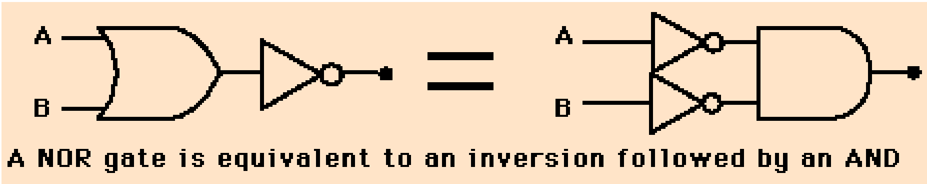


Part 7: XNOR Gate

- Connect x-nor gate using 7404(not) and 7404 (x-or) gate.

Part 8: DeMorgan's Theorem





a) Write down the expressions of Demorgan's low.

b) Use the truth table of NAND to verify that it is equivalent to (Negative-OR) and the truth table of the NOR gates to verify that it is equivalent to (Negative-AND).

4. Exercises

a) Design a 3-input NAND gate using 7400Ics (2-input NAND gate) only.

b) Build INV gate using a single 2-input NOR gate.

c) Build INV gate using a single 2-input NAND gate.