Lab-02

Basic Logic Gates

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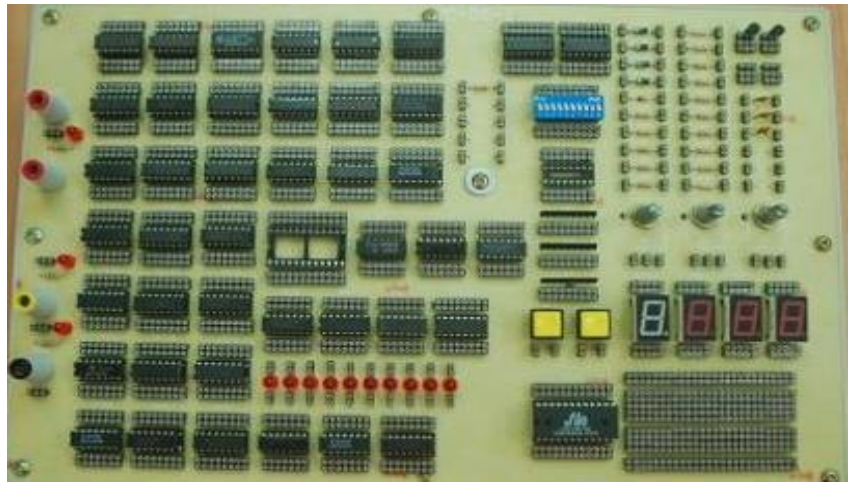
Objectives

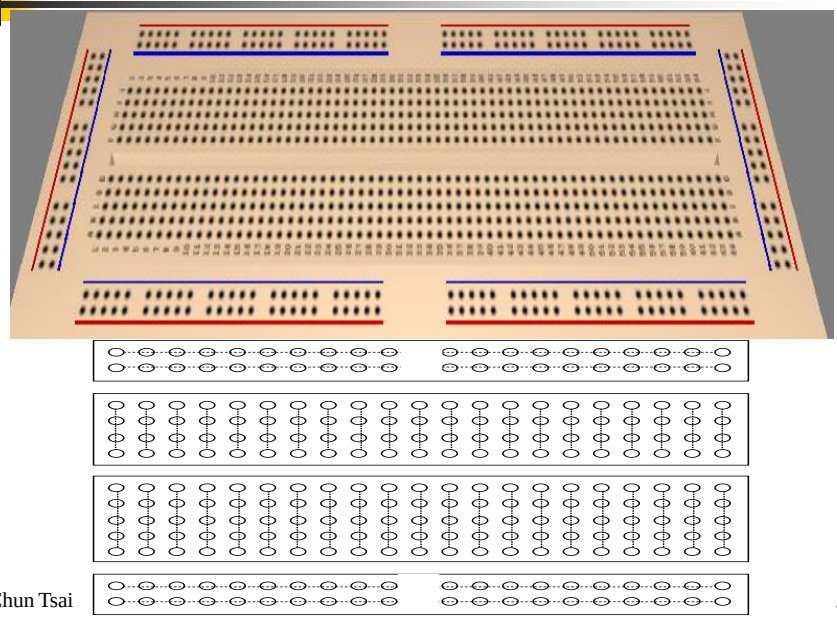
- Understand a module of digital system and all the components on the module
- Understand basic logic gates, NOT, AND, OR, NAND, NOR, XOR, and XNOR and their truth tables.
- Measure the voltage of logic "1" or "H" and the voltage of logic "0" or "L".
- Understand two major digital IC families, TTL and CMOS.

Module for Practice of Digital System

TTL/CMOS ICs, Resistors, Capacitors, LEDs, SW, 7-segment Display, Push-button, and IC slots.

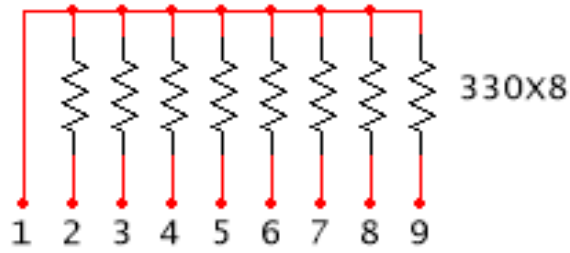


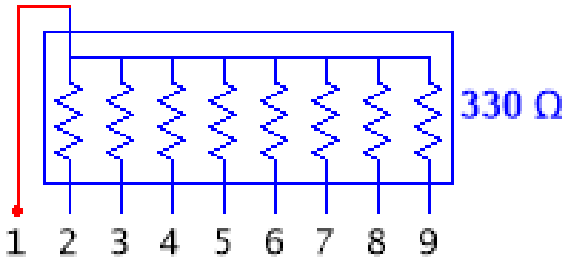
Breadboard



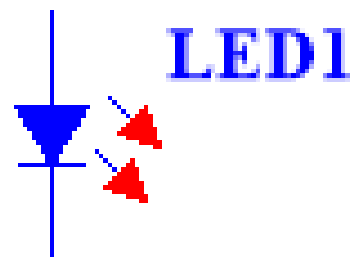
Resistor and Resistor Pack

Resistor2_4.7kOhm

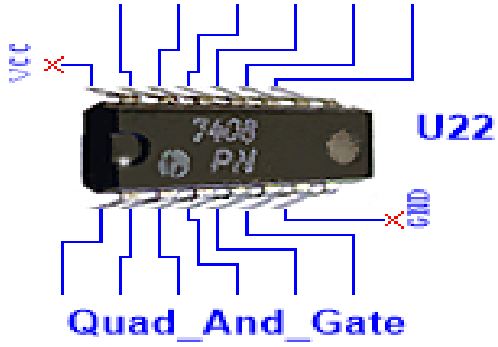


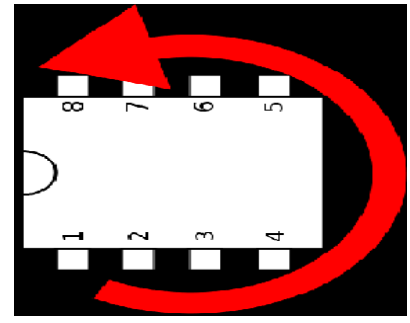


LED (Light Emitting Diode)



IC (Integrated Circuit)





Classification for Logic Gates

- **Basic Logic Gates have NOT, AND, OR, NAND, NOR, and XOR gates.**
- **Basic Logic Gates have two kinds of major circuits:**

TTL (Transistor-Transistor Logics)

74xx series: 7400, 7402, 7404, 7486, …

CMOS-FET (Compliment Metal-Oxide-Semiconductor Field-Effect-Transistor Logics)

40xx series: 4001, 4010, 4011, 4049, …

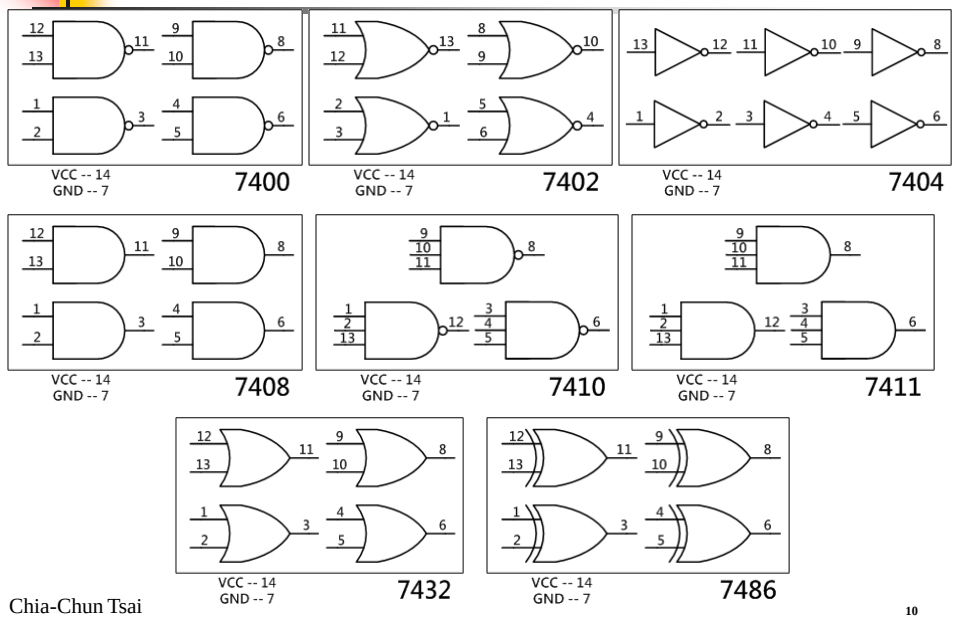
Integrated Circuits (ICs)

7400	7402	74147	7408	7474	4560		7476	7476
7411	7417	74165	74125	4518	7483			
7404	74151	7442	4011	7474	7490			
7410	7447	4049	2732	4561	74164	4070		
7432	74148	4010	4071	4001	7486	74155		
7409	74138	4013						
7490	4081	4027	7414	74121	4511		6116	

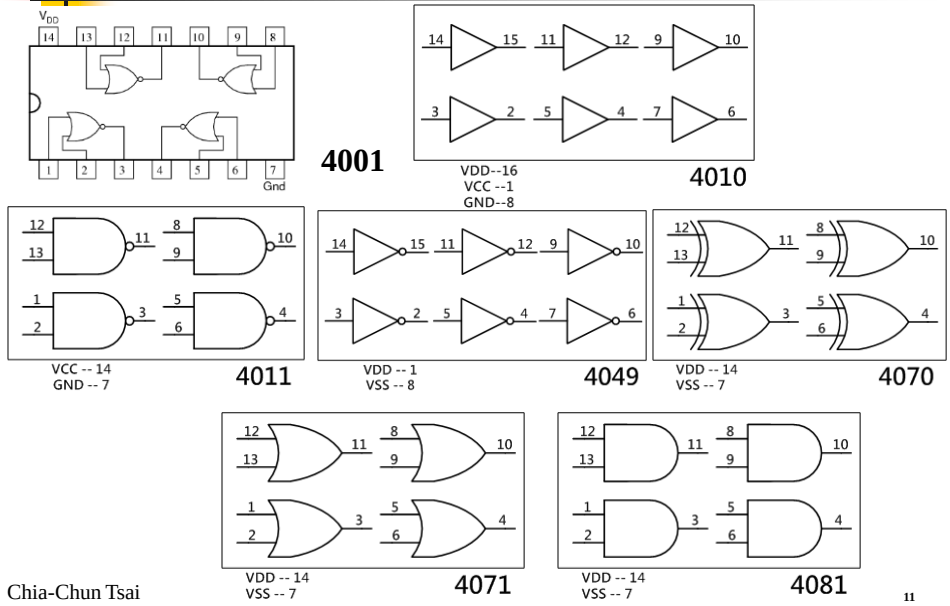
Open collector: 7409, 7417

Extra ICs: 555、7485、7493、74190、74198、4017

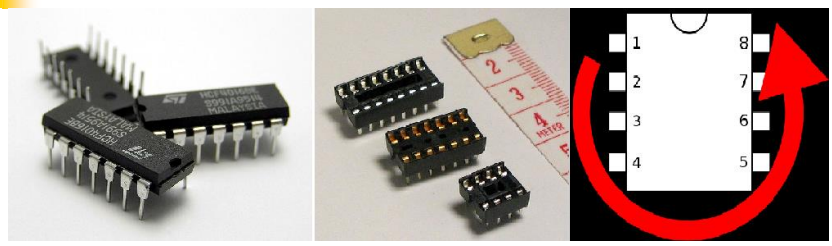
TTL ICs – Basic Gates

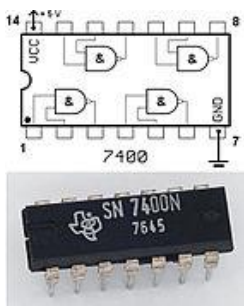


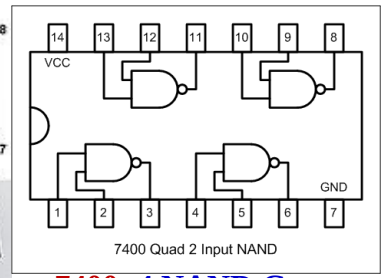
CMOS ICs – Basic Gates

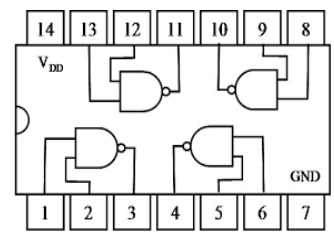


IC Types and Pins









7400: 4 NAND Gates

4011: 4 NAND Gates

TTL/CMOS Logics

- **Power supply**

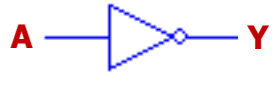
TTL ICs: VCC 5V GND 0V

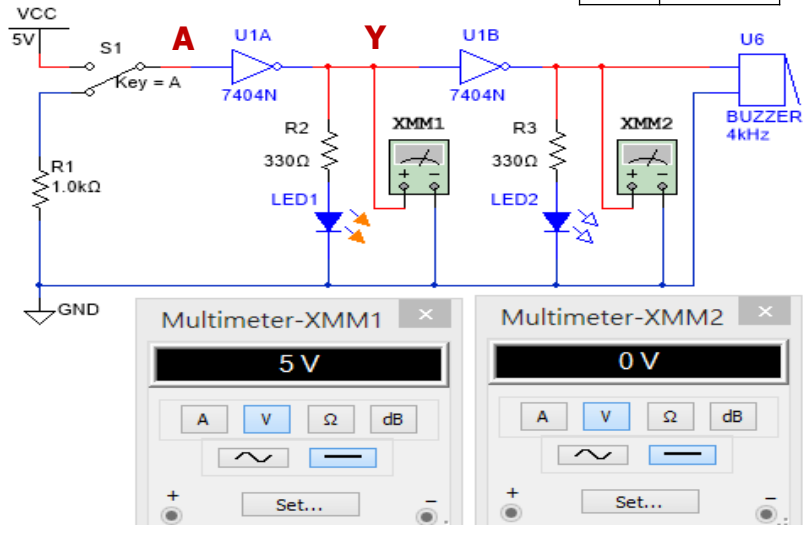
CMOS IC: VDD 3~18V VSS 0V

	TTL (VCC=5V)	CMOS (VDD=5V)	Logic
V_{IH}	≥2.0V	≥0.7 VDD ≥ 3.5V	1
V_{IL}	≤0.8V	≤0.3 VDD ≤ 1.5V	0
V_{oH}	≥2.4V	≈ VDD ≈ 5V	1
V_{oL}	≤0.4V	≈ VSS ≈ 0V	0

NOT Gate

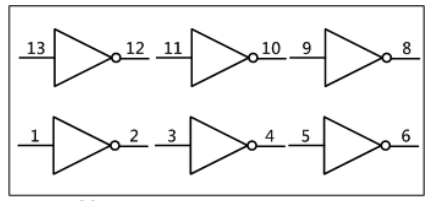
A	Y=/A
0	1
1	0





NOT Gate

A	Y=/A
0	1
1	0



A	Y=/A
0V	4.41V
5V	0.15V

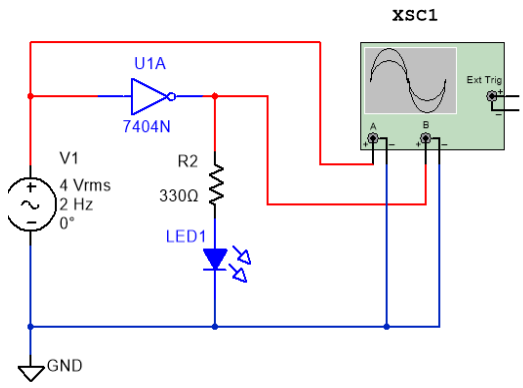
Every IC needs power supply

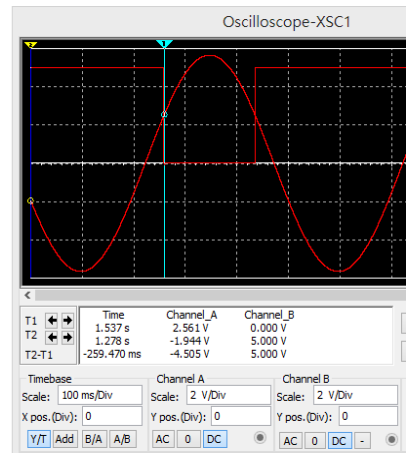
VCC pin-14 +5V

GND pin-7 0V

Transfer Voltage of NOT

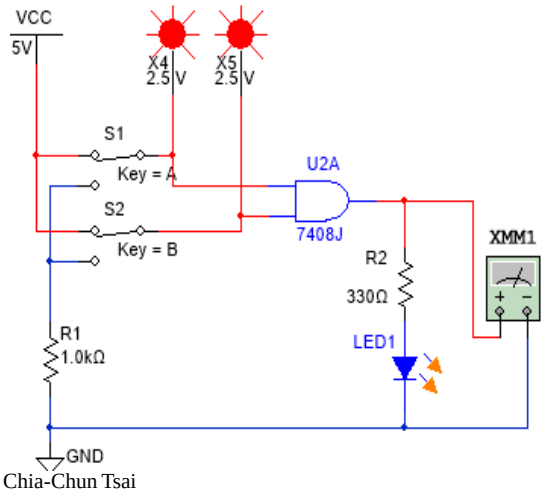
Transfer voltage Vtr = 2.561V

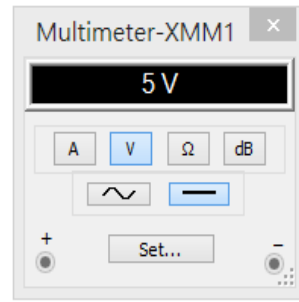




AND Gate

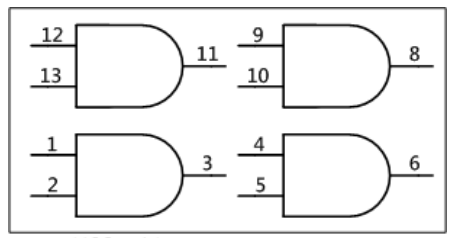
A	B	Y=AB
0	0	0
0	1	0
1	0	0
1	1	1





AND Gate

A	B	Y=AB
0	0	0
0	1	0
1	0	0
1	1	1



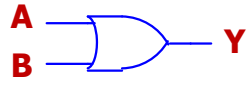
A	B	Y=AB
0V	0V	0.15V
0V	5V	0.15V
5V	0V	0.15V
5V	5V	4.41V

The IC needs power supply

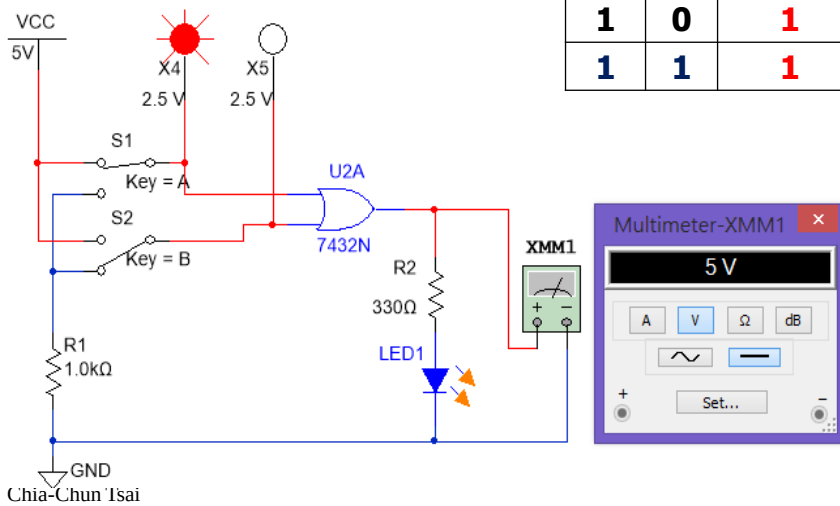
VCC pin-14 +5V

GND pin-7 0V

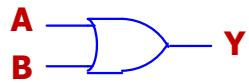
OR Gate



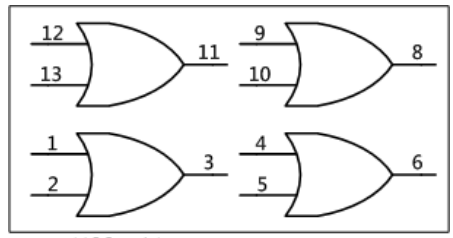
A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1



OR Gate



A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1



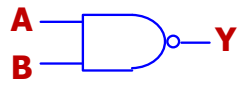
The IC needs power supply

VCC pin-14 +5V

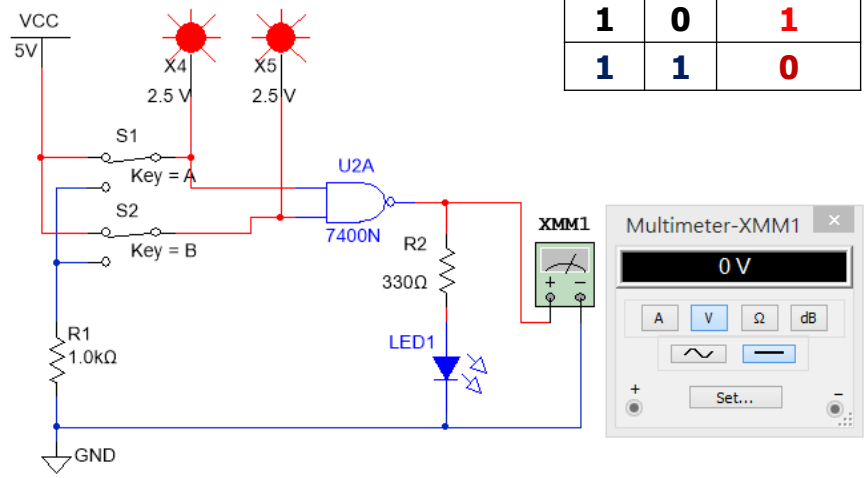
GND pin-7 0V

A	B	Y=A+B
0V	0V	0.15V
0V	5V	4.41V
5V	0V	4.41V
5V	5V	4.41V

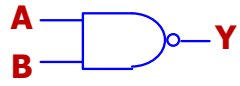
NAND Gate

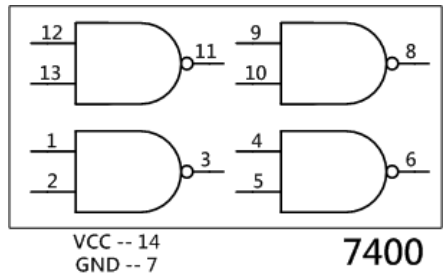


A	B	Y=/(AB)
0	0	1
0	1	1
1	0	1
1	1	0



NAND Gate





A	B	Y=/(AB)
0	0	1
0	1	1
1	0	1
1	1	0

A	B	Y=/(AB)
0V	0V	4.41V
0V	5V	4.41V
5V	0V	4.41V
5V	5V	0.15V

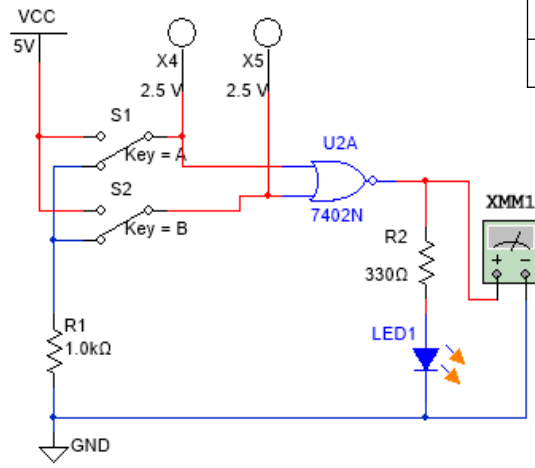
The IC needs power supply

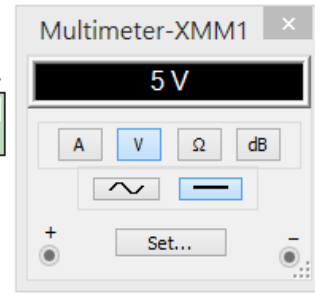
VCC pin-14 +5V

GND pin-7 0V

NOR Gate

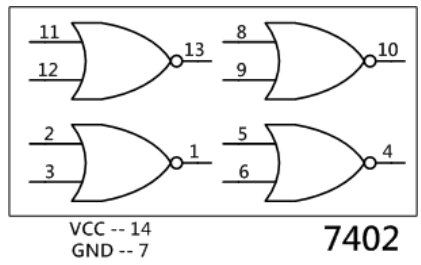
A	B	Y=/(A+B)
0	0	1
0	1	0
1	0	0
1	1	0





NOR Gate

A	B	Y=/(A+B)
0	0	1
0	1	0
1	0	0
1	1	0



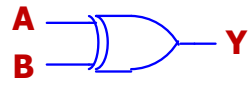
A	B	Y=/(A+B)
0V	0V	4.41V
0V	5V	0.15V
5V	0V	0.15V
5V	5V	0.15v

The IC needs power supply

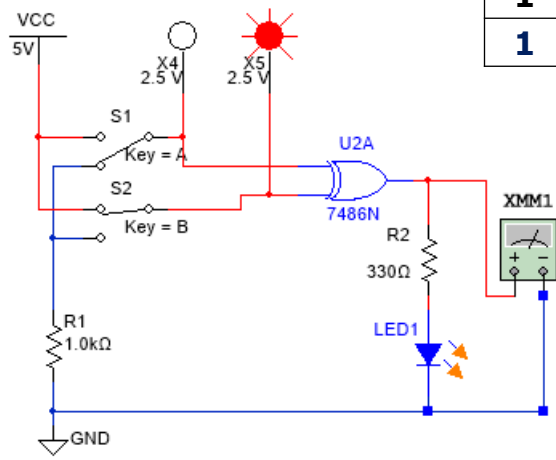
VCC pin-14 +5V

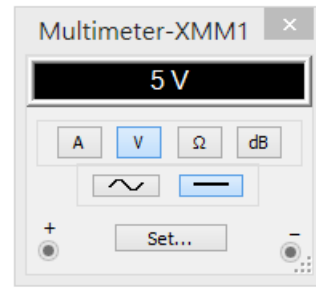
GND pin-7 0V

XOR Gate

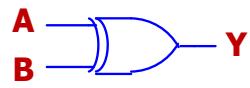


A	B	Y=A/B+B/A
0	0	0
0	1	1
1	0	1
1	1	0

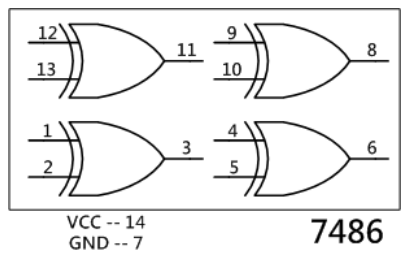




XOR Gate



A	B	Y=A/B+B/A
0	0	0
0	1	1
1	0	1
1	1	0



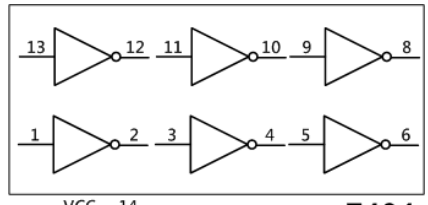
A	B	Y=A/B+B/A
0V	0V	0.15V
0V	5V	4.41V
5V	0V	4.41V
5V	5V	0.15V

The IC needs power supply

VCC pin-14 +5V

GND pin-7 0V

Experiment-1 NOT Gate



A	Y=/A
0	1
1	0

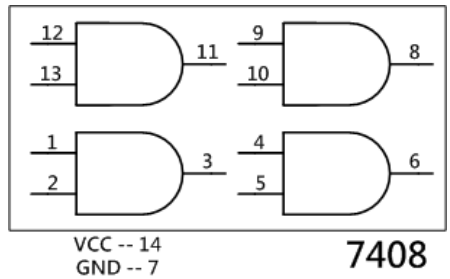
A	Y=/A
0V	_____V
5V	_____V

Every IC needs power supply

VCC pin-14 +5V

GND pin-7 0V

Experiment-2 AND Gate



A	B	Y=AB
0	0	0
0	1	0
1	0	0
1	1	1

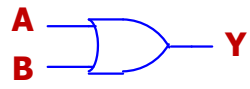
A	B	Y=AB
0V	0V	_____V
0V	5V	_____V
5V	0V	_____V
5V	5V	_____V

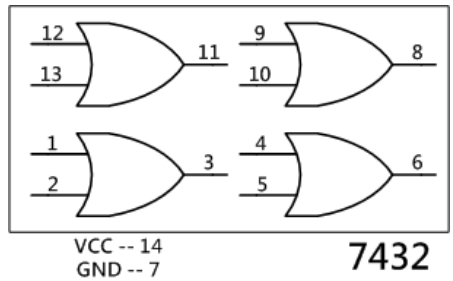
The IC needs power supply

VCC pin-14 +5V

GND pin-7 0V

Experiment-3 OR Gate





A	B	Y=A+B
0	0	0
0	1	1
1	0	1
1	1	1

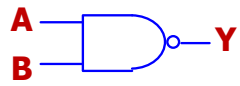
A	B	Y=A+B
0V	0V	_____V
0V	5V	_____V
5V	0V	_____V
5V	5V	_____V

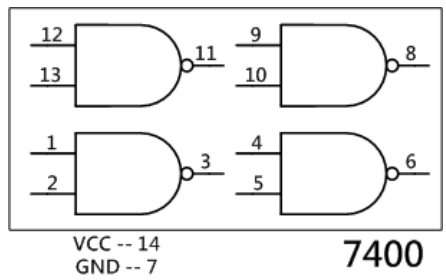
The IC needs power supply

VCC pin-14 +5V

GND pin-7 0V

Experiment-4 NAND Gate





A	B	Y=/(AB)
0	0	1
0	1	1
1	0	1
1	1	0

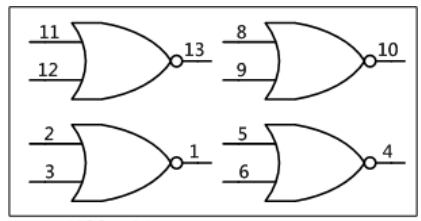
A	B	Y=/(AB)
0V	0V	_____V
0V	5V	_____V
5V	0V	_____V
5V	5V	_____V

The IC needs power supply

VCC pin-14 +5V

GND pin-7 0V

Experiment-5 NOR Gate



A	B	Y=/(A+B)
0	0	1
0	1	0
1	0	0
1	1	0

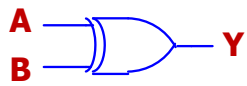
A	B	Y=/(A+B)
0V	0V	_____V
0V	5V	_____V
5V	0V	_____V
5V	5V	_____V

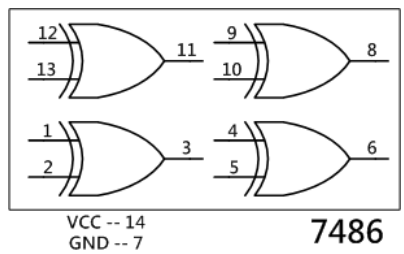
The IC needs power supply

VCC pin-14 +5V

GND pin-7 0V

Experiment-6 XOR Gate





A	B	Y=A/B+B/A
0	0	0
0	1	1
1	0	1
1	1	0

A	B	Y=A/B+B/A
0V	0V	_____V
0V	5V	_____V
5V	0V	_____V
5V	5V	_____V

The IC needs power supply

VCC pin-14 +5V

GND pin-7 0V