Logic Gate

College of
Engineering & Technology

Al-Mustaqbal
University

Level 1 , Semester 1
@ Department of prosthetic and orthotic Engineering

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Course Overview & Basic Concepts

The majority of this course material is based on text and presentations of :
Floyd, Digital Fundamentals, 10Th ed., © 2009 Pearson Education, Upper Saddle River, NJ 07458. All Rights Reserved

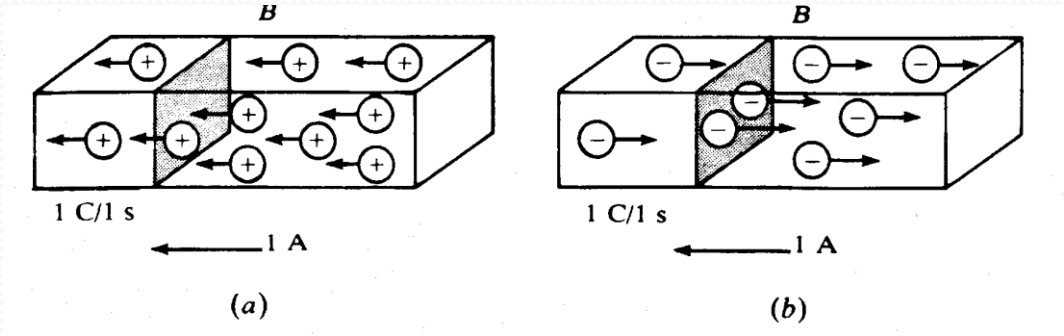
Outline

- **Climbs from Electronics History**
- **The notion of "*Digital* " in Electronics**
- **The notion of "*Logic*" in Electronics**
- **The notion of "Abstraction" in Electronics**
- **Pre-view at *Digital Logic* Gats in Electronics**

Electronics

Electronics is the branch of electrical science which deals with devices that control the flow of electrons.

Current (I) : flow of electrons, usually expressed in Amperes (A).



Charge is an electrical property of the atomic particles of which matter consists, measured in coulombs (C).

The charge (e)on one electron is negative and equal in magnitude to (1.602×10^{-19} C) which is called as electronic charge.

Voltage (V) is the potential difference always across the circuit element or between two points in a circuit.

Ohms Law

Ohm's law states that the voltage across a resistor is directly proportional to the current I flowing through the resistor.

Mathematical expression for Ohm's Law is as follows:

$$V = I R$$

Climbs from Electronics History

- **Electronics is the branch of Electrical Engineering.**
- **Historically:**

In 1904 :vacuum thermionic tube (*diode)*

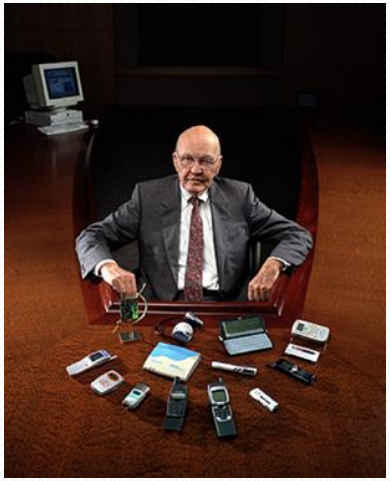
(1922 - 1937): > **100 million tubes** used in different industries (mainly, ***radio*** and ***Television***)

December 1947: 1st **Transistor** (***Solid State Semiconductor***) (*the beginning ear of* ***miniaturization*** *in electronics*)

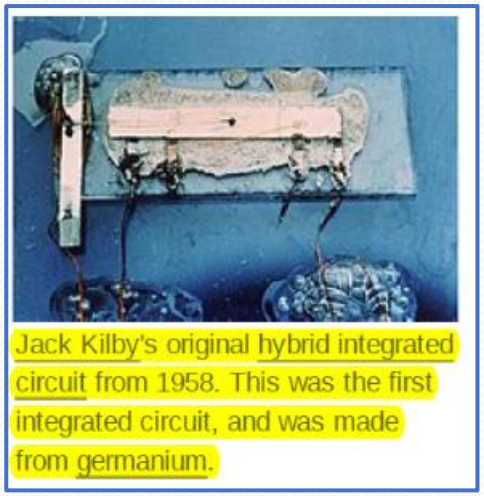
Climbs from Electronics History

December 23, 1947 : a completely new direction in electronics industries :
the first **transistor** (***Solid State semiconductor device***)
was demonstrated at the Bell Telephone Laboratories, USA.
(*the beginning ear of miniaturization in electronics*)

The next major development in electronics came up with the introduction of ***Integrated Circuits (IC)***.



On Sep. 12, 1958, **Jack Kilby**,
a Texas Instruments engineer, invented the first integrated circuit, measuring (***11.1 by 1.6 mm***).



Jack Kilby's original hybrid integrated circuit from 1958. This was the first integrated circuit, and was made from germanium.

Now . . .

Today, the Integrate Circuit of Intel ® Core TM i7 Extreme Edition Processor of has **731 million transistors** in a package that is only slightly larger than a ***1.67 sq. inches***.

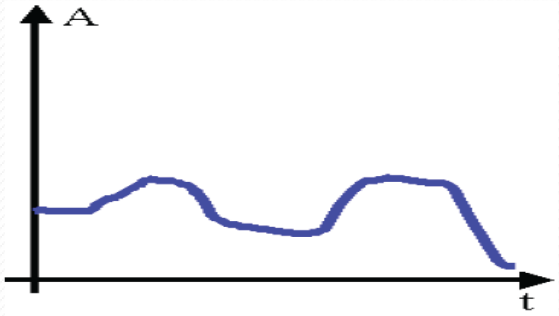
In all cases, the *information* within all *electronic* devices, is in the form of **voltage signals** or **current signals**.

Now, only two things which can be done to information (voltage or current) : it can be switched or varied.

- ***Switching****: on / off*
- ***Varying*** *: altering the attributes (amplify, change frequency of occurrence)*

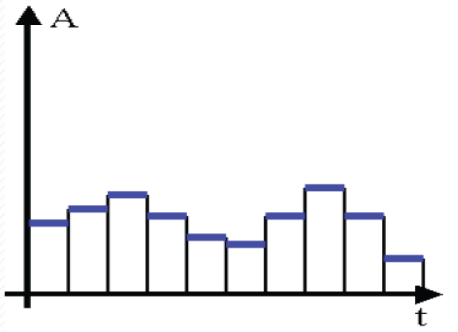
Accordingly, there are two main types of signals used in electronics: ***Analog signals*** and ***Digital signals***

Analog signal is ***time-varying*** and generally bound to a range (e.g. +12V to -12V, if we are talking about **voltage signal**), but there is an infinite number of values within that continuous range.



Analog signal – continuously varying

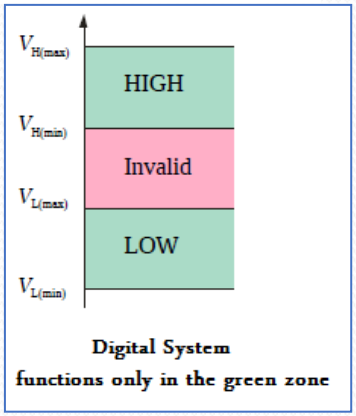
A digital signal is a signal that represents data as a sequence of ***discrete values***.
A **digital signal** can only take on one value from a finite set of possible values at a given time.



Digital signal – large time divisions

In *Digital Electronic Devices*, signals which can have just **two voltage values** (**two states**):
HIGH Voltage or LOW Voltage …
(true or false … 0 or 1).

This is why we say "Logic" ..

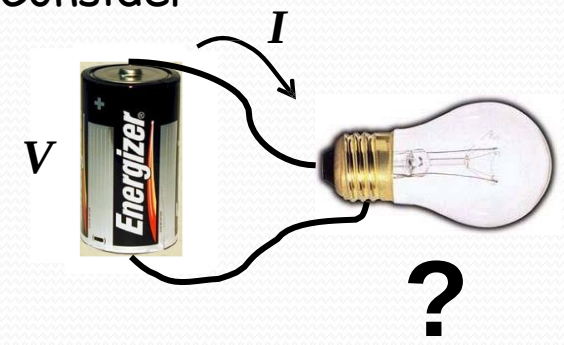


Digital System functions only in the green zone

Abstraction in Electronics

We could do it the Hard Way…

Consider



What is the current through the bulb?

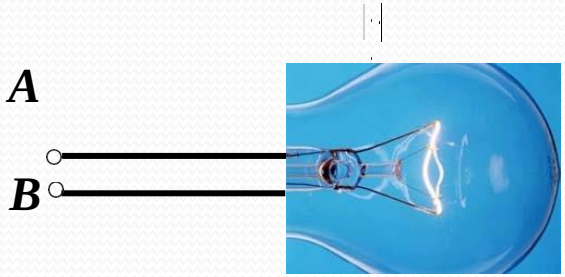
Apply Maxwell's

	Differential form	Integral form
Faraday's	$\nabla \times E = -\frac{\partial B}{\partial t}$	$\oint E \cdot dl = -\frac{\partial \phi_B}{\partial t}$
Continuity	$\nabla \cdot J = -\frac{\partial \rho}{\partial t}$	$\oint J \cdot dS = -\frac{\partial q}{\partial t}$
Others	$\nabla \cdot E = \frac{\rho}{\varepsilon_0}$	$\oint E \cdot dS = \frac{q}{\varepsilon_0}$
	⋮	⋮

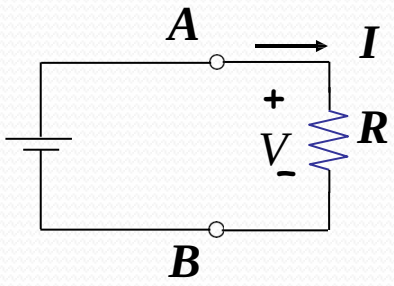
عرف عن (جيمس كليرك ماكسويل) المولود في عام 1831م ، بكونه عبقري يُضاهي بعبقريته كل من العالم آينشتاين ونيوتن، حيث أفنى ماكسويل نفسه لفهم الفيزياء، وأخذ مجموعة من القوانين التجريبية المعروفة، مثل: قانونيّ فاراداي وأمبير، ووحدّها في مجموعة متناسقة ومتماسكة من المعادلات عُرفت باسمه، وكان من أوائل من حددوا أنّ سرعة انتشار الموجات الكهرومغناطيسية هي نفسها سرعة الضوء، واستنتج أنّ الموجات الكهرومغناطيسية والضوء المرئي هما الشي ذاته، وتُوفي ماكسويل عام 1879م.

Abstraction in Electronics

The Easy Way…



Replace the bulb with a *discrete resistor* to calculating the current.



and $I = \frac{V}{R}$

R represents the only property of interest

في علم الإلكترونيك، التجريد (**Abstraction**) هي عملية تجريد التفاصيل غير الضرورية للتركيز على المعلومات الأساسية التي تساعد على فهم وتطوير النظام. حيث يستخدم هذا المفهوم لتحويل النظريات العلمية والقوانين الطبيعية (مثل معادلات ماكسويل) إلى تصميمات عملية للأجهزة والمنظومات.

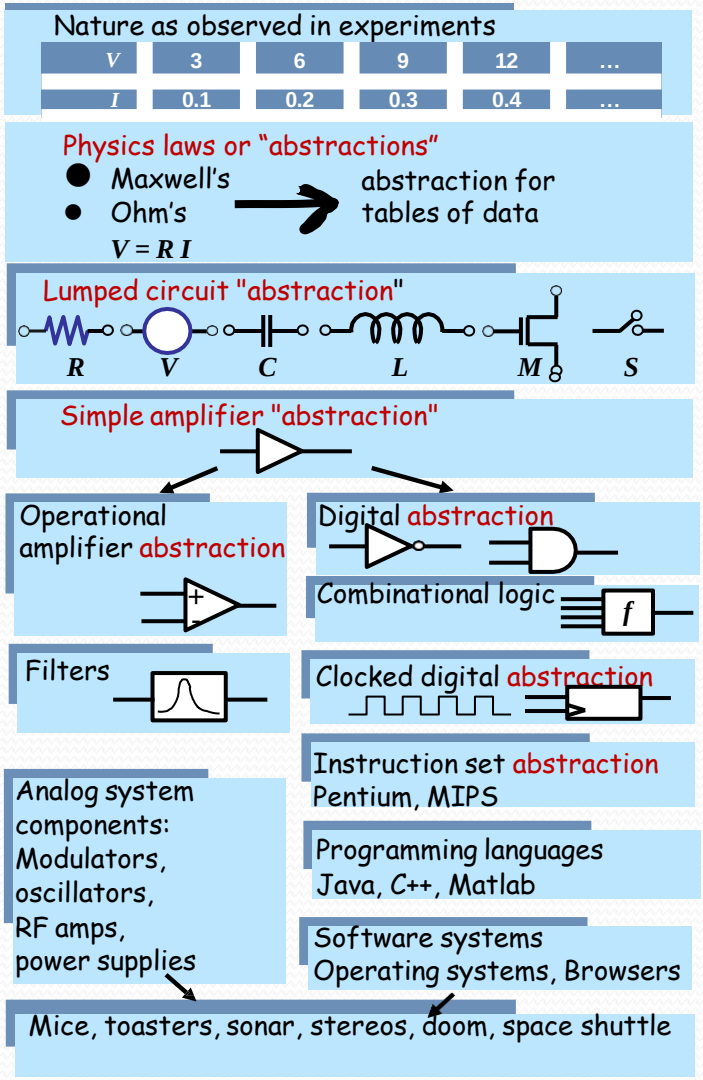
على سبيل المثال، يتم تحويل معادلات ماكسويل العلمية إلى مفاهيم أكثر تجريدًا مثل مفهوم الكهرباء والمغناطيسية وموجات الراديو. ثم يتم تحويل هذه المفاهيم إلى مخططات تصميم الدوائر الإلكترونية والمكونات المستخدمة فيها.

ويستخدم الـ **Abstraction** في تصميم الأجهزة والمنظومات الكبيرة مثل المركبات الفضائية وأجهزة الرنين المغناطيسي في المستشفيات.

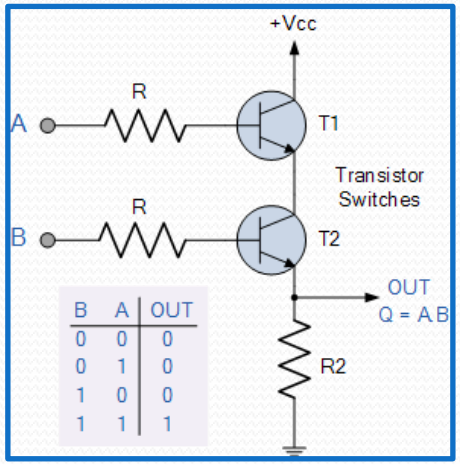
Abstraction in Electronics

Engineering is a purposeful use of Science

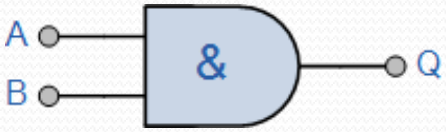
الهندسة
هي
الأستخدام الهادف
للعلوم



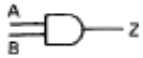
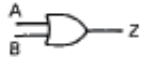
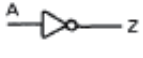
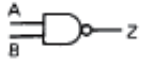
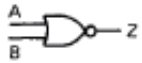
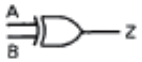
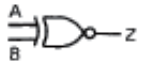
Abstraction in Electronics



AND circuit Abstraction



AND Logic Abstraction

Name	Symbol	Equation	Truth table A	B	Z
AND		Z = A.B.	0	0	0
			0	1	0
			1	0	0
			1	1	1
OR		Z = A + B	0	0	0
			0	1	1
			1	0	1
			1	1	1
NOT		$Z = \overline{A}$	0		1
			1		0
NAND		$Z = \overline{A.B}$	0	0	1
			0	1	1
			1	0	1
			1	1	0
NOR		$Z = \overline{A + B}$	0	0	1
			0	1	0
			1	0	0
			1	1	0
EXCLUSIVE OR		$Z = A \oplus B$	0	0	0
			0	1	1
			1	0	1
			1	1	0
EQUIVALENCE (EXCLUSIVE NOR)		$Z = \overline{A \oplus B}$	0	0	1
			0	1	0
			1	0	0
			1	1	1

AND Logics examples

VHDL (programming Language)

```
entity AND_Gate1 is
    port(A,B:in
    bit:Q:out bit);
end entity AND_Gate1
```

Programming Language Abstraction

For the rest of semester, we will work only in the

Digital (Logic) Level