Electronics Fundamentals

CTE 204

Lecture 1

- Introduction -

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Charge and Current

The current is flow of electrons. Thus current can be measured by measuring how many electrons are passing through material per second. This can be expressed in terms of the charge carried by those electrons in the material per second.

Key Point: ***Electric current is the time rate of change of charge, measured in amperes (A).***

Mathematically we can write the relation between the charge (Q) and the electric current (I) as,

$$i = \frac{dq}{dt}$$

Where current is measured in amperes (A), and

$$1 \text{ ampere} = 1 \text{ coulomb/second}$$

$$q = \int_{t_0}^{t} i\,dt$$

$$I = \frac{Q}{t} \quad \text{Ampere}$$

Where I: is the average current flowing;
Q: is the required for transfer of charge.

Concept of Electric Potential and Potential Difference

The electric potential at point due to a charge is one volt if one joule of work is done in moving a unit positive charge.

Key Point: ***potential is the energy required to move a unit charge through an element, measured in volts (V).***

Key Point: ***the difference between the electric potential at any two given points in a circuit is known as potential difference (p.d.) and measured in volts (V).***

Resistance

Key Point: ***This property of an electric current circuit tending to prevent the flow of current and at the same time causes electrical energy to be converted to heat is called resistance.***

The resistance is denoted by the symbol 'R' and is measured in ohm symbolically represented as **Ω**. We can define unit ohm as below.

Key Point: ***1 Ohm: Is the resistance of a circuit, when a current of 1 Ampere generates the heat at the rate of one joules per second.***

Factors Affecting the Resistance (R)

1. Length of the material: It varies directly as its length, l.

2. Cross-section area: It varies inversely as the cross-section area of the conductor, A.

3. The type and nature of the material.

4. Temperature: The temperature of the material affects the value of the resistance.

So for a certain material at a certain temperature we can write a mathematical expression as,

Factors Affecting the Resistance (R)

$$R = \frac{\rho l}{A}$$

Where

l: is the length in meters;

A: is the cross-sectional area in square meters;

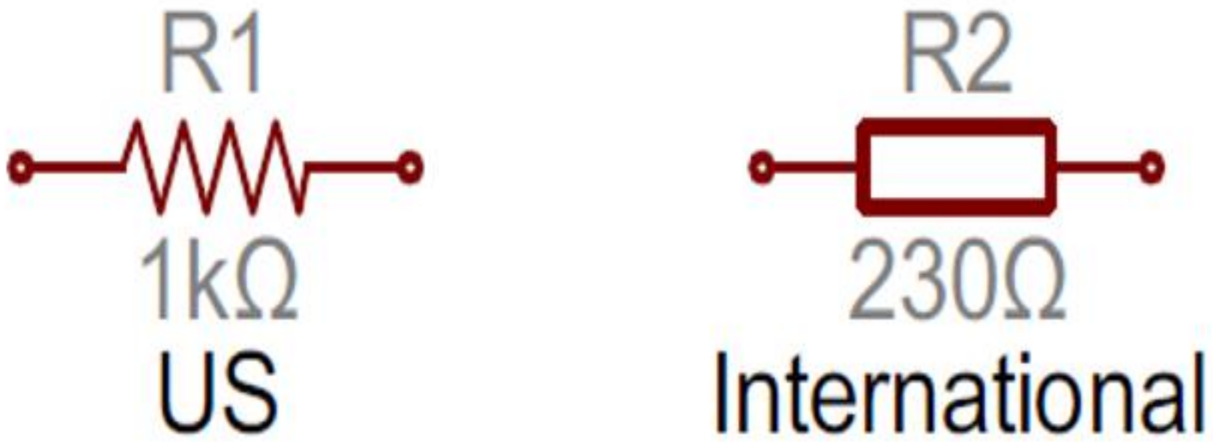
ρ: is the resistivity in Ω·m;

and R: is the resistance in ohms.

Resistors

- Resistors on a schematic are usually represented by a few zig-zag lines, with two terminals extending outward.

- Schematics using international symbols may instead use a featureless rectangle, instead of the squiggles.



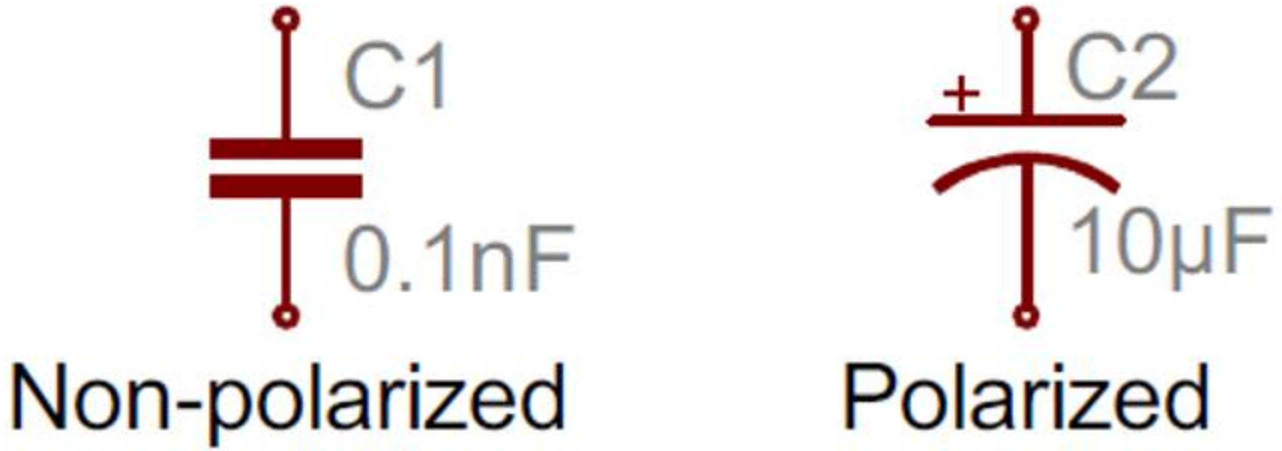
Capacitors

There are two commonly used capacitor symbols.

- One symbol represents a polarized (usually electrolytic or tantalum) capacitor. A plus sign should also be added to the positive pin of the polarized capacitor symbol.

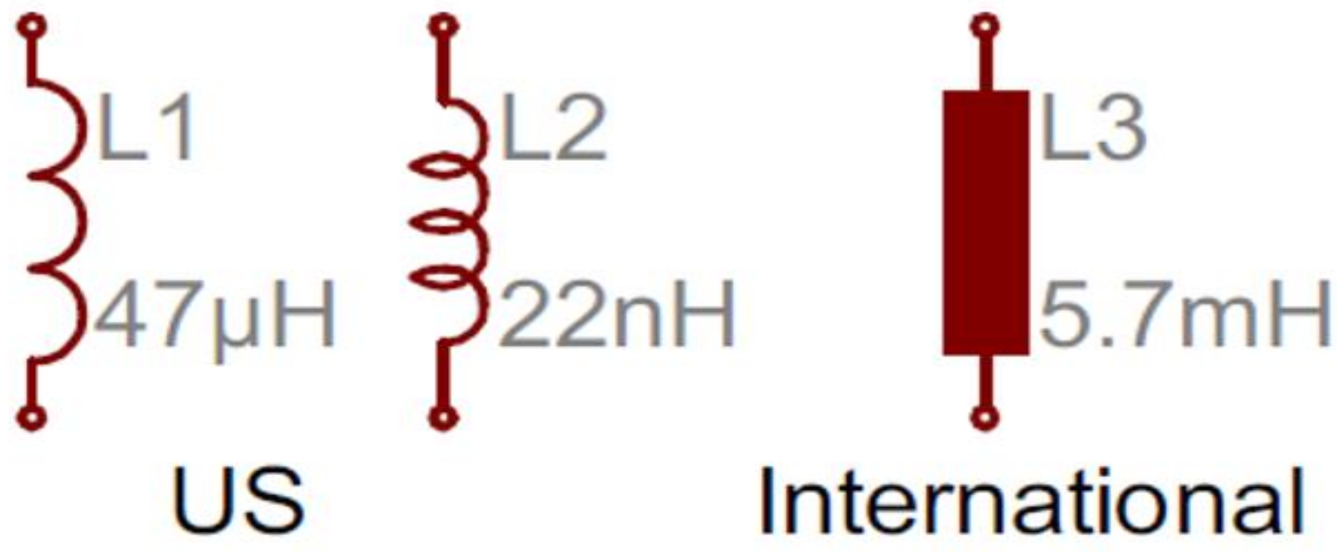
- The other one is for non-polarized caps.

In each case there are two terminals, running perpendicularly into plates.



Inductors

- Inductors are usually represented by either a series of curved bumps, or loopy coils.
- International symbols may just define an inductor as a filled-in rectangle.



Things have to know them

1. Block Diagrams.

2. Schematic Diagrams.

3. Circuit Diagrams.

Fundamental Quantities and Units

The common system of units are called 'SI' system i.e. International System of Units. The SI system is divided into six base units. The five fundamental or base units are length, mass, time, electric current, temperature, as Table below.
All other units are derived which are obtained from the above classes of units. The derived units are classified into three main groups.

1. Mechanical units,
2. Electrical units,
3. Heat units.

Quantity	unit	Symbol
Length	meter	m
Mass	kilogram	kg
Time	second	s
Electric current	ampere	A
Thermodynamic temperature	kelvin	K

Multiples and sub-multiples (Prefixes)

One great advantage of the SI unit is that it uses prefixes based on the power of 10 to relate larger and smaller units to the basic unit. Table below shows the SI prefixes and their symbols. For example, the following are expressions of the same distance in meters (m):
600,000,000 mm = 600,000 m = 600 km.

Multiplier	Prefix	Symbol
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deka	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

EXAMPLE

a. 1,000,000 ohms = $1 \text{ X } 10^{6}$ ohms
= 1 megaohm (M)

b. 100,000 meters = $100 \text{ X } 10^{3}$ meters
= 100 kilometers (km)

c. 0.0001 second = $0.1 \text{ X } 10^{-3}$ second
= 0.1 millisecond (ms)

d. 0.000001 farad = $1 \text{ X } 10^{-6}$ farad
= 1 microfarad (uF)