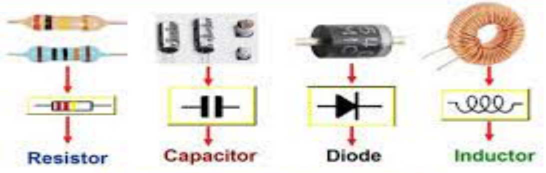
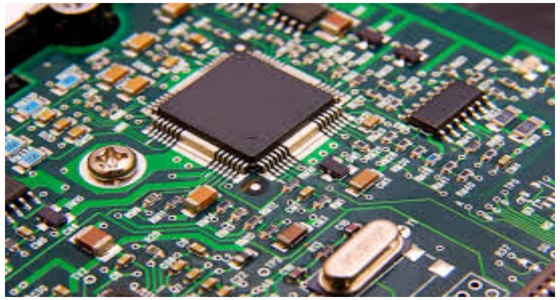
Electronics 1

BSC 113

Fall 2022-2023

Lecture 2&3





Circuit Variables and Elements

INSTRUCTOR

DR / AYMAN SOLIMAN

➢ Contents

1) Basic concepts
   - ➢ The international system of units
   - ➢ The international system of prefixes
2) Electrical charge
3) Electrical current
4) Voltage
5) Power
6) Energy
7) Circuit elements
   - ➢ Passive elements
   - ➢ Active elements
8) Ohm's law and conductance
9) Node, loop, and branch

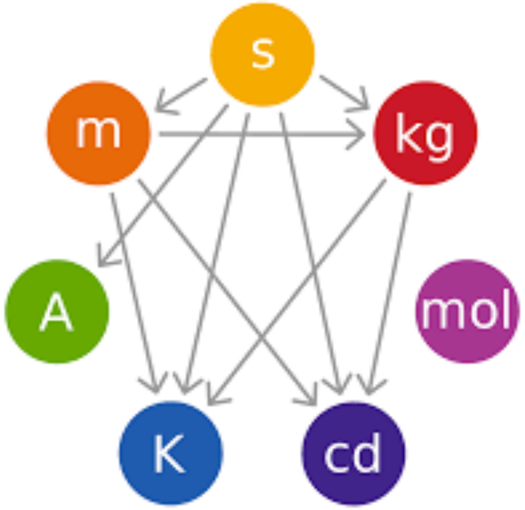
❑ 1. Basic concepts

- The electrical engineering is one of the most important field. First, we need to understand the basic concepts for electrical circuits.

❑ 1.1 The international system of units

- Here in this subsection, we will state the standard international (SI) units in electrical part in this course as shown in table.

Quantity	Basic Unit	Basic Unit Symbol
LENGTH	metre	m
MASS	kilogram	kg
TIME	second	s
TEMPERATURE	kelvin	K
QUANTITY OF MATTER	mole	mol
ELECTRIC CURRENT	ampere	A
LUMINOUS INTENSITY	candela	cd



1.2 The international system of prefixes

- As shown in the following table, the international system of prefixes will be illustrated.

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^{1}	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

❑ 1.2 The international system of prefixes

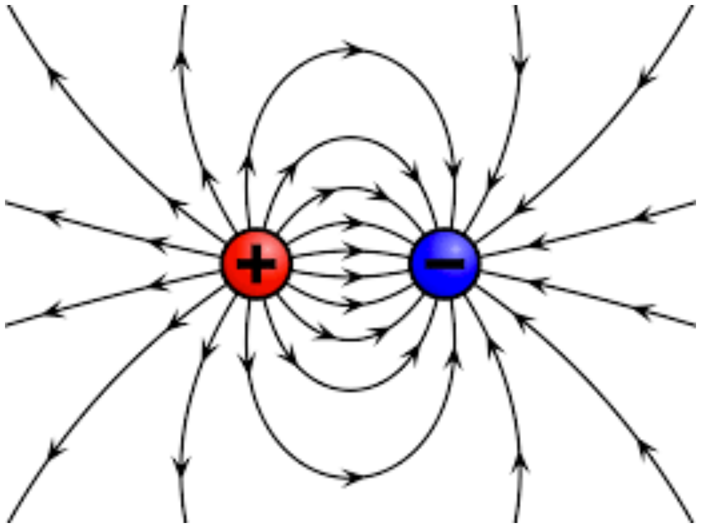
SI PREFIX	SI SYMBOL	SI UNIT CONVERSION FACTOR (STANDARD FORM)	FACTOR (POWER)	FACTOR LANGUAGE
yotta	Y	1 yottametre = 1 000 000 000 000 000 000 000 000 metres	10^{24}	septillion
zetta	Z	1 zettametre = 1 000 000 000 000 000 000 000 metres	10^{21}	sextillion
exa	E	1 exametre = 1 000 000 000 000 000 000 metres	10^{18}	quintillion
peta	P	1 petametre = 1 000 000 000 000 000 metres	10^{15}	quadrillion
tera	T	1 terametre = 1 000 000 000 000 metres	10^{12}	trillion
giga	G	1 gigametre = 1 000 000 000 metres	10^{9}	billion
mega	M	1 megametre = 1 000 000 metres	10^{6}	million
kilo	k	1 kilometre = 1 000 metres	10^{3}	thousand
hecto	h	1 hectometre = 100 metres	10^{2}	hundred
deca	da	1 decametre = 10 metres	10^{1}	ten
		1 metre = 1 metre	$\mathbf{10^{0}}$	**one**
deci	d	1 decimetre = 0.1 metres	10^{-1}	tenth
centi	c	1 centimetre = 0.01 metres	10^{-2}	hundredth
milli	m	1 millimetre = 0.001 metres	10^{-3}	thousandth
micro	µ	1 micrometre = 0.000 001 metres	10^{-6}	millionth
nano	n	1 nanometre = 0.000 000 001 metres	10^{-9}	billionth
pico	p	1 picometre = 0.000 000 000 001 metres	10^{-12}	trillionth
femto	f	1 femtometre = 0.000 000 000 000 001 metres	10^{-15}	quadrillionth
atto	a	1 attometre = 0.000 000 000 000 000 001 metres	10^{-18}	quintillionth
zepto	z	1 zeptometre = 0.000 000 000 000 000 000 001 metres	10^{-21}	sextillionth
yocto	y	1 yoctometre = 0.000 000 000 000 000 000 000 001 metres	10^{-24}	septillionth

❑ 2. Circuit variables

2.1 Electrical charge

- The definition of the electrical charge, is an electrical property of the atomic particles of which matter consists, measured in coulombs (C).

- Its symbols are Q or q(t).



❑ 2.2 Electrical current

- The definition of the electrical current, is the time rate of change of charge, measured in amperes (A).

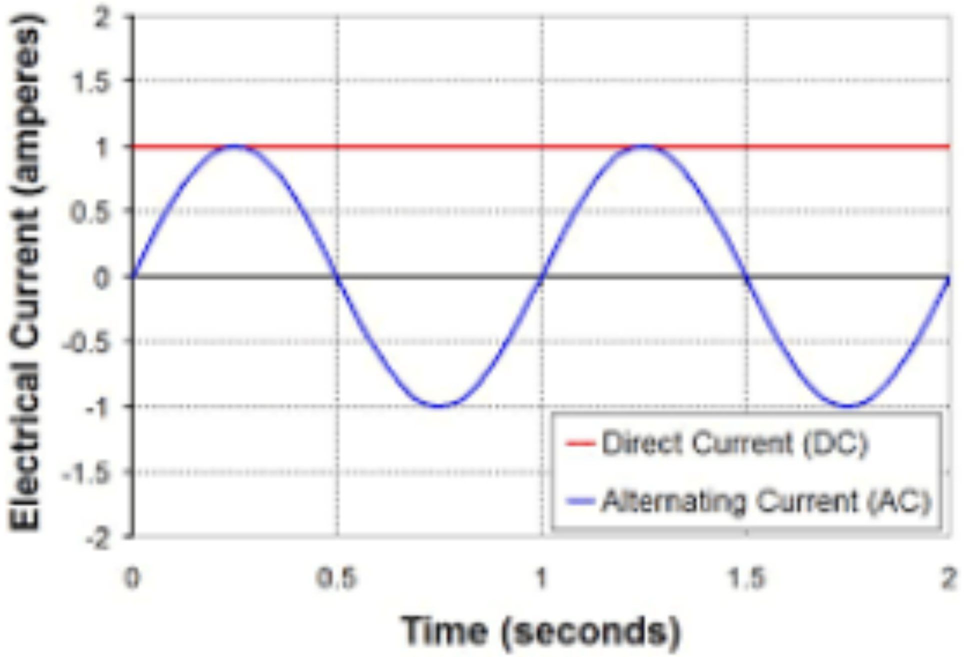
- Its symbols are I or i(t).

- In addition to the relation between electric current and charge is illustrated as the following:

$$i = \frac{dq}{dt} \text{ and } q = \int_{t_0}^{t} i\, dt \text{ where } 1\ \text{A} = 1\ \text{C/s}$$

❑ 2.2 Electrical current (cont.)

- we found two types in electric current. The first one is DC current which is a current that remains constant with time. The second one is AC current which is a current that varies sinusoidal with time.



❑ 2.3 Voltage

- The definition of the electrical voltage difference between two points is the energy or work needed to move unit charge from first point to second point, measured in volts (V).

- Its symbols are V or v(t).

- In addition to the relation between electric voltage and charge is illustrated as the following:

$$V = \frac{dw}{dq} \quad where\ 1\ V = 1\ J/C$$

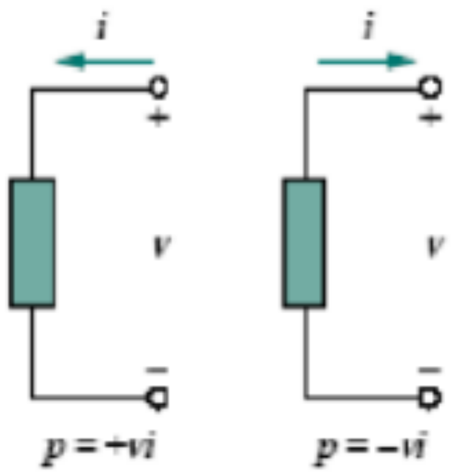
2.4 Power

- The definition of the power, is the time rate of expending and absorbing energy, measured in watts (W).
- Its symbols are P or p(t).
- In addition to the relation between power and energy is illustrated as the following:

$$P = \frac{dw}{dt} = \frac{dw}{dq} * \frac{dq}{dt} = V * i \quad where\ 1\ W = 1\ J/S$$

❑ 2.4 Power (cont.)

- When the current enters through the positive terminal of an element the relation is $p = +vi$ but if enters through the negative terminal of an element the relation is $p = -vi$ (power absorbed = - power supplied) as shown in figure



The difference between power absorbed and power supplied

❑ 2.5 Energy

- The definition of the energy, is the capacity to do work, measured in joules (J).
- Its symbols are W or w(t).
- In addition to the relation between power and energy is illustrated as the following:

$$W = \int_{t_0}^{t} p\,dt = \int_{t_0}^{t} v * i\,dt$$

❑ 2.5 Energy (cont.)

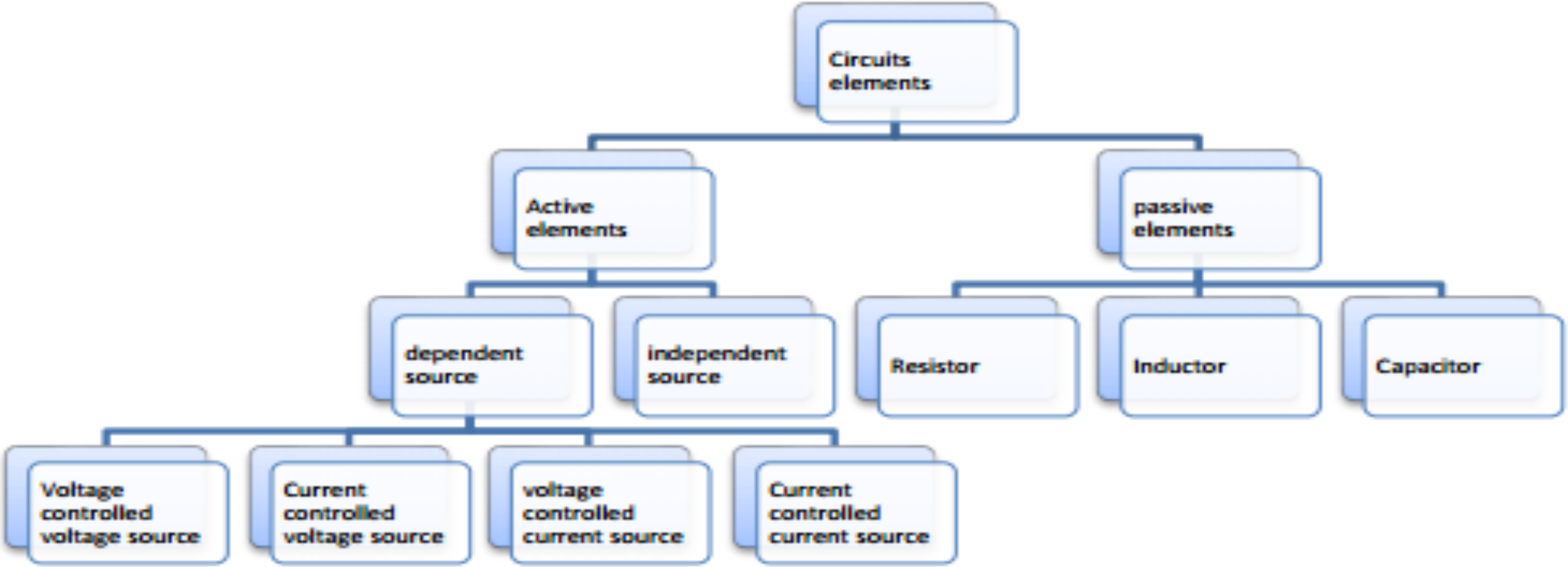
- Example : Calculate the energy were consumed in Two hours when 200 W electric bulb

$$w = p*t = 200 * 2 * 3600 = 1440 \text{ kJ is the same}$$

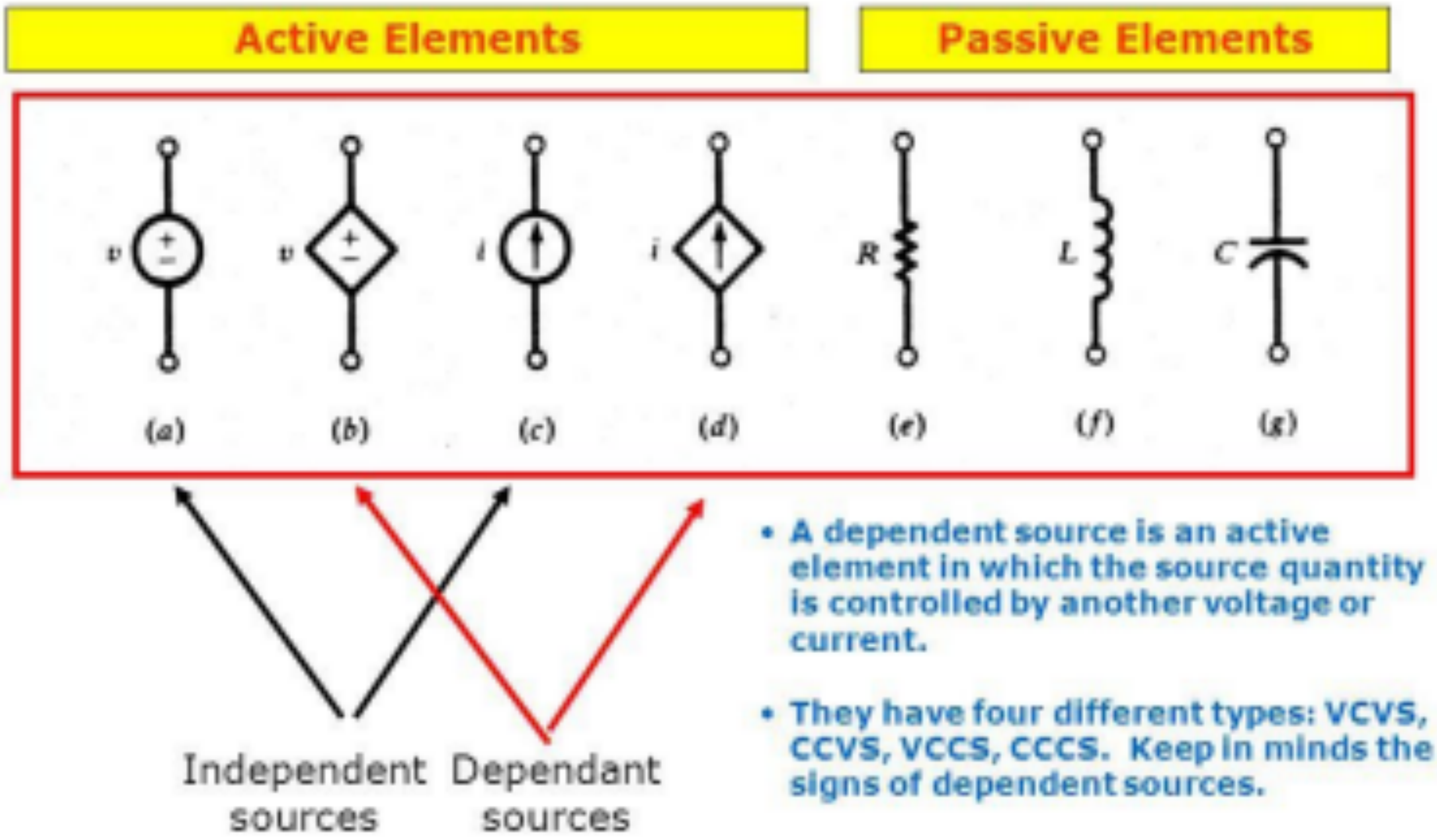
$$w = p * t = 200*2 = 400 \text{ Wh.}$$

❑ 3. Circuit elements

- Circuit elements are the main parts in any electrical circuits and are classified into two types as the following subsections



❑ 3. Circuit elements (cont.)



- A dependent source is an active element in which the source quantity is controlled by another voltage or current.
- They have four different types: VCVS, CCVS, VCCS, CCCS. Keep in minds the signs of dependent sources.

❑ 3.1 Passive elements

- Many components are considered as passive element such as
  - ❑ Resistor
  - ❑ Capacitors
  - ❑ Inductors etc...

❑ 3.2 Active elements

- Many components are considered as active element such as voltage and current source.

- We can state the four important dependent type:
  - ✓ voltage controlled voltage source
  - ✓ current controlled voltage source
  - ✓ current controlled current source
  - ✓ voltage controlled current source

❑ 4. Basic laws and definitions

4.1 Ohm's law and conductance

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

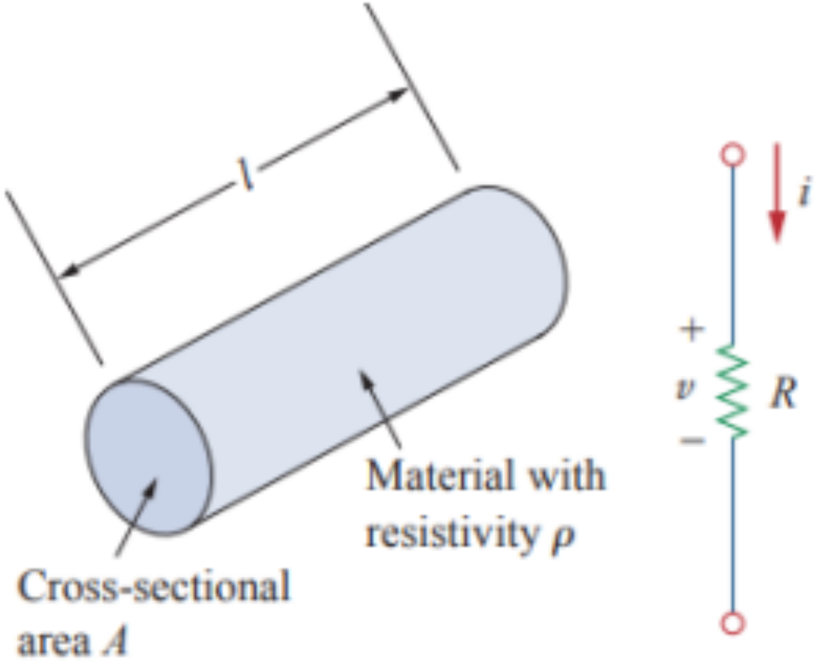
- That is mean v α i where $v = i * R$.

- Where the resistance of an element denotes its ability to resist the flow of electrical current, it is measured on ohms (Ω).

❑ 4.1 Ohm's law and conductance

- Where the resistance of any material with a uniform cross-sectional area A depends on A and its length L, as shown in figure.
- We can represent resistance as measured in the laboratory, in mathematical form

$R = \rho L / A$



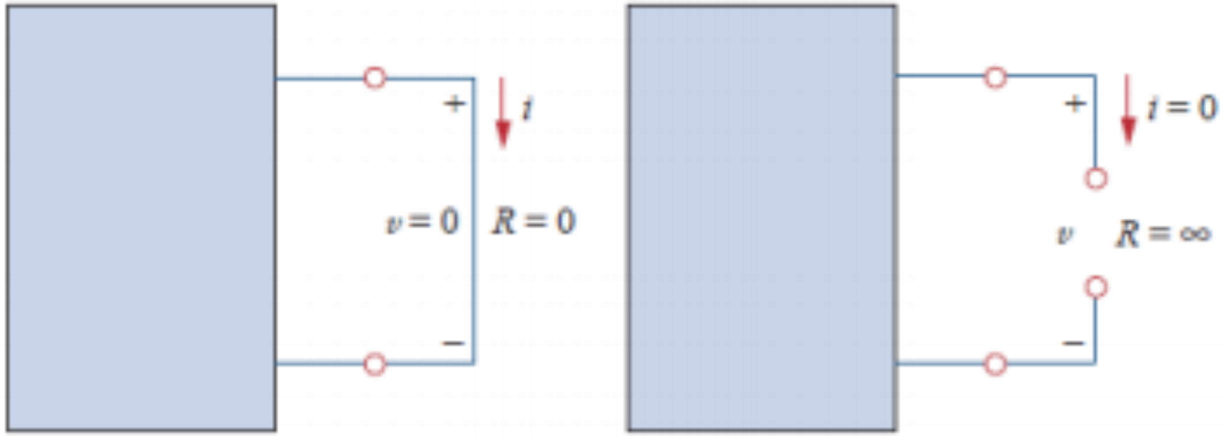
❑ 4.1 Ohm's law and conductance (cont.)

- where ρ is known as the resistivity of the material in ohmmeters.
- Good conductors, such as copper and aluminum, have low resistivity, while insulators, such as mica and paper, have high resistivity.
- Next table presents the values of for some common materials and shows which materials are used for conductors, insulators, and semiconductors.

Materials	Resistivity	Usage
Copper	$1.72*10^{-8}$	**Conductor**
Teflon	$3*10^{12}$	**Insulators**
Silicon	$6.4*10^{2}$	**Semiconductor**
Germanium	$47*10^{-2}$	**Semiconductor**

❑ 4.1 Ohm's law and conductance (cont.)

- We have special cases as shown in figure, when an open circuit is found that is mean $R = \infty$ and when a short circuit is found that is mean $R = 0$.
- On the other hand, conductance is the ability of an element to conduct electrical current, it is measured by moh (℧) or Siemens (S) and G = i * v. Now we can say $p = vi = i^2R = v^2/R = v^2G = i^2/G$.



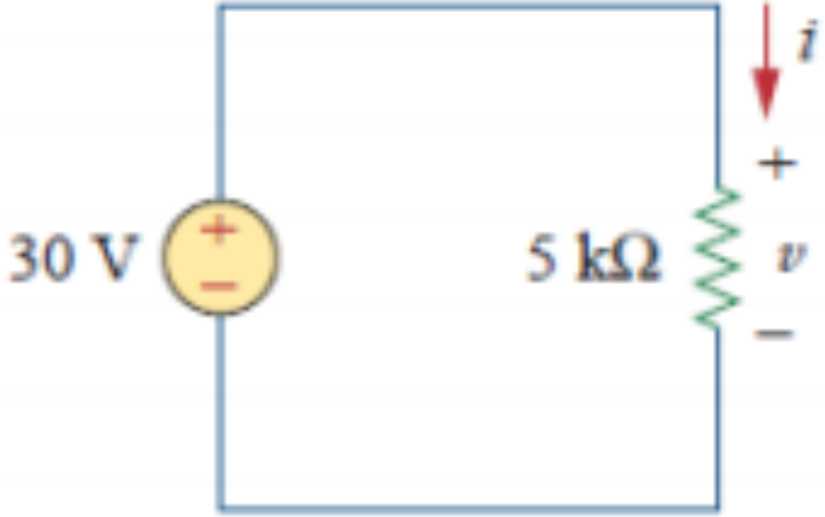
4.1 Ohm's law and conductance (cont.)

- Example : The essential component of a toaster is an electrical element (a resistor) that converts electrical energy to heat energy. How much current is drawn by a toaster with resistance 10 Ω at 110 V?

- Answer: 11 A.

❑ 4.1 Ohm's law and conductance (cont.)

- **Example** : In the circuit shown in the following figure, calculate the current i, the conductance G, and the power p.



Answer:

$i = v/R = 30/5*10^3 = 6\ mA$

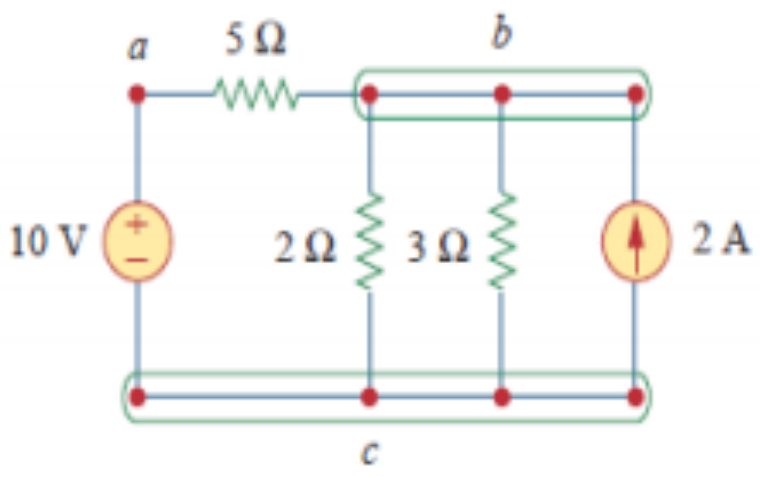
$G = i/v = 1/R = 0.2\ mS$

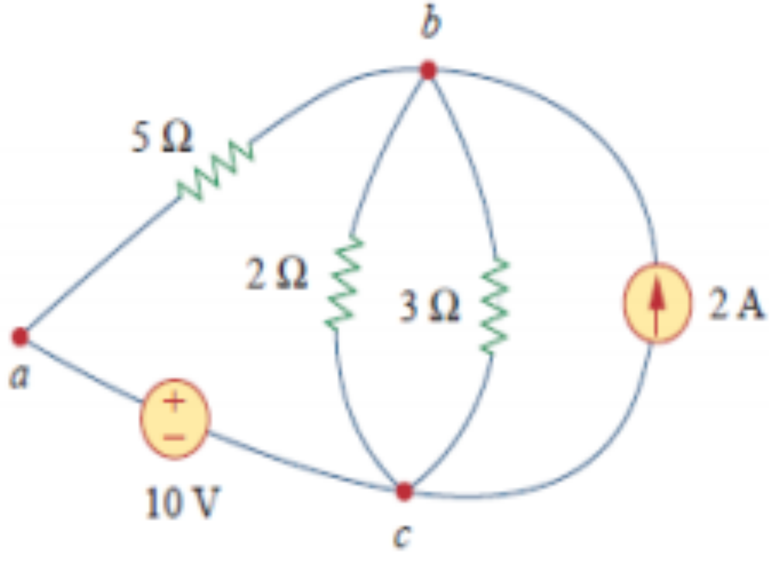
$P = v*i = 180\ mW$

❑ 4.2 Node, loop, and branch

➢ As shown in the next figure, we will present some definitions:

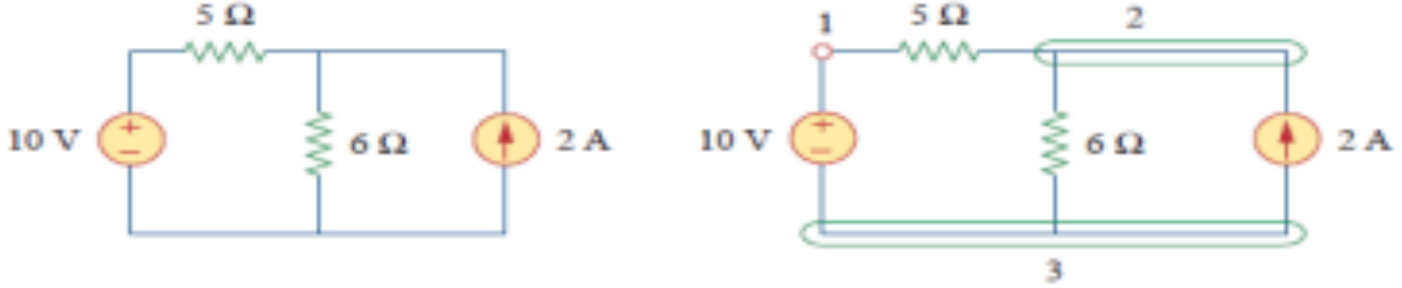
- ✓ Branch: represents a single element such as a voltage source or a resistor.
- ✓ Node: is a point to connect between two or more branches.
- ✓ Loop: is any closed path in the electrical circuit.





❑ 4.2 Node, loop, and branch (cont.)

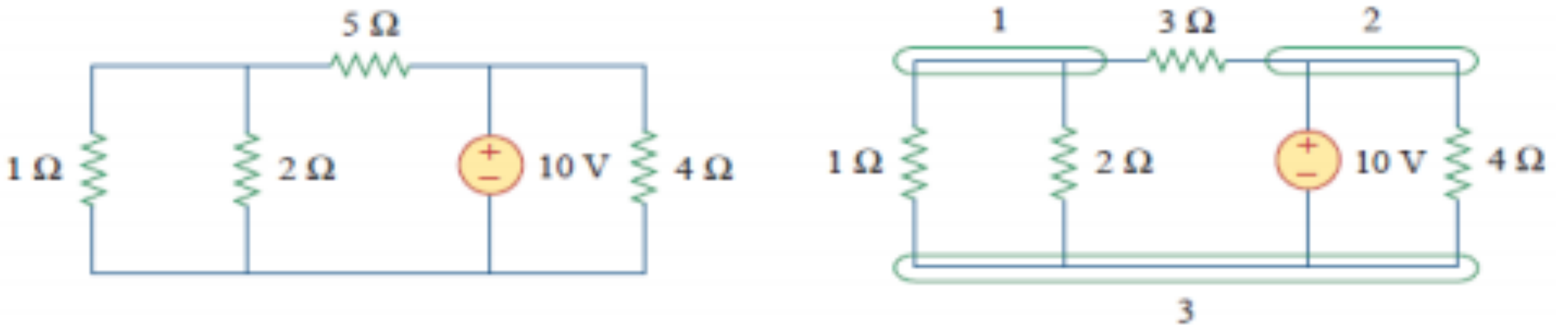
- Example: Determine the number of branches and nodes in the circuit shown in the following figure. Identify which elements are in series and which are in parallel.



- (a) Since there are four elements in the circuit, the circuit has four branches: 10 V, 5 Ω, 6Ω, and 2 A. The circuit has three nodes as identified in Fig. (a). The 5Ω resistor is in series with the 10-V voltage source because the same current would flow in both. The 6- resistor is in parallel with the 2-A current source because both are connected to the same nodes 2 and 3.

❑ 4.2 Node, loop, and branch (cont.)

- Example: Determine the number of branches and nodes in the circuit shown in the following figure. Identify which elements are in series and which are in parallel.



- (b) Five branches and three nodes are identified in Fig. (b). The 1Ω and 2Ω resistors are in parallel. The 4 Ω resistor and 10-V source are also in parallel.


Thank you