Introduction to Electrical Circuits

Mid Term
Lecture – 1

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Reference Book:

Introductory Circuit Analysis

Robert L. Boylestad, 11th Edition

Week No.	Class No.	Chapter No.	Article No., Name and Contents	Example No.	Exercise No.
W1	MC1	Chapter 1	1.6 POWERS OF TEN	------------	24, 25, 26, 27
			1.7 Only table 1.2	1.12	
			1.8 CONVERSION BETWEEN LEVELS OF POWERS OF TEN	1.13	
		Chapter 2	2.3 Voltage (Definition, Symbol, Unit and Equation)	2.1, 2.2	8, 9, 10, 11, 18, 19, 20
			2.4 Current (Definition, Symbol, Unit and Equation)	2.3, 2.4	
			2.5 VOLTAGE SOURCES (In general, dc voltage sources can be divided into three basic types: (1) batteries (chemical action or solar energy), (2) generators (electromechanical), and (3) power supplies (rectification — a conversion process to be described in your electronics courses).		
		Chapter 3	3.2 RESISTANCE: CIRCULAR WIRES (Definition, Symbol, Unit and Equation)	3.9	
			3.5 TEMPERATURE EFFECTS (Conductor, Semiconductor, Insulator, Inferred Absolute Temperature)		
			3.9 CONDUCTANCE (Definition, Symbol, Unit and Equation)		

CHAPTER 1

TABLE 1.2

Multiplication Factors	SI Prefix	SI Symbol
1 000 000 000 000 000 000 = 10^{18}	exa	E
1 000 000 000 000 000 = 10^{15}	peta	P
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1 000 000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
0.001 = 10^{-3}	milli	m
0.000 001 = 10^{-6}	micro	μ
0.000 000 001 = 10^{-9}	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0.000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

$1\,TB = 1 \times 10^{12}\,B$

$= 1,000,000,000,000\,B$

$+ 2,000,000,000,$

1×1

1.6 POWERS OF TEN

$$1 = 10^0 \qquad 1/10 = 0.1 = 10^{-1}$$
$$10 = 10^1 \qquad 1/100 = 0.01 = 10^{-2}$$
$$100 = 10^2 \qquad 1/1000 = 0.001 = 10^{-3}$$
$$1000 = 10^3 \qquad 1/10{,}000 = 0.0001 = 10^{-4}$$

EXAMPLE 1.12

a. 1,000,000 ohms = 1×10^6 ohms

= **1 megohm = 1 MΩ**

b. 100,000 meters = 100×10^3 meters

= **100 kilometers = 100 km**

c. 0.0001 second = 0.1×10^{-3} second

= **0.1 millisecond = 0.1 ms**

1.8 CONVERSION BETWEEN LEVELS OF POWERS OF TEN

EXAMPLE 1.14 Convert 20 kHz to megahertz.

Solution: In the power-of-ten format:

$$20\text{ kHz} = 20 \times 10^3\text{ Hz}$$

The conversion requires that we find the multiplying factor to appear in the space below:

Increase by 3

$$20 \times 10^3\text{ Hz} \Rightarrow \underline{\quad} \times 10^6\text{ Hz}$$

Decrease by 3

Exercise Problems

24. a) $6 \times 10^3 =$ ________ $\times 10^6$

$$\boxed{6 \times 10^3 = ? \times 10^6}$$

Solution: The given number should be multiplied and divided also by 1×10^6.

$$\frac{6 \times 10^3}{1 \times 10^6} \times 1 \times 10^6 = 0.006 \times 10^6$$

b) $4 \times 10^{-3} =$ ________ $\times 10^{-6}$ $= \frac{4 \times 10^{-3}}{10^{-6}} \times 10^{-6} = (4 \times 10^3)$

Solution: The given number should be multiplied and divided also by 1×10^{-6}.

$$\frac{4 \times 10^{-3}}{1 \times 10^{-6}} \times 1 \times 10^{-6} = 4000 \times 10^{-6}$$

$\times (1 \times 10^6)$

c) $50 \times 10^5 =$ ________ $\times 10^3 =$ ________ $\times 10^6 =$ ________ $\times 10^9$

$\times 10^6$

Solution:

$\times 10^6$

Step 1: The given number should be multiplied and also divided by 1×10^3.

$\times {}^6$

$$\frac{50 \times 10^5}{1 \times 10^3} \times 1 \times 10^3 = 5000 \times 10^3$$

Homework Problem No: 25, 26, 27

Similarly,

$50 \times 10^5 = 5 \times 10^6$ and $50 \times 10^5 = 0.005 \times 10^9$

2.3 VOLTAGE

Definition: A potential difference or voltage is always measured between two points in the system. Changing either point may change the potential difference between the two points under investigation.

Symbol: It is represented by 'E' or 'V'

E $\longrightarrow$ Source Voltage

V $\longrightarrow$ Voltage Drop

Equation of Voltage:

$$\boxed{V = \frac{W}{Q}} \qquad \text{(volts)}$$

Unit: Volt (V)

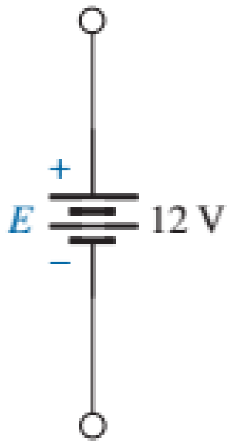
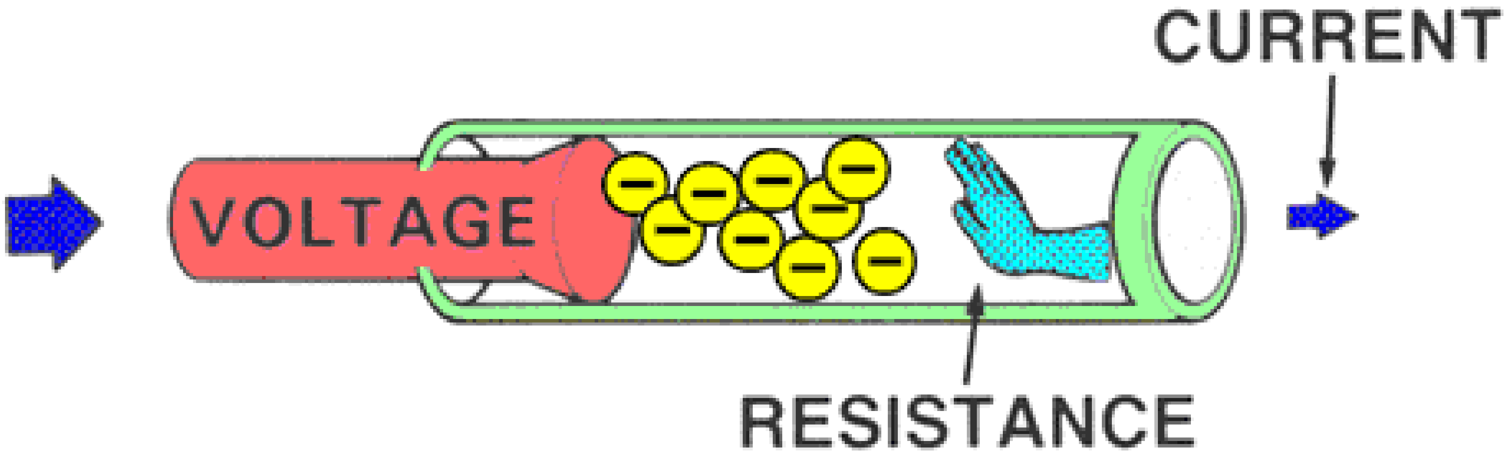


FIG. 2.11

2.5 VOLTAGE SOURCES

In general, dc voltage sources can be divided into three basic types: (1) batteries (chemical action or solar energy), (2) generators (electromechanical), and (3) power supplies (rectification—an AC to DC conversion process).

Voltage, Current & Resistance Analogy



EXAMPLE 2.1 Find the voltage between two points if 60 J of energy are required to move a charge of 20 C between the two points.

Solution: Eq. (2.2): $V = \frac{W}{Q} = \frac{60\ \text{J}}{20\ \text{C}} = \mathbf{3\ V}$

EXAMPLE 2.2 Determine the energy expended moving a charge of 50 μC between two points if the voltage between the points is 6 V.

Solution: Eq. (2.3):

$$W = QV = (50 \times 10^{-6}\ \text{C})(6\ \text{V}) = 300 \times 10^{-6}\ \text{J} = \mathbf{300\ \mu J}$$

2.4 Current

Definition: ***The applied voltage is the starting mechanism—the current is a reaction to the applied voltage.***

Symbol: It is represented by 'I'

Unit: Ampere (A)

Equation of Current:

$$\boxed{I = \frac{Q}{t}}$$

I = amperes (A)
Q = coulombs (C)
t = seconds (s)

$$\text{Charge/electron} = Q_e = \frac{1\text{ C}}{6.242 \times 10^{18}} = 1.6 \times 10^{-19}\text{ C}$$

EXAMPLE 2.3 The charge flowing through the imaginary surface in Fig. 2.9 is 0.16 C every 64 ms. Determine the current in amperes.

Solution: Eq. (2.5): $I = \frac{Q}{t} = \frac{0.16\text{ C}}{64 \times 10^{-3}\text{s}} = \frac{160 \times 10^{-3}\text{ C}}{64 \times 10^{-3}\text{ s}} = \mathbf{2.50\,A}$

EXAMPLE 2.4 Determine how long it will take 4×10^{16} electrons to pass through the imaginary surface in Fig. 2.9 if the current is 5 mA.

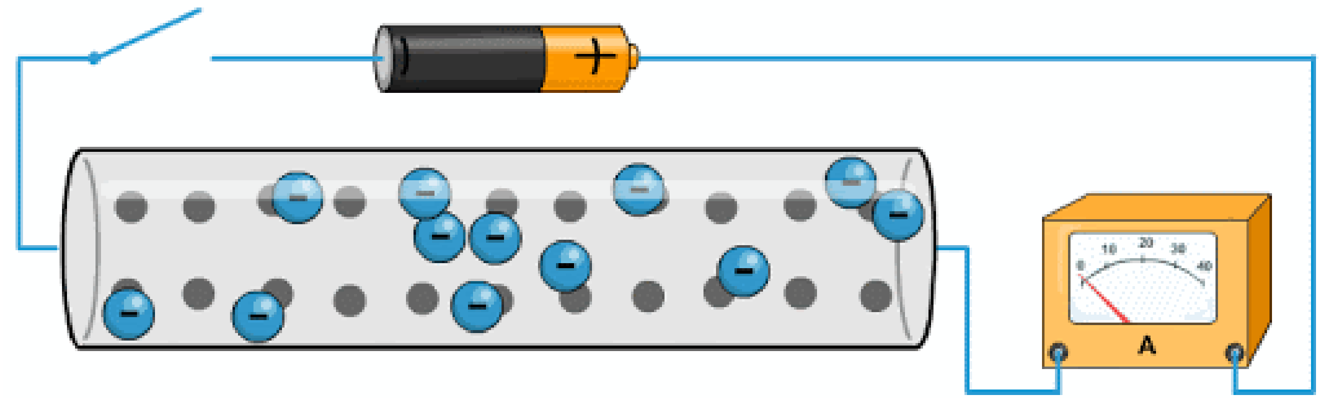
Solution: Determine the charge in coulombs:

$$4 \times 10^{16}\ \cancel{\text{electrons}}\left(\frac{1\text{ C}}{6.242 \times 10^{18}\ \cancel{\text{electrons}}}\right) = 0.641 \times 10^{-2}\text{C}$$

$$= 6.41\text{ mC}$$

Eq. (2.7): $t = \frac{Q}{I} = \frac{6.41 \times 10^{-3}\text{ C}}{5 \times 10^{-3}\text{ A}} = \mathbf{1.28\ s}$

Resistance



3.2 RESISTANCE: CIRCULAR WIRES

CHAPTER 3

Definition: The flow of charge through any material encounters an opposing force similar in many respects to mechanical friction. This opposition, due to the collisions between electrons and between electrons and other atoms in the material, *which converts electrical energy into another form of energy such as heat,* is called the **resistance** of the material.

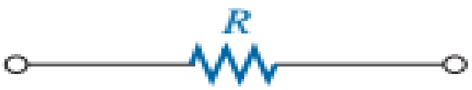


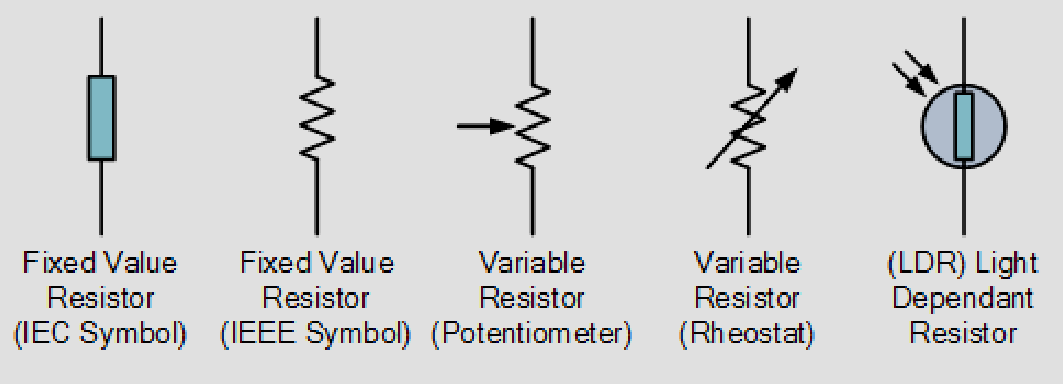
FIG. 3.1

Symbol: It is represented by 'R'

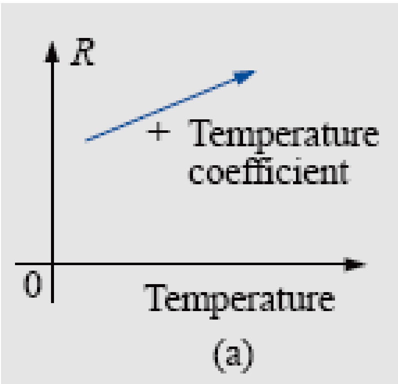
Unit: Ohm (Ω)

Equation of Resistance:

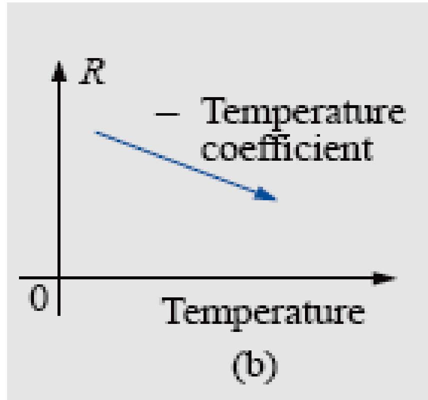
$$\boxed{R = \rho \frac{l}{A}} \qquad (\text{ohms}, \Omega)$$



1. Material
2. Length
3. Cross-sectional area
4. Temperature

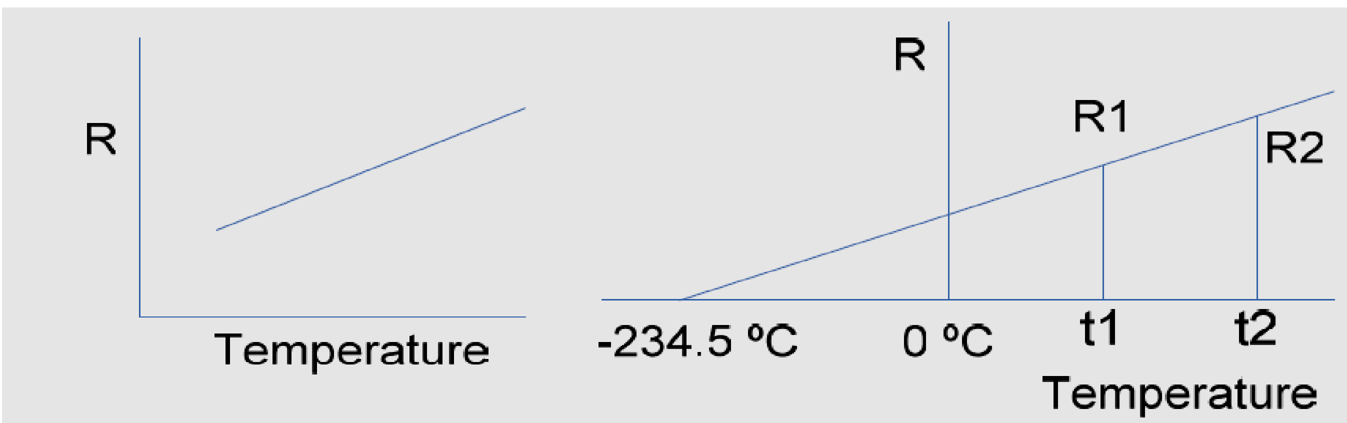


Conductors



Semiconductors

Effect of temperature on resistance of copper



$$\frac{R_2}{R_1} = \frac{|T| + t_2}{|T| + t_1}$$

The temperature of -234.5°C is called the **inferred absolute temperature T** of copper.

EXAMPLE 3.9 If the resistance of a copper wire is 50 Ω at 20°C, what is its resistance at 100°C (boiling point of water)?

Solution: Eq. (3.7):

$$\frac{234.5°\text{C} + 20°\text{C}}{50\ \Omega} = \frac{234.5°\text{C} + 100°\text{C}}{R_2}$$

$$R_2 = \frac{(50\ \Omega)(334.5°\text{C})}{254.5°\text{C}} = \mathbf{65.72\ \Omega}$$

3.9 CONDUCTANCE

Definition: By finding the reciprocal of the resistance of a material, we have a measure of how well the material will conduct electricity. The quantity is called **conductance.**

Symbol: It is represented by 'G'

Unit: Siemens (S)

Equation of Conductance:

$$\boxed{G = \frac{1}{R}} \quad \text{(siemens, S)}$$

$$\boxed{G = \frac{A}{\rho l}} \quad \text{(S)}$$


THE END.