Lecture 1: Basic Circuit Elements and Sources

Tuesday, February 15, 2022

Charge

- Electric charge is the physical property of matter that causes it to experience a force when placed in an electromagnetic field.

Current

- Flow of electrons.
- Unit: ampere (A)

Potential Difference

- The difference of electrical potential between two points.
- Unit: volt (V)

Resistance

- Measure of the opposition to current flow in an electrical circuit.
- Unit: Ohm (Ω)

Resistivity

- Resistance of a conducting material per unit length with unit area of cross section.
- Formula: $\rho = \frac{RL}{A}$
- Unit: $\Omega\ m^{-1}$

Conductivity

- Measure of electrical conduction and it shows the ability of a material to pass a current.
- Formula: $\sigma = \frac{1}{\rho}$
- Unit: $S\ m^{-1}$

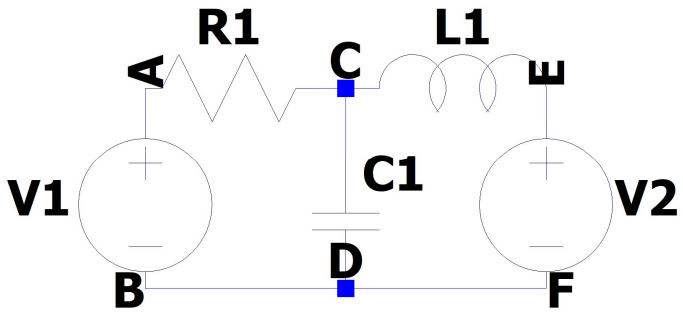
Basic Components

- Resistor: Used to reduce current flow.
- Inductor: Used to stores energy in a magnetic field when electric current flows through it.
- Capacitor: Used to store energy when it is connected to a battery.

Lecture 2: Ohm's Law

Thursday, February 17, 2022

Basic Terms in a circuit:



Active Circuit Elements
Voltage and Current Source
Passive Circuit Elements
Resistor, Inductor and Capacitor
Branch
- It is the part of the network which connects the various points of the network with one another.
- Example: AC, CE, EF, etc.

Junction Point
- The point where two or more branches are connected.
- Example: A, B, C, D, E, F.

Node
- The point where two or more elements (Passive circuit Element) are joined.
- Example: C

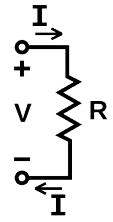
Mesh or Loop
- It is the closed path that forms a mesh or loop.
- Example: ACDBA, CEFDC, ACEFDBA.

Ohm's Law

Here, the temperature is constant.

$V \propto I$

$V = IR$



Power

$$\mathrm{P} = \mathrm{VI} = I^2R = \frac{V^2}{R}$$

Energy

$W = Pt$

Resistors in series and parallel:

When two or more resistors are connected in series,

$V = V_1 + V_2 + V_3$

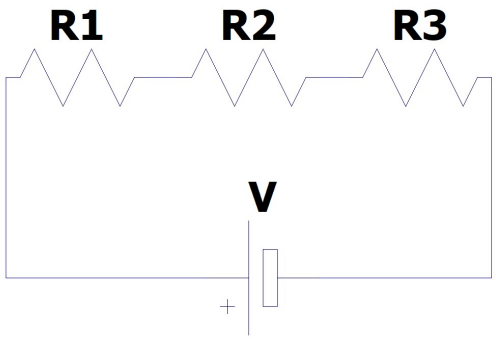
$V = IR_1 + IR_2 + IR_3$

$IR = I(R_1 + R_2 + R_3)$

$\boxed{R = R_1 + R_2 + R_3}$

R1 R2 R3

$$\boxed{R = R_1 + R_2 + R_3}$$



Don't consider R_3 below,

$V_1 = IR_1$

$V_2 = IR_2$

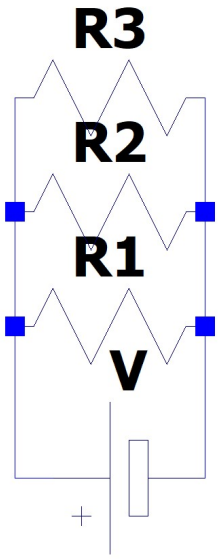
$$I = \frac{V}{R_1 + R_2}$$

$$\boxed{V_1 = \frac{VR_1}{R_1 + R_2}}$$

$$\boxed{V_2 = \frac{VR_2}{R_1 + R_2}}$$

This is called as voltage divider rule in series circuit.

<u>When two or more resistors are connected in parallel,</u>



$I = I_1 + I_2 + I_3$

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\boxed{\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

Don't consider R_3 below,

$I = I_1 + I_2$

$V = I_1R_1 = I_2R_2$

$$I_2 = \frac{I_1R_1}{R_2}$$

$$I = I_1 + \frac{I_1R_1}{R_2}$$

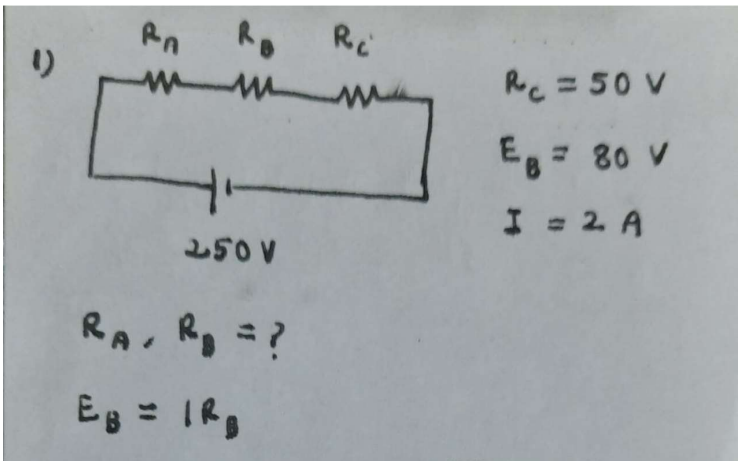
$$\boxed{I_1 = I\left(\frac{R_2}{R_1 + R_2}\right)}$$

$$\boxed{I_2 = I\left(\frac{R_1}{R_1 + R_2}\right)}$$

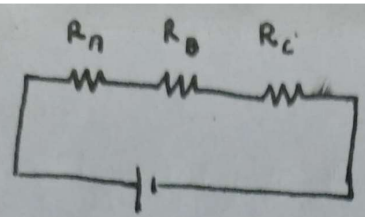
This is called as current divider rule in parallel circuit.

Example Problems:

1.



1)



$R_C = 50$ V

$E_B = 80$ V

$I = 2$ A

$R_A, R_B = ?$

$E_B = I R_B$

$R_B = \frac{E_B}{I} = \frac{80}{2} = \boxed{40\ \Omega}$

$E_B = \frac{E R_B}{R_A + R_B + R_C}$

$R_A + R_B + R_C = \frac{E R_B}{E_B}$

$R_A = \frac{E R_B}{E_B} - (R_B + R_C)$

$= \frac{125}{\cancel{250}\ (\cancel{40})^{1}} - (40 + 50)$

$= 125 - 90$

$R_A = 35\ \Omega$

2. Two resistors connected in parallel across 200 V supply, 10 A current. If the power dissipated in one resistor is 800 W, find the value of other resistor.

Given,

$V = 200\ V$; $I = 10\ A$; $P_1 = 800\ W$

Soln,

$P = VI = \frac{V^2}{R}$

$P = 200(10)$

$\boxed{P_t = 2000\ W}$

$P_2 = P_t - P_1$

$P_2 = 2000 - 800$

$\boxed{P_2 = 1200\ W}$

B $P_2 = \frac{V^2}{R_2}$

$R_2 = \frac{V^2}{P_2}$

$R_2 = \frac{200 \times 200}{1200}$

$\boxed{R_2 = 33.33\ \Omega}$