ELECTRICAL TECHNOLOGY

- Series Connection Cells

$$E_T = E_1 + E_2 + E_3 + E_4$$

- Parallel Connection Cells

$$E_T = E_1 = E_2 = E_3$$

- Electric Current, I

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

For steady state condition:

$$I = \frac{Q(charge)}{t(time)} \; thus, Q = It$$

dq = Changing of charge
dt = Changing of time
I = Current (Ampere)
Q = Charge (Coulomb)
t = Time (Second)

- Resistance & Resistivity

$$R = \frac{p\ell}{A}$$

R = Resistance (Ohm)
P = Resistivity (Ohm.m)
A = Cross-sectional area (m^2)
ℓ = Length (m)

- Ohm's Law

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

$$V = IR$$

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

- Electromotive Force, E

$$I = \frac{E}{R}$$

- Voltage Drop

$$V_{drop} = IR$$

- Series Circuit Characteristic

1. Total Resistance

$$R_T = R_1 + R_2 + R_3$$

2. Current Flows

$$I = I_{R1} = I_{R2} = I_{R3}$$

3. Voltage Drop

$$V_{R1} \neq V_{R2} \neq V_{R3}$$

4. Total E.m.f.

$$E = V_{R1} + V_{R2} + V_{R3}$$

5. Voltage Divider Rule

$$V_{R1} = \frac{R_1}{R_1 + R_2 + R_3} \times E$$

- Parallel Circuit Characteristic

1. Total Resistance

$$R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

2 Resistors Connection Only

$$R_T = \frac{R_1 \times R_2}{R_1 + R_2}$$

2. Current Flows

$$I_{R1} \neq I_{R2} \neq I_{R3}$$

3. Voltage Drop

$$E = V_{R1} = V_{R2} = V_{R3}$$

4. Total Current

$$I = I_{R1} + I_{R2} + I_{R3}$$

5. Current Divider Rule

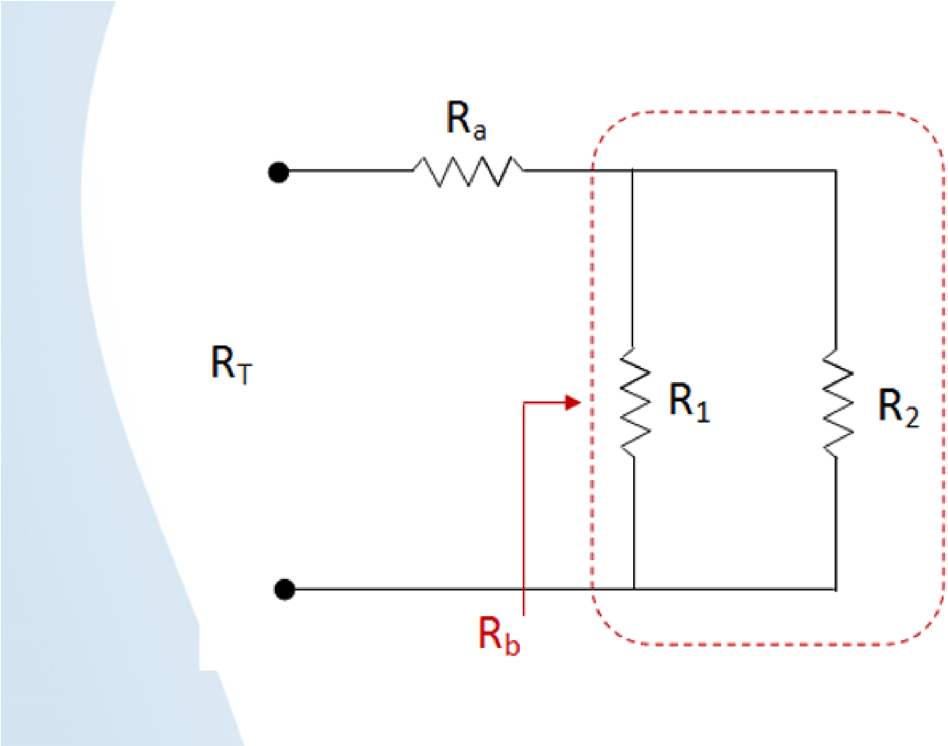
$$I_{R1} = \frac{\frac{1}{R_1}}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \times I$$

2 Resistors Connection Only

$$I_{R1} = \frac{R_2}{R_1 + R_2} \times I$$

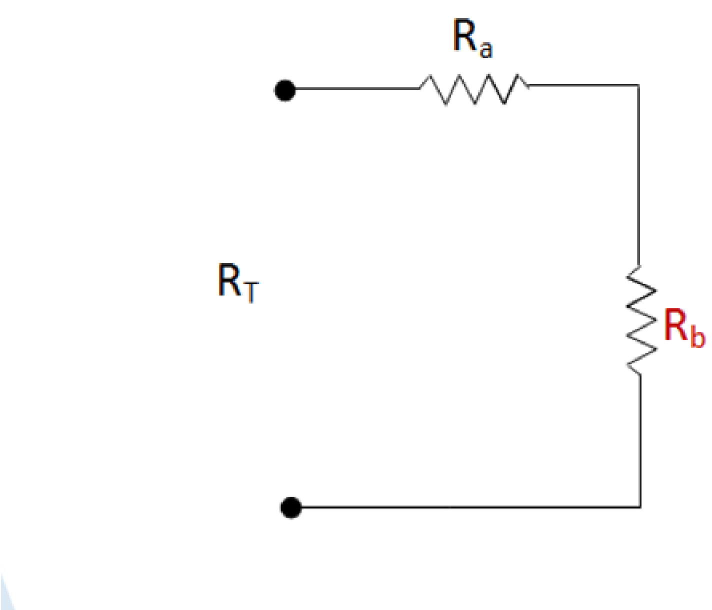
- Series-Parallel Circuit

1. Total Resistance



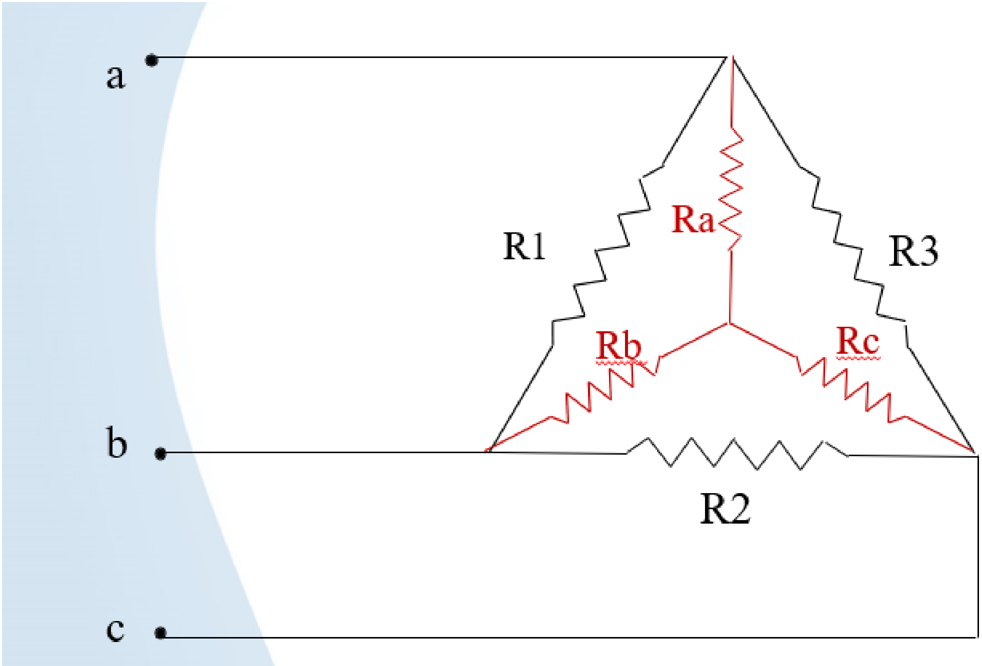
$$R_b = \frac{R_1 \times R_2}{R_1 + R_2}$$

After that,



$$R_T = R_a + R_b$$

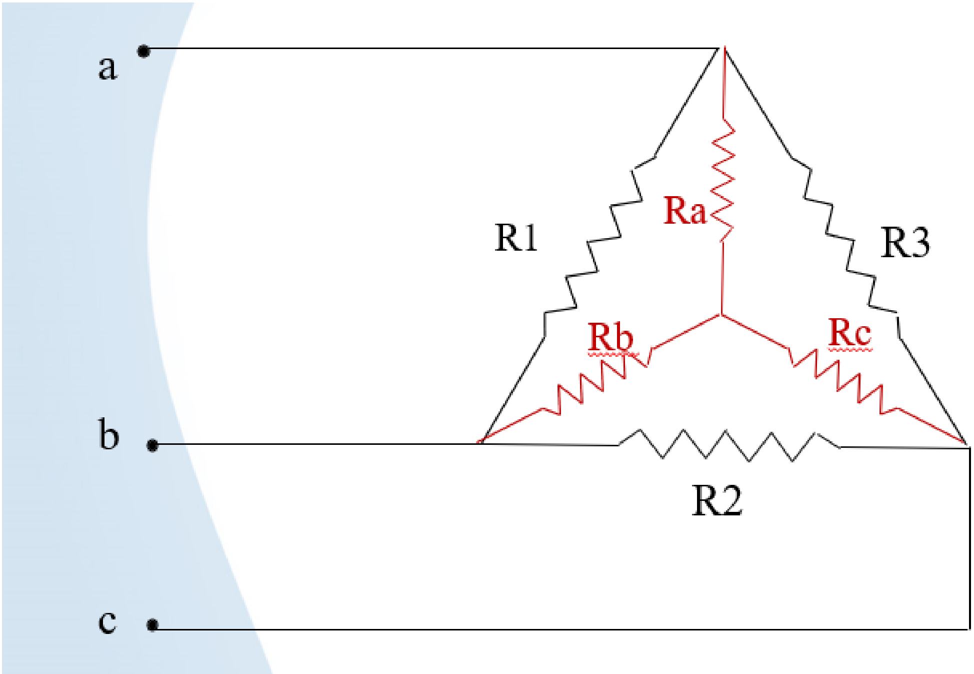
- Delta-Star Transformation



$$Ra = \frac{R1 \times R3}{R1 + R2 + R3}$$

$$Rb = \frac{R1 \times R2}{R1 + R2 + R3}$$

$$Rc = \frac{R2 \times R3}{R1 + R2 + R3}$$



$$R1 = \frac{(Ra \times Rb) + (Rb \times Rc) + (Ra \times Rc)}{Rc}$$

$$R2 = \frac{(Ra \times Rb) + (Rb \times Rc) + (Ra \times Rc)}{Ra}$$

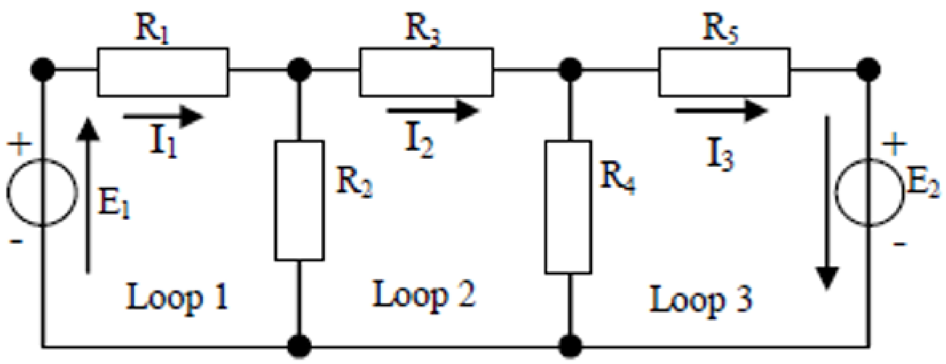
$$R3 = \frac{(Ra \times Rb) + (Rb \times Rc) + (Ra \times Rc)}{Rb}$$

- Electrical Power & Energy

$$Power, P = VI$$

$$Energy, W = Pt$$

- Mesh-current



Loop 1 $I_1(R_1+R_2)-I_2R_2=E_1$
Loop 2 $I_2(R_2+R_3+R_4)-I_1R_2-I_3R_4=0$
Loop 3 $I_3(R_4+R_5)-I_2R_4=-E_2$

- Kirchoff's Current Law

$$I_1+I_2=I_3+I_4+I_5$$

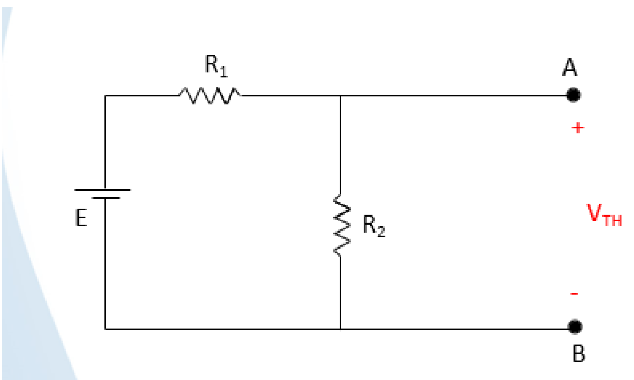
Or

$$I_1+I_2-I_3-I_4-I_5=0$$

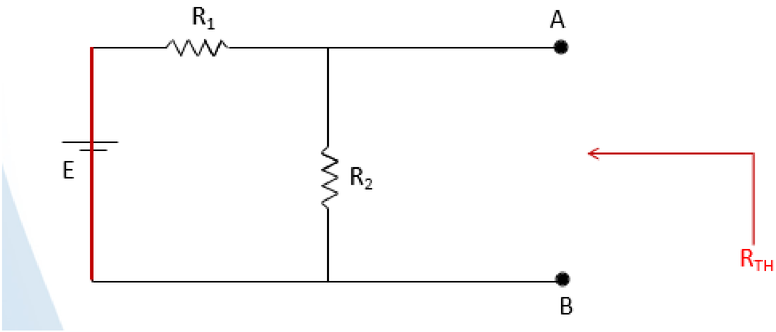
- Kirchoff's Voltage Law

$$\sum e.m.f.s=\sum V_{drops}$$

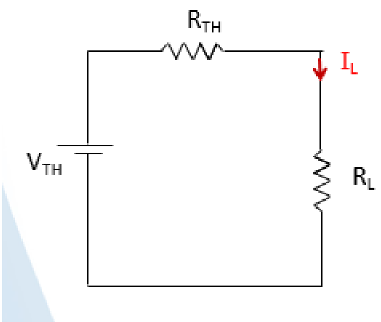
- Thevenin's Theorem



$$V_{TH}=V_{R2}=\frac{R_2}{R_1+R_2}\times E$$

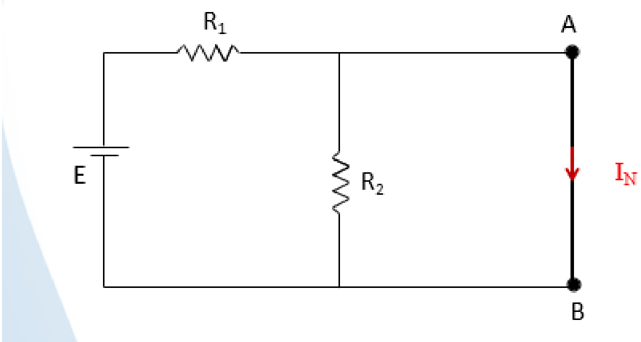


$$R_{TH} = \frac{R_1 \times R_2}{R_1 + R_2}$$

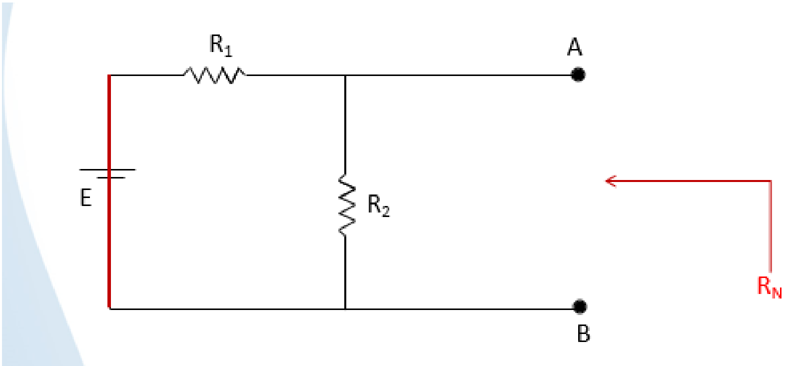


$$I_L = I_{TH} = \frac{V_{TH}}{R_{TH} + R_L}$$

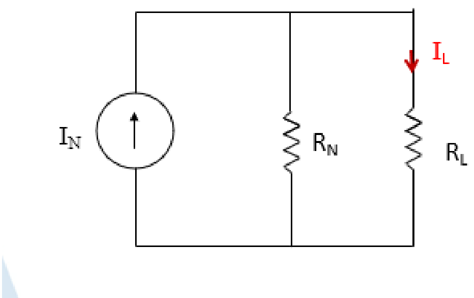
- Norton's Theorem



$$I_N = I_{SC} = \frac{E}{R_1}$$



$$R_N = \frac{R_1 \times R_2}{R_1 + R_2}$$



$$I_L = \frac{R_N}{R_L + R_N} \times I_N$$

- Capacitance

$$Where, Ic = \frac{dq}{dt}$$

Thus Capacitance, $C = \frac{Q(Charge)}{V(Potential\,Diff.)}$

- Capacitance Total (Series Connection)

$$C_{total} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$$

- Parallel Connection (Parallel Connection)

$$C_{total} = C1 + C2 + C3$$

- Current & Charge Relationship

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

For steady state condition:

$$I = \frac{Q(charge)}{t(time)}\ thus, Q = It$$

dq = Changing of charge
dt = Changing of time
I = Current (Ampere)
Q = Charge (Coulomb)
t = Time (Second)

- Electric Flux

$$Electric\ Flux = Charge, Q$$

- Electric Flux Density (D)

$$D = \frac{Q(Coulomb)}{A(metre^2)}$$

- Electric Field Strength (E)

$$E = \frac{V(Volt)}{d(metre)}$$

- Absolute Permittivity (ε)

$$\varepsilon = \frac{D}{E}\ (Unit: \frac{Farad}{metre})$$

$$\varepsilon = \varepsilon_r \times \varepsilon_0 (Unit: \frac{Farad}{metre})$$

- Influent Factors of Capacitance

$$C = \frac{\varepsilon_r \varepsilon_0 A}{d}$$

- Inductance

$$L = \frac{N.\varphi}{I}$$

- Inductance Equivalent Circuit (Series Circuit)

$$L_{total} = L_1 + L_2$$

- Inductance Equivalent Circuit (Parallel Circuit)

$$L_{total} = \frac{1}{\frac{1}{L_1} + \frac{1}{L_2}}$$

- Induced e.m.f.

$$V_L = e.m.f = -N\frac{d\varphi}{dt}$$

$$V_L = e.m.f = -L\frac{di}{dt}$$

- Factors that Influence Inductance

$$L = \frac{N^2 \mu_0 \mu_r A}{\ell}$$

- Time Constant

$$\tau = \frac{L}{R}$$

- Maximum Current

$$I_{max} = \frac{E}{R}$$

- Instantaneous Value of Current

$$I_{max}(1 - e^{\frac{-t}{\tau}})$$

- Time taken to make the Instantaneous value of current

$$ln\, e^{\frac{-t}{\tau}}$$

- Maximum Energy

$$E_C = \frac{1}{2} \times L \times I^2$$

- Magnetomotive Force (m.m.f.), Fm

$$m.m.f., F_m = IN$$

- Magnetic Field Strength, H

$$H = \frac{Fm}{\ell}$$

- Magnetic Flux Density, B

$$B = \frac{\varphi}{A}$$

- Absolute Permeability, μ

$$\mu = \mu_o \mu_r \text{ @ } \mu = \frac{B}{H}$$

- Reluctance, S

$$S = \frac{Fm}{\varphi}$$

$$S = \frac{1}{\mu_o \mu_r A}$$