ELEMENTS OF ELECTRICAL ENGINEERING
UE24EE141B

Vadhiraj K P P

Department of Electrical & Electronics Engineering

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Lectures 4 & 5 - Voltage & Current Division Rules; Concept of Short Circuit & Open Circuit

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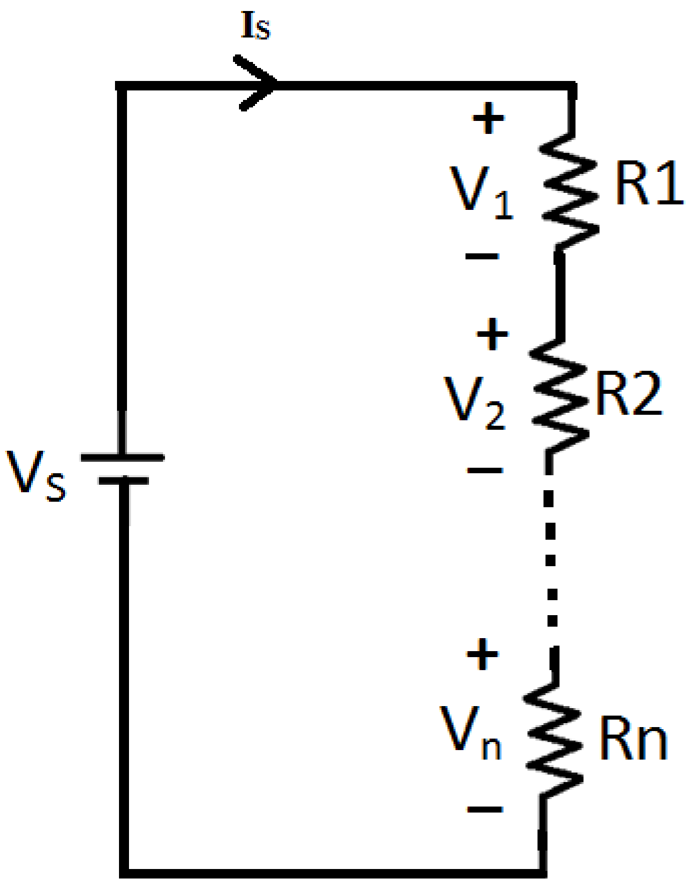
Voltage Division Rule

It is applicable to Series Networks



$V_1 = I_S * R_1$

$V_2 = I_S * R_2$

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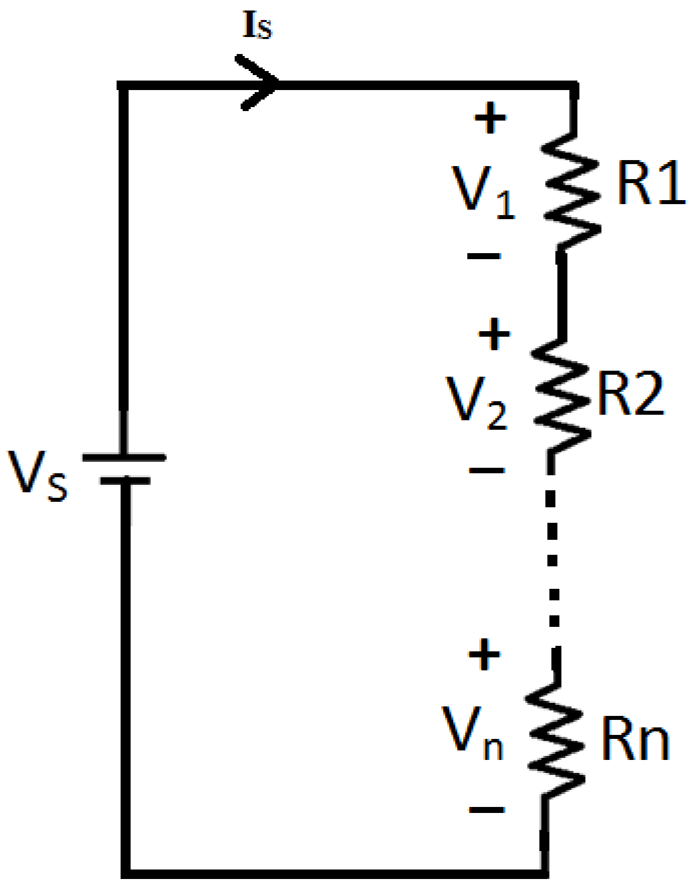
$V_n = I_S * R_n$

By KVL,

$V_S = V_1 + V_2 + \ldots + V_n$

Voltage Division Rule



Hence, $I_S = \dfrac{V_S}{(R_1+R_2+\cdots+R_n)}$

Therefore,

$$V_1 = \frac{V_S * R_1}{(R_1+R_2+\cdots+R_n)}$$

.

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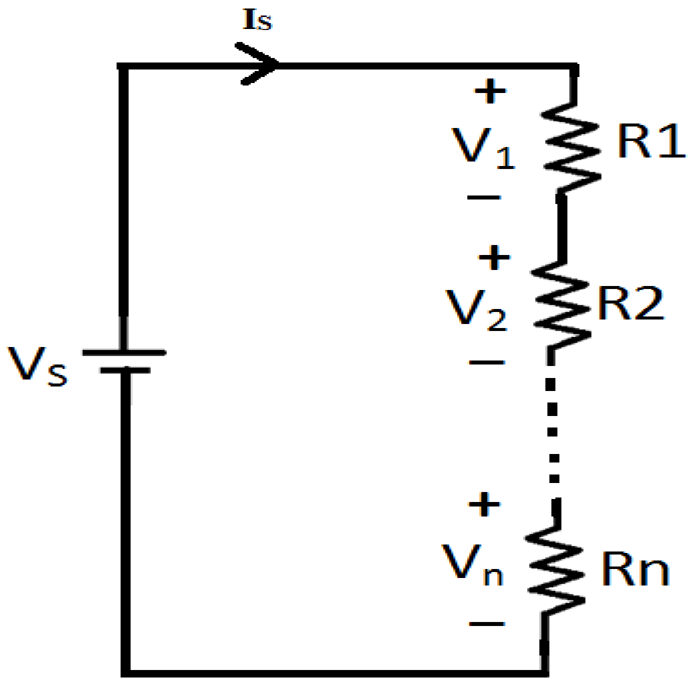
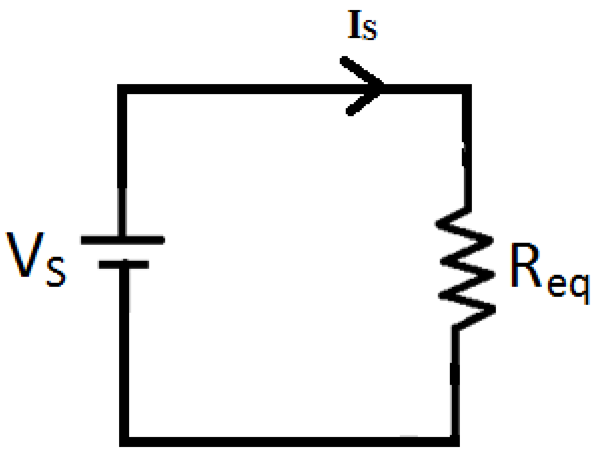
$$V_n = \frac{V_S * R_n}{(R_1+R_2+\cdots+R_n)}$$

Equivalent Series Resistance





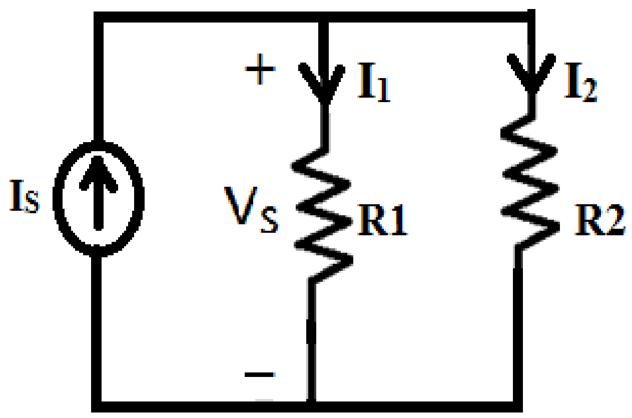
$$I_S = \frac{V_S}{R_{eq}}$$

$$I_S = \frac{V_S}{(R_1+R_2+\cdots+R_n)}$$

$$\boxed{R_{eq} = R_1+R_2+\ldots+R_n}$$

Current Division Rule

It is applicable to Parallel Networks



$I_1 = \frac{V_S}{R_1}$

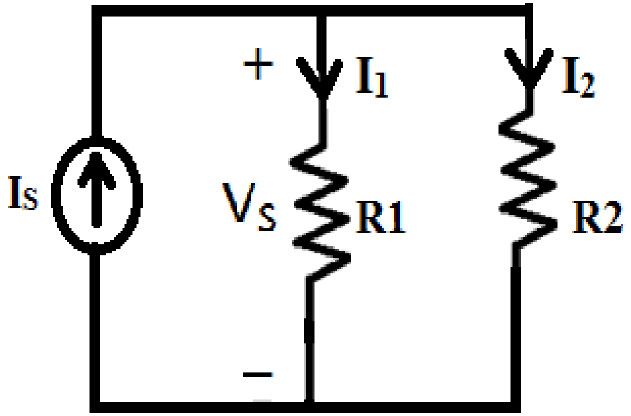
$I_2 = \frac{V_S}{R_2}$

By KCL,

$I_S = I_1 + I_2$

$I_S = V_S * \left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

Current Division Rule

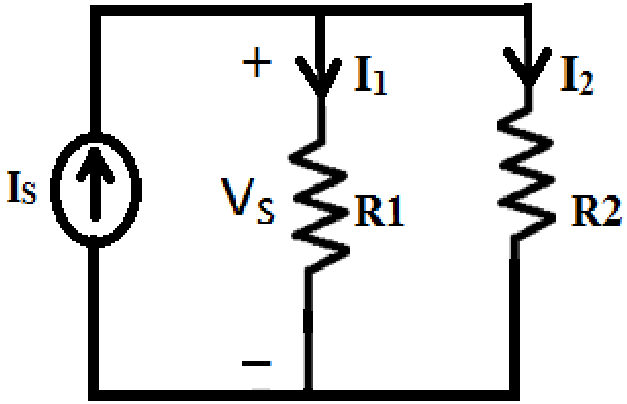


$$V_S = I_S * \frac{R_1 * R_2}{(R_1 + R_2)}$$

$$I_1 = I_s * \frac{R_2}{(R_1 + R_2)}$$

$$I_2 = I_s * \frac{R_1}{(R_1 + R_2)}$$

Equivalent Parallel Resistance

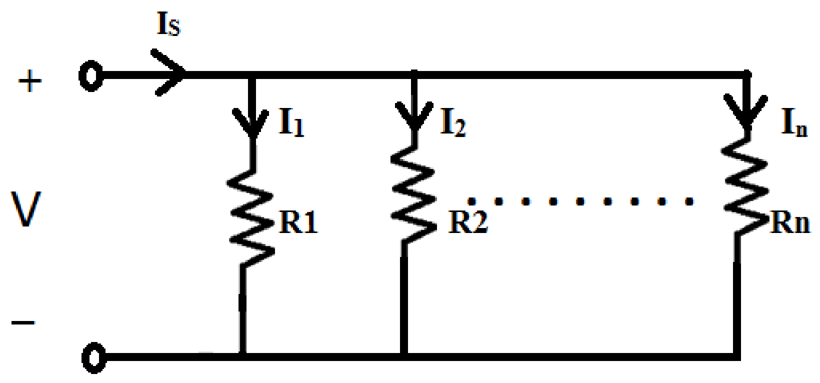


$$\frac{V_S}{I_S} = \mathrm{R_{eq}} = \left(\frac{1}{R_1} + \frac{1}{R_2}\right)^{-1} = \frac{R_1 * R_2}{(R_1 + R_2)}$$

In general, For n Resistors in Parallel,

$$\frac{1}{R_{eq}} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}\right)$$

Current Division Rule – More than two resistors in Parallel



- Obtain R_{eq} using

$$\frac{1}{R_{eq}} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}\right)$$

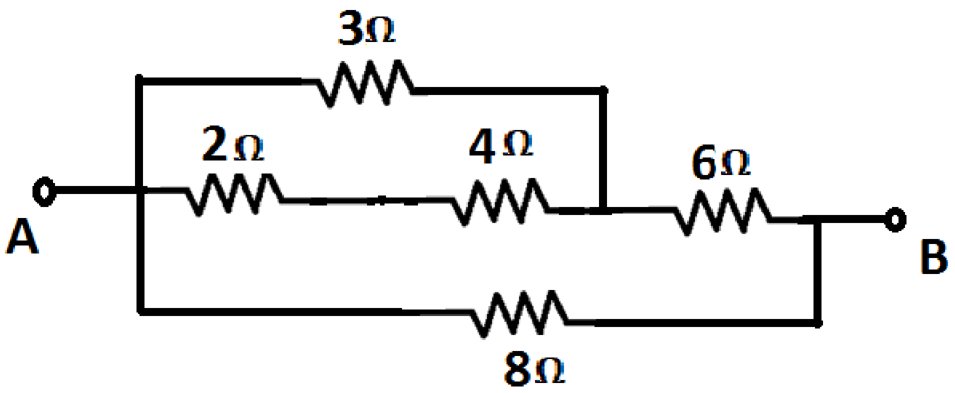
- Find V using

V $= I_S * R_{eq}$

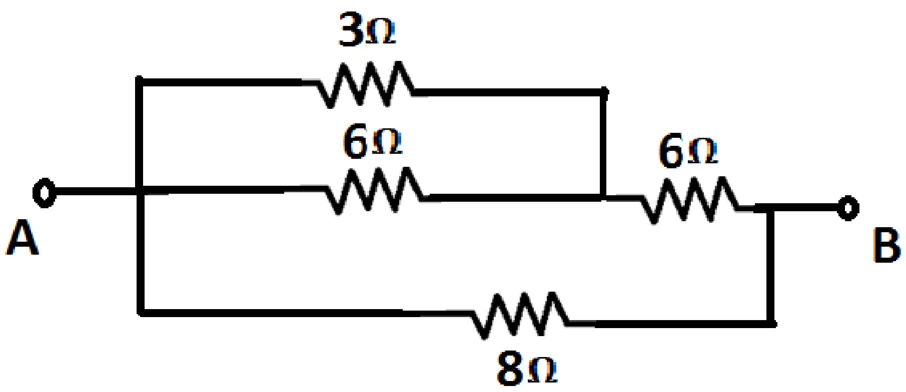
- Use Ohm's Law to find branch currents

Numerical Example – Finding Equivalent Resistance

Find the equivalent resistance between A & B

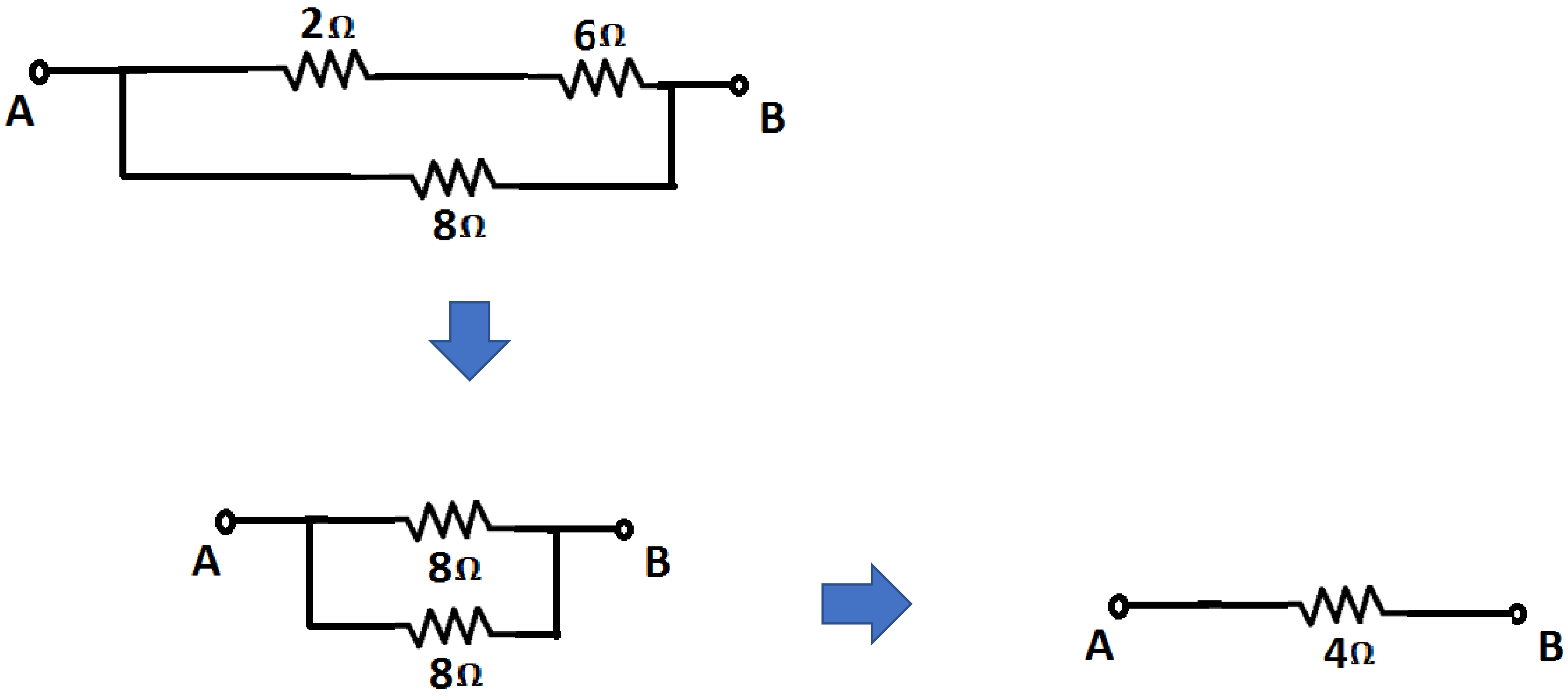


Solution:



Numerical Example – Finding Equivalent Resistance

Solution: (Continued..)



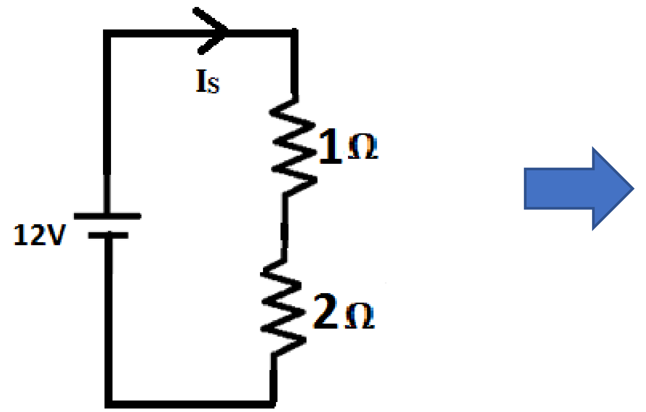
Open Circuit

An Open Circuit has Infinite resistance.

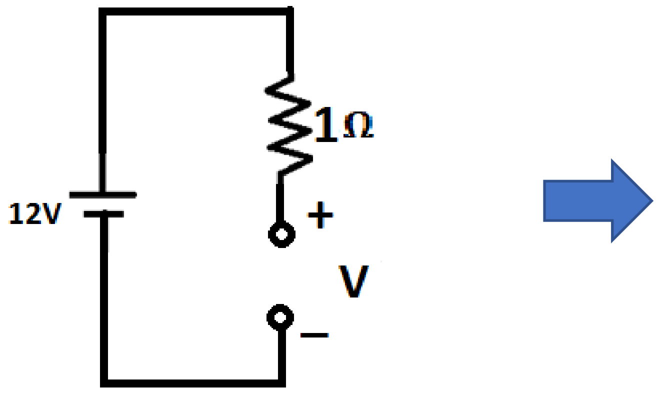
Current through the Open Circuit is Zero.

Voltage across the Open Circuit can be any finite value.

Open Circuit



$I_S = 4A$

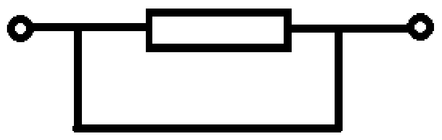


$I_S = 0A$

$V = 12V$

Short Circuit

A Short Circuit has Zero resistance.

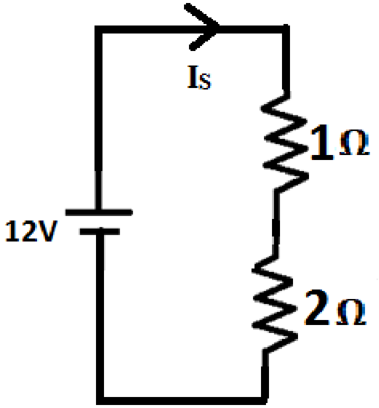


Voltage across a Short Circuit is Zero.

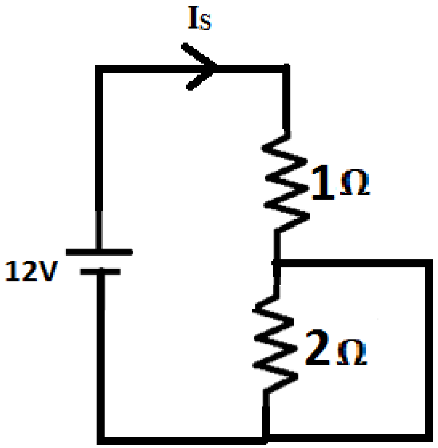
Current through the Short Circuit can be any finite value.

Current through a Dead Short Circuit is dangerously high.

Short Circuit



$I_S = 4A$



$I_S = 12A$

Numerical Example – Open & Short Circuits

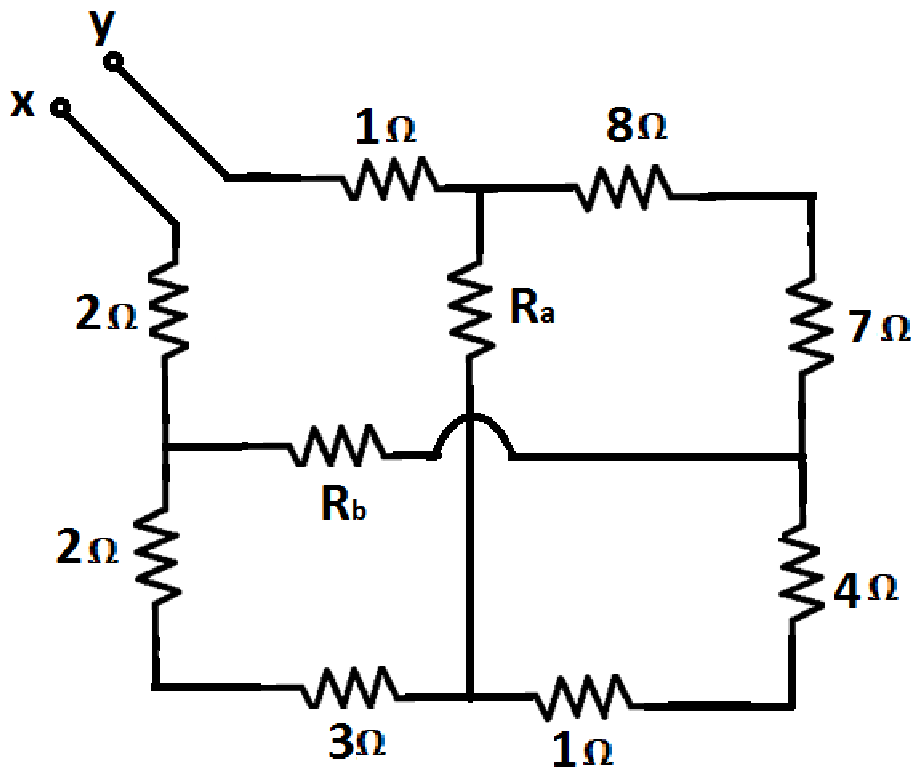
Find the equivalent resistance between X & Y if

i) $R_a = \infty$ & $R_b = \infty$

ii) $R_a = 0$ & $R_b = \infty$

iii) $R_a = \infty$ & $R_b = 0$

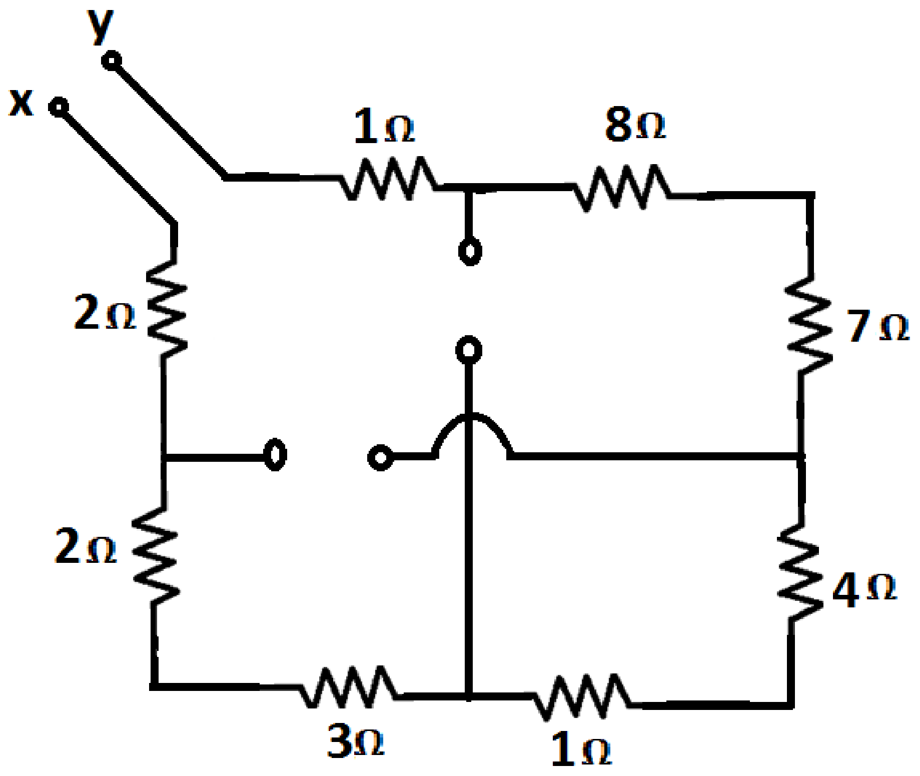
iv) $R_a = 0$ & $R_b = 0$



Numerical Example – Open & Short Circuits

Solution:

Case i) $R_a = \infty$ & $R_b = \infty$

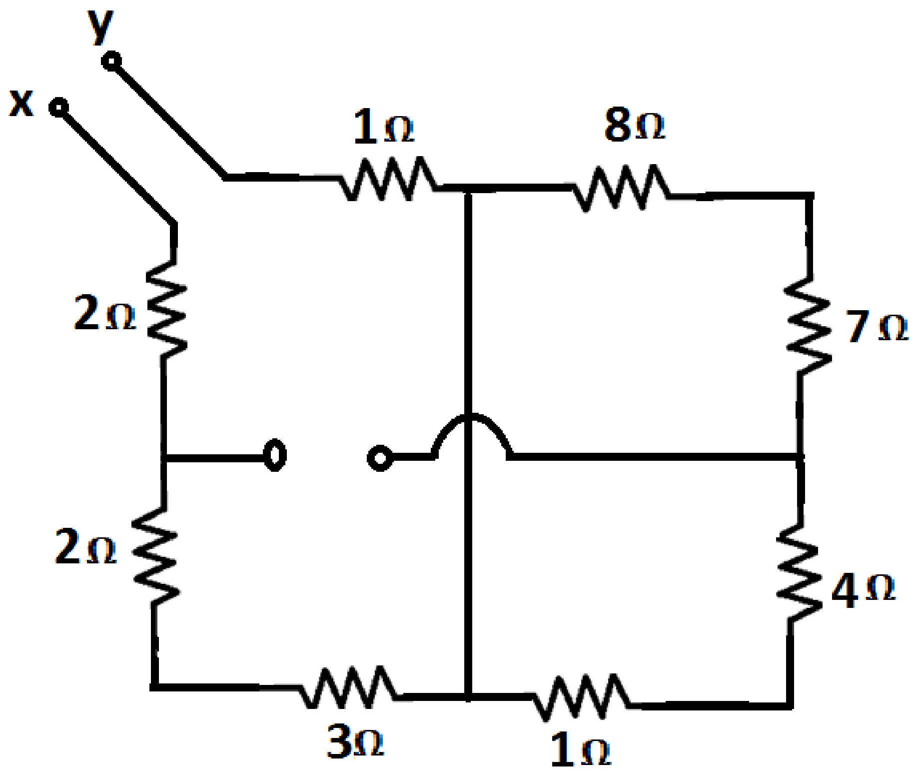


All the resistors are in series.

Hence, $R_{XY} = 28\Omega$

Solution:

Case ii) $R_a = 0$ & $R_b = \infty$

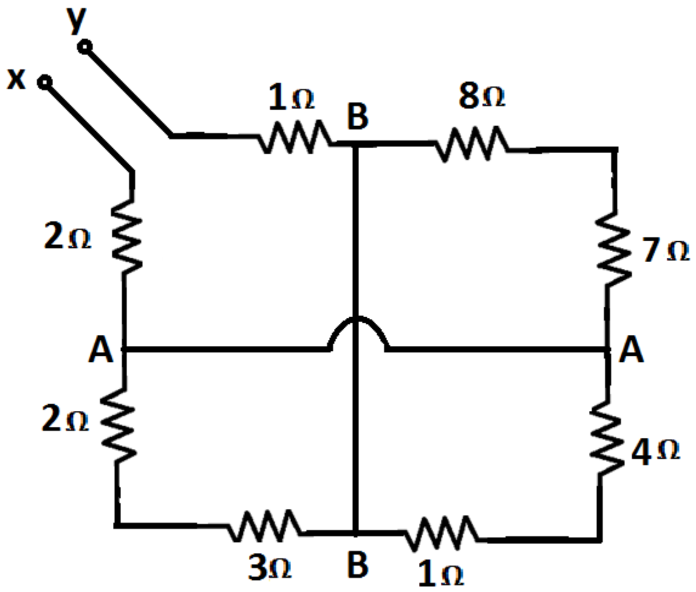


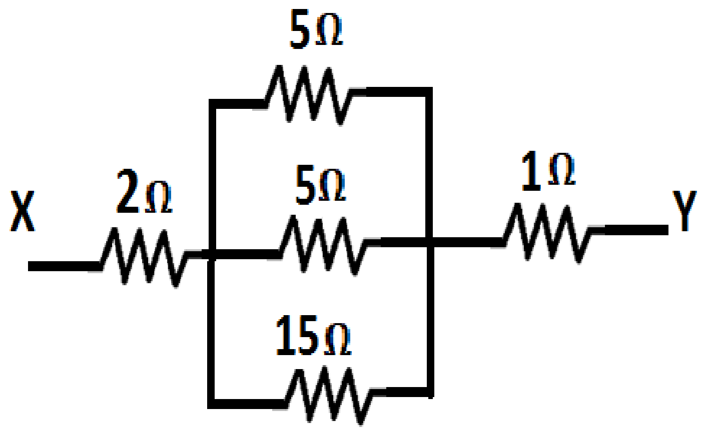
$R_{XY} = 8\Omega$

Numerical Example – Open & Short Circuits

Solution:

Case iv) $R_a = 0$ & $R_b = 0$





$R_{XY} = 5.143\Omega$

Text Book & References

Text Book:

"Electrical and Electronic Technology" E. Hughes (Revised by J. Hiley, K. Brown & I.M Smith), 11th Edition, Pearson Education, 2012.

Reference Books:

1. "Basic Electrical Engineering", K Uma Rao, Pearson Education, 2011.
2. "Basic Electrical Engineering - Revised Edition", D. C. Kulshreshta, Tata- McGraw-Hill, 2012.
3. "Engineering Circuit Analysis", William Hayt Jr., Jack E. Kemmerly & Steven M. Durbin, 8th Edition, McGraw-Hill, 2012.

THANK YOU

Vadhiraj K P P
Department of Electrical & Electronics Engineering
vadhirajkpp@pes.edu