EEE1024: Fundamentals of Electrical and Electronics Engineering

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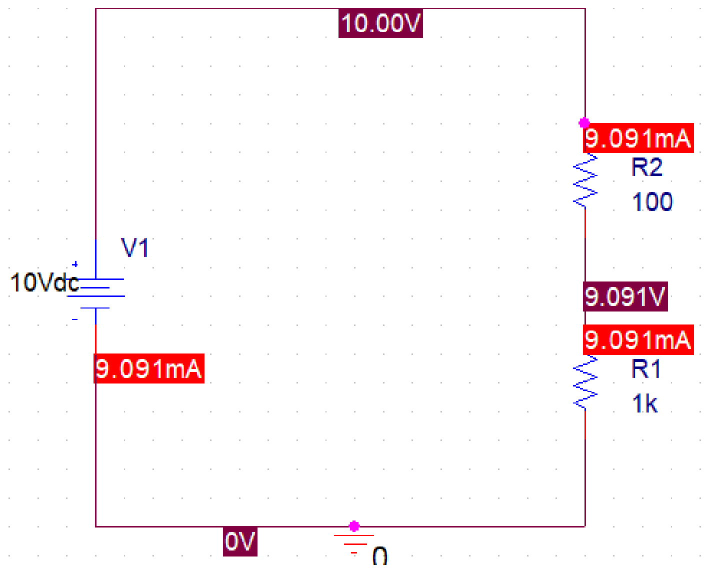
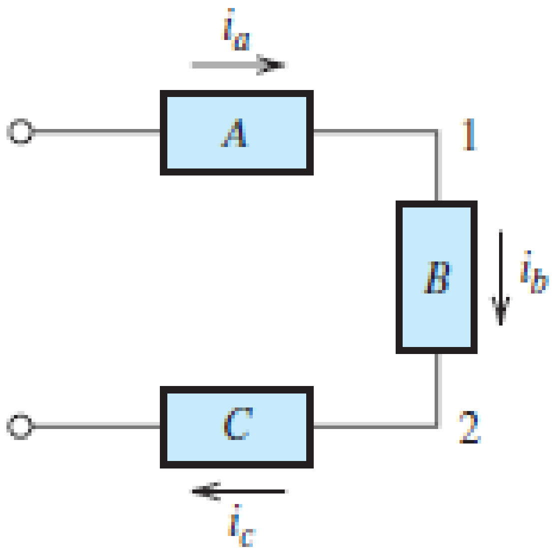
Kirchhoff's Current law (KCL)





Elements connected from end to end ———— Series circuit

CURRENT in a ***SERIES*** circuit – remains same!

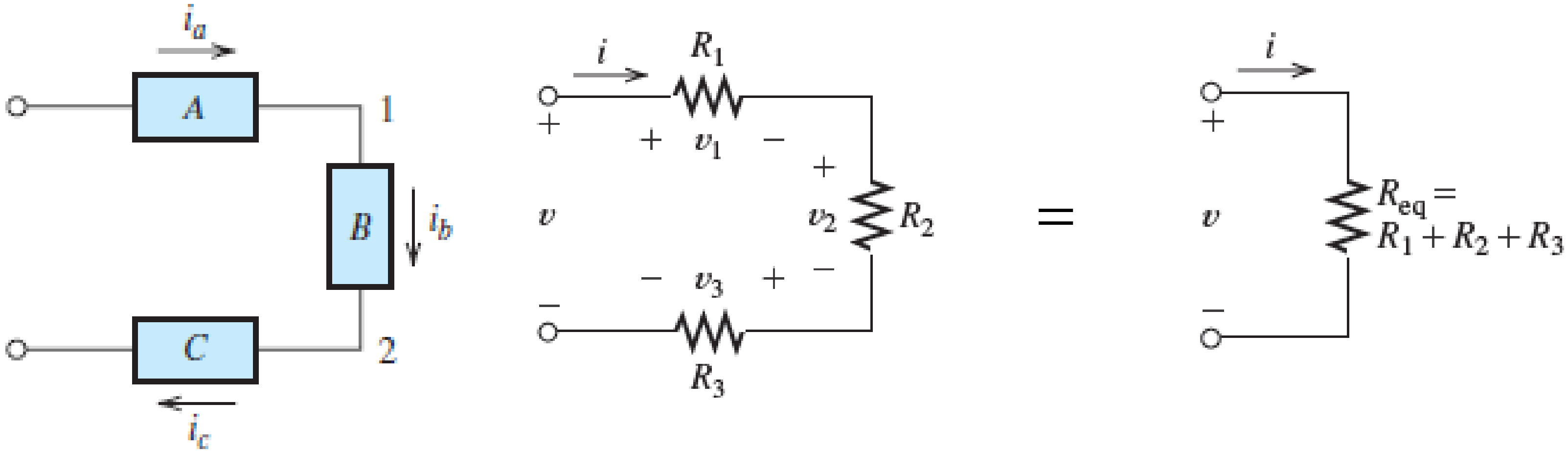
Apply KCL to check this!

@ Node 1, $i_a = i_b$

@ Node 2, $i_b = i_c$

Thus, $i_a = i_b = i_c$

Series Circuit



Ohm's law

$$v_1 = R_1 i$$
$$v_2 = R_2 i$$
$$v_3 = R_3 i$$

Apply KVL

$$v = v_1 + v_2 + v_3$$

Substituting

$$v = R_1 i + R_2 i + R_3 i$$

Factoring out

$$v = (R_1 + R_2 + R_3) i$$

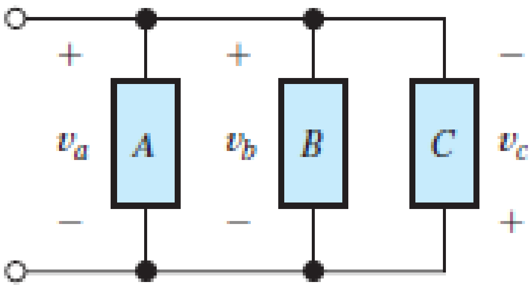
Define an ***equivalent resistance*** - R_{eq}

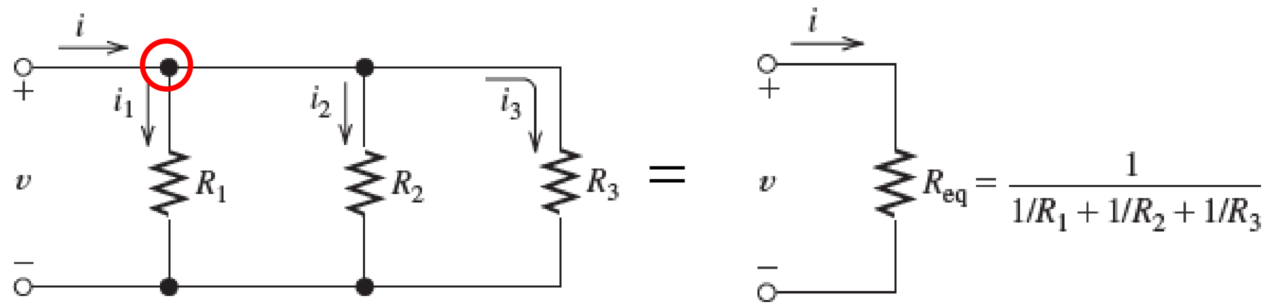
$$R_{eq} = R_1 + R_2 + R_3$$

$$v = R_{eq} i$$

Series combination of resistances has an ***equivalent resistance*** which is equal to sum of individual resistances

Kirchhoff’s Voltage law (KVL)



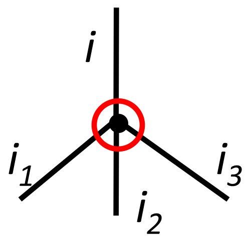


Ohm’s law

$$i_1 = \frac{v}{R_1}$$

$$i_2 = \frac{v}{R_2}$$

$$i_3 = \frac{v}{R_3}$$



Apply KCL

$$i = i_1 + i_2 + i_3$$

Substituting

$$i = \frac{v}{R_1} + \frac{v}{R_2} + \frac{v}{R_3}$$

Factoring

$$i = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)v$$

Define an ***equivalent resistance*** - R_{eq}

$$R_{eq} = \frac{1}{1/R_1 + 1/R_2 + 1/R_3}$$

$$i = \frac{1}{R_{eq}}v$$

Parallel combination of resistances also has an ***equivalent resistance***.
It can be replaced in place of the parallel combination, without changing V’s and I’s in other parts of circuit !

Combining Resistances in series and parallel

For 3 resistances in llel,

$$R_{eq} = \frac{1}{1/R_1 + 1/R_2 + 1/R_3}$$

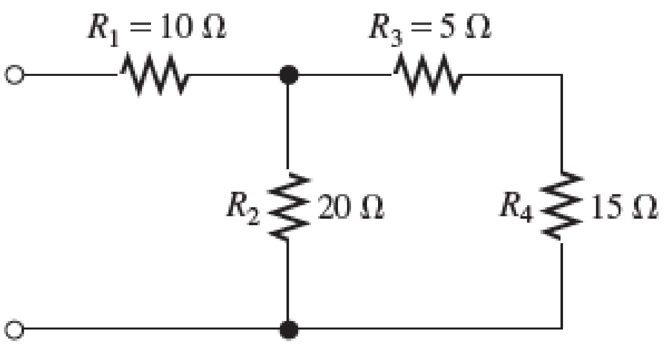
For 2 resistances in llel,

$$R_{eq} = \frac{1}{1/R_1 + 1/R_2}$$

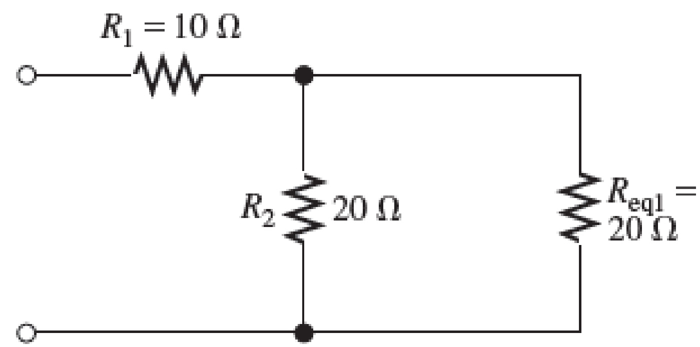
OR

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2}$$

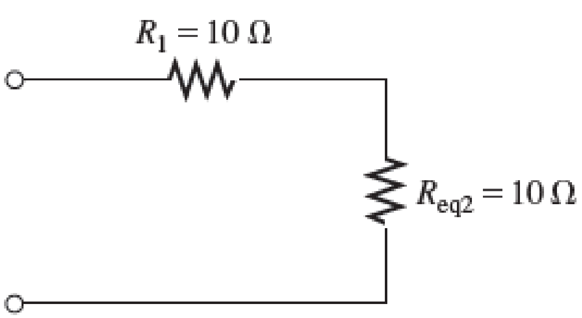
Example:



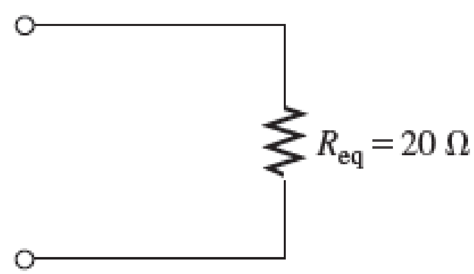
A) $R_{eq1} = R_3 + R_4 = 5 + 15 = 20\ \Omega$



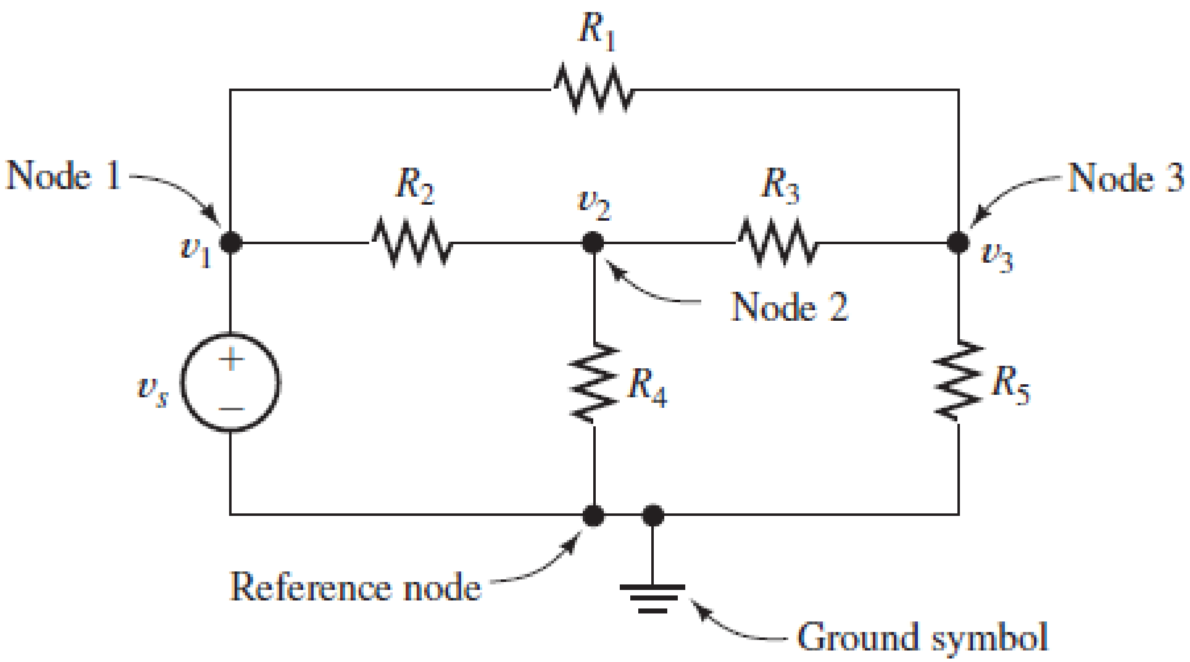
B) $R_{eq2} = \dfrac{1}{1/R_{eq1} + 1/R_2} = \dfrac{1}{1/20 + 1/20} = 10\ \Omega$



C) $R_{eq} = R_1 + R_{eq2} = 10 + 10 = 20\ \Omega$



Node Voltage Analysis



Series or parallel combinations – no use for this circuit!

Acknowledgements

1. H. Hayt, J.E. Kemmerly and S. M. Durbin, ‘Engineering Circuit Analysis’, 6/e, Tata McGraw Hill, New Delhi, 2011
2. Allan R. Hambley, ‘Electrical Engineering - Principles & Applications, Pearson Education, First Impression, 6/e, 2013