ELEC 1207 - Harris L1 - Circuit theory

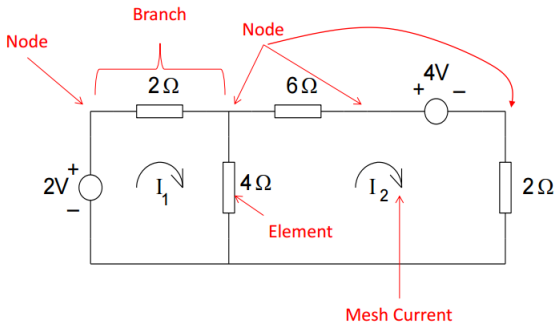
Anton Nikitin

Monday 30th January 2017

1 Linear Circuit Theory

1.1 Definitions

- Node = Point of connection of 2 or more ideal circuit elements
- Mesh/Loop = A closed path in a circuit
- Circuit element = A mathematical model of a useful component



1.2 Components/Equations

Ideal Resistor:

$$v = IR \tag{1}$$

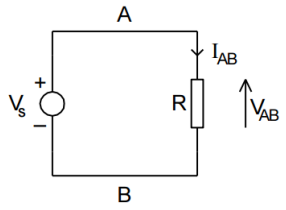
$$I = GV \tag{2}$$

G - Conductance = $\frac{1}{R}$
Power:

$$P = VI = I^2R = \frac{V^2}{R} \tag{3}$$

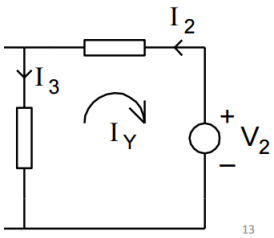
1.3 Sign Conventions

V_{AB} = Voltage of A with respect to B
V_{AB} = - V_{BA}
I_{AB} = Current from node A to B
I_{AB} = - I_{BA}



1.4 Mesh Currents

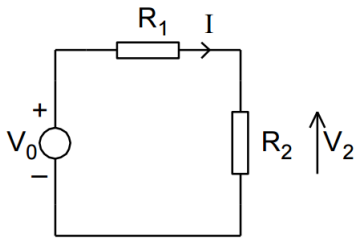
Current that flows all round perimeter of mesh - indicated as clockwise (by convention)



In the above figure I_2 = -I_y and I_3 = -I_y.

1.5 Voltage divider

When two or more resistors connected in series - voltage across each of them is a proportion of the total voltage and is dependant on the value of the resistor.



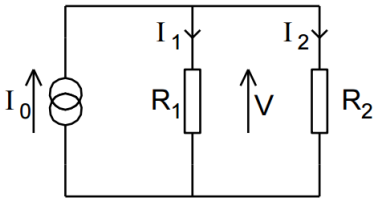
We can calculate voltage across R_2 using:

$$V_2 = V_0 \frac{R_2}{R_2 + R_1} \tag{4}$$

Proof in **Appendix A**.

1.6 Current divider

Much like a voltage divider, a current source divides the current in proportion with the resistance values. A current source in parallel with two resistors forms a current divider.



We can calculate current through1 R_1 using:

$$I_1 = I_0 \frac{R_2}{R_2 + R_1} \tag{5}$$

Proof in **Appendix B**.

1.7 Linearity

A function is considered linear if the sum of two excitations is equal to the sum of the excitations taken seperately.

$$F(X_1 + X_2) = F(X_1) + F(X_2) \tag{6}$$

In normal circuits, only resistors, inductors and capacitors are linear. We can "make" non linear components linear so that modelling with them is a lot easier.

1.8 Ideal voltage source

An ideal voltage source is one that maintains a constant voltage between its terminals regardless of size and direction of current through it.