Introduction to Electrical Engineering

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Contents

1 Lecturer Information

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2 Required Reading

C.A. Desoer and E.S. Kuh: *Basic Circuit Theory*, Mc-Graw-Hill, International Edition.

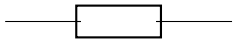
Part I
Basic Definitions and Laws

1 Basic Definitions

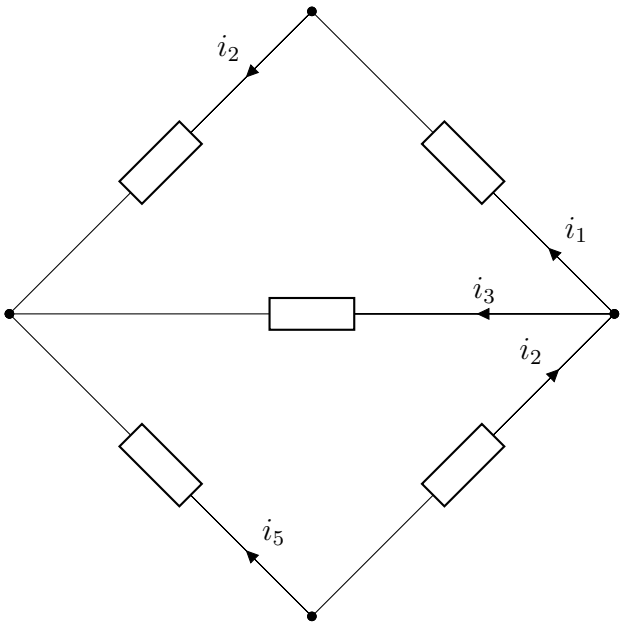
Definition 1 (Electrical circuit)**.** A collection of interconnected components.

Definition 2 (Lumped component)**.** An electrical component whose dimensions are very very small compared to the wavelength of the electromagnetic waves passing through it is called a lumped component.

Definition 3 (One port device)**.** An electrical component with two terminals is called a one port device.



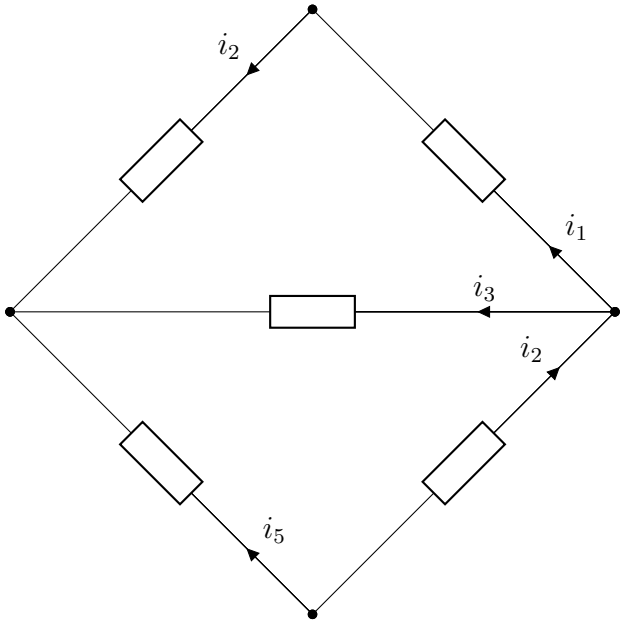
Definition 4 (Nodes and branches)**.** In the figure, all the black dots are called nodes. The parts of the circuit between two nodes are called branches.



2 Kirchoff's Laws

2.1 Kirchoff's Current Law

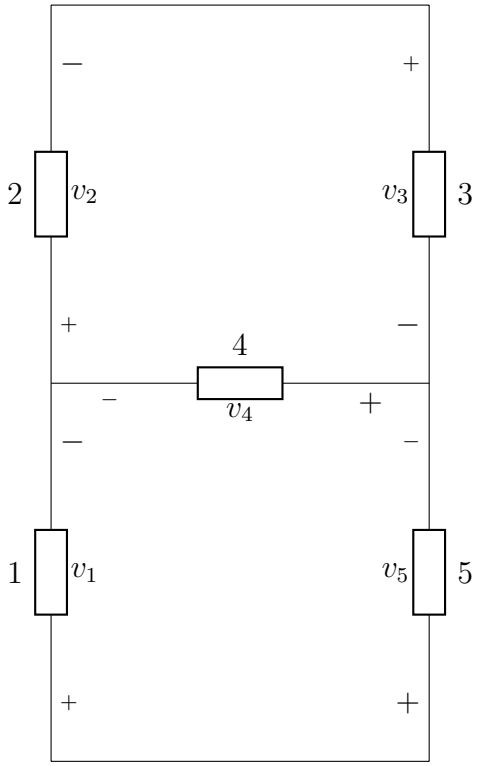
The sum of all currents entering or exiting a node is zero.



$$i_1 + i_3 - i_4 = 0$$

2.2 Kirchoff's Voltage Law

The sum of all branch voltages along a closed loop is zero.



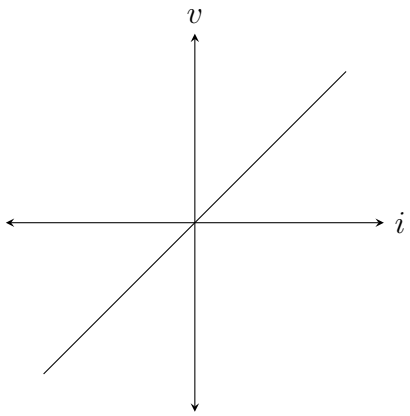
$$v_1 - v_4 - v_5 = 0$$
$$v_2 + v_3 + v_4 = 0$$
$$v_1 + v_2 + v_3 - v_5 = 0$$

3 Components

3.1 Resistors

Definition 5 (Resistor)**.** A two terminal component is called a resistor if the voltage across it at any given time t is a function of the current at the same time t.

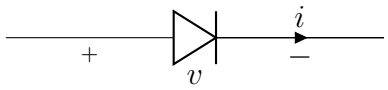
3.1.1 Linear Time Independent Resistor



$$v(t) = R \cdot i(t)$$
$$i(t) = G \cdot v(t)$$

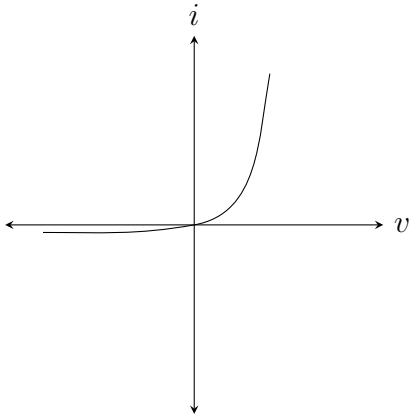
R is called the resistance and G is called the conductance.

3.1.2 Non-linear Resistors (Diodes)



$$i(t) = I_s \left(e^{\frac{q \cdot v(t)}{kT}} - 1 \right)$$

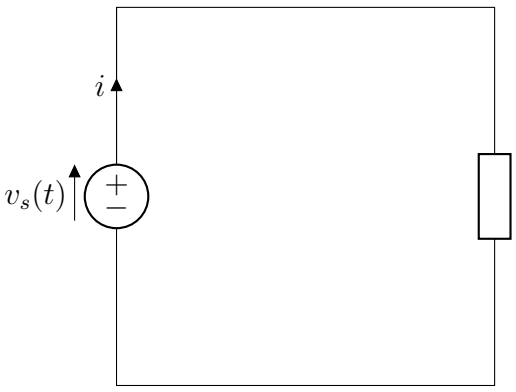
$I_s =$ reverse current
$k =$ Boltzman constant
$T = a$bsolute temperature
$q =$ electronic change
$\frac{kT}{q} = 0.026($ at 300K$)$

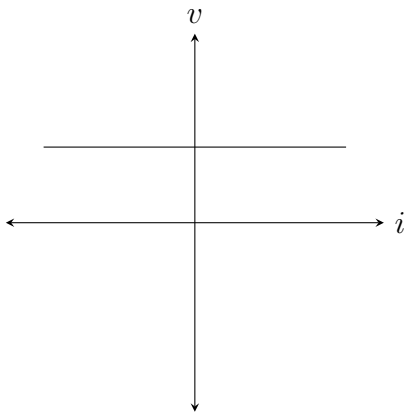


3.2 Independent Sources

3.2.1 Voltage Sources

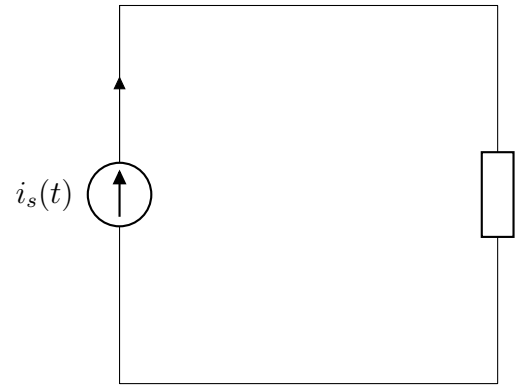
Definition 6 (Voltage source)**.** A two terminal component is called a voltage source if the voltage on its terminals is independent of the current through it.

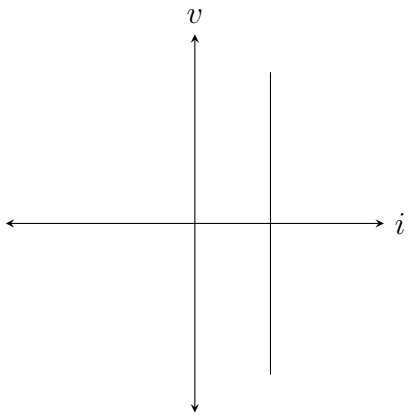




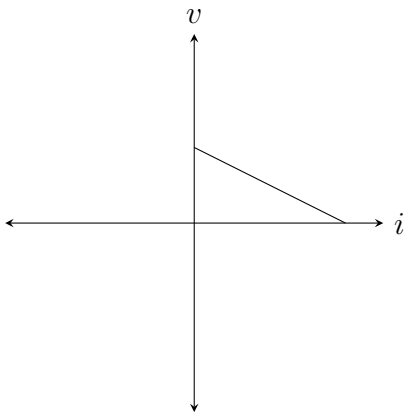
3.2.2 Current Sources

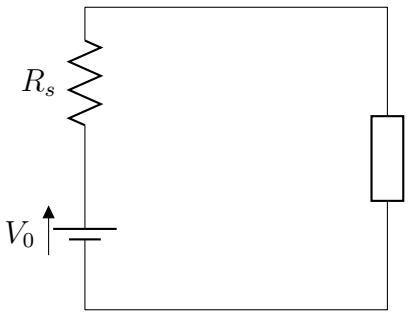
Definition 7 (Current source)**.** A two terminal component is called a current source if it can supply a current $i_s(t)$ independent of the voltage across its terminals.





3.2.3 Real Batteries





$$
\begin{aligned}
0 &= -V_0 + v_R + v \\
v &= V_0 - v_R \\
\therefore v &= V_0 - R_s i
\end{aligned}
$$