EEE141

`Key points and formulae`

- Free electrons (usually from the outermost shell of an atom) carry charge
- Current is the Rate of flow of charged particles

$$I = \frac{Q}{t}$$

- Types of current
  - DC (Direct Current) : Output current constant over time
  - AC (Alternating Current) : Output current fluctuates up and down over time
- Voltage is the energy required to displace a unit charge through a circuit.

$$v = \frac{W}{q}$$

- Types of Materials
  - Conductors : Charge can freely move from one atom to neighboring atoms
  - Insulator : Resists movement of charge
  - Semi-conductors : Resistance greater than traditional conductors but also lower than traditional insulators
- Types of circuit components
  - Passive : Absorb power/energy
  - Active : Deliver power/energy
- Resistance across two points is the ratio between the potential difference and current

$$R = \frac{v}{i}$$

- Conductance is the reciprocal of resistance

$$G = \frac{1}{R} = \frac{i}{v}$$

- Resistance is proportional to length and inversely proportional to cross-sectional area

$$R = \rho\frac{l}{A}$$

- Ohms law states that potential difference/voltage across a component is proportional to current flowing through it, assuming temperature remains constant

$$v = iR$$

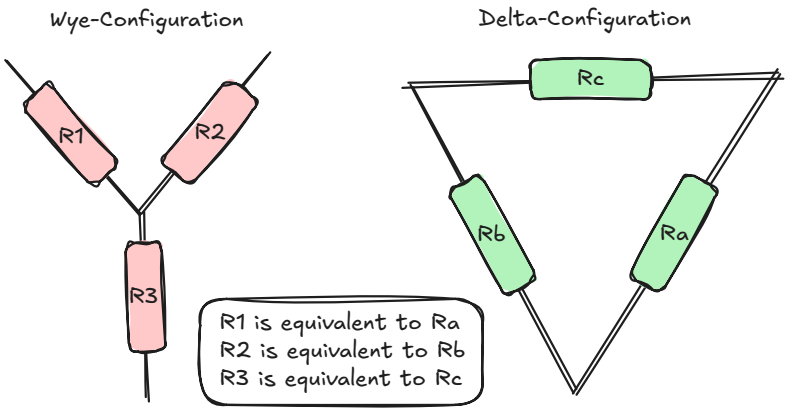
- Power is the rate of change of energy

$$p = \frac{W}{t} = \frac{W}{q} \times \frac{q}{t} = vi$$

- Circuit terminology
  - Branch(b): Single elements
  - Nodes(n): Points where atleast two branches connect
    - Binary nodes : Nodes that connect only two branches
    - Primary/True nodes : Nodes that connect more than two branches
  - Loop(l): Closed path in a circuit
  - $b = l + n - 1$
- Types of connections
  - Series: Elements are in series when they only share binary nodes
    - Current stays constant
    - Voltage varies
    - Total Resistance : $R_T = R_1 + R_2 + R_3 + \ldots + R_N$
  - Parallel: Elements are in parallel when they are connected between the same primary nodes
    - Current varies
    - Voltage stays constant
    - Total Resistance : $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots + \frac{1}{R_N}$
- Kirchhoff's laws
  - Kirchhoff's Current Law (KCL) : Net current entering a node is 0, in other words current entering a node must be equal to current exiting that node.
  - Kirchhoff's Voltage Law (KVL) : Net voltage around a closed loop is 0, in other words all of the energy provided by an active component must be used up by all passive components in a loop.
- Voltage regulation
  - Power lost due to internal resistance of a cell,

$$\% \text{ regulation} = \frac{V_{NL} - V_{FL}}{V_{NL}} \times 100$$

- Wye-Delta Transformation



$$R_1 = \frac{R_b \cdot R_c}{R_a + R_b + R_c} \quad ; \quad R_a = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1}$$

$$R_2 = \frac{R_a \cdot R_c}{R_a + R_b + R_c} \quad ; \quad R_b = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_2}$$

$$R_3 = \frac{R_a \cdot R_b}{R_a + R_b + R_c} \quad ; \quad R_c = \frac{R_1R_2 + R_1R_3 + R_2R_3}{R_3}$$