#ELECNUMBER1

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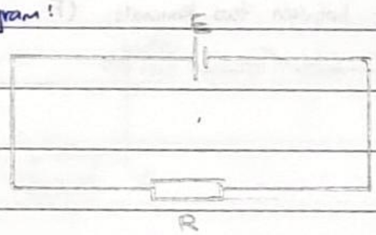
DATE: 18/09/2024

CHAPTER 4 : CIRCUIT THEORIES

4.1 What are the common terms used to describe a circuit?

A. Circuit

- Consists of electrical components connected tgt with wires
  - Batteries, Light bulbs, Switchs
- Provides ≥1 paths for current to flow.
- Diagrams of circuits ⊂ symbols [chap 1] → Circuit Diagram
- E.g. of circuit diagram:

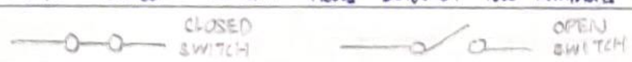


- For current to flow in circuit, there must be a source
- Source provides e.m.f needed to move electric charges around circuit.
- E.g. of sources
  - Batteries
  - Power supply
- The Battery and Power Supply are called direct current (DC) voltage sources
  - Provides CONSTANT emf
- Resistor → load
- Load: Component which converts electrical energy supplied by a source into other forms (light, heat, kinetic)
- Current flows in circuit with cont. path linking +ve terminal to −ve terminal.
  - known as closed circuit.
- Circuit that has a break → open circuit.
- Short circuit: low-resistance path (undesirable & harmful)
  - Current in circuit becomes v. large (overheating)

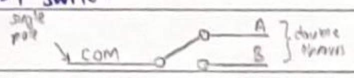
B. Switches.

- Types of switches
  - Single Pole Single Throw [SPST]
  - Single Pole Double Throw [SPDT]
- SPST switch:

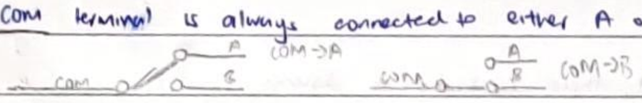
  - when switch closed: current flows between two terminals



- SPDT switch



  - COM terminal is always connected to either A or B.



C. Overloading

- Current rating: max current a wire / component can carry w/o getting overheated
- Overloading happens when current > current rating
- Causes:
  - Using a wire of current rating that is too low.
  - Insulating covering becomes damaged.
    - ↳ Bare wires touch
    - ↳ Causes short circuit
  - Connecting multiple appliances to single mains switch

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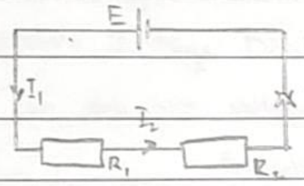
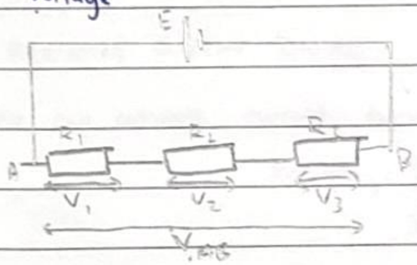
4.2 How do we determine the current and voltage in series circuits?

A. Current



Formula: $I_1 = I_2 = I_3$

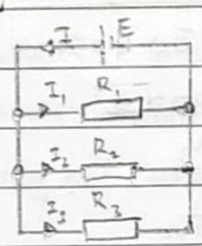
B. Voltage



Formula: $V_{AB} = V_1 + V_2 + V_3$

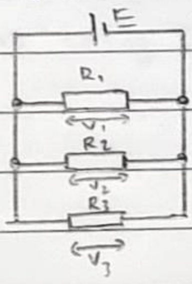
4.3 How do we determine the current and voltage in parallel circuits?

A. Current



Formula: $I = I_1 + I_2 + I_3$

B. Voltage



Formula: $E = V_1 = V_2 = V_3$

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4.4 : How do we determine the current and voltage in series-parallel circuits?

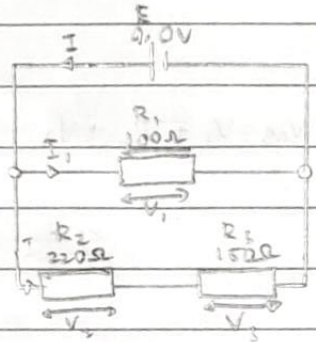
Example 1:

For the circuit in Fig 1, calculate

(a) I_1 ;

(b) I_2 ; and

(c) I_1



(a) $R_1 \parallel E$, $V_1 = E = 9.0V$

$I_1 = \frac{V_1}{R_1}$

$= \frac{9.0V}{100\Omega}$

$= 0.09A$

$= 90mA$ #

(b) R_2 & $R_3 \parallel DC$.

$V_2 + V_3 = E = 9.0V$

$R_{2+3} = R_2 + R_3$

$= 150 + 220$

$= 370\Omega$

$I_2 = \frac{V_2 + V_3}{R_{2+3}}$

$= \frac{9.0}{370\Omega}$

$= 0.024A$

$= 24mA$ #

(c) $I = I_1 + I_2$

$= 90mA + 24mA$

$= 114mA$ #

4.5 How do we use the voltage-divider and current-divider formulae to determine the voltage and current in a circuit?

A. Resistive Voltage Divider

- We can calculate voltage across each resistor using voltage-divider formula

Formula: $V_1 = \frac{R_1}{R_1 + R_2} \times E$

$V_2 = \frac{R_2}{R_1 + R_2} \times E$

B. Resistive Current Divider

- We can calculate current through each resistor using current-divider formula

Formula: $I_1 = \frac{R_2}{R_1 + R_2} \times I$

$I_2 = \frac{R_1}{R_1 + R_2} \times I$

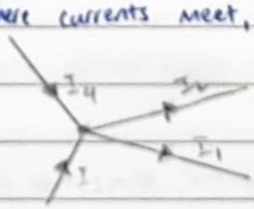
4.6: How do we use Kirchhoff's Voltage and Current Law to determine voltage and current in a circuit?

A. Kirchhoff's Current Law

- Kirchhoff's Current Law (KCL) states that the algebraic sum of ALL currents entering and leaving a node is given by:

$$\Sigma I_{node} = 0$$

- Node: Junction in circuit where currents meet, while 'Σ' means 'sum of'.
- Currents entering (+ve)
- Currents exiting (-ve)



$$I_1 + I_2 - I_3 - I_4 = 0$$

$$I_1 + I_2 = I_3 + I_4$$

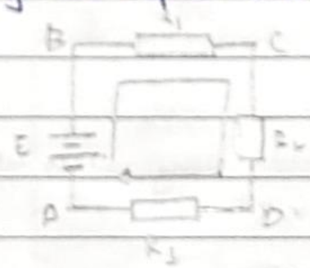
$$\therefore \Sigma I_{entering} = \Sigma I_{leaving}$$

B. Kirchhoff's Voltage Law

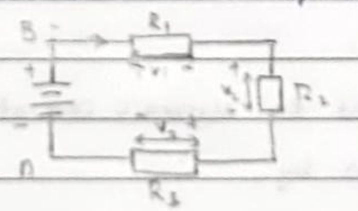
- Kirchhoff's Voltage Law (KVL) states that the algebraic sum of all the voltages within a closed loop is given by:

$$\Sigma V_{loop} = 0$$

- Closed loop: Electrical path starting & ending @ same point
  - can move along the loop in clockwise / anticlockwise



- The polarity of voltages (+, -) across the components is useful to be labelled
  - Sources (label +ve / -ve respectively)
  - Others (current enters → +ve, other end → -ve)



- Voltages that ↑ : +ve
- Voltages that ↓ : -ve