EEE 1203: Electronic Devices and Circuits
1st Year 2nd Semester

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Course Learning Outcome (CLO)

CLO1	Learn basic concepts about semiconductor physics.
CLO2	Know about formation of semiconductor diodes, transistors, and their working principle.
CLO3	Know about amplifiers and other electronic circuits.
CLO4	Construct electronic circuit to operate different semiconductor devices
CLO5	Know about FET, MOSFET, Classification of MOSFET and CMOS.
CLO6	Design of oscillator circuits, their uses and optical electronic devices

Course Content

Topics	Content
Energy Bands in Solids	The nature of the Atom, Atomic energy levels, Valence and conduction bands, Conductors, Semiconductors and Insulators.
Semiconductor Diode and Rectifiers	Semiconductors' characteristics and their types, P-N Junction Diodes and their V-I Characteristics; Zener Diode, Ideal Rectifier Concept, P-N Junction Diode as a Rectifier; Half-wave and Full-wave Rectifiers; Rectifier Filters and Ripple Factor, Voltage Regulator Using Zener Diode, Clipper, Clamper.
Transistor	PNP and NPN Junction Transistors; CB, CE and CC Configurations and their V_c-I_c Characteristics; Transistor Action; Different Types and Biasing; Bias Stabilisation; Operating Point; DC and AC Load Lines; Dynamic Transfer Curve, Current, Voltage and Power Gains. Transistor as a Circuit Element, Transistor Hybrid Parameters
Transistor Amplifiers	Transistor DC Amplifiers; CE, CB and CC Amplifiers and their Equivalent Circuits; Class A, Class B and Class C Amplifiers, class AB pushpull Amplifier
Feedback Circuits	Feedback Principles and Characteristics; Current and Voltage Feedback Amplifiers; Positive and negative feedback.
Oscillators	Oscillators and Conditions for Sustained Oscillations; RC Phase Shift, Collpit and Crystal Oscillators.
MOS devices	Introduction to JFET, MOSFET, PMOS, NMOS& CMOS: biasing & application in switching circuits.
Optoelectronic devices	PN & PIN photodiode, phototransistor; solar cell, photocell, LED, LCD & alphanumeric display.

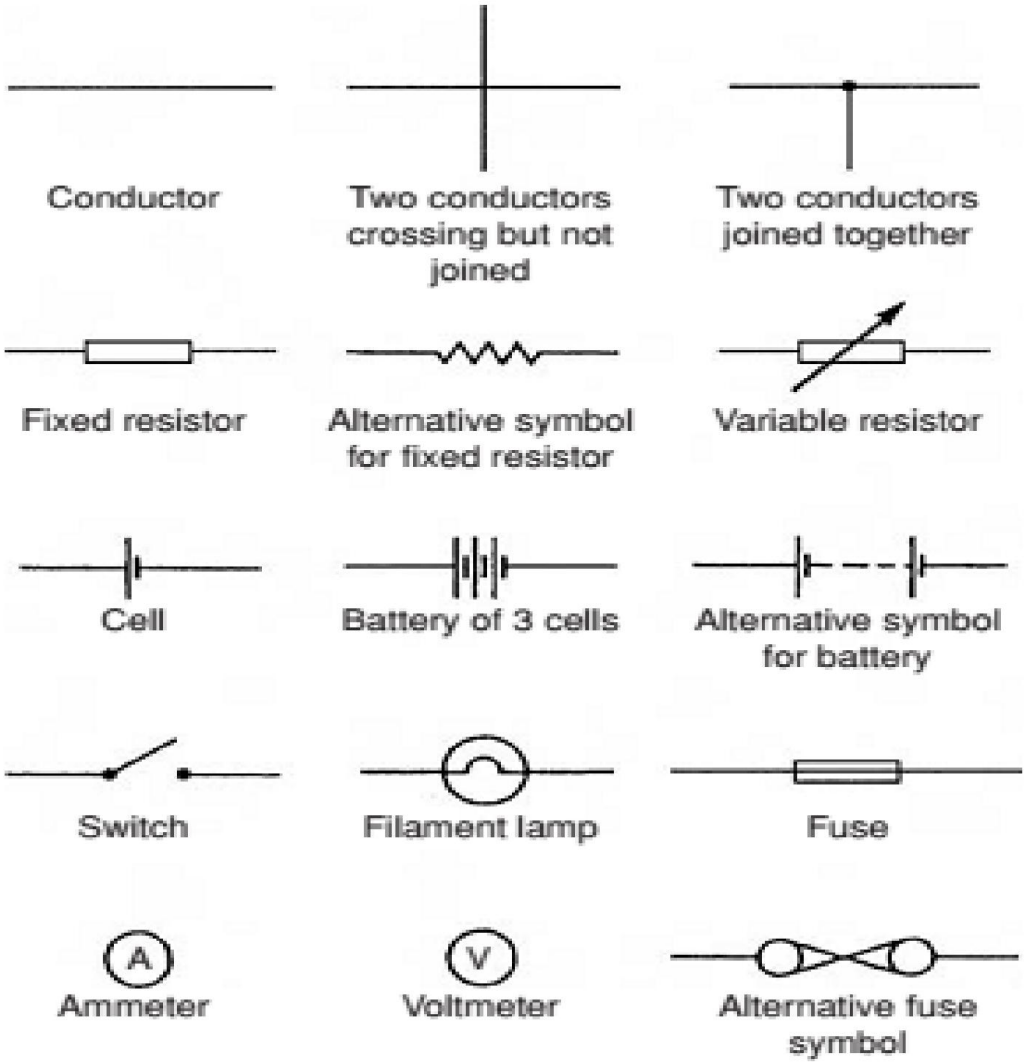
Basics of Electrical Engineering

- The unit of charge is coulomb (C). (1 coulomb = 6.24×10^{18} electrons).
  - C = I*t (where I is the current in amperes and t is the time in seconds)
- The unit of electric potential is the volt (V), where one volt is one joule per coulomb.

$$\text{volts} = \frac{\text{watts}}{\text{amperes}} = \frac{\text{joules/sec ond}}{\text{amperes}} = \frac{\text{joules}}{\text{coulombs}}$$

- A change in electric potential between two points in an electric circuit is called a potential difference.
- The electromotive force (e.m.f.) provided by a source of energy such as a battery or a generator is measured in volts.

Standard symbols for electrical components



Basic electrical measuring instruments

- An **Ammeter** is an instrument used to measure current and must be connected in series with the circuit.
  - Since all the current in the circuit passes through the ammeter it must have a very low resistance.
- A **Voltmeter** is an instrument used to measure potential difference (p.d.) and must be connected in parallel with the part of the circuit whose p.d. is required. A voltmeter must have a very high resistance.
- An **Ohmmete**r is an instrument for measuring resistance.
- A **Multimeter**, or universal instrument, may be used to measure voltage, current and resistance. AVO meter (Ampere, Volt, Ohms)'
- The **Oscilloscope** may be used to observe waveforms and to measure voltages and currents.

Some Important Terms and Laws

- **Ohm's law** states that the current I flowing in a circuit is directly proportional to the applied voltage V and inversely proportional to the resistance R, provided the temperature remains constant.
- **Power** P in an electrical circuit is given by the product of potential difference V and current I.

  The unit of power is the watt, W. $P = V \times I = I^2R = V/R^2$ watts
- **Electrical energy** = power × time
- **A conductor** is a material having a low resistance which allows electric current to flow in it. All metals are conductors and some examples include copper, aluminium, iron etc.
- An **insulator** is a material having a high resistance which does not allow electric current to flow in it. Some examples of insulators include plastic, rubber,

Some Important Terms and Laws

- **Resistance** - It may be defined as the property of a substance due to which it opposes (or restricts) the flow of electricity (i.e., electrons) through it. Unit of resistance is ohm (Ω).
- **Laws of Resistance** - The resistance R offered by a conductor depends on the following factors :
  - It varies directly as its length, l.
  - It varies inversely as the cross-section A of the conductor.
  - It depends on the nature of the material.
  - It also depends on the temperature of the conductor.
- **Resistivity** (ρ) is a measure of the resistance of a given size of a specific material to electrical conduction.
  - $\rho = AR/L$ (A = cross section; R = Resistance; L = Length)
  - Important parameter for all substances associated with electrical usage, electronic circuit design, etc.

Some Important Terms and Laws

- **Conductance** (G) is reciprocal of resistance.

$$R = \rho \frac{l}{A} \quad \text{or} \quad G = \frac{1}{\rho} \cdot \frac{A}{l} = \frac{\sigma A}{l}$$

where σ is called the **conductivity** or **specific conductance** of a conductor

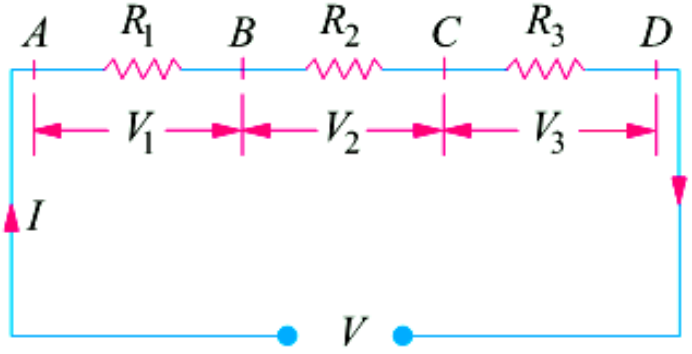
$$\sigma = G \frac{l}{A} = \frac{G \text{ siemens} \times l \text{ metre}}{A \text{ metre}^2} = G \frac{l}{A} \text{ siemens/metre}$$

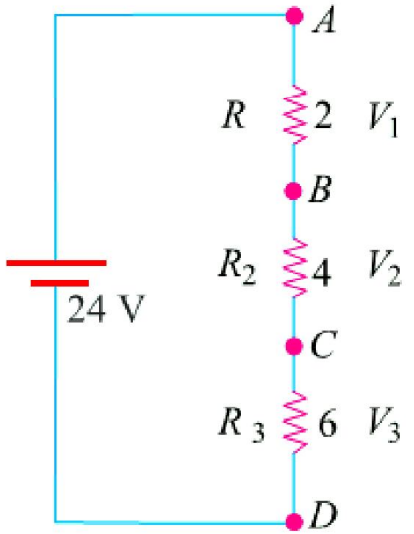
the unit of conductivity is siemens/metre (S/m).

Some Important Terms and Laws

Voltage Divider Network (Series)

- Being a series circuit, it should be remembered that
  - current is the same through all the conductors
  - voltage drop across each is different due to its different resistance and is given by Ohm's Law
  - sum of the voltage drops is equal to the voltage applied across the conductors.
  - resistances are additive
  - powers are additive.





$$V_1 = V \cdot \frac{R_1}{R} = 24 \times \frac{2}{12} = 4\ \text{V}$$

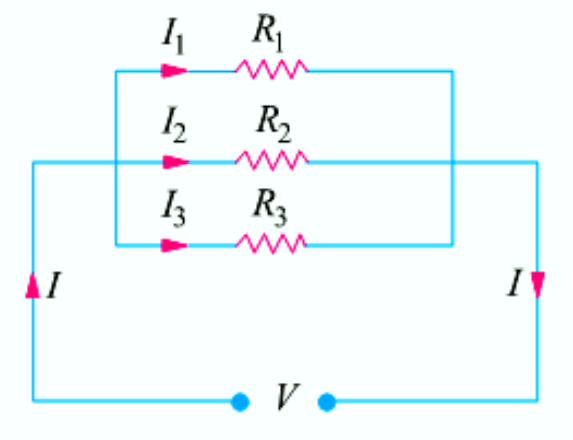
$$V_2 = V \cdot \frac{R_2}{R} = 24 \times \frac{4}{12} = 8\ \text{V}$$

$$V_3 = V \cdot \frac{R_3}{R} = 24 \times \frac{6}{12} = 12\ \text{V}$$

$$R = R_1 + R_2 + R_3 = 12\ \Omega$$

Some Important Terms and Laws

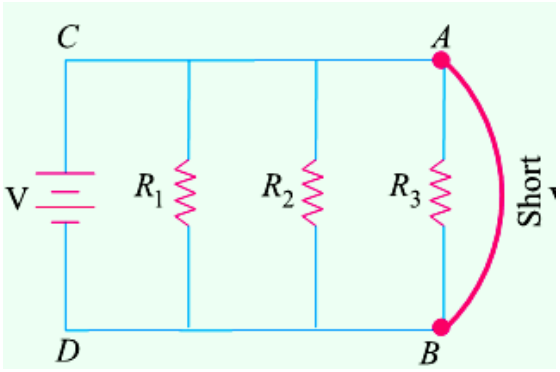
- **Resistances in Parallel**
- The main characteristics of a parallel circuit are :
  - same voltage acts across all parts of the circuit
  - different resistors have their individual current.
  - branch currents are additive.
  - conductances are additive.
  - powers are additive.
- **'Shorts' in Parallel Circuits**
  - short across one branch means short across all branches.



$$I = I_1 + I_2 + I_3 = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$I = \frac{V}{R}$ where V is the applied voltage.

$$\frac{V}{R} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3} \quad \text{or} \quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$



Some Important Terms and Laws

Different electric circuits

- **Circuit -** A circuit is a closed conducting path through which an electric current either flows or is intended flow.
- **Parameters -** The various elements of an electric circuit are called its parameters like resistance, inductance and capacitance. These parameters may be lumped or distributed.
- **Liner Circuit -** A linear circuit is one whose parameters are constant i.e. they do not change with voltage or current.
- **Non-linear Circuit** - It is that circuit whose parameters change with voltage or current.
- **Bilateral Circuit -** A bilateral circuit is one whose properties or characteristics are the same in either direction.
  - The usual transmission line is bilateral, because it can be made to perform its function equally well in either direction.

Some Important Terms and Laws

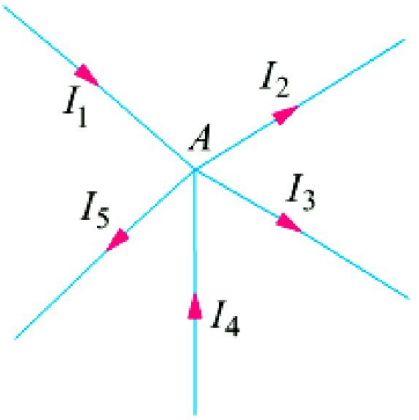
Different electric circuits

- **Unilateral Circuit -** It is that circuit whose properties or characteristics change with the direction of its operation.
  - A diode rectifier is a unilateral circuit, because it cannot perform rectification in both directions.
- **Electric Network -** A combination of various electric elements, connected in any manner whatsoever, is called an electric network.
- **Passive Network** is one which contains no source of e.m.f. in it.
- **Active Network** is one which contains one or more than one source of e.m.f.
- **Node** is a junction in a circuit where two or more circuit elements are connected together.
- **Branch** is that part of a network which lies between two junctions.
- **Loop -** It is a close path in a circuit in which no element or node is encountered more than once.

Some Important Terms and Laws

KCL and KVL

- **Kirchhoffs First Law – The Current Law, (KCL)**
- **Kirchhoffs Current Law** or KCL, states that the "*total current or charge entering a junction or node is exactly equal to the charge leaving the node as it has no other place to go except to leave, as no charge is lost within the node*".
- In other words the algebraic sum of ALL the currents entering and leaving a node must be equal to zero,



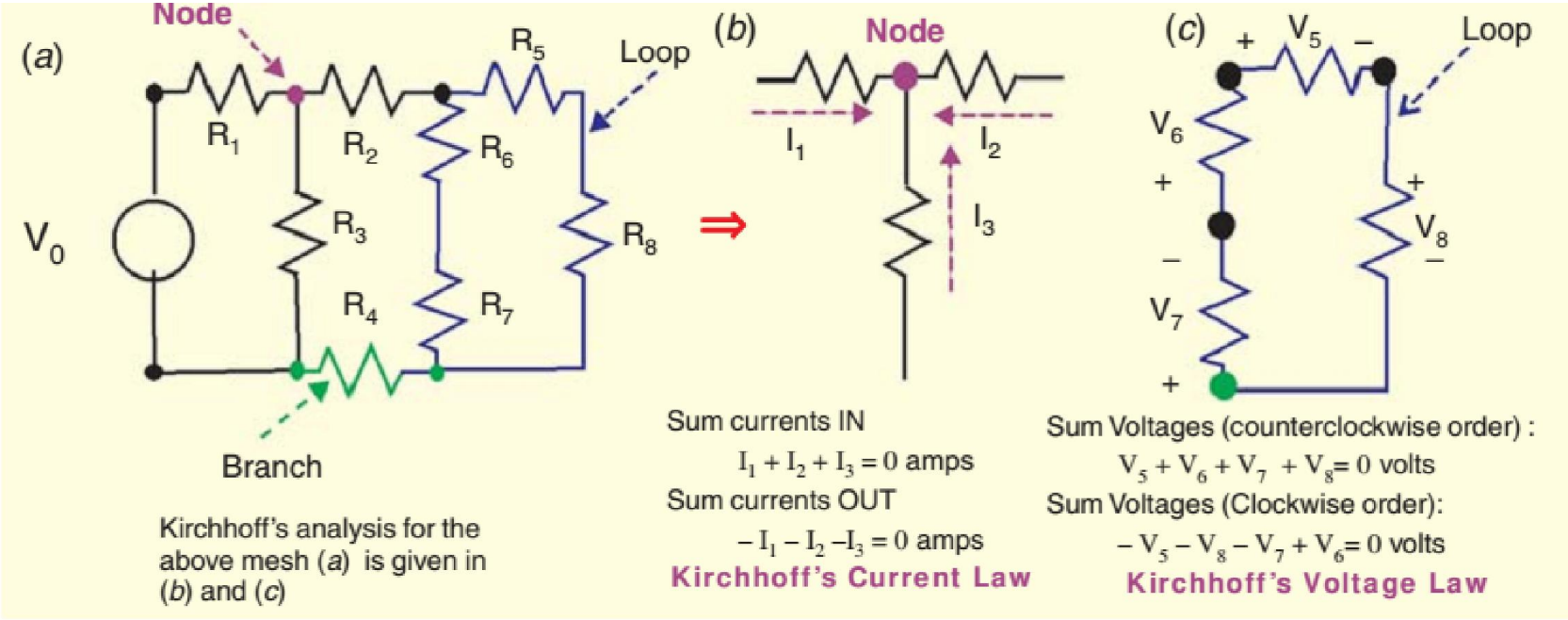
$$I_1 + (-I_2) + (-I_3) + (+I_4) + (-I_5) = 0$$

$$I_1 + I_4 - I_2 - I_3 - I_5 = 0 \quad \text{or} \quad I_1 + I_4 = I_2 + I_3 + I_5$$

incoming currents = outgoing currents

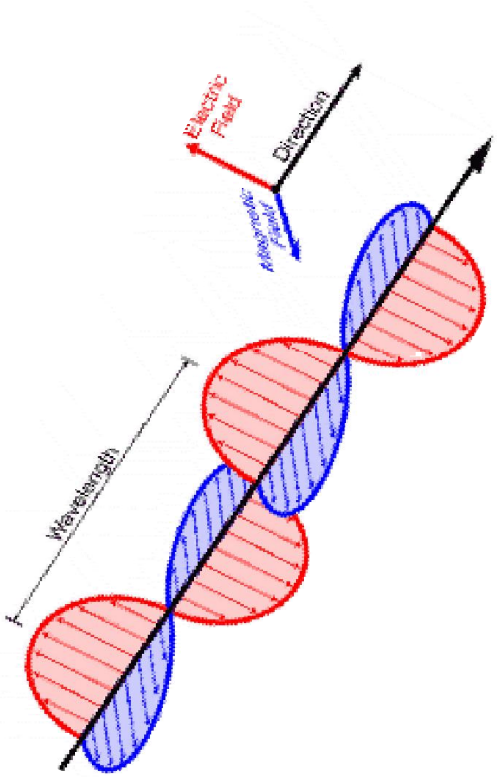
Some Important Terms and Laws

- **Kirchhoffs Second Law – The Voltage Law, (KVL)**
- **Kirchhoffs Voltage Law** or KVL, states that "*in any closed loop network, the total voltage around the loop is equal to the sum of all the voltage drops within the same loop*" which is also equal to zero.
- In other words the algebraic sum of all voltages within the loop must be equal to zero.



Different Types of Electrical Waves

Types of Periodic Waveform



Electromagnetic waves