Unit - II

Date :- 29/04/2024

Fundamental of EL & EC Engineering

Unit - II (Electrical Fundamental).

Topic :- Electricity

- Electric charge :- is the property of subatomic particles that causes it to experience a force when placed in an electromagnetic field.

There are two type of charge :-

* Positive charge.
* Negative charge.

(Same charge repel each other and different charged attract each other).

* S.I unit of charge is Coulomb (C).
* 1 Coulomb means 6.24×10^{18} electron.
* An electron has ~~highest~~ negative charge of 1.6×10^{-19} C.

✓ Electric Current :- The rate of flow of electric charge through a conductor.

It is denoted by I or i.

i.e $I = \frac{dQ}{dt}$ or $I = \frac{Q}{t}$ ✓

Its S.I unit is ampere (A). [Ammeter).

✓ Electric potential :- Electric potential at a point within an electric field in the amount of work done in bringing an unit +ve charge from infinite to the point.

(Scaler quantity).

It is denoted by V.

Its S.I unit is Volt (V). [Measured by Voltmeter]

• Voltmeter is always connected in parallel.

Resistance :- It is opposition or the obstruction offered by conductor to the passage of drifting electron.

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- Potential difference :- Potential difference between two point within an electric field in the amount of work done in bringing a unit tve charge from one point to another point.

- Resistance of a material is its property by virtue of which its opposes the flow of current through it.
  It is denoted by R or r.
  Its S.I unit is ohm (Ω).
  Measured by ohmmeter. (Meger - Surface).

- Ohm's law :- The relation between potential difference and current is called ohm's law.
  Potential difference ∝ Electric current.
  $V \propto I$
  $[V = I \cdot R]$

- Voltage :- The "pressure" the pushes electricity.

- EMF (electromotive force) :- The total difference in electrical potential between the terminal of cell, when it is not doing any external work.

- [When no current is drawn from a cell, the potential difference between the terminal of the cell is called its emf.]

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- Describe the source of electrical energy.

i) Hydral power
⇒ Hydro power is electricity generated by harnessing the energy of flowing or falling water. This energy is converted into electrical power using turbines and generators.

ii) Thermal power plant
⇒ A thermal power plant is a place where electricity is made using heat. They burn things like coal or gas to create steam which turns to generate electricity.

iii) Nuclear power
⇒ Nuclear power is electricity made by splitting atoms. This process releases a lot of heat, which is used to make steam and turn turbines for generating electricity.

iv) Petrolium & gas power plant
⇒ A petrolium and gas power plant is a place where electricity is produced by burning oil or natural gas. This burning creates heat which is used to make steam and turn turbines to generate electricity.

v) ~~Wind power plant~~ Solar power plant
⇒ A ~~wind~~ solar power plant is a place where electricity is made using sunlight panels called solar panels. Soak up sunlight and turn it into electricity.

vi) Wind power plant

⇒ A Wind power plant is a place where electricity is made using wind. Big wind mills catch the wind and spin, turning turbines to generate electricity.

vii) Bio-gas plant

⇒ A bitgas plant is where gas is made from waste. It used things like food scraps, man use or plants which break down and produced gas that can be used for cooking or making electricity.

viii) Geo-thermal energy.

⇒ Geothermal energy is heat from the earth. We use it to make electricity or to heat building.

- ~~Electrical Work~~

3) • Mention meters used to measure different electrical quantities.

⇒* Ammeter, Voltmer, Wattmeter, ohmmeter, Digital multimeter, Megger, Tong tester.

4) Explain Supply System like AC and DC.

⇒ AC (Alternating Current)

- AC is easy to transferred over longer distance even between two cities without much energy loss.
- The rotating magnets cause the change in direction of electric flow.
- The frequency of AC is dependent upon the

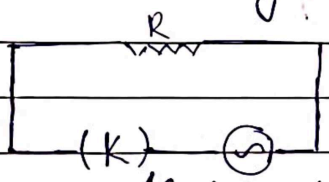
Country, But generally the frequency is 50 Hz. or 60 Hz.

- In AC the flow of current changes its direction forward and backward periodically.

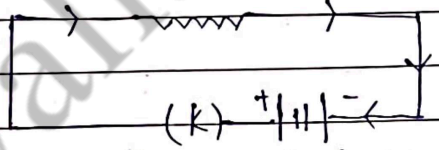
Dc (Direct Current)

- Dc cannot be transferred over a very long distance. It loses electric power.

- The steady magnetism make Dc flow in a single direction.
- Dc has no frequency or Zero frequency.
- It flow in single direction.



AC power source



Dc power source. (Constant)

Relationship between V, I and R.

- Ohm's law state that current flowing through the conductor is directly proportional to voltage cross the conductor is inversely proportional to the resistance of the conductor, kept temperatures remain constant.

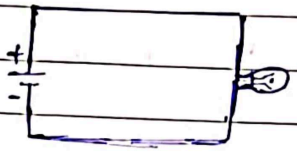
$$I = \frac{V}{R}, \quad V = IR, \quad R = \frac{V}{I}$$

Describe open circuit, close circuit and short circuit:

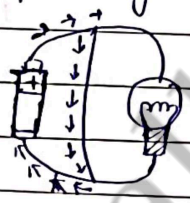
- Open Circuit :- An open circuit is a circuit in which the path is incomplete which means there is no flow of current.

$I \propto \frac{1}{R}$

- Closed Circuit : A closed circuit is a circuit in which the path is complete and there is flow of current.



- Short Circuit : A short circuit is a circuit which offer very little resistance to current flows and can cause dangerously high current flow through a circuit.



Electric Circuit :- A continuous conducting path, between the terminals of source of electricity such as cell, battery is called an electric circuit.

Behaviour of V, I in series and parallel DC Circuit.

- Series DC Circuit

⇒ In a series DC circuit, the same current flows through all components and the total voltage is the sum of individual voltage drops across resistor.

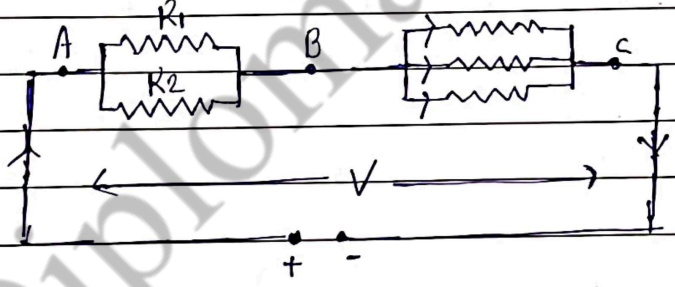
- The voltage is divided among resistors, with different voltage drops across each based on their resistance value.
- The total effective resistance in a series circuit is the sum of individual resistance.
- The behaviour of voltage and current in a series DC circuit follows ohm's law where ~~Vot~~ voltage

is directly proportional to resistance and current is constant throughout the circuit.

- Parallel DC Circuit:

→ In a parallel DC circuit, components share a common voltage but have different currents flowing through them. The total current drawn from the source equals the sum of currents through each component.

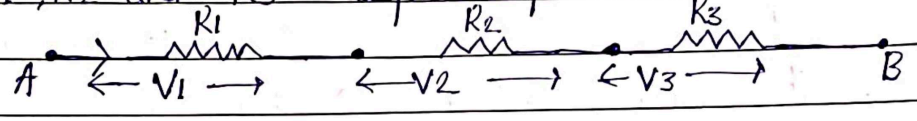
- The voltage across all components in parallel is the same as the source voltage.
- Current in parallel circuit divides among the paths available, flowing ohm's law inversely proportional to resistance.
- The total circuit current equals the sum of individual branch current in a parallel circuit.



DC Series, parallel circuit.

Equation to find the effective Resistance connected in Series:

⇒ Consider three resistor in series as shown, with resistance R_1, R_2 and R_3 respectively



If V_1, V_2 and V_3 are potential difference across them respectively, the total potential difference across the the system of resistor.

$V = V_1 + V_2 + V_3$

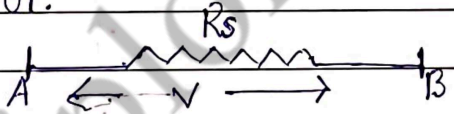
~~(Since the Current through them in the same).~~

i.e $V = IR_1 + IR_2 + IR_3$

$= I(R_1 + R_2 + R_3)$ — (1)

(Since the Current through them in the same).

Let the three resistors be placed by a single resistor of resistance R_s called the equivalent or effective resistor.



Hence for equivalent resistor, $V = IR_s$ → (2)

from (1) and (2).

We have, $R_s = R_1 + R_2 + R_3$.

CRO → (Cathode Ray Oscilloscope)

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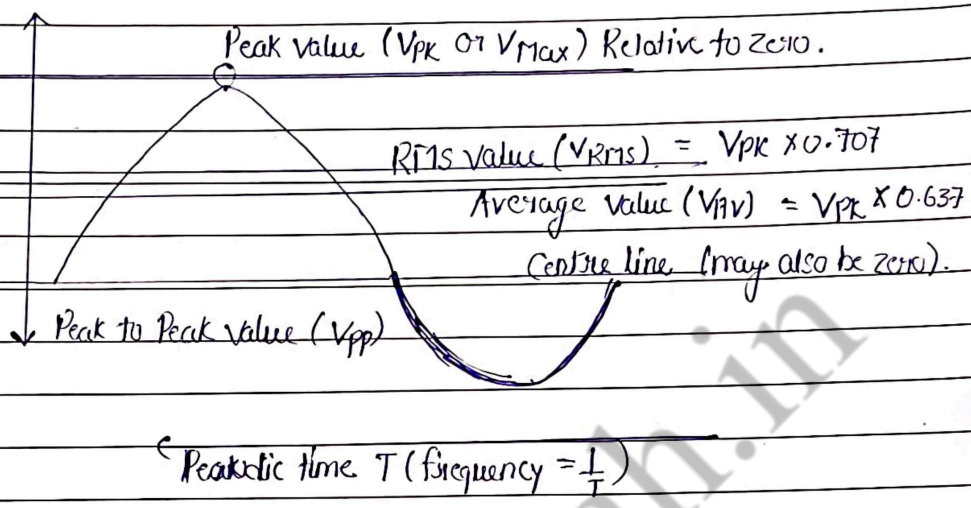
AC Sine Wave



Sinusoidal Voltage → Alternators produce Sinusoidal alternating Voltage i.e alternating Voltage is a Sine Wave.
A Sinusoidal alternating Voltage can be produce by rotating a coil with a constant angular Velocity in a uniform magnetic field.
The Sinusoidal alternating Voltage can be expressed by the equation,

$$V = V_m \sin \omega t$$

Where
V = Instantaneous Value of alternating Voltage
Vm = Max, Value of alternating voltage
(omega) ω = Angular Velocity of the coil. ($2\pi n$)

Sinusoidal Voltage always produce Sinusoidal Currents, unless the Circuit is non-linear.
Therefore, a Sinusoidal Voltage can expressed in the same way as Voltage i.e $i = I_m \sin \omega t$.

i = Instantaneous Current
I_0 = peak value of " "
e = Instantaneous Emf
E_0 = Peak value of " "

Resistor I = V =
Inductor I ∝ 1/L
Capacitor V ∝ 1/C

(1.5 volt) → Cell

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- Amplitude / Peak Value / Maximum Value
Amplitude of an alternating current (voltage or current) is the instantaneous value of that alternating quantity when it reaches its maximum value, either in the positive or negative direction. It occur twice during each cycle.

- Time period :- Time taken by an alternating current to complete one cycle is called the time period. ($T = 1/f$).

- Frequency :- The number of cycles that a sine wave complete in one second. is measured in Hertz (Hz).

(Ques.) Phase / Phase angle :- The development of an alternating quantity (current or voltage) through different stage is known as phase or phase angle.

- Phase difference : The phase difference refers to the time intervals by which one wave is behind or ahead of the waveform. Expressed in electrical degree or radians.

Electrical Work :- When certain charge is transferred from one point to another point, in an electric circuit, against a potential difference, the electrical work is said to be done or electrical energy expended.

Unit :- Joule / watt second

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In other word :- If a charge of Q Coulombs is transferred between two points of an electrical circuit against a potential difference of E-Volts, then electrical work is done.

∴ It is measured by using Energy meter in Kwhr.

Electric power :- The rate of doing electric work is called electric power.

$$\text{Electric power} = \frac{\text{Electric Work done}}{\text{Time taken.}}$$

S.I unit of electric power is watt.
When one joule of energy is used for 1 Second, electric power is equal to one watt.