FUNDAMENTALS OF ELECTRICAL AND ELECTRONICS ENGINEERING

CHAPTER 4 SOLUTION

PARUL UNIVERSITY

DIPLOMA STUDIES

ELECTRICAL ENGINEERING DEPATEMENT

CHAPTER – 4 ELECTRIC CIRCUIT

2 MARKS QUESTIONS

1. Define the terms 1) electric current 2) Potential difference.

Electric current: If there are less than 4 electrons in the outer orbit of the atomic structure they are known as free electrons, this free electron is having tendency to move from one atom to another atom when they experience any external force. Free electrons are electrically charged. This movement of free electrons are termed as electric current.

It is represented by the letter I, and unit is ampere.

Potential Difference: Work required to be done (or energy needed) to move unite positive charge from one point to another in the circuit is called voltage or the potential difference.

Voltage = work or energy/charge. Voltage = W/Q

2. State law of energy conversion.

Energy conversion, also termed as energy transformation, is the process of changing one form of energy into another. Energy conversion occurs everywhere and every minute of the day. There are numerous forms of energy like thermal energy, electrical energy, nuclear energy, electromagnetic energy, mechanical energy, chemical energy, sound energy, etc. On the other hand, the term Energy Transformation is used when energy changes forms from one form to another. Whether the energy is transferred or transformed, the total amount of energy doesn't change and this is known as the Law of Conservation of Energy.

The first law of thermodynamics states that

"Energy can neither be created nor destroyed, it can only be transformed from one form to another".

3. Define the terms 1) Inductor 2) Capacitor.

Inductor: Inductors much like conductors and resistors are simple components that are used in electronic devices to carry out specific functions. Normally, inductors are coil-like structures that are found in electronic circuits. The coil is an insulated wire that is looped around the central core.
Inductors are mostly used to decrease or control the electric spikes by storing energy temporarily in an electromagnetic field and then releasing it back into the circuit.

The S.I. unit of inductance is henry (H) and when we measure magnetic circuits it is equivalent to weber/ampere. It is denoted by the symbol L.

Capacitor: A capacitor is a little like a battery but they work in completely different ways. A battery is an electronic device that converts chemical energy into electrical energy whereas a capacitor is an electronic component that stores electrostatic energy in an electric field.
capacitor is a two-terminal electrical device that possesses the ability to store energy in the form of an electric charge. It consists of two electrical conductors that are separated by a distance. The space between the conductors may be filled by vacuum or with an insulating material known as a dielectric. The ability of the capacitor to store charges is known as capacitance.

4. Define the terms 1) E.M.F 2) Resistance.

E.M.F: Flow of electric charge is essential to make current to flow through a conductor. So, it is necessary to do work. And to do work, energy is required. This energy is supplied by battery. This is called electro motive force.
The force required to move the electrons from one point to another point is called electro motive force. **Its unit is volt and represented by a letter E.**

Resistance: The property of a material to oppose the flow of electric current through it is called resistance. When a conductor is given emf, electric current flows due to the flow of free electrons. When these electrons move, they collide with the atoms. So, flow of electric current is opposed. Due to this Collison, some kinetic energy is converted in to heat energy. Crystalline structures of different materials are different. So, all materials do not oppose the flow of electric current equally. That means resistance of different material is different.

It is denoted by letter R. Its unit is ohm (Ω).

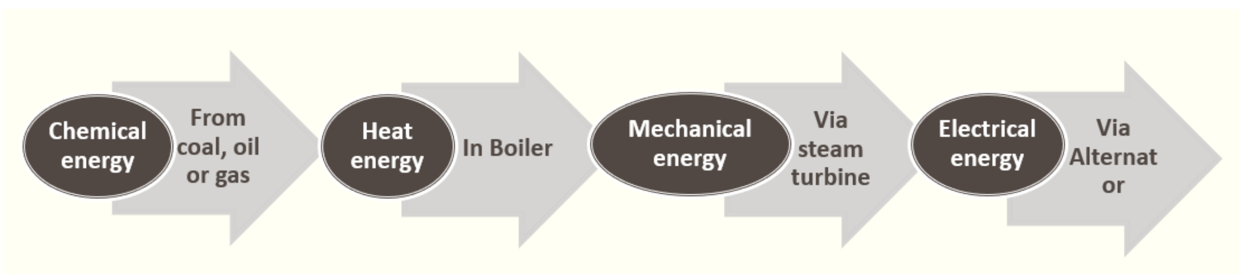
R= V/I

3 MARKS QUESTIONS

1. Draw and explain flow chart of energy transformation in thermal power and nuclear plant.

Thermal power plant

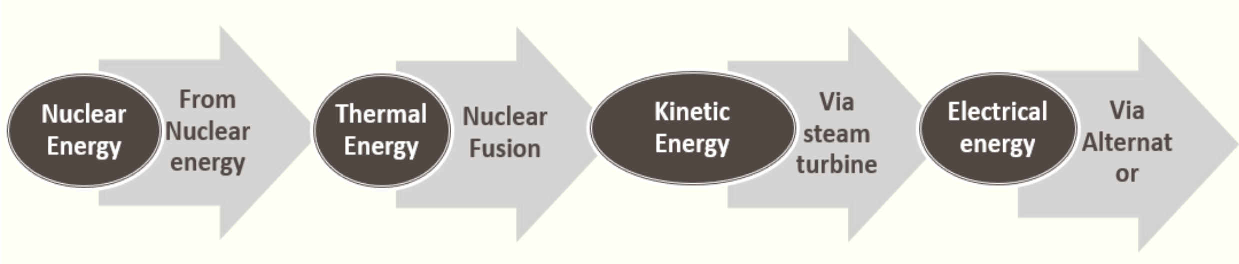
Water is heated in a boiler. Using the thermal energy released due to burning of coal, steam of very high temperature and pressure is generated. The energy in the steam drives the turbine. Thus, the generator connected to the turbine rotates and electrical energy is produced.



Energy conservation in thermal power plant

Nuclear power plant

Nuclear power plants consist of nuclear reactors. These reactors use uranium rods as fuel and heat is generated by the process of nuclear fission. Neutrons smash into the nucleus of the uranium atoms, which roughly split into half and release energy in the form of heat. Carbon dioxide gas is pumped through the reactor to take the heat away. The hot gas then heats water to form steam. This steam drives the turbines of generators to produce electricity. Thus, the steps of energy conversion are:



Energy conservation in nuclear power plant

2. Give comparisons between A.C and D.C forms of electricity.

Alternating Current	Direct Current
AC is safe to transfer longer distance even between two cities, and maintain the electric power.	DC cannot travel for a very long distance. It loses electric power.
The rotating magnets cause the change in direction of electric flow.	The steady magnetism makes DC flow in a single direction.
The frequency of AC is dependent upon the country. But generally, the frequency is 50 Hz or 60 Hz.	DC has no frequency of zero frequency.
In AC the flow of current changes its direction backwards periodically.	It flows in a single direction steadily.
Electrons in AC keep changing its directions – backward and forward	Electrons only move in one direction – that is forward.

3. Give difference between E.M.F and Potential Difference.

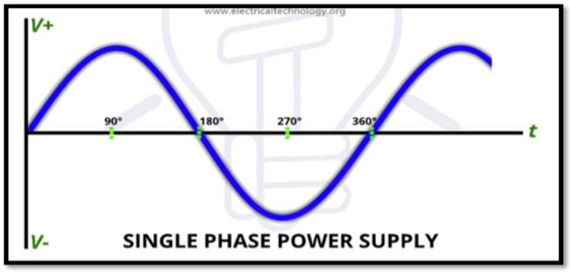
Flow of electric charge is essential to make current to flow through a conductor. So, it is necessary to do work. And to do work, energy is required. This energy is supplied by battery. This is called electro motive force.

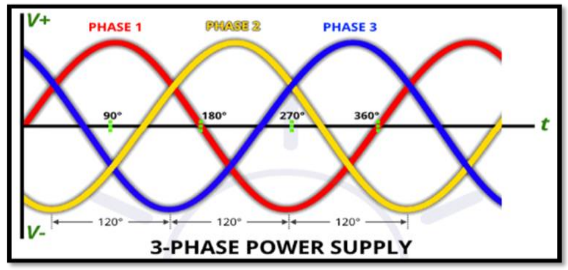
Work required to be done (or energy needed) to move unite positive charge from one point to another in the circuit is called voltage or the potential difference.

E.M.F Shows the reason while potential difference represents the effect.

4. Give comparisons between 1-phase and 3-phase supply.

- In a single-phase connection, the flow of electricity is **through a single conductor.** A three-phase connection, on the other hand, consists **of three separate conductors that are needed for transmitting electricity.**
- In a single-phase power supply system, the **voltage may reach up to 230 Volts.** But on a three-phase connection, it can carry a **voltage of up to 415 Volts.**
- For smooth flow of electricity on a single-phase connection, it requires two separate wires. **One represents the neutral wire and another one represents a single phase.** These are required to complete the circuit. In a three-phase connection, the system requires **one neutral wire and three-phase wires to complete the circuit.**
- **Maximum power gets transmitted on a three-phase connection compared to a single-phase power supply.**
- A single-phase connection consists of two wires that make a simple network. But the network is complicated on a three-phase connection because there are four different wires.
- **Because a single-phase connection has one phase wire, if anything happens to the network, the complete power supply gets interrupted.** However, in a three-phase power supply, if anything happens to a single phase the other phases still work. As such, there is no power interruption.
- Regarding efficiency, a single-phase connection is less compared to a three-phase connection. This is because a three-phase supply needs less conductor compared to a single-phase power supply for the same circuit.





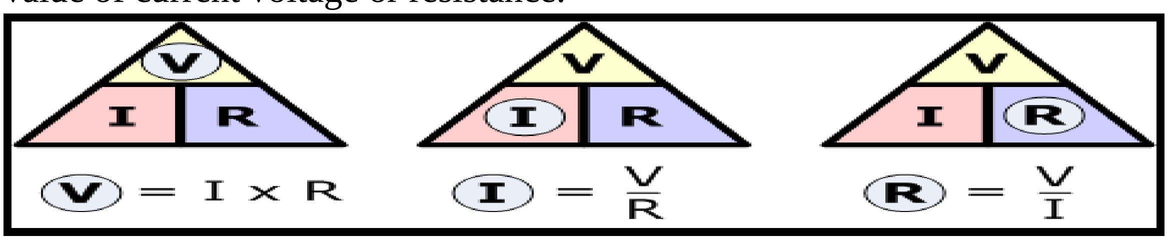
4-MARKS QUESTIONS

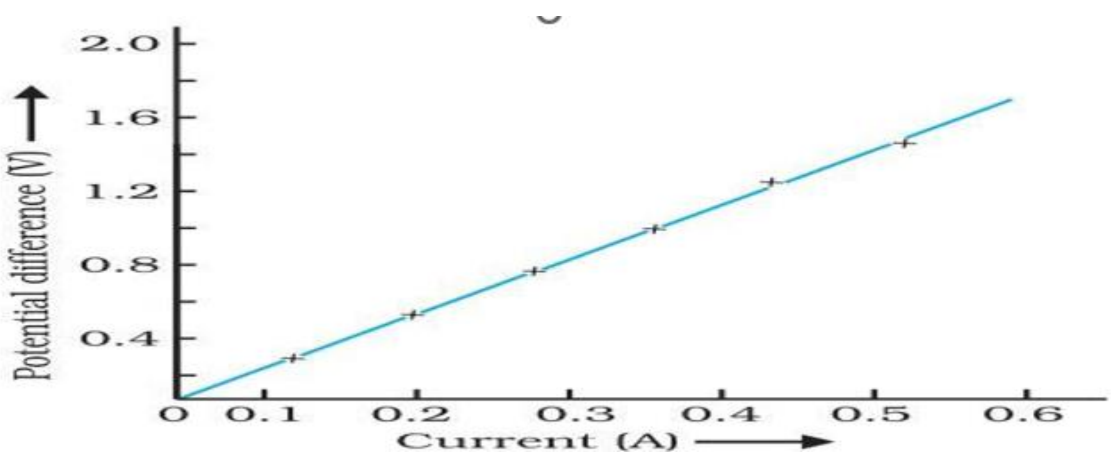
1. State and explain ohm's law with its limitation.

Ohm's law establishes relation between the voltage V applied to a conductor and current I passing through it. It can be given as below:
"If the temperature remains constant, ratio of applied voltage V applied across the conductor and current I flowing through it remains constant.

So, ratio V/I = constant. (Constant is replaced with resistance R).
So, V/I = R. (where V = voltage, I = current and R= resistance).

If in above equation if the value of voltage V= 1 Volt, current I = 1 Amp., the resistance R = 1ohm. So, with the help of ohm's law, we can find the value of current voltage or resistance.





Limitations of Ohm's Law

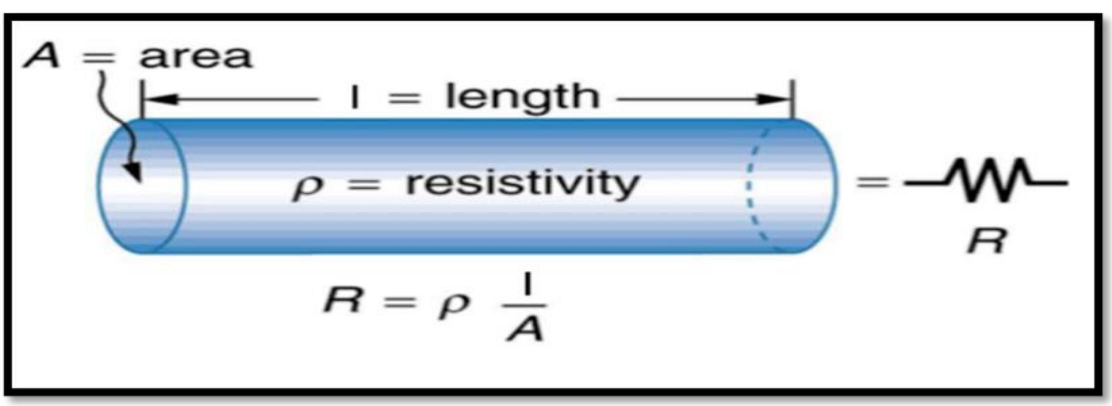
- Ohm's law can be applied only when temperature is constant. Because when temperature changes, resistance changes.
- Ohm's law is not applicable to all materials. For example, the characteristics of semiconductor, silicon carbide etc. are not linear.
- In a.c circuit, Ohm' law can be applied to resistance only. This law cannot be applied to inductor or capacitor.

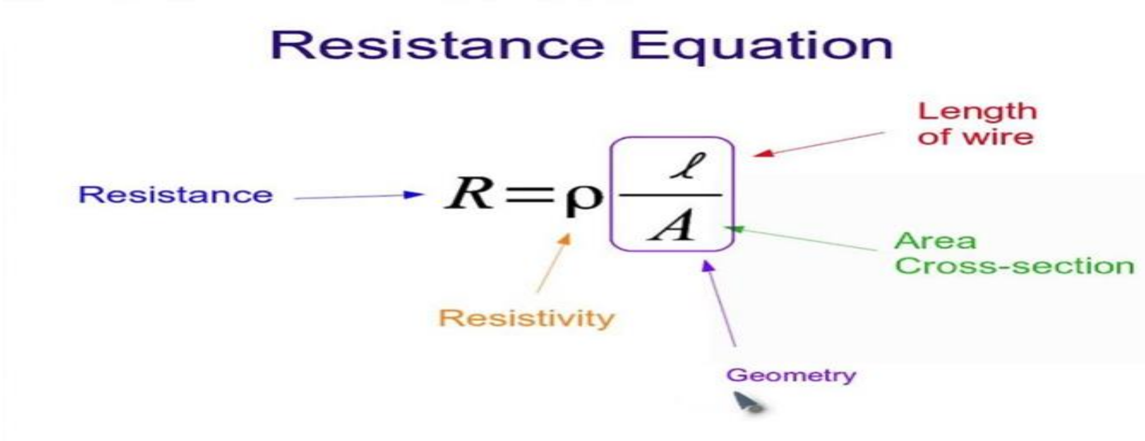
2. State and explain factors affecting the value of electrical resistor.

Resistance id depends upon below mentioned factors.

- **Length of material.**
- **Cross sectional area.**
- **Temperature.**
- **Type of Material.**

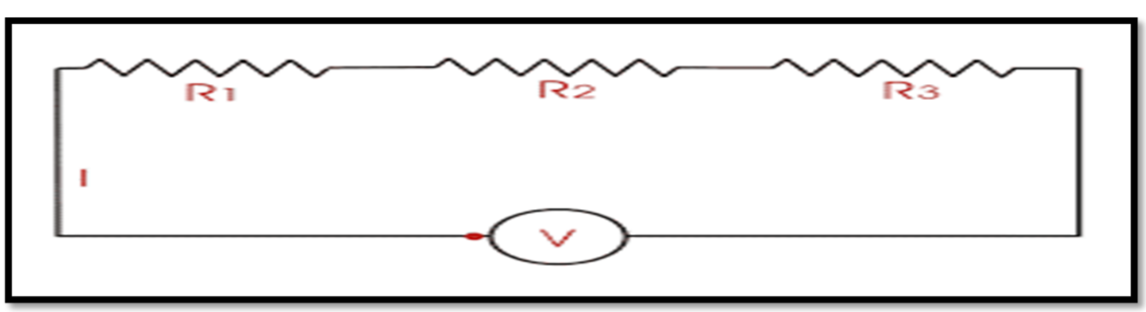
Length of material: Resistance of material increases as length increases.
Cross-sectional area: Resistance is inversely proportional to the cross-sectional area. When area increases resistance decreases and when area decreases, resistance increases.
Temperature: As temperature increase resistance also increases.
Material: Resistance varies according to the types of material e.g., conductor, semi-conductor and insulator.





3. Derive the equation of equivalent resistance when "n" number of resistors are connected in series.

- When three resistors are connected in series, then the same current passes through each resistor but the voltage drop is different for each resistor.
- We know that applied voltage is(V)
  ∴V=V1+V2+V3
- we also know that,
  V=I·R (from ohm's law)
  ∴I·Req=I·R1+I·R2+I·R3
  ⇒I·Req=I·(R1+R2+R3)
  ⇒ Req=R1+R2+R3
- It can be extended for n resistors
  Req= R1+R2....................................Rn
- So, the equivalent resistance or the total resistance of the circuit can be defined as a single value of resistance that can replace any number of resistors connected in series without altering the values of the current or the voltage in the circuit.



4. Derive the equation of equivalent resistance when "n" number of resistors are connected in parallel.

- In Parallel connection voltage V is same throughout the circuit.
- Current I is divided between resistors.
- So, in parallel connection,
  CURRENT I = DIVIDED
  AND VOLTAGE V = SAME IN THE CIRCUIT
- **SO, I=I1+I2+I3**
- According to ohm's law
  I=V/R.
- **SO, V/R=V/R1+V/R2+V/R3**
- Take voltage V common from both side we get,
  1/R=1/R1+1/R2+1/R3
- It can be extended for n resistors
  1/R=1/R1+1/R2+1/R3+………..1/Rn