Victoria University of Bangladesh

Mid - Assessment

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Ans to the Qu.No: 1

① (a)

Gauss Law :

Gauss's law is a fundamental principle in classical electromagnetism that relates the distribution of electric change to the resulti electric field. It states that the total electri flux through any closed surface is proportiona to the net electric change enclosed within that surface. In other words, Gauss's law relates the the behavior of electric changes to the electric field they create, and vice versa. mathematically, Gauss's law is expressed as :

$$\oint_S E \cdot dA = Q/\epsilon_0$$

where E is the electric field, S is a closed surface, dA is an infinidesimal surface element, Q is the total electric change enclosed by the surface, and ϵ_0 is the electric constant (also known as the vacuum permittivity)

① (b)

Below Describe Gauss law to columbs law :-

Gauss's law is a fundamental principle in electrostatics that relates the electric field to the distribution of electric charges. It states that the electric flux through any closed surface is proportional to the net charge enclosed within that surface.

In other words, Gauss's law relates the distribution of electric charges to the resulting electric field.

Coulomb's law, on the other hand, describes the interaction between two charged particles, stating that the force between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them.

Gauss's law can be derived from coulomb's law, by considering the net electric field at a point due to all the changes enclosed within a closed surface. By using coulomb's law to calculate the contribution of each change to the electric field at that point, we can integrate over the entire surface to find the net electric field. This integral is proportional to the net change enclosed within the surface, leading to the statement of Gauss's law.

In summary, while coulomb's law describes the force between two changed particles, Gauss's law relates the electric field to the distribution of changes, and can be derived from coulomb's law by considering the net electric field due to all changes enclosed within a surface.

① (C)

self and mutual inductance :

self inductance is a property of an electrical circuit that describes the ability of a circuit to generate an electromotive force (EMF) in itself when the current flowing through the circuit changes. It is measured in hennies and is denoted by the symbol L. The self-inductance of a circuit depends on the geometry and material of the circuit and is independent of any other circuit.

Mutual inductance, on the other hand, is a property of two nearby electrical circuits that describes the ability of one circuit to generate an EMF in the other circuit when the current flowing through the first circuit changes. It is also measured in hennies and is denoted by the symbol M. The mutual inductance between two circuit depends on the geometry, material, and relative position of the two

self and mutual inductance expression:

self-inductance (L) is a property of a conducting wire or coil that describes the amount of electromagnetic energy stored in the coil when a current flows through it. It is defined as the ratio of the magnetic flux (ϕ) through the coil to the current (I) that produces it:

$$L = \phi / I$$

The unit of self-inductance is the Henry (H).

mutual inductance (M) describes the relationship between two coils that are in close proximity to each other. It is defined as the ratio of the magnetic flux produced in one coil (ϕ_1) to the current flowing through the other coil (I_2).

$$M = \phi_1 / I_2$$

Mutual inductance depends on the geometry and position of the two coils with respect to each other, and it is a measure of the strength of the coupling between them.

Ans to the Qu; No: 2

(2) (a)

Lens law formula and explain the terms :-

Len's Law is a fundamental principle of electromagnetism that describes the direction of the electric current induced in a conductor when it is exposed to a changing magnetic field. It states that the direction of the induced current will be such that it creates a magnetic field that opposes the change in the original magnetic field. Mathematically, Lenz's Law can be expressed as :

$$\varepsilon = -d\phi/dt$$

where ε is the electromotive force (EMF) induced in the conductor, ϕ is the magnetic flux through the conductor, and $d\phi/dt$ represents the rate of change of the magnetic flux. The negative sign indicates that the induced

current will always oppose the change in the original magnetic field, in accordance with the conservation of energy.

The terms in the equation can be further explained as follows :-

⊛ **Electromotive force (e) :-** This is the voltage induced in the conductor by the changing magnetic field. It is measured in volts (v) and is proportional to the rate of change of the magnetic flux.

⊛ **Magnetic flux (ϕ) :-** This is the total magnetic field passing through a given area, and is measured in webers (wb). It is a function of the strength and orientation of the magnetic field, as well as the size and shape of the area.

⊛ **Rate of change of magnetic flux ($d\phi/dt$) :-** This is the rate at which the magnetic flux passing through the conductor is changing with time.

It is measured in webers per second (wb/s) or volts per second (v/s).

Applications are Lenz law :-

Lenz's Law is a fundamental principle of electromagnetism, and it has several practical applications in various fields. some of the applications of Lenz's Law are :-

① **Electromagnetic braking :-** Lenz's Law is used in electromagnetic braking systems, such as those used in trains and other large vehicles. when an electric current is passed through the braking system, it creates a magnetic field that opposes the motion of the vehicle, slowing it down.

② **Eddy current testing :-** Lenz's Law is used in eddy current testing to detect defects and cracks in metal surfaces.

A changing magnetic field is used to induce eddy currents in the metal, which in turn create their own magnetic fields that can be detected and analyzed to identify any flaws.

③ **Electric generators** ÷ Lenz's Law is used in electric generators to convert mechanical energy into electrical energy. when a coil of wire is rotated in a magnetic field, an EMF is induced in the coil due to the changing magnetic flux, and this EMF can be harnessed to generate electricity.

④ **magnetic levitation** ÷ Lenz's Law is used in magnetic levitation systems, such as those used in high-speed trains and other transporation systems. By using powerful electromagnets and carefully controlling the magnetic fields, objects can be suspended in mid-air without any physical contact, leading to reduced friction and increased speed.

② (b)

start by using the equation for the electric force on an electron in an electric field :-

$$F = QE$$

where F is the electrical force, Q is the charge of the electron (which is $-16. \times 10^{-19}$ c), and E is the electric field strength.

we also know that the weight of an electron is given by:

$$W = mg$$

where w is the weight, m is the mass of the electron (which is $9.11 \times 10^{-31} kg$) and g is the acceleration due to gravity (which is $9.81 m/s^2$).

since we want electrical force to be equal to the weight of the electron, we can set F equal to w and solve for E:

$F = W$

$2E = mg$

$E = mg/2$

substituting the values we have:

$E = (9.11 \times 10^{-31} kg) \times (9.81 \ m/s^2) / (-1.6 \times 10^{-19})$

$E = -5.26 \times 10^{-11} \ N/C$

so the magnitude of the electric field strength E such that an electron, placed in the field, would experience an electrical force equal to its weight is approximately $5.26 \times 10^{-11} \ N/C$.