Victoria University of Bangladesh

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Answer to the question number : 01

Gauss's Law :

Gauss's law is a fundamental principle in classical electro-magnetism that relates the distribution of electric charge to the result in electric field. It states that, the total electri-flux through any closet surface is propentional to the net electric charge enclosed within that surface. In other words Gauss's law relates the behaviour of electric charges 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 infinitesimal surface element, Q is the total electrical charge enclosed by the surface and ϵ_0 is the electric constant

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Answer to the question number : 4

(b)

Gauss's law to colamb law :

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

Columb's law, on the interaction between two charged particles, stating that the force between two point charges is directly propontional to the product of the charges and invensely proportional to the square of the distance between them.

Gauss's law can be derived from columbs law by considering the net electric field at a point due to all the charges enclosed within a closed surface. By using columbs law to calculate the contribution of each charg. 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 charge enclosed within the surface, leading to the statement of Gauss's law.

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

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Answer to the question number : 01

(c)

Self and mutual inductance :

Self and mutual 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 following 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 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 following through the

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first circuit changes. It is also measured in hennies and is denoted by the symbol depends on the geometry, material and relative position.

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 coil to the current (i) that produces it: $L = \Phi / I$

The unit of self inductance is the henry (H).

Mutual inductance (M) desenibes the relationship between two coils that are in close proximity to each othen.. It is definied as the nation of the magnetic flux produed in one coid ($\Phi 1$) the current following through the other coil ($I 2$)

$M = \Phi 1 / I 2$

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

Answer to the question number : 2

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Lenz's law formulla and terms :

Lenz's law is a fundamental principle of electromagnetism that desribes the direction of the electric current indueced in a conductor when it is exposed to a changing magnetic field. It states that, the direction of the indueed current will be such that it creates

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a magnetic field that opposes the changes in the original magnetic field. Mathematically, Len's law can be expressed as :

$$\mathcal{E} = -d\Phi/dt$$

Where e is the electromotive force (EMF) induced in the conducton, Φ is the magnetic flux through the conducton and dt/dt nepresents that nate 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 ~~of~~ in the equation can b further explained as follows :-

Electromotive Force : This is the voltage induced in the conducton by the changing magnetic field. It is measured in volts (V) and is proportional to the nate of change of the magnetic flux.

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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 magnetic field as well as the size and shape of the area.

Rate of change of Magnetic Area:

This is the rate at which the magnetic flux passing through the conducton is changing with time. It is measured in webers per second (wb/s) or volts per sec (V/s).

Applications are Lenz law:

Len's law is a fundamental prinaiple of electromagnetism and it has several

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Practicle applications in various fields Some of the applications of Lenz's law are

① Electromagnetic bracking :

Lenz's law is used in electromagnetic bracking systems such as those used in trains and other large vehicles. when electric current is passed through the bracking 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 Magnetic Levitation :

Lenz's Law is used in magnetic levitation systems such as those used in high-speed trains and other transportion systems By using powerful electromagnetic fields Objects can be suspended in mid-air without any physical contact, leading to redueed friction and increased speed.

Answer to the question no : 2

(b)

Start by using the equation for the electrical force on an electron in an electric field.

$$F = qE$$

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Where F is the electrical field force, q is the charge of the electron (which is -1.6×10^{-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 and m is the mass of the electron (which is 9.11×10^{-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:

$$F = w$$
$$qE = mg$$
$$E = mg/q$$

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Substituting the values we have :

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

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

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

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