Magnetism and magnetic effects of electric current

SUMMARY:

- A vertical plane passing through geographic axis is called geographic meridian.
- A vertical plane passing through magnetic axis is called magnetic meridian.
- The angle between magnetic meridian at a point with the geographical meridian is called the declination or magnetic declination.
- The angle subtended by the Earth's total magnetic field $\vec{B}$ with the horizontal direction in the magnetic meridian is called dip or magnetic inclination at that point.
- The magnetic moment is defined as the product of its pole strength and magnetic length. It is a vector quantity, denoted by $\vec{P}_m$.
- The region surrounding magnet where magnetic pole of strength unity experiences a force is known as magnetic field. It is a vector quantity and denoted by $\vec{B}$ Its unit is N A^{-1} m^{-1}.
- The number of magnetic field lines crossing per unit area is called magnetic flux Φ_B. It is a scalar quantity. In SI unit, magnetic flux Φ_B is Weber, symbol Wb.
- Statement of Coulomb's law in magnetism "The force of attraction or repulsion between two magnetic poles is proportional to the product of their pole strengths and inversely proportional to the square of distance between them".
- Magnetic dipole kept in a uniform magnetic field experiences torque.
- Tangent galvanometer is a device used to measure very small currents. It is a moving magnet type galvanometer. Its working is based on tangent law.
- Tangent law is $B = B_H \tan\theta$.
- The magnetic field which is used to magnetize a sample or specimen is called the magnetising field. It is a vector quantity and denoted by $\vec{H}$ and its unit is A m^{-1}.
- The measure of ability of the material to allow the passage of magnetic lines of force through it is known as magnetic permeability.
- The net magnetic moment per unit volume of material is known as intensity of magnetisation or magnetisation vector or magnetisation.
- Magnetic susceptibility is defined as the ratio of the intensity of magnetisation $(\vec{I})$ induced in the material due to the magnetising field $(\vec{H})$.
- Magnetic materials are classified into three categories: diamagnetic, paramagnetic and ferromagnetic materials.
- The lagging of magnetic induction $\vec{B}$ behind the cyclic variation in magnetising field $\vec{H}$ is defined as "Hysteresis", which means "lagging behind".
- The right hand thumb rule "If we hold the current carrying conductor in our right hand such that the thumb points in the direction of current flow, then the rest of the fingers encircling the wire points in the direction of the magnetic field lines produced".
- Maxwell right hand cork screw rule "If we rotate a screw by a screw driver, then the direction of current is same as the direction in which screw advances, and the direction of rotation of the screw will determine the direction of the magnetic field".

- Ampère's circuital law is $\oint_C \vec{B} \cdot d\vec{l} = \mu_\circ I_{enclosed}$.
- Magnetic field inside the solenoid is $B = \mu_\circ nI$, where n is the number of turns per unit length.
- Magnetic field interior to the toroid is $B = \mu_\circ nI$, where n is the number of turns per unit length.
- Lorentz force is $\vec{F} = q\left(\vec{E} + \vec{v} \times \vec{B}\right)$.
- Charged particle moving in a uniform magnetic field will undergo circular motion.
- Fleming's Left Hand Rule: Stretch forefinger, the middle finger and the thumb of the left hand such that they are in mutually perpendicular directions. If we keep the forefinger in the direction of magnetic field, the middle finger in the direction of the electric current, then the thumb points in the direction the force experienced by the conductors.
- One ampere is defined as that current when it is passed through each of the two infinitely long parallel straight conductors kept at a distance of one meter apart in vacuum causes each conductor to experience a force of 2×10^{-7} newton per meter length of the conductor.
- When a current carrying coil is placed in a uniform magnetic field, the net force on it is always zero but net torque is not zero. The magnitude of net torque is $\tau = NABI \sin\theta$.
- Moving coil galvanometer is an instrument used for the detection and measurement of small currents.
- In moving coil galvanometer, current passing through the galvanometer is directly proportional to the deflection. Mathematically, $I = G\theta$, where $G = \frac{K}{NAB}$ is called galvanometer constant or current reduction factor of the galvanometer.
- Current sensitivity is defined as the deflection produced per unit current flowing through it, $I_s = \frac{\theta}{I} = \frac{NAB}{K} \Rightarrow I_s = \frac{1}{G}$.
- Voltage sensitivity is defined as the deflection produced per unit voltage which is applied across it, $V_s = \frac{\theta}{V} = \frac{1}{GR_g} = \frac{I_S}{R_g}$, where, R_g is the resistance of galvanometer.
- Ammeter is an instrument used to measure current in an electrical circuit.
- A galvanometer can be converted into an ammeter of given range by connecting a suitable low resistance S called shunt in parallel to the given galvanometer.
- An ideal ammeter has zero resistance.
- Voltmeter is an instrument used to measure potential difference across any element in an electrical circuit.
- A galvanometer can be converted into suitable voltmeter of given range by connecting a suitable resistance R in series with the given galvanometer.
- An ideal voltmeter has infinite resistance.