APPLIED PHYSICS-II (2ND SEMESTER DIPLOMA ENGG STUDENTS FROM SUMMER 2025 ONWARDS

Unit-5 (Electromagnetism)

2 MARKS QUESTIONS & SOLUTIONS

Q.No.	Question	Taxonomy Level	Marking Scheme
Q 1.	**Define Magnetic Field and its SI unit.**	L1	2
Ans.	A magnetic field is a region around a magnet where the force of magnetism acts& the magnetic effect can be realised. The SI unit of magnetic field strength is Tesla (T).		
Q2.	**What is meant by Magnetic flux? What is its SI unit?**	L1	2
Ans.	Ans. Magnetic flux is the total magnetic field passing through a given area. and it is given by the product of the magnetic field (B) and the area (A) through which the magnetic field lines pass: $$\Phi_B = \vec{B}.\vec{A}$$ The SI unit of magnetic flux is the Weber (Wb),		
Q3.	**Define magnetization.**	L1	2
Ans.	Magnetization is the vector quantity that represents the magnetic moment per unit volume of a material. It indicates the degree to which a material is magnetized and is measured in Amperes per meter (A/m).		
Q 4.	**Define Lorentz forcefor a charged particle moving in a magnetic field.**	L1	2
Ans.	The Lorentz force is the force experienced by a charged particle moving in a magnetic field. It is given by: $$\mathbf{F} = q(\vec{\boldsymbol{v}} \times \vec{\boldsymbol{B}})$$ where q is the charge, **v** is the velocity of the particle, and **B** is the magnetic field.		
Q5.	**What are the different types of magnetic materials?**	L1	2
Ans.	Magnetic materials are classified into three types: • Diamagnetic materials: These materials are weakly repelled by a magnetic field. Example: Copper, Zinc. • Paramagnetic materials: These materials are weakly attracted by a magnetic field. Example: Aluminum, Platinum. • Ferromagnetic materials: These materials are strongly attracted by a magnetic field and retain their magnetism. Example: Iron, Nickel, Cobalt		
Q6.	**What happens to a Ferro magnetic material if it is heated at high Temperature.**	L3	2

Ans	The Properties of a Ferro-magnet are depended on temperature. When they are heated up to a high temperature, it loses its Ferro-magnetic properties and becomes a paramagnet. This transition occurs at a specific temperature, called the transition point.		
Q7.	**StateFaraday's laws of Electromagnetic Induction**	**L1**	**2**
Ans.	**Faraday's laws** In 1831, Michel Faraday has given two laws of electromagnetic induction. They are stated as follows: **I Law:** "Whenever the magnetic flux linked with closed circuit changes, an emf is induced in the circuit, the induced emf persists only, as long as there is change in magnetic flux". If we have a nearby magnet and a coil and there is a relative motion between them that is either coil ismoving, or magnet is moving. Due to relative motion of the coil, the coil cuts the magnetic flux coming. out of the magnet and this produces an induced emf across the coil. **II Law:**"The magnitude of the induced emf is proportional to rate of change of magnetic flux, linkedwith the closed circuit". Mathematically, $emf(e) =- kd\phi/dt$ where, k is proportionality constant and negative sign indicates that the induce emf opposes the changeof flux.		
Q8.	**Define Magnetic Intensity. Write its SI unit.**	**L1**	2
Ans	It is represented by H. The magnetic field intensity is the ratio of magnetic field with the permeability. For free space $H = B/\mu_0$ $B = \mu_0 H$ The SI unit of magnetic intensity is Amp / meter		
Q9.	**A point charge of 2.5 C is moving perpendicular to magnetic field of 10amp/ meter with a velocity 20m/s. Find the Lorentz force acting on charge of a charge.**	**L2**	2
Ans.	Given $q = 2.5C, B = 10amp/m$ and $v = 20m/s$ As. $F = q \vee B \sin(\theta) = q \vee B \quad \{As\ \theta = 90°\}$ $F = 2.5 \times 10 \times 20 = 500N$		
Q 10.	**Find the force on a current carrying conductor of length 20 cm having current 5 A and the magnetic field 4Amp/ meter. The angle between magnetic field and direction of current is 45°.**	**L2**	2
Ans.	Given $l = 0.2m, I = 5A$ and $B = 4A/m$ As $F = BIL \sin\theta$, $F = 4 \times 5 \times 0.2 \times \sin(45°) = 2.8N$		
Q 11.	**A rectangular loop of size 20cm × 40cm is placed in uniform vertical magnetic field of 0.60 Weber /m². Find the flux when the plane of loop is (a) vertical and (b) horizontal.**	**L3**	2
Ans.	The flux passing through the loop is $\phi = BA\cos(\theta)$ Where θ is the angle between normal to loop and magnetic field For (a) $\theta = 90°$ as the normal to the loop is perpendicular to magnetic field		

Hence $\phi = 0$

In (b) $\theta = 0°$ as the normal to the loop is parallel to magnetic field

Hence $\phi = 0.60 \times 0.2 \times 0.4 = 4.8 \times 10^{-2}$ weber

Q 12. **When a shunt of 3 ohms is attached to a Galvanometer, the deflection reduces to $1/10^{th}$. If an additional shunt of 3 ohms is added. Find reduced current in the deflection.** **L3** 2

Ans.

Given S = 3 ohm, $I_g/I = 1/10$

As, $I_g/I = S/(S + G)$

$$\Rightarrow 1/10 = 3/(3 + G)$$
$$\Rightarrow 3 + G = 30$$
$$\Rightarrow G = 27 \text{ ohms}$$

Now If we add Additional shunt 3 ohm than the new shunt (S') will be

$$1/S' = 1/3 + 1/3 = 2/3$$
$$\Rightarrow S' = 3/2$$

Now reduce in current will be

$$I_g/I = S'/(S' + G)$$
$$\Rightarrow I_g/I = 3/2/\{(3/2) + 27\}$$
$$\Rightarrow I_g/I = 3/2 \times 2/57$$
$$\Rightarrow I_g/I = 1/19$$

Q 13. **A moving coil galvanometer has a coil of resistance 10Ω and full-scale deflection current 1 mA. Calculate the shunt resistance required to convert it into an ammeter to measure currents up to io A.** **L3** 2

Ans.

The total current ammeter needs to measure is = 10A. The full-scale deflection current of the galvanometer is I_g = 1mA = 0.001A.

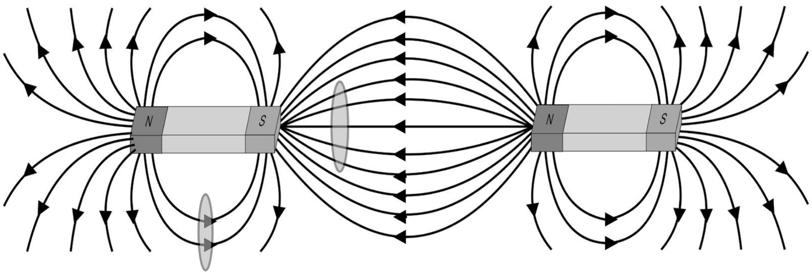
Using the formula for the shunt resistance R_s in parallel with the galvanometer:

$$R_s = \frac{R_g}{\left(\frac{I}{I_g} - 1\right)}$$

where:

	• $R_g = 10\Omega$ (resistance of the galvanometer), • $I = 10\text{A}$ (maximum current), • $I_g = 0.001\text{A}$ (current for full-scale deflection). Substituting the values: $$R_s = \frac{10}{\left(\frac{10}{0.001} - 1\right)} = \frac{10}{9999} \approx 0.001\Omega$$		
Q 14.	**What will be the path of a charged particle if it moves perpendicular to a uniform magnetic field?**	**L2**	2
Ans.	The particle will follow a **Circular path** in a plane perpendicular to the direction of the magnetic field because the Lorentz force acts as a centripetal force, changing the direction of velocity but not its magnitude		
Q15.	**What happens to the motion of a charged particle if it moves at an angle to a uniform magnetic field?**	**L2**	2
Ans.	The particle will follow a **helical path**, will move in a spiral trajectory along the magnetic field lines due to the combined effect of a circular motion perpendicular to the field and a constant motion parallel to the field.		

Unit-V (5MARKSQUESTIONS& SOLUTIONS)

Q1.	**Define Magnetic lines of force. Write five Properties of Magnetic lines of force.**	**L2**	5
Ans.	The magnetic force existing around the magnet can be explained in terms of the magnetic lines of force (Fig.1). Magnetic field lines originate from the north pole and merge to the south pole of a bar magnet. They do not intersect each other and the strength of the magnetic field is defined as the number of lines of force passing through a unit area perpendicular to the field.  Fig. 1 Magnetic lines of force originating from bar magnet **Five Properties of Magnetic lines of force:** 1. **Closed Loops** – Magnetic field lines always form continuous, closed loops, emerging from the north pole and entering the south pole outside the magnet. 2. **No Intersection** – Field lines never cross each other, ensuring a unique direction of the magnetic field at every point. 3. **Strength Indication** – The density of field lines represents the strength of the magnetic field; closer lines indicate a stronger field. 4. **Repulsion and Attraction** – Field lines exert lateral pressure (like poles repel) and tend to contract (opposite poles attract). 5. **Generated by Currents** – Magnetic fields arise from moving charges and electric currents, following the right-hand rule.		2 1 1 1
Q2.	**Define Magnetization. Explain Magnetization in details drawing Magnetization curve.**	L3	5
Ans.	**Magnetization:** When a magnetic material is placed in a magnetizing field, it gets		

magnetized. The magnetic moment developed per unit volume in magnetizing material is known as intensity of magnetization of magnetization or Magnetization (I) 1

$$I = M/V$$

where, V is the volume of the material, with length 2 l and area of cross section A 1

As Magnetic moment m × 2l{m is pole strength and 21 is length of magnet }
We can write magnetization (I) as,

$$I = m \times 2l/V = m/(V/2l) = m/A$$
1

Thus, magnetization (I) can also be defined as the pole strength per unit area of cross section. The unit of I is Ampere / meter.

Magnetization curve:

The variation of I with H is known as magnetization curve. The diamagnetic, and paramagnetic materials have a linear relation between I and H curve and retain no magnetization when the field is removed. The ferromagnetic materials show nonlinear relationship curve between I and H. At large magnetic field when magnetization becomes constant is known as saturation (I_s). In ferromagnetic materials, I do not reduce to zero when applied field is removed and it is known as retentivity of material (I_R). The field has to be applied in opposite direction to remove the magnetization and this applied field is called coercive magnetic field (H_C). 1

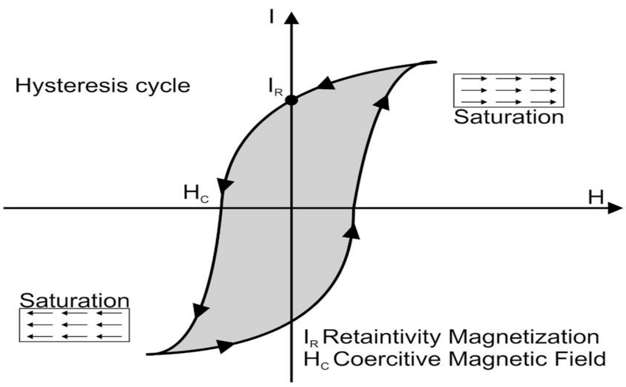


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Fig1. Magnetization Curve

Q3.	**Expain the methods of conversion of a galvanometer into ammeter and voltmeter.**	L3	5
Ans	**Conversion of a galvanometer into ammeter and voltmeter:** Any galvanometer which we get in the market or available in laboratory has two specific parameters. The current Ig for full scale deflection (FSD) and resistance of galvanometer due to resistance of wire of coil. If we know these two parameters, we can convert galvanometer in to ammeter and voltmeter of given desired range. **(i) Conversion of galvanometer into ammeter** A galvanometer is converted into an ammeter by connecting a low resistance called as shunt parallel to galvanometer coil. Shunt resistance is selected as		1

per requirement of the desired range of the ammeter and by connecting shunt the total resistance becomes very low, due to parallel combination of resistances. Ammeter is always connected in series to measure the electric current flowing in the circuit. The current passing though ammeter is divided into two parts: Ig passes through galvanometer coil and remaining current (I − Ig) passes through shunt, as given in Fig. 1. The voltage across the galvanometer and shunt resistance is equal,due to theparallel connection. Therefore,
Therefore,

$$GI_g = (I - I)S$$
$$S/G = I_g/(I - I_g)$$

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Where, G - Resistance of the galvanometer coil, I - Total current passing through the circuit, I_g - Total current passing through the galvanometer which corresponds to full-scale reading or full-scale deflection, S - Value of shunt resistance.

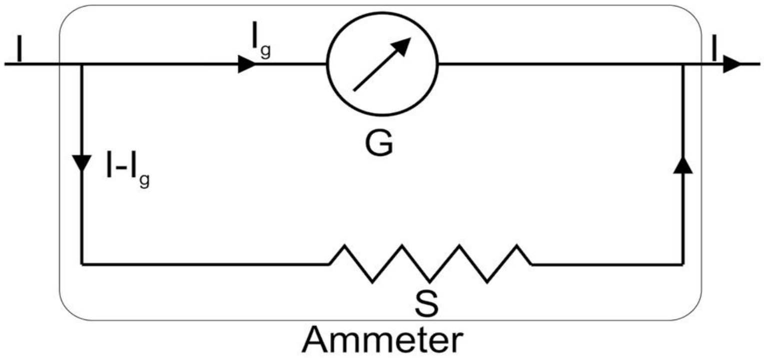

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Fig. 1. Conversion of galvanometer into ammeter parallel connection.

Whenever we connect shunt to galvanometer, maximum current passes through the shunt and low current passes through the galvanometer. The deflection in galvanometer is an indication of current in the circuit. The resistance of ammeter is very low and for ideal ammeter the resistance should be zero.

(ii) Conversion of galvanometer into voltmeter

A galvanometer is converted into a voltmeter by connecting high resistance in series. As voltage across two parallel point is same, hence voltmeter is always connected in parallel to the component in a given circuit, whose voltage we have to measure. A suitable high resistance is selected, depending on the range of the voltmeter. In the given circuit, G = Resistance of the galvanometer, R = Value of high resistance, I = Total current passing through the circuit, I_G = Total current passing through the galvanometer which corresponds to a full-scale deflection, V = Voltage drops across the series connection of galvanometer and high resistance. When current I_g passes through the series combination of the galvanometer and the high resistance R; the voltage drop across the branch ab is given by:

1

$$
\begin{aligned}
V &= G \cdot I_g + R \cdot I_g \\
V/I_g &= G + R \\
R &= (V/I) - G
\end{aligned}
$$

The value of R can be obtained using the above equation.

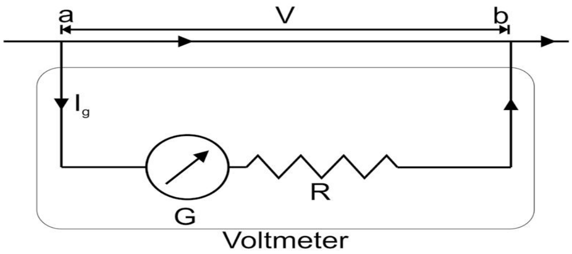

Fig.2 Conversion of galvanometer into voltmeter

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Q4.	**Derive the expression for Force acting on rectangular coil placed in magnetic field.**	L3	5

Force on rectangular coil placed in magnetic field :

Let us consider a current carrying rectangular loop PQRS, placed in magnetic field. The direction of magnetic field and a current loop is such that the normal $(\hat{n})$ to the plane of loop making an angle θ with $\vec{B}$. As described in previous section there will be force in each side of current loop i.e., PQ, QR, RS and SP. Namely F_1, F_2, F_3 and F_4 respectively. For simplicity let us consider that the angle between $\hat{n}$ and $\vec{B}$ is zero then, 1

$$\vec{F}_1 = I(l(-\hat{k}) \times B\hat{j}) = IlB(\hat{i})$$
$$\vec{F}_1 = I(l(-\hat{k}) \times B\hat{j}) = \mathrm{IlB}\ (\hat{i})$$
$$\vec{F}_3 = I(l(\hat{k}) \times B\hat{j}) = \mathrm{IlB}\ (-\hat{i})$$
$$\vec{F}_4 = I(l(-\hat{i}) \times B\hat{j}) = IlB(-\hat{k})$$

1

Than resultant force on coil is zero and if the angle between $\hat{n}$ and $\vec{B}$ is 90° then,

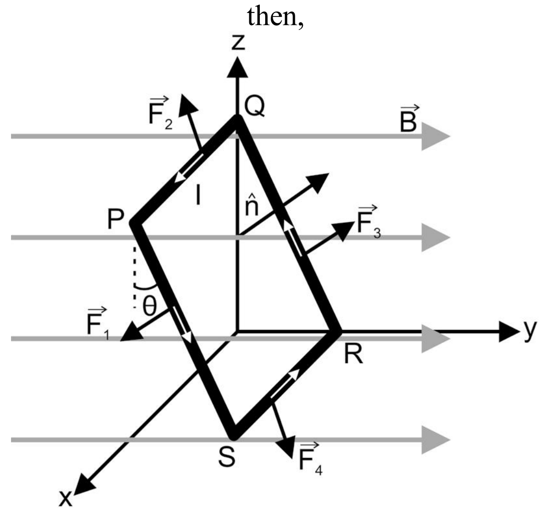

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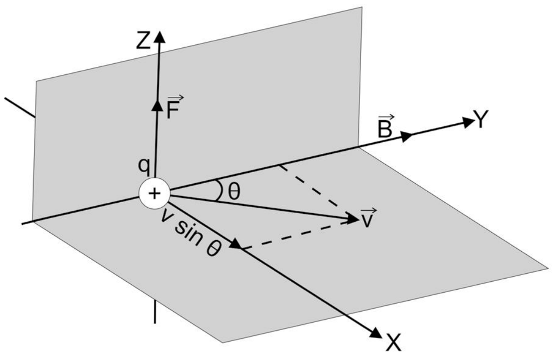
Fig. 1 Force on rectangular coil placed in magnetic field

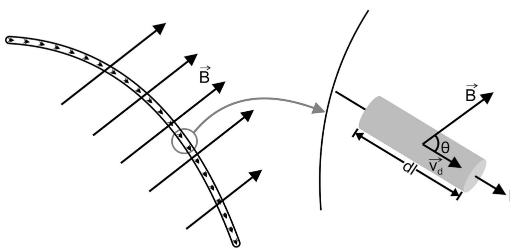
$$\vec{F}_1 = I(l(\hat{j}) \times B\hat{j}) = 0$$
$$\vec{F}_2 = I(l(\hat{i}) \times B\hat{j}) = IlB(\hat{k})$$
$$\vec{F}_3 = I(l(\hat{j}) \times B\hat{j}) = 0$$
$$\vec{F}_4 = I(l(-\hat{i}) \times B\hat{j}) = IlB(-\hat{k})$$

Hence due to presence of two equal and opposite forces F_2 and F_4 acting in opposite direction a couple acts on the coil and produces torque (τ), causes the coil to deflect and is given by, 1

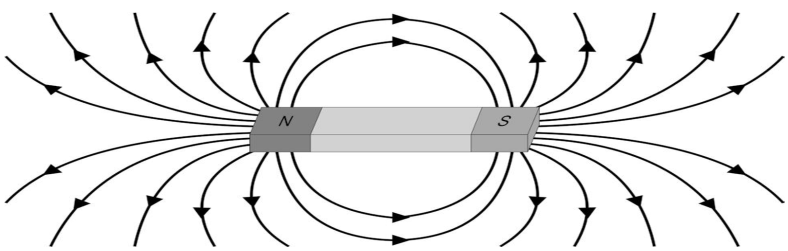
$$\tau = \text{ Force } \times \text{ perpendicular distance between the Forces}$$
$$\tau = IlB \times b$$
$$\tau = I(lb)B = IAB$$

In vector form, $\tau = I(\vec{A} \times \vec{B})$

	The force is maximum when area vector $\vec{A}$ (normal to the plane of coil) and $\vec{B}$ are perpendicular, and it decreases as the angle between Area vector and $\vec{B}$ decreases.		1
Q5.	**Write the Lorentz force for a moving charge in magnetic field. Predict the trajectory for the angle $\boldsymbol{\theta = 0}$ *and* $\boldsymbol{90}$ *degree*, where** ***$\boldsymbol{\theta}$ is the angle between velocity and magnetic field.***	**L4**	**5**
	Lorentz force (force on moving charge in magnetic field) :  Fig. 1. Force on a moving charge in magnetic field Let us consider a magnetic field (B) along y direction and a charge (q) moving in xy plane with velocity (v) making an angle θ with the direction of magnetic field. The moving charge will experience a force in the direction perpendicular to motion of charge and magnetic field. This force is known as Lorentz force. The Lorentz force depends upon following factors $F \quad \alpha \quad B$ $F \quad \alpha \quad q$ $F \quad \alpha \quad v\sin\theta$ $F = qvB\sin\theta$ $F = qvB$ (In case if θ is 90 degree.) $\bar{F} = q(\vec{v} \times \bar{B})$ $F \propto v\sin\theta$ {$v\sin\theta$ is perpendicular component of velocity } Case I: If a particle is moving in a direction parallel to magnetic field ($\theta = 0$) then the magnitude of force will be 0 . Case II: If a particle is moving in a direction perpendicular to magnetic field ($\theta = 90$), then the particle will move in circular path in a plane perpendicular to the direction of magnetic field. Also, if a particle is moving perpendicular to magnetic field than the force only changes the direction of motion of particle, the magnitude of velocity remain unaltered. Case III: If a particle is moving in a direction, which is making angle with magnetic field, the particle will move in a helical path.		1 1 1 1 1

Q6.	**Derive the expression for Force on current carrying conductor.**	L2	5
	Force on current carrying conductor : As we know that the rate of flow of charge is current and If the current carrying conductor is kept in magnetic field it will also experience a force. To find the value of that force let us consider a current (I) is flowing is conductor of length (L) and area of cross section (A) with (n) no of charge per unit volume and placed in magnetic field (B). The force due to magnetic field in small length element dl will be given by Lorentz force, $dF = qvB\sin(\theta)$ q is the charge in element $= (nAdl)e$ v is the velocity of electron in element $= v_d$ {drift velocity} θ is the angle between magnetic field and v_d  Fig. 1.Force on current carrying conductor Hence $dF = (nAdl)e \times v_d \times B\sin(\theta)$ $dF = \big(nAe \times v_d ddl \times B\sin(\theta) \quad [I = nAevd]$ $dF = I \times dl \times B\sin(\theta)$ on integrating over complete length $\vec{F} = I(\vec{l} \times \vec{B})$		1 1 1 1 1

Q7.	**State &Explain Coulomb law of magnetostatics. Trace Magnetic lines of force due to bar magnet.**	L2	5
Ans.	Consider a bar magnet consisting of magnetic poles (North and South poles) around the end (Figure.1). If we put another bar magnet near to this magnet, there will be force of attraction or repulsion between poles, depending upon the nature of the two poles. The force of attraction or repulsion is directly proportional to the product of the pole strengths of corresponding poles and inversely proportional to the square of the distance between the two poles. This force is also known as Coulomb magnetic force. (like electrostatic force between two charges.)		1

	Mathematically $$F \;\alpha\; m_1 \times m_2$$ $$F \;\alpha\; 1/r^2$$ $$F = km_1m_2/r^2$$ $k = \mu_0/4\pi = 10^7$ Henry/meter, and m_1 and m_2 in SI unit that is Amp $\times$ m, r in meter and μ_0 is magnetic permeability of free space		1
	An isolated unit positive charges exists, whereas an isolated magnetic pole doesn't exists, but still if we consider an isolated north pole of unit pole strength (m) and kept it at a point ' P ' near to the bar magnet or a current carrying conductor (acting as magnet) then the force on north pole of unit pole strength is the magnetic field due to bar magnet or a current carrying conductor at that point.		1
	$$B = F/m$$ Dimensional formula of $B = MLT^2/AL = MA^{-1}T^{-2}$		1
	The CGS unit of magnetic field is Gauss. The SI unit of magnetic field is Tesla. The magnetic field strength of earth is 3.05×10^{-5} Tesla 1 Tesla $= 10^4$ Gauss  Fig. 1. Magnetic lines of force due to bar magnet		1