2025-05-05

ELECTRODYNAMICS

Dept of Physics-SEAS

SRM University A.P

Registration Number: _____

Name: _____

Branch & Section: _____

SRM UNIVERSITY AP
Andhra Pradesh

SRM UNIVERSITY – AP, ANDHRA PRADESH

End Term Examination, May 2025

[Question Paper ID: **008859**]

Subject Title	:	ELECTRODYNAMICS	**Subject Code**	:	PHY 206
Batch	:	2023	**Max Marks**	:	100
Degree	:	B.Sc.	**Duration**	:	3 hours
Branch	:	Scie.	**QP Set**	:	---

Instructions:

PART A

Short Answers

Answer All Questions

10 Questions x 2 Marks = 20 Marks

PART B

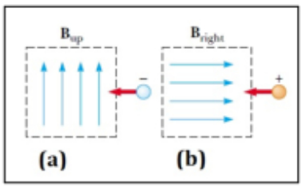
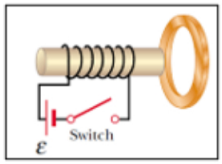
Descriptive Questions

Answer All Questions

5 Questions x 16 Marks = 80 Marks

PART A (10 × 2 Marks = 20 Marks)

Answer **all** Questions

		Marks	BL	CO
1.	Calculate the gradient of scalar field F(x, y, z) = xyz at point (1, 2, 3).	2	1	1
2.	Determine the direction of initial deflection of the charge particles entering the Magnetic field regions (See Figure). 	2	2	1,2
3.	Define Magnetic Induction (B) and Auxiliary Magnetic Field (H) and their units.	2	3	1,3
4.	Explain Curie Temperature and Neel Temperature for Ferro and Anti-ferromagnetic materials.	2	4	1,3
5.	Using Lenz's Law determine the direction of current in the metallic coil at the at the instant the switch is thrown close - Explain your answer. 	2	3	1,3
6.	Define the four fundamental circuit elements. Draw the schematics how they connect charge, voltage, current and magnetic flux.	2	4	1,4
7.	Draw the magnetization vs magnetic field graph for paramagnetic and diamagnetic at different temperatures.	2	4	1,2
8.	Can this following field be a Magnetic field $\vec{B}(x,y,z) = x^2\hat{x} + y^2\hat{y} + z^2\hat{z}$, at (1,1,1) point. Explain your answer.	2	3	1,5
9.				

How do electromagnetic braking systems function to decelerate high-speed maglev trains?	**2**	**2**	**5**	**2,3**
10. How do polarized sunglasses improve visual clarity and safety while riding a motorcycle in summer conditions?	**2**	**2**	**4**	**1,5**

PART B (5 × 16 Marks = 80 Marks)

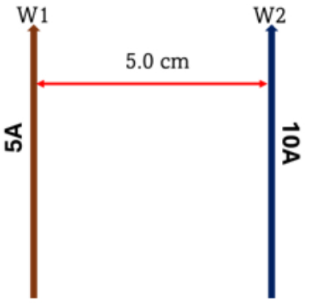
Answer **all** Questions

	Marks	BL	CO

11. **16** **16** **2** **1,2**

A. **Current Carrying Wires**:

Two infinite wires carrying current **5 A & 10 A** (in same direction) is separated by **5cm** (See Figure)



I. Calculate magnetic force per unit length between the two wires.

II. What is the type of force – attractive or repulsive, explain.

III. Find the point where the magnetic field will be zero.

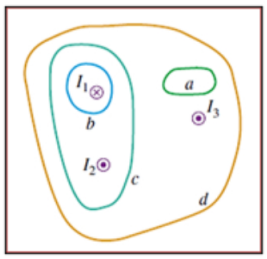
IV. Now, find the point where the magnetic field will be zero, if currents in both wires flow in the opposite direction.

MARKS 4+2+4+6=16

OR

B. **Ampere's Law**:

a) The adjacent diagram shows, in cross section, several conductors that carry currents through the plane of the figure. The currents have magnitudes $I_1 = 6\ A$, $I_2 = 3\ A$, *and* $I_3 = 5\ A$, and the directions shown. Four paths, labelled **a through d**, are shown. What is the line integral of magnetic field for each path? Each integral involves going around the path in the **clockwise direction**.



b) A cylindrical conductor has radius (R) and a uniform current density with total current (I) flowing through it.

I. Find expression of current density J.

II. What is the unit of current density (J).

III. Calculate magnetic field (B) every-where 1) outside ($r > R$), 2) On the surface ($r = R$) and 3) inside wire ($r < R$).

IV. Draw the distribution of current with distance r. **MARKS 8+1+1+4+2=16**

12. **16** **16** **2** **1,2**

A) Magnetic Field and Magnetization

a) Derive the expression relating to Magnetic Induction (B), Magnetic Field (H) and Magnetization (M) for any general Magnetic Material.

b) Magnetic susceptibility of Gold (-3.4×10^5) and Platinum (2.7×10^4) are given in the parenthesis – what type of magnetic material are they?

c) What would be their relative permeability (μ_r)?

d) A magnetic material has a magnetization of 2700A/m and produces a flux density of $0.0045 Wb/m^2$. Calculate the Auxiliary Magnetic Field and relative permeability of the material.

e) Define ferromagnetic domain and domain wall with schematic diagrams.

MARKS 4+2+2+4+4=16

OR

B) Magnetic Materials

a) Define Paramagnetic, Ferromagnetic, Anti-ferromagnetic and Ferrimagnetic materials and draw their spin orientations.

b) Give at least two examples of each type of magnetic material.

c) Draw Hysteresis Curve for a Ferromagnetic material – clearly define saturation magnetization, remnant magnetization and coercive field.

d) Draw Hysteresis Curve for a hard and soft ferromagnetic material in the same graph.

MARKS 4+4+4+4=16

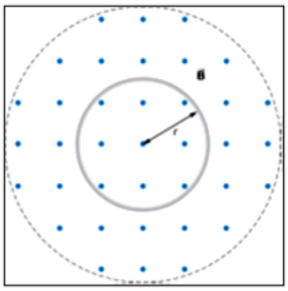
13.

16 16 5 1,3

A) **Magnetic Induction**

a) Define Faraday's Law and Lenz's Law.

b) Find the self-inductance of a uniformly wound solenoid having 100 turns and length 100m and cross-sectional area $4m^2$. Assume that the core of the solenoid is air.



c) A magnetic field $\vec{B}$ is directed outward perpendicular to the plane of a circular coil of radius r = 0.50 m (See Figure). The field is cylindrically symmetrical with respect to the centre of the coil, and its magnitude decays exponentially according to $\mathbf{B(t) = (3.5\ T)\ e^{-(5.0/sec)t}}$, where B is in Tesla and t is in second.

I. Calculate flux through the coil at $t_1 = 0$, and $t_2 = 1.0$ s

II. Calculate the emf induced in the coil at the times $t_1 = 0$, and $t_2 = 1.0$ s.

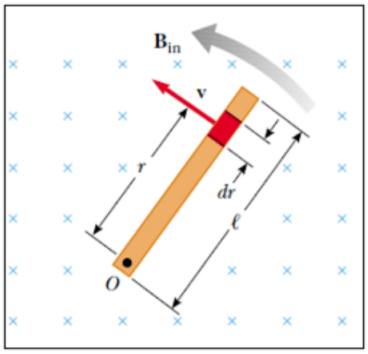
III. Determine the current in the coil at these two times if its resistance is 10 Ω.

MARKS 2+4+4+4+2=16

OR

B) **Motional EMF**

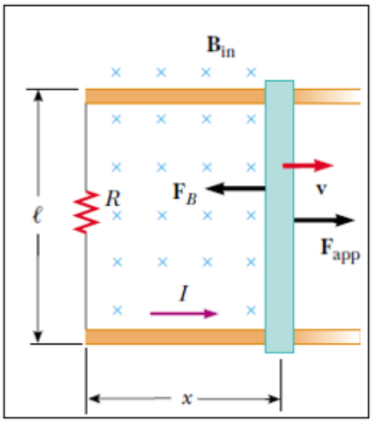
a) A conducting bar of length l rotates with a constant angular speed w about a pivot at one end. A uniform magnetic field **B** is directed perpendicular to the plane of rotation, (See Figure).



I. Derive the expression of induced motional emf.

II. Calculate the motional emf induced between the ends of the bar when l **= 2.0m,** w **= 20** ***rad/sec*** **and** B **– 5Tesla.**

b) The conducting bar (See Figure) moves on two frictionless parallel rails in the presence of a uniform magnetic field $\mathbf{B_{in} = 2\ Tesla}$ directed into the page. The bar has mass **m = 5Kg** and its length is l **= 1.0m**. The bar is pulled towards right at a constant velocity of $\mathbf{v_0 = 5m/sec}$.



I. Calculate the induced motional emf.

II. If resistance of the rod is zero and the resistance of the circuit is **R = 10 Ohm**, calculate induced current.

III. Using Newton's Laws calculate the applied Force (F_{app}) required to maintain the constant velocity of the rod.

MARKS 4+3+3+3+3=16

14. 16 16 4 1,4

A) Maxwell's Equation:

a) Mention the differential forms of Maxwell's equations.

b) Staring from the differential form of Maxwell's Equations derive the modified Maxwell's Equations in a dielectric and magnetic material.

c) Define any four important physical significance of Maxwell's Equation.

MARKS 4+8+4=16

OR

B) Displacement Current:

a) Define the differential forms of Faraday's law and Ampere's law.

b) Show that Faraday's law is consistent in terms of vector calculus, whereas Ampere's law is not.

c) State the continuity equation of the related to charge and current.

d) Using continuity equation derive the modified Ampere's Law – show that it is consistent (with vector calculus).

e) Now define displacement current and its physical significance. **MARKS 2+4+2+4+4 = 16**

15.

16 **16** **5** **1,5**

A) **EM Wave Propagation**:

a) An EM wave is propagating through a lossy dielectric material, if magnetic field is defined by the equation $\vec{H} = 8Sin[2.8\pi \times 10^7 t - 0.3z]\hat{x}$, define the corresponding oscillating electric field ($\vec{E}$) if intrinsic impedance is 50 Ω and phase angle is $\pi/4$.

b) What is the frequency, wavelength, and phase velocity of the EM Wave?

c) Define the direction the EM wave propagation, Poynting's vector, Electric and Magnetic fields oscillation?

MARKS 4+6+6=16

OR

B) **EM Wave Polarization and Reflection**:

a) Determine the polarization of the following EM plane waves:

i. $\vec{E}(z,t) = 6\cos[(0.4\pi \times 10^7)t - 0.3z)]\,\hat{x} + 9\cos[(0.4\pi \times 10^7)t - 0.3z)]\,\hat{y}$

ii. $\vec{E}(z,t) = 6\cos[(0.8\pi \times 10^7)t - 0.8z)]\,\hat{x} + 9\sin[(0.8\pi \times 10^7)t - 0.8z)]\,\hat{y}$

b) An electromagnetic plane wave defined as $\vec{E} = 5\sin[(0.5\pi \times 10^7)t - 0.7z)]\,\hat{x}$ is reflected at the interface of two magnetic materials. Clearly define the direction of electric field oscillation, magnetic field oscillation and EM wave propagation for the i) Transmitted wave and ii) Reflected wave.

c) Let us assume a Plane Wave front of EM wave reflects (normal incidence) at the interface of two perfect dielectric material with permeability $\epsilon_{r1} = 25$ *and* $\epsilon_{r2} = 9$. Determine the values of reflection and transmission coefficients.

MARKS 6+6+4=16

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