

Registration Number:

Date & session:



**ST JOSEPH'S UNIVERSITY, BENGALURU -27**  
**B.Sc. (Physics) – 2<sup>nd</sup> SEMESTER**  
**SEMESTER EXAMINATION: APRIL 2024**  
(Examination conducted in May / June 2024)  
**PH 221: Electricity and Magnetism**

**(For regular/supplementary students)**

**Time: 2 Hours**

**Max Marks: 60**

**This paper contains 2 printed pages and 3 parts**

**Part A**

**Answer any four questions:**

**( 4 x 8 =32)**

1. (a) What is an electric dipole? Define dipole moment.  
(b) Derive an expression for the electric potential due to a dipole. (2+6)
2. (a) Obtain an expression for the growth of charge in an RC circuit connected to a DC source.  
(b) Define the time constant of the RC circuit and represent the growth of charge graphically. (6+2)
3. (a) Define the capacitance of a capacitor. Deduce an expression for the capacitance of a parallel plate capacitor.  
(b) Derive an expression for electrostatic energy stored in a capacitor. (5+3)
4. (a) Using the vector method, derive an expression for the resonant frequency of a parallel resonance circuit with resistance in the inductance arm.  
(b) State Faraday's laws of electromagnetism. (5+3)
5. (a) Derive an expression for the velocity of propagation of a plane electromagnetic wave  
(b) Define the Poynting vector and write the expression for the same. (6+2)
6. (a) Show how orbital magnetic moment is related to orbital angular momentum.  
(b) Define the terms (i) Magnetic susceptibility and (ii) magnetic permeability. (6+2)

**Part B**

**Answer any four questions:**

**(4 x 5 = 20)**

7. If  $\mathbf{A} = 2x^2\hat{i} - yz\hat{j} + 3xz^3\hat{k}$  find (i)  $(\nabla \times \mathbf{A})$  and (ii)  $\text{div } \mathbf{A}$  at the point (1, 1, 1)

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8. A silver wire 1 mm in diameter carries a charge of 90 coulomb in 1 hour and 15 minutes. Silver contains  $5.8 \times 10^{22}$  free electrons per  $\text{cm}^3$ . Calculate the current in the wire in amperes. Also, calculate the drift velocity of the electrons.
9. Calculate the induced dipole moment per unit volume of Helium gas if placed in an electric field of 6000 V/cm. The molecular polarizability of Helium is  $2.33 \times 10^{-41}$  farad- $\text{m}^2$  and the density of helium is  $20.6 \times 10^{19}$  molecules/cc.
10. A metal block of charge density  $10^{23} \text{ m}^{-3}$  is used in studying the Hall effect, in which a magnetic field of 0.5 Tesla is used and a current of 3A is passed. If the thickness of the block is 4mm and the area of cross-section is  $100 \text{ cm}^2$ , find the Hall coefficient and Hall voltage developed.
11. Find the magnitude of the current and its phase difference for the applied voltage when an alternating potential of 220 volts and 50 cycles is applied to a fan having an inductance of 0.2 H and a resistance of 20 ohms.
12. The intensity of sunlight reaching the Earth's surface is 2 calories/ $\text{cm}^2$ / min. Calculate the strength of the magnetic and electric fields of the sunlight.

### Part C

**Answer any four questions:**

**(4 x 2 = 8)**

13. What is meant by lamellar and solenoidal vector fields?
14. Generally when an electric motor is switched off, a spark passes between the air gap of the switch contact. Why?
15. Can two equipotential surfaces intersect each other? Give reason.
16. Why does the path of a charged particle in a transverse magnetic field become circular?
17. 220 V AC. is more dangerous than 200 Volts DC Why?
18. Which law relates susceptibility to the temperature? Does the law hold good for all temperatures?