STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2019-2020 and thereafter)

SUBJECT CODE : 19PH/MC/EM54

B.Sc. DEGREE EXAMINATION NOVEMBER 2022
BRANCH III - PHYSICS
FIFTH SEMESTER

COURSE : MAJOR – CORE
PAPER : ELECTROMAGNETISM
TIME : 3 HOURS **MAX. MARKS 100**

SECTION – A

ANSWER ALL QUESTIONS: **25 MARKS**
(10 x 1 = 10)

I. CHOOSE THE CORRECT ANSWER:

1. Differential form of Gauss' s law in electrostatics is
   (a) $\vec{\nabla} \cdot \vec{E} = \frac{\rho}{\epsilon_0}$ (b) $\vec{\nabla} \cdot \vec{E} = 0$ (c) $\nabla^2 \emptyset = 0$ (d) $\nabla^2 \emptyset = \frac{\rho}{\epsilon_0}$

2. Electrostatic energy
   (a) is linear in the fields and obeys superposition principle
   (b) is linear in the fields and does not obey superposition principle
   (c) is quadratic in the fields and obeys superposition principle
   (d) is quadratic in the fields and does not obey superposition principle

3. Capacitance of a capacitor is
   (a) $\frac{V}{Q}$ (b) $\frac{Q}{V}$ (c) QV (d) $\frac{Q}{V^2}$

4. Torque($\vec{N}$) experienced by a dipole of dipole moment $\vec{p}$ in a uniform field $\vec{E}$ is
   (a) $\vec{p} \times \vec{E}$ (b) $\vec{E} \times \vec{p}$ (c) $\vec{\nabla}(\vec{E} \cdot \vec{p})$ (d) $\vec{\nabla} X \vec{E} X \vec{p}$

5. MKS unit of magnetic field $\vec{B}$ is
   (a) tesla (b) gauss (c) $\frac{N}{A^2}$ (d)$\frac{N}{A}$

6. Physical content of $\vec{\nabla} \cdot \vec{B} = 0$ is
   (a) there are no magnetic monopoles (b) there are no magnetic dipoles
   (c) $\vec{B}$ is irrotational (d) $\vec{B}$ is conservative

7. ---------- are nonlinear media.
   (a) Ferromagnets (b) Diamagnets
   (c) Paramagnets (d) Both Diamagnets and Paramagnets

8. Magnetic susceptibility of a diamagnet is
   (a) negative (b) positive (c) 0 (d) infinity

9. Ampere's law with Maxwell's correction is
   (a) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} + \epsilon_0 \mu_0 \frac{\partial \vec{E}}{\partial t}$ (b) $\vec{\nabla} \times \vec{E} = \mu_0 \vec{J} + \epsilon_0 \mu_0 \frac{\partial \vec{B}}{\partial t}$
   (c) $\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} + \epsilon_0 \frac{\partial \vec{E}}{\partial t}$ (d) $\vec{\nabla} \times \vec{E} = \mu_0 \vec{J} + \mu_0 \frac{\partial \vec{B}}{\partial t}$

10. Law of conservation of charge is
    (a) $\vec{\nabla} \cdot \vec{J} = \frac{\partial \rho}{\partial t}$ (b) $\vec{\nabla} \cdot \vec{J} = 0$ (c) $\vec{\nabla} \cdot \vec{J} = -\frac{\partial \rho}{\partial t}$ (d) $\vec{\nabla} \cdot \vec{J} = \rho$

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II. FILL IN THE BLANKS: **(5 X 1 = 5)**

11. Value of permittivity of free space is _____
12. Dipole moment per unit volume is called as _____
13. Lorentz force law is _____
14. Magnetization is defined as _____
15. Energy stored in a magnetic field is _____

III. ANSWER BRIEFLY: **(5 X 2 = 10)**

16. State Coulomb's law.
17. What is the principle of a capacitor?
18. What is meant by steady current? Does a truly steady current exist?
19. Show that for a linear medium $\mu = \mu_0(1 + \chi_m)$.
20. State the Faraday's laws of electromagnetic induction.

SECTION – B **(5 X 6 = 30)**

ANSWER ANY FIVE QUESTIONS:

21. Write short notes on electrostatic boundary conditions.

22. A long cylinder carries a charge density which is proportional to the distance from the axis, $\rho = kr$, for some constant k. Find the electric field intensity inside this cylinder.

23. A primitive model for an atom consists of a point nucleus (+q) surrounded by a uniformly charged spherical cloud (-q) of radius a. Calculate the atomic polarizability of such an atom.

24. Obtain the Gauss's law in the presence of dielectrics.

25. A current of 20 amperes is flowing in a long straight wire. An electron is moving with a velocity 10^7 m/s. How much force will act on the electron if wire is 2 cms away from it and the velocity of electron is (i) towards the wire (ii) parallel to the wire and (iii) perpendicular to the directions given by (i) and (ii).

26. A rod of magnetic material 0.5 m in length has a coil of 200 turns wound over it uniformly. If a current of 2 ampere is sent through it, calculate (a) the magnetising field **H**, (b) the intensity of magnetisation **M,** (c) the magnetic induction **B** and (d) the relative permeability $\mu_r$of the material. Given $\chi_m = 6\ X\ 10^{-3}$.

27. (a) Calculate the self-inductance of a solenoid having 1000 turns and length 1 m. The area of cross-section is 7 cm^2 and $\mu_r$of the core is 1000. (3 marks)
    (b) Two coils, a primary of 600 turns and a secondary of 30 turns, are wound on an iron ring of mean radius 0.1m and cross-section 4 x 10^{-2} m diameter. Find their mutual inductance (μ_r for iron = 800). (3 marks)

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SECTION - C (3 X 15 = 45)

ANSWER ANY THREE QUESTIONS:

28. Determine the energy of a point charge and continuous charge distributions.

29. Determine the capacitance of a spherical capacitor
    (i) when outer sphere is charged and inner sphere is earthed and
    (ii) when inner sphere is charged and outer sphere is earthed.

30. (a) By applying Ampere's law, determine the magnetic field of a toroidal coil. (8 marks)
    (b) Determine the conditions under which a moving coil galvanometer becomes (i) dead beat and (ii) ballistic. (7 marks)

31. Obtain an expression for torque and force experienced by a magnetic dipole placed in a magnetic field.

32. (a) Obtain the relation connecting mutual inductance and self-inductance. (7 marks)
    (b) Discuss the magnetic boundary conditions. (8 marks)

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