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

B.Sc. DEGREE EXAMINATION NOVEMBER 2023 BRANCH III - PHYSICS FIFTH SEMESTER

COURSE : MAJOR – CORE

PAPER : ELECTROMAGNETISM

SUBJECT CODE : 19PH/MC/EM54

TIME : 3 HOURS MAX. MARKS 100

SECTION - A

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

I. CHOOSE THE CORRECT ANSWER:

1. The equation used to find the electric potential when charge distributions are given is,

A) Laplace's Equation

B) Gauss's Equation

C) Ampère's Equation

- D) Poisson's Equation
- 2. The curl of electrostatic field is zero. It implies that electric field is,
 - A) conservative.

B) non-conservative.

C) dissipative

- D) non-divergent.
- 3. Presence of the dielectric between the plates of the capacitor,
 - A) increases the electric field.
- B) decreases the electric field.
- C) has no effect on the electric field.
- D) reverses the direction of the electric field..
- 4. The primary factor influencing the dielectric strength of a material is,
 - A) The permittivity of the material
- B) The temperature of the material
- C) The shape and size of the electrodes
- D) The frequency of the applied electric field
- 5. According to the Biot-Savart Law, what is the magnetic field direction around a long straight wire carrying a steady current?
 - A) Radially outward from the wire
- B) Radially inward toward the wire
- C) Tangential to a circular loop centered on the wire D) Parallel to the wire
- 6. In the context of magnetic field, (div B=0) indicates,
 - A) absence of magnetic monopoles
- B) presence of magnetic dipoles
- C) continuity of magnetic field lines
- D) all the above
- 7. The unit of magnetic susceptibility is,
 - A) $A.m^2$
- B) A.m⁻¹
- C) A.m
- D) no unit
- 8. Energy loss in a magnetization cycle is a measure of,
 - A) area of hysteresis loop

B) coercivity

C) remenence

- D) retentivity
- 9. The term "boundary conditions" in Maxwell's equations refer to,
 - A) The physical limits of a magnetic field within a material.
 - B) The properties that describe the behavior of electric fields.
 - C) The constraints on electromagnetic fields at the interface between different media.
 - D) The conditions for electromagnetic waves to become self-sustaining.
- 10. Faraday's Law of Electromagnetic Induction states that:
 - A) The electric field within a conductor is zero.
 - B) A changing magnetic field induces an electric field.
 - C) A changing electric field induces a magnetic field.
 - D) The magnetic field within a conductor is zero

II. FILL IN THE BLANKS: 11. Write the Laplace equation for electrostatic field _____. 12. In the external electric field, the nonpolar dielectric materials get _____ polarization. 13. The direction of Lorentz force on a charge is _____ to velocity and magnetic field. 14. Magnetic susceptibility is the ratio of _____ and ____. 15. The equation for energy stored per unit volume in magnetic field is _____.

III. ANSWER BRIEFLY:

 $(5 \times 2 = 10)$

- 16. Define electric potential
- 17. State Gauss's law in the presence of dielectrics.
- 18. What is deadbeat of ballistic galvanometer?
- 19. Define magnetization.
- 20. Give the relation between self-inductance and mutual-inductance.

SECTION - B

 $(5 \times 6 = 30)$

ANSWER ANY FIVE QUESTIONS:

- 21. Calculate the electrostatic force and gravitational force between the protons and electrons in free space, when they are separated by a distance of 0.5×10^{-10} meter given that the charge of a proton is 1.6×10^{-27} kg, mass of electron = 9.1×10^{-31} kg and G= 6.67×10^{-11} Nm² kg⁻².
- 22. A rod of magnetic material 0.5m in length has a coil of 200 turns wound over it uniformly. If a current of 2 amperes is sent through it, calculate a) the magnetizing field H, b) the intensity of magnetization M, c) the magnetic induction B and d) the relative permeability μ_r of the material. Given $\chi_m = 6 \times 10^{-3}$.
- 23. The radii of the inner and outer spheres of a spherical capacitor are 4x10⁻²m and 6x10⁻²m. If the dielectric medium between the plates is air, calculate the capacitance of the spherical capacitor if the outer is earthed and the inner sphere is positively charged.
- 24. A magnetizing field of 50Am⁻¹ produces a magnetic field induction 0.024T in a bar of length 8 cm and area of cross-section 1.5 cm². Calculate i) the magnetic permeability ii) the magnetic susceptibility.
- 25. An air solenoid of 80 cm. length has 500 turns and its circular cross-section has a diameter of 2 cm. Calculate a) the self-inductance of the solenoid b) the self linked flux when the current in the solenoid is 2 amp c) the rate of change of current in the solenoid that will produce a self induced e.m.f of 0.3 volt.
- 26. What is self-inductance? Obtain the expression for self-inductance.
- 27. Derive the equation for magnetic field produced by toroid. Mention its application.

SECTION - C

 $(3 \times 15 = 45)$

ANSWER ANY THREE QUESTIONS:

- 28. (a) Discuss about the energy of a continuous charge distribution.
 - (b) What are electrostatic boundary conditions?
- 29. (a) Obtain the equation for concentric spherical capacitor.
 - (b) Discuss about the change in energy due to the presence of dielectric in a capacitor.
- 30. (a) Describe working of ballistic galvanometer.
 - (b) What is damping in ballistic galvanometer?
- 31. (a) Discuss in details the torque acting on a magnetic dipole.
 - (b) What is magnetic hysteresis? How is it useful in choosing materials for permanent magnet?
- 32. Derive Maxwell's equation with the cases in vacuum and medium.
