STELLA MARIS COLLEGE (AUTONOMOUS) CHENNAI – 600 086.
(For candidates admitted during the academic year 2004-05 & thereafter)

SUBJECT CODE : **PH/MC/EM54**

B.Sc. DEGREE EXAMINATION NOVEMBER 2008
BRANCH III - PHYSICS
FIFTH SEMESTER

REG. No._____

COURSE : **MAJOR – CORE**
PAPER : **ELECTRICITY AND MAGNETISM**
TIME : **30 MINS.** MAX. MARKS : **30**

SECTION – A

TO BE ANSWERED IN THE QUESTION PAPER ITSELF

ANSWER ALL QUESTIONS: (30 x 1 = 30)

I CHOOSE THE CORRECT ANSWER:

1. The unit for permittivity is
   a) Cm^{-2} b) C^2Nm^{-2} c) $C^2N^{-1}m^{-2}$ d) $C^2N^{-1}m^2$

2. The potential at any point inside a charged hollow sphere
   a) increases with distance from the centre.
   b) is a constant
   c) decreases with distance from the centre
   d) is zero everywhere inside the sphere

3. The electronvolt is a unit of
   a) charge b) momentum
   c) energy d) potential difference

4. P and Q are two points 0.1 m apart in an electric field. If 500 joules of work are required to move a 2 C charge from P to Q, what is the potential difference in volts between P and Q?
   a) 100 b) 250 c) 1000 d) 2500

5. The electric field at any point near a large surface carrying a large charge density σ is
   a) $\sigma/\in_0$ b) $\sigma/2\in_0$ c) $2\sigma/\in_0$ d) $\sigma^2/\in_0$

6. Three identical capacitors, each of capacitance C are connected in parallel. Then this combination is connected in series with one more identical capacitor of C. The resultant capacitance is
   a) c/4 b) 3C/4 c) 4C/3 d) 4C

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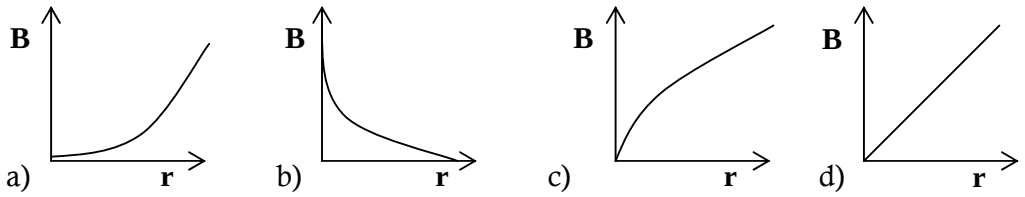
7. For a very long straight solenoid, the ratio of the magnetic field strength at the end on its long axis to that at its geometric centre is
a) 1 b) $1/\sqrt{2}$ c) ½ d) ¼

8. An e.m.f. of 20 volt is applied to a coil having a resistance of 10 ohm and a self-inductance of 0.5 H. The time constant of the circuit in seconds is
a) 0.05 b) 0.5 c) 2 d) 20

9. Five lengths of wire, each of length 20 cm are bent to form different rectangles and are hung in the plane of a radial magnetic field. The one which experiences the greatest torque when a current of 1 A is passed through it, is the one with dimensions (in cm)
a) 8 x $2cm^2$ b) 7 x 3 cm^2 c) 6 x 4 cm^2 d) 5 x 5 cm^2

10. The magnetic flux density B at a distance r from a long straight wire carrying a steady current varies with r as shown in



11. An electron is stationary in a uniform *electric* field pointing north. In which direction does the stationary electron experience a force?
a) North b) East c) West d) none of these

12. An electron is stationary in a uniform *magnetic* field pointing north. In which direction does the stationary electron experience a force?
a) East b) west c) north d) none of these

13. A *magnetic* field acting on a moving charge will change its
a) speed b) kinetic energy c) direction d) both (a) and (c)

14. The torque exerted by a magnetic field **B** on a current loop of dipole moment **p** is given by
a) $\tau = \mathbf{p} \times \mathbf{B}$ b) $\tau = \mathbf{B} \times \mathbf{p}$ c) $\tau = \mathbf{p}.\mathbf{B}$ d) $\tau = \mathbf{pB}$

15. When the potential difference across a parallel plate air capacitor is doubled, the electric field strength between the plates is
a) unaltered b) halved c) doubled d) quadrupled

II FILL IN THE BLANKS:

16. A ballistic galvanometer has a _____ suspension fibre.

17. The electric field everywhere inside a charged conductor is _____.

18. The condition for oscillatory discharge in a series circuit containing inductance, capacitance and resistance is _____.

19. The work done per unit volume to build up a magnetic field in the presence of matter is given by the equation _____.

20. The relationship between electric displacement **D** and the polarization **P** is given by the equation _____.

III STATE WHETHER TRUE OR FALSE:

21. The electrostatic field is a conservative field.

22. The work done in taking a point charge from one point to another in an electrostatic field depends on the path along which the charge is carried.

23. In a series resonant a.c. circuit, the impedance is equal to the resistance.

24. The divergence of the magnetic field is never zero.

25. The magnetic dipole moment is normal to the current loop.

IV ANSWER BRIEFLY:

26. Define magnetic susceptibility.

27. What is meant by the term "bound current"?

28. State the magnetic boundary conditions.

29. Define quality factor of an acceptor circuit.

30. State Gauss' law in differential form.

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COURSE : **MAJOR – CORE**
PAPER : **ELECTRICITY AND MAGNETISM**
TIME : **2 ½ HOURS** MAX. MARKS : **70**

SECTION – B

ANSWER ANY FIVE QUESTIONS: (5 x 5 = 25)

1. Three point charges $Q_1 = 2\,\mu C$, $Q_2 = -3\,\mu C$, $Q_3 = -4\,\mu C$ are placed along the x-axis at distance $x_1 = 20cm$, $x_2 = 30cm$, $x_3 = 40cm$, respectively. Calculate the potential at the origin due to these charges.

2. A capacitor of 3 pF and another of 6 pF are connected in series with a 1000 volt d.c. source. Calculate the (a) equivalent capacitance (b) the charge on each capacitor (c) the potential drop across each capacitor and (d) the total energy stored.

3. A cylindrical co-axial cable consists of a copper core of radius 1×10^{-3} m, surrounded by an outer cylindrical metal sheath of radius 1×10^{-2} m. They are separated by an insulation of dielectric constant = 5. Calculate the capacitance per km length of the cable. What is the energy stored per km if the potential difference between the core and sheath is 10,000V?

4. A circuit consists of a capacitor of 20 μF, a coil of self inductance 0.1 H and a resistor of 100 Ω in series across a 110 volt, 60 hertz a.c. power source. Find the impedance of the circuit, the current in the circuit and the phase angle between the current and applied voltage.

5. A toroidal sample of magnetic material of susceptibility $X = 2 \times 10^{-2}$ is wound with 1000 turns of wire carrying a current of 2.0 A. The circumference is 15 cm. Calculate the magnetizing field intensity, H, the permeability of the material and the induced magnetization, M, of the material.

6. Two large flat parallel metal plates separated by 2 cm in vacuum are connected to a battery of 120 V. (a) Find the electric field between the plates. (b) Find the force experienced by an electron between the plates. (c) What is the loss of electrostatic potential energy in going from the negative to the positive plate? ($e = 1.6 \times 10^{-19}$C)

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7. A charge of 5 C is at the centre of a sphere of radius 2m.
   a) How many electric flux lines originate on the charge?
   b) What is the electric field at the surface of the sphere?
   c) How many electric field lines emerge through an area of ½ m^2 of the surface of the sphere?

SECTION – C

ANSWER ANY THREE QUESTIONS: (3 x 15 = 45)

1. a. State Gauss' law in electrostatics. Use it to find the field outside a cylindrical charge distribution. 8
   b. Prove Poisson's and Laplace's equations for electric field. 7

2. a. Use Biot-Savart law to derive the magnetic flux density near a narrow circular coil of wire of N turns. 8
   b. Derive the relation between magnetic flux density, magnetizing field and intensity of magnetization. 7

3. a. Derive an equation for the capacitance of a parallel plate capacitor. 8
   b. Discuss the discharge of a capacitor through a resistor. 7

4. a. State and prove Ampere's circuital law 8
   b. Derive the curl of the magnetic field. Hence define the magnetic vector potential. 7

5. a. Discuss the theory of the moving coil ballistic galvanometer. 8
   b. Obtain an expression for damping correction of the ballistic galvanometer. 7

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