REV-01
BSP/02/05

2024/07

SET A

B.Sc. PHYSICS
SECOND SEMESTER
ELECTRICITY & MAGNETISM
BSP – 201 [SPECIAL REPEAT]

[USE OMR FOR OBJECTIVE PART]

Duration: 3 hrs. **Full Marks: 70**

(Objective)

Time: 30 min. **Marks: 20**

Choose the correct answer from the following: ***1X20=20***

1. If the electric charge on sphere is doubled, the electrostatic potential energy of the sphere will be
   a. doubled
   b. halved
   c. Become 4 times
   d. Become one fourth

2. The flux of an electric field $\vec{E}$ through a surface S is given by
   a. $\Phi_E = \int_S \vec{E} \cdot d\vec{a}$
   b. $\Phi_E = \int_S \vec{\nabla} \times \vec{E} \cdot d\vec{a}$
   c. $\Phi_E = \int_S (\vec{\nabla}\vec{E}) \cdot d\vec{a}$
   d. None of these

3. The work done on a unit positive charge in bringing it from infinity to any point in an electric field is called
   a. Intensity at that point
   b. Electric potential at that point
   c. Electric potential at infinity
   d. Electric intensity at infinity

4. Which of the following molecules are polar molecules
   a. CH_4
   b. H_2
   c. NH_3
   d. None of these

5. For conductors, the charges located
   a. Inside the conductors
   b. On the surface
   c. Outside the conductors
   d. Nowhere

6. Six charges each +Q, are placed at the corners of a regular hexagon of side a. The electric field at the center of hexagon is
   a. $\frac{1}{4\pi\epsilon_0}\frac{6Q}{a^2}$
   b. $\frac{1}{4\pi\epsilon_0}\frac{Q}{a^2}$
   c. $\frac{1}{4_0}\frac{6^2}{^2}$
   d. 0

7. Work done in carrying 2C charge in a circular path of radius 3 m around a charge of 10 C is
   a. Zero
   b. 6.66J
   c. 15J
   d. 3.33

8. Laplace's equation reads as
   a. $\nabla^2 V = -\rho/\epsilon_0$ b. $\nabla^2 V = \rho/\epsilon_0$
   c. $\nabla V = 0$ d. $\nabla^2 V = 0$

9. For parallel LCR circuit, the current is
   a. Maximum at resonance b. Minimum at resonance
   c. Finite and constant throughout the frequency range d. Zero always

10. For a capacitor
   a. The current leads the voltage by $\frac{\pi}{2}$ b. The current lags the voltage by $\frac{\pi}{2}$
   c. The current and voltage are in phase d. The current leads the voltage by π

11. The value of $\nabla \times B$ at a point outside the current loop is
   a. $\mu_0 . J$ b. $\frac{\mu_0 . J}{2}$
   c. Zero d. Infinity

12. The magnetic vector potential is zero
   a. Never b. Always
   c. In free space d. In current carrying space

13. No force is exerted by a magnetic field on a charge
   a. Moving with constant velocity b. Moving in a circle
   c. At rest d. Moving along a curved path

14. An atom is paramagnetic if it has
   a. An electric dipole moment b. Zero electric dipole moment
   c. Zero magnetic moment d. A permanent magnetic moment

15. S.I. unit of magnetic susceptibility are
   a. A/m b. A/m^2
   c. Unit less d. Am^2

16. The equation $\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$ represents
   a. Gauss's law b. Coulomb's law
   c. Faraday's law d. Ampere's law

17. Mark the statement which is correct in all circumstances
   a. $\vec{\nabla} . \vec{B} = 0$ b. $\vec{\nabla} \times \vec{B} = 0$
   c. $\vec{\nabla} . \vec{E} = 0$ d. $\vec{\nabla} \times \vec{E} = 0$

18. The direction of induced e.m.f. in a circuit is given by
    a. Faraday's law
    b. Fleming left hand rule
    c. Lenz's law
    d. None of these

19. An electromagnetic field satisfies
    a. Gauss's law
    b. Faraday's law
    c. Ampere's law
    d. All of them

20. The displacement current is due to
    a. Variation of magnetic field
    b. Flow of steady current
    c. Variation of electric field
    d. Magnetic flux linked with the circuit

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Descriptive

Time : 2 hrs. 30 mins. **Marks : 50**

[Answer question no.1 & any four (4) from the rest]

1. State and prove the Gauss's divergence theorem. Express it in both integral and differential form. **2+4+4 =10**

2. A spherical charge distribution is given by **3+3+4 =10**

$$\rho = \rho_0\left(1 - \frac{r}{a}\right) \qquad when\ r \leq a$$

$$\rho = 0 \qquad when\ r > a$$

Where 'a' is the radius of the sphere.

Calculate: (*i*) The total charge, (*ii*) electric field intensity outside the charge distribution, (*iii*) for what value of r is the field maximum?

3. **a.** Deduce Faraday's law of electromagnetic induction in differential form. **5+5=10**
   b. Find the potential at a point P far from a dipole.

4. **a.** Find the potential at the centre of a 1 m square having charges q, -2q, 3q and 2q at its corners.($q = 1\times10^{-8}$ C) **5+5=10**

b. A circular coil has a radius of 0.1 m and a number of turns of 50. Calculate the magnetic induction at a point (i) on the axis of the coil and distance 0.2 m from the centre; (ii) at the centre of the coil, when a current of 0.1 A flows on it.

5. **a.** The dielectric constant of a medium is 4. Electric field in in the dielectric is $10^6 Vm^{-1}$. Calculate electric displacement and polarization. **5+5=10**

b. Show that $V = \frac{q}{4\pi\varepsilon\sqrt{x^2+y^2+z^2}}$ satisfies Laplace's equation.

6. State and prove the reciprocity theorem. **2+8=10**

7. **a.** Calculate the capacitance of a capacitor consisting of two concentric sphere of radius *a* and *b* respectively separated by *(i) air* and *(ii) a dielectric of dielectric constant k (or relative permeability ε_r);* when the outer sphere is earthed and the inner sphere is charged. **3+2+5 =10**

b. What is charge density in a region of space where electrostatic potential is given by $V = a - b(x^2 + y^2) - c\log(x^2 + y^2)$?

8. Define electric dipole. Derive the electric field due to an electric dipole at an axial point. A dipole is consisting of an electron and proton, 4×10^{-10} m apart. Compute the electric field at a distance 2×10^{-8} m on a line making an angle 45^0 with the dipole axis from the centre of the dipole. **2+5+3 =10**

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