May 2024

B. Tech. (ME/ME(Hindi)) (Second Semester)

Physics (Introduction to Electromagnetic Theory) (BSC-101F)

Time : 3 Hours] [*Maximum Marks : 75*

Note : It is compulsory to answer all the questions (1.5 marks each) of Part A in short. Answer any *four* questions from Part B in detail. Different sub-parts of a question are to be attempted adjacent to each other. Non-scientific calculator is allowed.

Part A

1. (a) What is Electric Displacement ? Discuss in brief. **1.5**

(b) Show that the potential function $V = a(x^2 + y^2 + z^2)^{1/2}$ does not satisfy the Laplace equation. **1.5**

(c) Twelve negative charges of same magnitude are equally spaced and fixed on the circumference of a circle of radius R. Relative

to potential being zero at infinity, find the electric potential and electric field at the centre C of the circle. **1.5**

(d) What is divergence of a static magnetic field ? Describe the physical significance of it. **1.5**

(e) Define the relation between relative magnetic permeability and susceptibility. **1.5**

(f) Differentiate between Ferromagnetic and Paramagnetic materials along with an example. **1.5**

(g) What is Electromagnetic breaking ? Write its applications. **1.5**

(h) What factor governs the magnitude of E.M.F. induced in a coil ? **1.5**

(i) Describe quasi-static approximation. **1.5**

(j) What is Poynting vector ? What does it governs ? **1.5**

Part B

2. (a) Determine the electric field intensity due to an electric dipole at the axial and equatorial positions. **12**

(b) Two charges 3×10^{-8} C and -2×10^{-8} C are located 15 cm apart. At what point on the line joining the two charges is the electric potential zero ? Take the potential at infinity to be zero. **3**

3. (a) Define the boundary conditions on the magnetic field and vector potential at surface of a magnetic material. **5**

(b) A point charge 'Q' is placed at the center of a sphere of linear dielectric material of permittivity $\in$, compute the potential difference, volume bound charge density and surface bound charge density. **10**

4. (a) What is Vector Potential ? Calculate it for a given magnetic field using Stoke's Theorem. **10**

(b) A wire placed along north-south direction carries a current of 5A from south to north. Find the magnetic field due to a 1 cm piece of wire at a point 200 cm north east from the piece. **5**

5. (a) Develop the equivalence between Faraday's Law and Motional EMF. **10**

(b) A metal disc of radius 200 cm is rotated at a constant angular speed of 60 rad/s in a plane at right angles to an external field of magnetic induction 0.05 Wb/m^2. Find the e.m.f. induced between the centre and a point on the rim. **5**

6. (a) Discuss Maxwell's equation in non-conducting medium along with their physical significances. **7**

(b) In a plane electromagnetic wave, the electric field oscillates sinusoidally at a frequency of 2.0×10^{10}Hz and amplitude 48 V/m. **8**

(i) What is the wavelength of the wave ?

(ii) What is the amplitude of the oscillating magnetic field ?

(iii) Find the total average energy density of the electromagnetic field of the wave.

7. What is Continuity equation for current densities ? Define displacement current and modify equation for the curl of magnetic field to satisfy continuity equation. **15**