NATIONAL EXAMS, MAY 2016

04-BS-9, BASIC ELECTROMAGNETICS

3 HOURS DURATION

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. Candidates may use one of two calculators, the Casio or Sharp approved models. This is a closed book exam.

3. Any five questions constitute a complete paper. Only the first five questions as they appear in your answer book will be marked.

4. All questions are of equal value.

5. Aids: $\varepsilon_0 = 8.85 \times 10^{-12}\ F/m$, $\mu_0 = 4\pi \times 10^{-7}\ H/m$, $e = 1.6 \times 10^{-19}\ C$

1. A positive charge of $+e$ ($=1.6\times10^{-19}$ C) is located at $x = -d/2(= 10^{-10}\ m)$ of a cartesian coordinate system. A negative charge $-e$ is located at $x = d/2$.

   Determine the magnitude and direction of electric field intensity $\vec{E}$ at points $(0, d/2, 0)$ and $(0, 0, d/2)$.

2. What is the value of the electric energy stored in an air dielectric, parallel plate capacitor consisting of two circular plates of 5 cm radius and 0.5 mm plate separation, with charges $\pm10^{-12}$ C on the plates?

3. Two circular current loops of 5 cm radius are located in two parallel vertical planes 2.5 cm apart and centered on a common horizontal axis perpendicular to the planes. Each loop carries 0.1A current with both currents circling in the same direction.

   Determine the direction and magnitude of magnetic flux density vector $\vec{B}$ at the centre of the system.

4. A square loop of 10 cm per side and having 10 turns is located in a vertical plane and rotates at 10^4 RPM about its vertical axis. The loop is located in a horizontal, uniform DC magnetic field of 10^{-5} teslas pointing north.

   Determine:

   (i) RMS voltage induced in the loop and,

   (ii) position of the loop at which the induced voltage is maximum.

5. Cartesian components (X, Y, Z) of an electric field intensity vector $\vec{E}$ are listed below:

$$(X, Y, Z) = \left\{ \begin{array}{l} A(x, y, z) \\ A(R/r)^3(x, y, z) \end{array} \right\} \begin{array}{l} r \leq R \\ r > R \end{array},$$

with $A = 1.44\ 10^{21}\ V/m^2$, $r = (x^2 + y^2 + z^2)^{1/2}$, $R = 10^{-10}\ m$

Determine charge distribution producing the field specified above.

Aid : $\text{div}\ (X, Y, Z) = \frac{\delta X}{\delta x} + \frac{\delta Y}{\delta y} + \frac{\delta Z}{\delta z}$,

6. An electron accelerated from rest by 10^4 V potential is injected between plates of parallel plate capacitor, parallel to the plates. The capacitor voltage is 100 V, plate separation is 1 mm.

What is the magnitude and direction of the magnetic flux density vector $\vec{B}$ that would keep the electron moving parallel to the capacitor plates?

Aid : $e = -1.6 \times 10^{-19} C$, electron mass $m = 9.1 \times 10^{-31}$ kg.

7. EMF and internal resistance of a DC generator are 12 V and 0.1 ohms. The generator delivers power to a 10 ohm resistive load through a transmission line the resistance of which is 1 ohm. Calculate powers delivered to the load, transmission line and internal resistance of the generator.

8. An observer in air sees an object at the bottom of 1m deep body of water at a 45° angle. Index of refraction of water, n = 1.333.

What is the distance between the apparent and actual position of the object?