NATIONAL EXAMS, MAY 2017

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

1. A negative charge –e is uniformly distributed inside a sphere of 5×10^{-11} m radius. A thin spherical surface charge layer of total charge –e adheres and covers the above mentioned charge sphere. A positive point charge +3e is located at the centre of the spheres.

   What is the difference in values of electric field at points just inside and just outside of the spherical surface charge layer?

2. Electric current flows in three infinitely thin and infinitely long straight metallic cylinders of 1mm, 2mm and 3mm radius. The 2mm radius cylinder has 2A current flowing in one direction, the 1mm and 3mm cylinders carry 1A of current each in the opposite direction.

   What are minimum and maximum magnetic flex density fields B in the two spaces between the metallic cylinders?

3. 2A current flows in a circular horizontal loop of 5cm radius. Viewed from above the current circles clockwise.

   What are magnitude and direction of the magnetic flux density vector B at a point 5cm above the centre of the loop?

4. A circular loop of 10 turns and a 5cm radius is located in a vertical plane and rotates at 10000 RPM about its vertical diameter. The loop is located in a magnetic field of 10^{-5} teslas pointing 45^0 up.

   What is the RMS value of EMF induced in the loop?

5. Plate separation in a parallel plate capacitor is 0.5mm. The permittivity of the electric medium separating the plates is 2.5 and maximum allowed electric field is 10^7 V/m.

What is the minimum possible area of the plates if the capacitor is to store 1 joule of electric energy?

6. Radius of two coaxial solenoids with circular cross-sections are 2mm and 1mm. Lengths of both solenoids are 5cm. Number of turns in the outer solenoid is 100 and 50 in the inner.

What is the mutual inductance of the two solenoids?

7. An infinite plate of charges perpendicular to the x-axis produces an electric field (E.O.O) with E=0 for $|x| > d/2$ and Eϱd $[(x/d)^2 - ¼]/\varepsilon_0$ elsewhere with $d=10^{-6}$ m and $\varrho = 1\ C/m^3$.

Determine distribution charge density in the plate of charge

8. A beam of light enters at a 45^0 angle of incidence a body of water 4m deep. It is reflected by a small horizontal mirror located at the bottom of the water, emerges from the water and is detected by an observer.

What is the difference in apparent location of the mirror as seen by the observer who knows the depth of water, and actual location?

Assistance: Index of refraction of water is 1.33.