NATIONAL EXAMS, DECEMBER 2018

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. In a parallel plate capacitor plate separation d is 1mm and circular plate area is 5 cm^2. A Cartesian ζ - coordinate perpendicular to the plates is established with $\zeta = 0$ located on one of the plates, the ζ - coordinate of the other plate being d. Relative permittivity ε of the dielectric filling completely the space between the plates is $\varepsilon = \varepsilon_1/(1 + \alpha\zeta/2)$ with $\varepsilon_1 = 3$ and $\alpha = 0.2/d$.

   What is the value of capacitance of the capacitor?

2. Inductance L of an air core tightly wound solenoid of N turns, length L and circular cross-section are A is $L = \mu_0 N^2 A/L$ *for the case of* $A/L^2 << 1$. A magnetic cylinder of circular cross-section A, length L and relative permeability $\mu = 20$ is inserted into the solenoid described above with portion of length L/2 inside the solenoid and length L/2 portion outside.

   Calculate inductance of magnetic core solenoid described above.

3. A layer of current flows below the horizontal flat surface of a metallic plate of infinite dimension. The current and associated current densities are uniform in horizontal directions but vary from maximum at the metallic surface to zero, 10^{-5} m below the surface. The total linear current is .05 A/m and the direction of the flow is north.

   What are the values and direction of the magnetic flux density B on the surface of the metal and 10^{-5} m below it?

4. Two positive point charges +Q are 10^{-10} m apart. A negative charge –q is located at midpoint of the two positive charge locations.

   For what minimum value of absolute value of q will the mutual repulsion of the two positive charges be eliminated?

5. A straight horizontal metallic rod 2m long is aligned in the 30^0 north of east direction. It is moving in the horizontal, north direction at 50 m/s velocity in a vertical magnetic field of 10^{-5} teslas pointing up.

What are the magnitude and polarity of the voltage induced between the tips of the rod?

6. A plane wave of 10^{10}Hz frequency is incident at a 45^0 angle on the horizontal surface of water. Relative permittivity of water at that frequency is approximately 81.

Determine the directions of reflected and penetrating waves and their wavelengths.

7. A 2A current loop consists of three quarter circles, one lying in the positive x – y plane a Cartesian x-y-z coordinate system, one in the positive y-z plane and one in the positive z-x plane. Centers of the three quarter circles are in the origin of the coordinate system and their common radius is 10 cm.

What is the magnitude of the magnetic flux density B at the center of the loop?

8. A beam of electrons accelerated by 10^4V is moving horizontally in the east direction. It is deflected by an electric field of 10^6 V/m pointing down. The electric deflecting force is cancelled by a magnetic field.

What is the magnitude and direction of the magnetic flux density value of the field?