NATIONAL EXAMS, MAY 2014

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. Two infinite parallel layers of charge 10^{-6} m thick are 10^{-6} m apart. The uniform charge densities are $1 C/m^3$ in one of the layers and $-1 C/m^3$ in the other. Relative permittivity of the medium, both charged and neutral is 10.

   Determine:

   (i)   the electric field intensity E in the neutral region and,

   (ii) the electric potential between the outside surfaces of the two layers.

2. A capacitor consists of two infinitely long coaxial metallic cylinders of 1 mm and 6 mm diameters. The space between the cylinders is filled with dielectric of relative permittivity 2.5. The breakdown electric field of the dielectric is 10^7 V/m.

   Determine:

   (i)   the capacitance of 1 m long section of the system and,

   (ii) the upper limit of the voltage that can be applied to the capacitor.

3. A DC transmission line delivers 10^5 W power at 10 KV to a load. The line consists of two straight parallel cylindrical conductors of 2 cm diameter, 50 cm horizontally apart.

   What are the magnitude and direction of the magnetic flux density vector B at a midpoint between the two conductors?

4. A current loop consists of two joined semicircles of common centre and 5 cm radius. One of the semicircles lies in horizontal plane, the other in vertical plane. A 2 ampere current circulates in the loop. Viewed from above the current circulates clockwise.

   What are the magnitude and direction of the magnetic flux density vector B at the common center of the semicircles?

5. A square loop with 10 cm sides and 70 turns is located in a north-west, south-east vertical plane. An east-west horizontal magnetic field of 0.7 teslas RMS amplitude and 60 Hz frequency passes through the loop.

   What is the RMS EMF induced in the loop?

6. Inductance of an air core solenoid of 100 turns, 5 cm length and 0.25 cm^2 cross-section area is 6.28×10^{-6} henrys.

   What will be the inductance if a slug of magnetic material of relative permeability 10, 2 cm length and 0.25 cm^2 cross-section area is inserted into the solenoid?

7. What is the electrostatic energy of a charge system consisting of a positive charge $+4e$ ($e = 1.6 \times 10^{-19}$ C) at the center of a square with a 10^{-10} m side and negative charges $-e$ located at the vertices of the square?

8. An electron moving horizontally in westerly direction at 10^5 m/s is acted on by a vertical field of 0.5 teslas pointing down. The magnetic force is cancelled by electric field obtained from a parallel plate air core capacitor of 1 mm separation between plates.

   What are the potential, polarity thereof, and orientation of the capacitor?