NATIONAL EXAMS, December 2010

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 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

1. Radii of inner and outer conductors of an infinite coaxial line are 2.5 mm and 5 mm respectively. The inner conductor is coated by a 1mm thick layer of dielectric of relative permittivity 5, while the remainder of the inter-conductor space is filled with dielectric of relative permittivity 2.5. Calculate the capacitance of a 1m long section of the line.

2. A semicircle of 5cm radius lies in the x-y plane of an x-y-z cartesian coordinate system. The diameter of the semicircle lines in the x-*axis* and its center is in the origin of the coordinate system. Another semicircle of 5 cm radius lies in the x-z plane, with its center in the origin of the coordinate system and its diameter in the x-*axis*. The curved parts of the two semicircles form a closed, folded current loop. A 2 ampere current circulates in the loop. Viewed from a point on the positive z-*axis* the current circulates clockwise. What is the magnitude and the direction of magnetic flux density vector B at the common centre of the two semicircles?

3. In a square loop of 10 cm sides two of the sides are vertical, while the other two sides are horizontal. The loop lies in a vertical east-west plane. A 3 ampere current circulates in the loop. Viewed from south the current circulates clockwise. A separate magnetic field of 0.1 teslas points north-west. What's the magnitude and direction (sense) of the torque exerted by this magnetic field on the loop?

4. An infinite straight transmission line consists of two 1 cm wide, thin metallic ribbons located horizontally one above the other with a 1 mm gap between them. Calculate self-inductance of a 1 m long section of the line, neglecting the effects of fringing fields at the edges.

5. A metallic sphere of 2 cm radius carries an electric charge which produces on its surface a field of 10^6 V/m pointing inward. What is the magnitude and sign of the charge?

6. A square loop of 10 cm^2 area lies in a vertical north-east, south-west plane. An AC magnetic field of 10 MHz frequency, 10^{-3} teslas RMS amplitude points in the north-south direction. What is the peak amplitude of the EMF induced in the loop?

7. A negative point charge of 1.6×10^{-19} coulombs moves horizontally east at 3×10^5 m/s velocity in a 10^5 V/m vertical electric field pointing down. Determine the magnitude and direction of the weakest magnetic field that would cancel the force exerted by the electric field on the charge.

8. A beam of light traverses at normal incidence a layer of air and a layer of water. Index of refraction of water is 1.3. What are the relative thicknesses of the two layers if travel times through them are same?