

NATIONAL EXAMS, DECEMBER 2008

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: $\epsilon_0 = 8.85 \times 10^{-12} F/m$, $\mu_0 = 4\pi \times 10^{-7} H/m$, $e = 1.6 \times 10^{-19} C$

1. A positive point charge $+4e$ is located at the centre of a square of 3×10^{-10} m sides. Negative charges $-e$ are located in the corners of the square. What is the magnitude and direction of the electric field acting on one of the negative charges?

2. Radii of inner and outer conductors of a coaxial line are 3mm and 6mm. The medium between the conductors is a dielectric of relative permittivity 2.5. The voltage between the two conductors is 10 volts, the outer conductor being negative.
 - (i) determine the charge on the outer conductor of a 1m long section of infinite transmission line and,
 - (ii) calculate the capacitance of the section

3. The uniform electron density in a long circular beam of 1mm radius is 10^{13} per meter³. The electrons move with uniform velocity of 10^7 m/s. What are:
 - (i) the total current of the beam and,
 - (ii) magnetic flux density B on the surface of the beam?

4. A current loop consists of two semicircles of 25 cm radius and common center located in the origin of a Cartesian coordinate system. One of the semicircles lies in the $x - y$ plane, the other in the $x - z$ plane with the junction of the two semicircles on the x axis at $x = \pm 25$ cm. A 5 ampere current circulates in the

loop. Viewed from a point on the positive z-axis the current circulates clockwise. Determine the direction and magnitude of the magnetic flux density vector \vec{B} at the center of the loop.

5. A square loop of 10 cm sides lies in a vertical plane which rotates about a vertical axis at 3600RPM. A uniform constant magnetic field of 0.5 teslas is inclined at 30° to the horizontal. What is the RMS electromotive force induced in the loop?
6. A linearly polarized 10^4 MHz plane wave propagates in a medium of relative permittivity 9. Power density of the wave is $0.1 \frac{W}{m^2}$. What are:
 - (i) the RMS value of the electric field and,
 - (ii) the wavelength of the wave in the medium?
7. A 10cm x 10cm square is located in a vertical plane with two of its sides vertical and two horizontal. A 5 ampere current circulates in the loop. A horizontal magnetic field of 0.2 teslas is inclined at 30° to the plane of the loop. What is the magnitude of the torque exerted by the magnetic field on the loop?
8. A parallel plate capacitor consists of metallic parallel circular plates of 5cm radius separated by a 2mm wide gap completely filled by dielectric of relative permittivity 2.5. A field of 10^6 volts / m exists inside the capacitor. What is the value of electric energy stored in the capacitor?