

NATIONAL EXAMS, MAY 2015

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. Four electrons each of charge  $-e$  are located in four corners of a square of  $10^{-10}$  m side. At the centre of the square are located four protons of charge  $+e$ .

Determine the magnitude and direction of electric field acting on one of the electrons.

2. The radius of an infinitely long, straight electron beam is  $10^{-6}$  m. The current carried by the beam is  $10^{-6}$  amperes, the velocity of the electrons is  $6 \times 10^7$  m/s.

What are the magnitude and direction of electric field on the surface of the beam?

3. What are the magnitude and direction of magnetic flux density vector  $\vec{B}$  produced by one ampere current circulating in a horizontal circular loop of 1 m radius at a point 1 m above the centre of the loop? Viewed from above the current circulates clockwise.

4. Currents flow in two infinite, flat, horizontal sheets of 1 mm thickness and 1 mm apart. The current in the upper sheet flows north, that in the lower sheet flows south. Current density in both sheets is  $2 \text{ A/mm}^2$ .

What are the direction and magnitude of the flux density vector  $\vec{B}$  in the empty space between the sheets?

5. A horizontal circular wire loop is located in a uniform, vertical magnetic field of 0.1 teslas. The initial circumference of the loop is 30 cm and is being reduced (wound down) from 30 cm to zero at the rate of 1 cm/s.

What are the maximum and minimum values of EMF induced in the loop?

6. Electric energy of 1 joule is stored in an air-dielectric circular, parallel plate capacitor of  $10 \text{ cm}^2$  area and 1 mm separation between the plates.

What is the value of electric field intensity vector  $\vec{E}$  between the plates?

7. What is the mutual inductance of two coaxial circular loops located in two parallel planes 5 cm apart? The radius of one of loop is 5 cm, that of the other is 2 mm.

8. A pulse of light is generated at a point 10 m above a horizontal ground plane and detected at a point 30 m above the ground plane and 40 m horizontally away from the source point. The detected signal consists of a pulse travelling directly from the source to the detector and a pulse reflected from a horizontal mirror on the ground plane.

Determine:

- (i) the location of the reflecting mirror on the ground plan and,
- (ii) time delay between the arrivals of the pulses at the detector.

Assistance:  $c = 3 \times 10^8$  m/s.