

NATIONAL EXAMS,

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

1. A parallel plate capacitor consists of two circular plates of 5cm radius separated by a 1mm gap. A 0.5mm layer of dielectric of relative permittivity 2.5 covers the inside surface of one of the plates. The dielectric strength of air is assumed to be 10^6 volt/meter, that of the dielectric 10^7 volt/meter.

What is the upper limit on the energy that can be stored in the capacitor?

2. The magnitude and direction of terrestrial magnetic field are 10^{-5} teslas and horizontally north respectively. A rectangular shape loop of 5cm side and 10 turns rotates at 7200RPM about its axis (the axis parallel to one of its sides). The axis lies in a north-south vertical plane and is inclined at 30° to the horizontal.

What is the RMS amplitude of the EMF induced in the loop?

3. A 2 ampere current circulates in a circular current loop of 50cm radius located in a north-south vertical plane. Viewed from west the current circulates clockwise. The local magnetic field points horizontally due north and the value thereof is 10^{-5} teslas.

What are the magnitude and direction of the total magnetic field 20cm due east of the center of the current loop?

4. 60 ampere DC current and its return are supplied by a coaxial line the radii of inner and outer conductor of which are 5mm and 1cm respectively. The inner conductor is a solid metallic rod while the outer conductor is a very thin metallic cylinder. The intervening medium is air and is assumed to be non-magnetic.

Derive expressions for magnetic flux density produced by the currents and draw a diagram representing the result obtained.

5. The conductivity of material in a conductor of 5mm radius varies linearly from minimum 0.2×10^6 mho/meter at the center to maximum of 10^6 mho/meter at the circumference.

What is the resistance of a 2 meter long section of the conductor?

6. The radius of the center line of an iron torus (doughnut shaped body) is 10cm, the radius of the torus body is 5mm. The relative permeability of iron is 100. A 2mm wide gap, perpendicular to the center line is cut in the torus. A winding of 400 turns is wound around the torus.

What current in the winding is required to produce of field of 0.25 teslas in the 2mm gap?

7. An east-west horizontal straight line carries 50 ampere DC current flowing due west. The local terrestrial magnetic field is 10^{-5} teslas pointing north and 30° down from horizontal.

What are the magnitude and direction of magnetic force acting on 2 km long section of the line?

8. A linearly polarized 10MHz plane propagates in free space in the positive z-direction. The power density in the wave is $.01 \text{ watt}/m^2$.

Determine:

- (i) the RMS amplitude of the magnetic field of the wave and,

- (ii) the shortest distance between any two points on the z-axis such that at all times the fields at these are identical.