

NATIONAL EXAMS, DECEMBER 2010

07-ElecA7, 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: $\epsilon_0 = 8.85 \times 10^{-12} \text{ F/m}$, $\mu_0 = 4\pi \times 10^{-7} \text{ H/m}$

1. A 100 MHz linearly polarized magnetic field is monitored by a planar loop of 10^{-2}m^2 area located in a vertical NW-SE plane. The amplitude and direction of the magnetic field is 3×10^{-12} teslas RMS and NE, 30° up.

What is the RMS voltage induced in the loop?

2. A 2 ampere current loop consists of a 20cm radius semicircle and the diameter thereof. The loop is located in a horizontal plane and viewed from above the loop, current circulates clockwise.

What is the direction and magnitude of magnetic flux density vector at 20cm above the midpoint of the loop diameter?

3. In a coaxial line the diameters of the inner and outer conductors are 2.7mm and 1cm respectively. The relative permittivity of the inter conductor medium is 2.5.

What are

- (i) the phase velocity of the line and,
- (ii) the characteristic impedance thereof?

4. The characteristic impedance and phase velocity of a transmission line are 50 ohms and 3×10^8 m/s respectively. A 50cm long section of the line is terminated in a short circuit.

What are the four lowest frequencies for two of which the input impedance of the section is a short-circuit and an open circuit for other two frequencies?

5. Phase velocity and characteristic impedance of a transmission line are 3×10^8 m/s and 50 ohms respectively. A 9 km long section of the line is terminated in a 25 ohm load resistor. The line is driven by a generator the internal resistance of which is 2.5 ohms, and EMF a stepfunction of 81 volt amplitude.

What are the load voltage and current 100 microseconds after the stepfunction has been launched on the line?

6. Two 10 GHz plane waves propagate in the horizontal direction. One propagates 30° east of north, the other 30° west of north. Both are linearly polarized (electric field) in vertical direction and amplitudes of both are 50 millivolts per meter RMS. At a point in space the amplitude of the total electric field (sum field) is zero.

What are the direction and RMS amplitude of the total magnetic field at that point?

7. The charge in a spherical thundercloud of 100m radius is 1 coulomb. Assuming uniform charge distribution inside the cloud determine the total energy (both inside and outside the cloud) stored in the system.
8. 10 MHz and 20 MHz vertical current elements are located at the same location on a perfectly conducting ground plane. The lengths and current amplitudes of the two elements are same. The RMS amplitude of the 10 MHz signal 10 km away from the source on the ground plane is 2 millivolts per meter.

What is the time averaged power density of the 20 MHz signal, 5 km away radially, 30° above the ground plane?