

Department of Physics, Bennett University

EPHY105L (I Semester 2018-2019)

Problem Sheet 6

1. Consider an infinitely long cylinder of circular cross section of radius a which is uniformly magnetized parallel to its axis.
 - a) Obtain the bound surface and volume currents.
 - b) Obtain the magnetic field produced by the magnetized cylinder.
2. An infinitely long straight wire made of copper and of radius R carries a current I which is uniformly distributed across its cross section. Using Ampere's law obtain the values of the fields \vec{H} and \vec{B} within and outside the wire. What are the bound surface and volume currents?
3. A coaxial cable consists of two very long cylindrical tubes separated by a linear insulating material with magnetic susceptibility χ_m . If a current I flows along the inner tube and returns along the outer tube, find the magnetic field in the region between the two tubes. [Ans: $\mu_0(1 + \chi_m)I/2\pi r$].
4. Consider an infinitely long solenoid with circular cross section of radius R having N turns per unit length and carrying a current I . If a cylindrical rod of radius $a < R$ and made of a material of magnetic susceptibility χ_m is placed coaxially within the solenoid, calculate the magnetic field \vec{B} and the field \vec{H} in different regions within the solenoid. What are the values of bound surface and volume currents?
5. An infinitely long wire and a square conducting loop of side a are placed in a plane with one side of the square loop being parallel to the wire. The loop is moving away from the long wire at a speed v . If a current I flows through the wire, calculate the magnitude of the induced emf in the loop at an instant when the nearest side of the square is at a distance b from the wire. [Ans: $\mu_0 I a^2 v / 2\pi b(b + a)$].
6. A coil consisting of 100 turns of radius 20 cm is placed perpendicular to a uniform magnetic field of 0.5 T. Calculate the emf induced in the coil if 0.2 s (i) the field is reduced to zero, (ii) the field is reversed in direction and (iii) if the coil is rotated through 90° . [Ans: (i) 31.4 V; (ii) 62.8 V, (iii) 31.4 V]
7. Consider a long hollow solenoid of radius $R = 2$ mm and length $L = 20$ cm having a total of 100 turns. If an alternating current of amplitude 5 A and frequency $f = 10$ kHz is passed through the coils, find the magnitude of the induced electric field inside the solenoid. What will be the direction of the electric field? [Ans: $E = 98.7r \cos(2\pi ft)$ V/m; Azimuthal direction.]
8. Consider an infinitely long solenoid of radius 1 cm and having 1000 turns per meter. The current in the solenoid is increased linearly from zero to 1 A in 1 ms. Calculate the magnitude of the induced electric field at (i) a distance of 2 mm from the axis and (ii) a distance of 2 cm from the axis. [Ans: (i) $4\pi \times 10^{-4}$ V/m; (ii) $\pi \times 10^{-3}$ V/m]