Department of Physics (Bennett University)
EPHY105L (I Semester, 2020-21)

Tutorial Set - 7

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: $E = 98.7 r\cos(2\pi f t)$ 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]