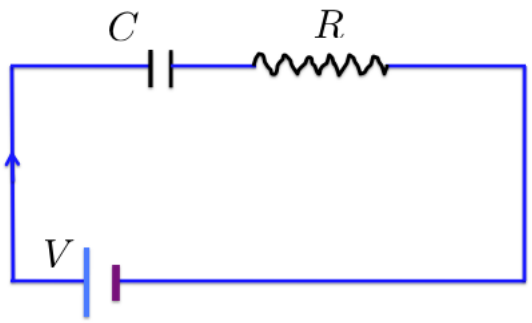
Indian Institute of Technology Madras
PH1020, Tutorial Set-8

1. A 50 pF parallel plate capacitor is getting charged at such a rate that its voltage is increasing at 300 V/s. The plates are circular with a radius of 10 cm. Calculate J_D and the magnetic induction at a distance of 5 cm from the axis of the capacitor in the space between the plates.



2. Medium 1 comprising the region $z > 0$ of a Cartesian coordinate system is characterized by the permeability $\mu_1 = 4\mu_0$, whereas medium 2 comprising the region $z < 0$ is characterized by $\mu_2 = 2\mu_0$. μ_0 is the permeability of free space. The magnetic induction $\vec{B}_1$ in medium 1 is given by

$$\vec{B}_1 = B_0(2\hat{e}_x + 4\hat{e}_y + 5\hat{e}_z)$$

where B_0 is a constant of suitable dimensions. The boundary $z = 0$ between the two media carries a free surface current density $\vec{K}_f$ given by

$$\vec{K}_f = \left(\frac{B_0}{\mu_0}\right)(\hat{e}_x - 2\hat{e}_y)$$

All fields are independent of time and spatially uniform in both the media. Determine the magnetic induction $\vec{B}_2$ in the medium 2.

3. A current flowing in a long straight solenoid with the radius R of cross section is varied so that the magnetic field inside the solenoid increases with time according to the law $B = \beta t^2$, where β is a constant. Find the displacement current density as a function of the distance r from the solenoid axis.

4. If the electric field in vacuum is $\vec{E} = E_0 cos(\omega t - ky)\hat{x}$, what is the $\vec{H}$ field ? Does the electric field $\vec{E} = E_0 cos(\omega t - kx)\hat{x}$ in vacuum satisfy the Maxwell's equations ? Under what circumstances would this $\vec{E}$ field satisfy the Maxwell's equations ?