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10% 1. A charged conductor has a small-diameter hole in a region where the surface charge density is σ. Show that the electric field intensity in the hole close to the surface of the conductor is $\sigma/2\epsilon_0$.

20% 2. (a) Calculate the electric polarization $\vec{P}$ in a long dielectric cylinder spinning at an angular velocity ω about its axis in a uniform axial magnetic field.

(b) Calculate the bound charge densities ρ_b and σ_b.

20% 3. Consider a long solenoid. Show that $\vec{B}$ has the following characteristics both inside and outside the solenoid.

(a) $B_\rho = 0$

(b) $\dfrac{\partial B_z}{\partial \rho} = 0$

Find also the magnetic induction $(\vec{B})$ both inside and outside the solenoid.

10% 4. Find the magnetic moment $\vec{m}$ of a charged ring as a function of time. The charge density per unit length on the ring is λ and the radius of the ring is r. The ring starts spinning about its axis when $t=0$ and has a constant angular acceleration α.

15% 5. (a) Show that a current-carrying coil tends to orient itself in a magnetic field in such a way that the total magnetic flux linking the coil is maximum.

(b) Show that the torque exerted on the coil is $\vec{m} \times \vec{B}$, where $\vec{m}$ is the magnetic moment of the coil and $\vec{B}$ is the magnetic induction when the current in the coil is zero.

25% 6. Prove that the plane electromagnetic waves are transverse in any homogeneous, isotropic, linear and stationary medium.

Hints: 1. $\nabla^2\vec{E} - \epsilon\mu\frac{\partial^2\vec{E}}{\partial t^2} - \sigma\mu\frac{\partial\vec{E}}{\partial t} = \nabla\frac{\rho_f}{\epsilon}$

$\nabla^2\vec{H} - \epsilon\mu\frac{\partial^2\vec{H}}{\partial t^2} - \sigma\mu\frac{\partial\vec{H}}{\partial t} = 0$

2. Consider a plane wave propagating in the positive direction of the z-axis

3. Use Gauss's law to dispose the charge density that appears in the first equ.