國立成功大學七十九學年度物理研究所碩士班入學考試（電磁學　試題）共 1 頁 第 1 頁

1. (20%) Two thin-walled coaxial pipes of radii a and b ($a<b$) are lowered vertically into an oil bath. If a voltage V is applied between the pipes, what is the height that the oil rises? Assume the density and dielectric constant of the oil are ρ and K respectively.

2. (20%) (a) What is the current distribution $\vec{J}(x,y,z)$ to produce a magnetic field $\vec{B} = y^3\hat{x}$? $\hat{x}$ is the unit vector along x-axis.
(b) The axial electric field intensity E_z in the accelerating tube of an ion accelerator is given by $E_z = E_0 + kz^2$, where E_0 and k are constants; z is measured from the center of the tube along its axis. The azimuthal component E_ϕ is zero. Find the radial electric field intensity E_r inside the tube, assuming a uniform charge density ρ within the tube. [$\vec{\nabla}\cdot\vec{E} = \frac{1}{r}\frac{\partial}{\partial r}(rE_r) + \frac{1}{r}\frac{\partial E_\phi}{\partial \phi} + \frac{\partial E_z}{\partial z}$.]

3. (20%) A conducting sphere of radius a is charged to a potential V and spun about a diameter at an angular velocity ω. Find (a) the magnetic induction $\vec{B}$ at the center of the sphere, (b) the magnetic dipole moment of the sphere.

4. (20%) (a) Find approximately the mutual inductance of two coaxial loops whose radii are a and b respectively. The planes of the loops are parallel to each other and are spaced at a distance c much larger than a and b. (b) If the current in the first loop is $I_1 = I_0 \sin\omega t$, fined the electromotance (emf) induced in the second loop.

5. (20%) (a) In a low-pressure (collisionless) plasma, find the phase velocity and group velocity, for $\omega > \omega_p$.
(b) Calculate the skin depth and wave velocity in copper ($\sigma = 6\times10^7$ mho/m) at a frequency of 1 GHz.

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