2018 Spring PHYS2320 電磁學（Electromagnetism) Midterm (double sides)

[Griffiths Chs. 7.2-9] 2018/04/23, 10:10am – 12:00am, 教師：張存續 滿分 100

1. Find the self-inductance L of a solenoid (radius R, length l, current I, and n turns per unit length),

(a) Using the flux relation $\Phi = LI$. (10%)

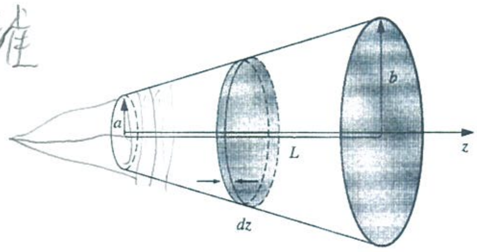
(b) Using the energy relation $W = \frac{1}{2} LI^2$. (10%)

柱

2. (a) Calculate the resistance of a conical shaped object, of resistivity ρ, with length L, radius a at one end and radius b at the other. The two ends are flat, and are taken to be equipotentials. The suggest method is to slice it into circular disks of width dz, find the resistance of each disk, and integrate to get the total. Calculate R this way. (10%) 平([illegible])

(b) Suppose the ends are, instead, spherical surfaces, centered at the apex of the cone. Calculate the resistance in this case. (Let L be the distance between the centers of the circular perimeters of the caps.) (10%)

凸透 圓椎



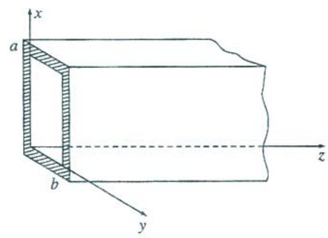
3. (a) Consider two equal point charges q, separated by a distance $2a$. Construct the plane equal-distant from the two charges. By integrating Maxwell's stress tensor over this plane, determine the force of one charge on the other. (10%)

(b) Do the same for charges that are opposite in sign. (10%)

[Hint: $\mathbf{F} = \oint_S \vec{\mathbf{T}} \cdot d\mathbf{a} - \varepsilon_0 \mu_0 \frac{d}{dt} \int_V \mathbf{S} d\tau$ and $T_{ij} \equiv \varepsilon_0 (E_i E_j - \frac{1}{2}\delta_{ij} E^2) + \frac{1}{\mu_0}(B_i B_j - \frac{1}{2}\delta_{ij} B^2)$]

real

4. A wave is propagating in a rectangular waveguide with fundamental TE_{10} mode.
$B_z(x,z,t) = B_0 \cos(\pi x / a)\cos(kz - \omega t)$.



(a) Find E_x, E_y, B_x, and B_y? (10%) [Hint: Express in real components.]

(b) Find the surface current $\mathbf{K}$ on the bottom of the inner wall (the yz plane)? (10%) [Hint: $\mathbf{K}$ is a vector.]

$$E_x = \frac{\hat{\ }}{\frac{\omega^2}{c^2} - k^2} \quad k\frac{\partial E_z}{\partial x} + \omega\frac{\partial B_z}{\partial y}$$

$$E_y \quad k\frac{\partial E_z}{\partial y} - \omega\frac{\partial B_z}{\partial x}$$

$$B_x \quad k\frac{\partial B_z}{\partial x} + \frac{\omega}{c^2}\frac{\partial E_z}{\partial y}$$

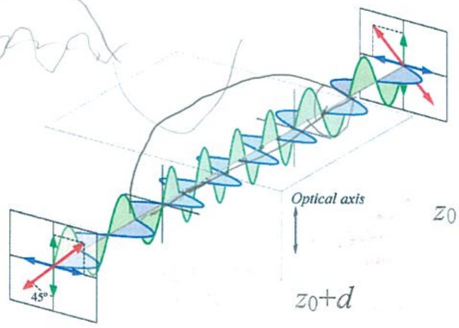
$$B_y \quad k\frac{\partial B_z}{\partial y} - \frac{\omega}{c^2}\frac{\partial E_z}{\partial x}$$

$v = \frac{\omega}{k}$

$\frac{B}{v} = E$

$kv = \omega$ $\quad v = \frac{\omega}{k}$ $\quad k = \frac{\omega}{c}$

5. Birefringence: the wave plate



Linearly polarized light entering a wave plate can be resolved into two waves, parallel and perpendicular to the optical axis of the wave plate. In the plate, assume that the parallel wave (k_y) propagates slightly slower than the perpendicular one (k_x).

Near side: $f_0 = A_0 \cos(k_x z_0 - \omega t)\hat{\mathbf{x}} + A_0 \cos(k_y z_0 - \omega t)\hat{\mathbf{y}}$

Far side: $f_d = A_0 \cos(k_x(z_0 + d) - \omega t)\hat{\mathbf{x}} + A_0 \cos(k_y(z_0 + d) - \omega t)\hat{\mathbf{y}}$ $\quad kv = \omega \quad z \to \lambda$

(a) At the far side of the plate, can we change the polarization of the resulting combination orthogonal to its entrance state? At what condition? (10%)

(b) Is it possible to form a right or left hand circular polarization? At what condition? (10%)

$z_0 + \lambda$ $\quad k = \frac{2\pi}{\lambda}$

$k_y \lambda = 2\pi$