九十六學年第二學期 PHYS2320 電磁學 期末考試題(共二頁)

[Griffiths Chaps. 7, 8, 9 10, and 12] 2008/06/10, 10:10am–12:00am, 教師：張存續

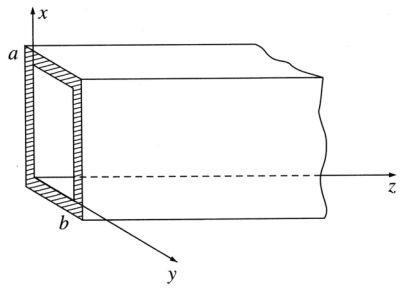
記得寫上學號，班別及姓名等。請依題號順序每頁答一題。

1. (7%, 7%, 6%)
   (a) Write down Maxwell's equations in terms of free charges ρ_f and current $\mathbf{J}_f$. Also for linear media, write the appropriate constitutive relations, giving **D** and **H** in terms of **E** and **B**.
   (b) Write down the four boundary conditions ($\mathbf{E}^{\perp}$, $E^{//}$, $\mathbf{B}^{\perp}$, and $B^{//}$) for linear media, if there is no free charge and no free current at the interface.
   (c) Write down the equations for conservation of charge, energy, and momentum . Please explain the symbols you use as clear as possible.

2. (10%, 10%) The field of the TE_{10} waveguide mode is

$$B_z = B_0 \cos(\pi x/a) e^{i(kz-\omega t)} \quad \text{and} \quad B_x = \frac{-ika}{\pi} B_0 \sin(\pi x/a) e^{i(kz-\omega t)}$$

$$E_y = \frac{i\omega\mu a}{\pi} B_0 \sin(\pi x/a) e^{i(kz-\omega t)}$$



(a) If $a = 2.54$ mm and $b = 1.72$ mm (WR-10 waveguide), find the cutoff frequency of this mode ($f_{mn} = \omega_{mn}/2\pi$).

(b) Consider the resonant cavity by closing off the two ends of the waveguide, at $z = 0$ and $z = d$, making a perfect empty conducting box. Determine the electric and magnetic fields using the boundary conditions.

3. Explain the following terms as clear as possible.
   (a) Einstein's postulates for the special relativity (4%)
   (b) Lorentz gauge and Coulomb gauge (4%)
   (c) Retarded potentials (4%)
   (d) Lienard-Wiechert potentials (4%)
   (e) Invariant quantity and conserved quantity (4%)

4. (6%, 7%, 7%) Suppose V=0 and $\mathbf{A}$=$A_0\cos(kx-\omega t)\,\hat{\mathbf{z}}$, where A_0, ω, and k are constants.

(a) Find **E** and **B**.

(b) Use the gauge function $\lambda = xt$ to transform the potentials V' and $\mathbf{A}'$.

(c) Find the new $\mathbf{E}'$ and $\mathbf{B}'$. Comment on the gauge freedom.

[Hint: $\mathbf{A}' = \mathbf{A} + \nabla\lambda,\ \ V' = V - \partial\lambda/\partial t$]

5. (7%, 7%, 6%) A long coaxial cable, of length l, consists of an inner conductor (radius a) and an outer conductor (radius b). It is connected to a battery at one end and a resistor at the other. The inner conductor carries a uniform charge per unit length λ and a steady current I to the right; the outer conductor has the opposite charge and current.

(a) What is the electric field and magnetic field?

(b) Calculate the power (energy per unit time) transported down the cable.

(c) Find the total momentum of all charges in the loop. [i.e. hidden momentum]