2023-2학기 전자기파와 광학 HW5, Due: 11:59pm Nov. 3rd (eTL upload)

File name: NAME_ID_HW#, e.g. 홍길동_20230101_HW#

1. **Griffiths problem 10.1 (수업시간에 성실하게 필기한 분에게 유리한 문제입니다)**

Problem 10.1 Show that the differential equations for V and $\mathbf{A}$ (Eqs. 10.4 and 10.5) can be written in the more symmetrical form

$$\left.\begin{aligned} \Box^2 V + \frac{\partial L}{\partial t} &= -\frac{1}{\epsilon_0}\rho, \\ \Box^2 \mathbf{A} - \boldsymbol{\nabla} L &= -\mu_0 \mathbf{J}, \end{aligned}\right\} \tag{10.6}$$

where

$$\Box^2 \equiv \nabla^2 - \mu_0\epsilon_0 \frac{\partial^2}{\partial t^2} \quad \text{and} \quad L \equiv \boldsymbol{\nabla}\cdot\mathbf{A} + \mu_0\epsilon_0 \frac{\partial V}{\partial t}.$$

2. **Griffiths problem 10.2**

Problem 10.2 For the configuration in Ex. 10.1, consider a rectangular box of length l, width w, and height h, situated a distance d above the yz plane (Fig. 10.2).

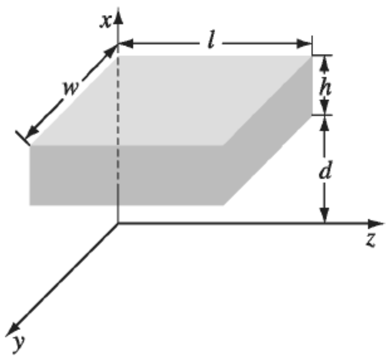

FIGURE 10.2

(a) Find the energy in the box at time $t_1 = d/c$, and at $t_2 = (d+h)/c$.

(b) Find the Poynting vector, and determine the energy per unit time flowing into the box during the interval $t_1 < t < t_2$.

(c) Integrate the result in (b) from t_1 to t_2, and confirm that the increase in energy (part (a)) equals the net influx.

3. **Griffiths problem 10.3**

Problem 10.3

(a) Find the fields, and the charge and current distributions, corresponding to

$$V(\mathbf{r}, t) = 0, \quad \mathbf{A}(\mathbf{r}, t) = -\frac{1}{4\pi\epsilon_0}\frac{qt}{r^2}\,\hat{\mathbf{r}}.$$

(b) Use the gauge function $\lambda = -(1/4\pi\epsilon_0)(qt/r)$ to transform the potentials, and comment on the result.

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4. **Griffiths problem 10.4**

Problem 10.4 Suppose $V = 0$ and $\mathbf{A} = A_0 \sin(kx - \omega t)\,\hat{\mathbf{y}}$, where A_0, ω, and k are constants. Find **E** and **B**, and check that they satisfy Maxwell's equations in vacuum. What condition must you impose on ω and k?

5. 수업시간에 Jefimenko's equations 을 유도하는 과정을 상세히 다뤘습니다. Griffiths 교재 pp. 449-pp.450 을 읽고

   (a) Retarded scalar potential 이 다음을 만족함을 보이시오.

$$\nabla^2 V - \mu_0 \epsilon_0 \frac{\partial^2 V}{\partial t^2} = -\frac{1}{\epsilon_0}\rho.$$

   (b) Retarded vector potential 이 다음을 만족함을 보이시오.

$$\nabla^2 \mathbf{A} - \mu_0 \epsilon_0 \frac{\partial^2 \mathbf{A}}{\partial t^2} = -\mu_0 \mathbf{J}.$$

   (c) Equation 10.36 과 Equation 10.38 을 유도해 보세요. (수업시간에 성실하게 필기한 분에게 유리한 문제입니다)

$$\boxed{\mathbf{E}(\mathbf{r}, t) = \frac{1}{4\pi\epsilon_0} \int \left[\frac{\rho(\mathbf{r}', t_r)}{\mathscr{r}^2} \hat{\boldsymbol{\mathscr{r}}} + \frac{\dot{\rho}(\mathbf{r}', t_r)}{c\mathscr{r}} \hat{\boldsymbol{\mathscr{r}}} - \frac{\dot{\mathbf{J}}(\mathbf{r}', t_r)}{c^2 \mathscr{r}} \right] d\tau'.} \qquad (10.36)$$

$$\boxed{\mathbf{B}(\mathbf{r}, t) = \frac{\mu_0}{4\pi} \int \left[\frac{\mathbf{J}(\mathbf{r}', t_r)}{\mathscr{r}^2} + \frac{\dot{\mathbf{J}}(\mathbf{r}', t_r)}{c\mathscr{r}} \right] \times \hat{\boldsymbol{\mathscr{r}}}\, d\tau'.} \qquad (10.38)$$