2023-2학기 전자기파와 광학 HW7, Due: 23/11/24(Fri) 11:59 pm (eTL upload)

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

1. **Griffiths problem 11.1**

Problem 11.1 Check that the retarded potentials of an oscillating dipole (Eqs. 11.12 and 11.17) satisfy the Lorenz gauge condition. Do *not* use approximation 3.

2. **Griffiths example 11.2**

Example 11.2.

(a) In the case of an oscillating electric dipole,

$$p(t) = p_0 \cos(\omega t), \quad \ddot{p}(t) = -\omega^2 p_0 \cos(\omega t),$$

and we recover the results of Sect. 11.1.2.

(b) For a single point charge q, the dipole moment is

$$\mathbf{p}(t) = q\mathbf{d}(t),$$

where $\mathbf{d}$ is the position of q with respect to the origin. Accordingly,

$$\ddot{\mathbf{p}}(t) = q\mathbf{a}(t),$$

where $\mathbf{a}$ is the acceleration of the charge. In this case the power radiated (Eq. 11.60) is

$$P = \frac{\mu_0 q^2 a^2}{6\pi c}. \tag{11.61}$$

This is the famous **Larmor formula**; I'll derive it again, by rather different means, in the next section. Notice that the power radiated by a point charge is proportional to the *square* of its *acceleration*.

3. **Griffiths equation 11.73 을 유도해 보시오. 수업시간에 소개한 바와 같이 equation 11.72 를 유도해야 하고 그 이후 적분을 수행해야 합니다.**

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4. **Griffiths example 11.3. 수업시간에 수행한 상세 계산과정을 함께 보이시오.**

5. **Griffiths problem 11.16**

Problem 11.16 In Ex. 11.3 we assumed the velocity and acceleration were (instantaneously, at least) *collinear.* Carry out the same analysis for the case where they are *perpendicular*. Choose your axes so that $\mathbf{v}$ lies along the z axis and $\mathbf{a}$ along the x axis (Fig. 11.14), so that $\mathbf{v} = v\,\hat{\mathbf{z}}$, $\mathbf{a} = a\,\hat{\mathbf{x}}$, and $\hat{\boldsymbol{\imath}} = \sin\theta\cos\phi\,\hat{\mathbf{x}} + \sin\theta\sin\phi\,\hat{\mathbf{y}} + \cos\theta\,\hat{\mathbf{z}}$. Check that P is consistent with the Liénard formula. [*Answer:*

$$\frac{dP}{d\Omega} = \frac{\mu_0 q^2 a^2}{16\pi^2 c}\frac{[(1-\beta\cos\theta)^2 - (1-\beta^2)\sin^2\theta\cos^2\phi]}{(1-\beta\cos\theta)^5}, \qquad P = \frac{\mu_0 q^2 a^2 \gamma^4}{6\pi c}.$$

6. **Griffiths problem 11.24**

Problem 11.24 As a model for electric quadrupole radiation, consider two oppositely oriented oscillating electric dipoles, separated by a distance d, as shown in Fig. 11.19. Use the results of Sect. 11.1.2 for the potentials of each dipole, but note that they are *not* located at the origin. Keeping only the terms of first order in d:

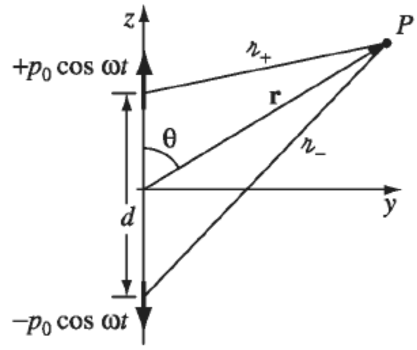

FIGURE 11.19

(a) Find the scalar and vector potentials.

(b) Find the electric and magnetic fields.

(c) Find the Poynting vector and the power radiated. Sketch the intensity profile as a function of θ.