Final Exam (2020 Spring)

PHYS 420: Electricity and Magnetism II

Department of Physics, Southern Illinois University–Carbondale
Date: 2020 May 8

Instruction: You are allowed to refer to any resource of your choice. Choose to be honest and fair to your peers. After completing the exam, scan your work and submit it as a single PDF file to `shajesh@siu.edu`. This exam is due on the official date of the exam.

1. (**20 points.**) Compute the numerical value of

$$\frac{\mu_0 c}{4\pi} \tag{1}$$

   in SI units.

2. (**20 points.**) By taking the curl of the Maxwell equation

$$-\boldsymbol{\nabla} \times \mathbf{E} - \frac{\partial \mathbf{B}}{\partial t} = 0 \tag{2}$$

   and using Maxwell's equations, without introducing potentials, show that the electric field satisfies the inhomogeneous wave equation

$$\left(-\nabla^2 + \frac{1}{c^2} \frac{\partial^2}{\partial t^2} \right) \mathbf{E}(\mathbf{r}, t) = -\frac{1}{\varepsilon_0} \boldsymbol{\nabla} \rho(\mathbf{r}, t) - \mu_0 \frac{\partial}{\partial t} \mathbf{J}(\mathbf{r}, t). \tag{3}$$

3. (**20 points.**) Starting from the relation

$$\gamma = \frac{1}{\sqrt{1 - \dfrac{\mathbf{v} \cdot \mathbf{v}}{c^2}}} \tag{4}$$

   evaluate

$$\frac{d\gamma}{dt}. \tag{5}$$

4. (**20 points.**) Using the identity

$$\delta(F(x)) = \sum_r \frac{\delta(x - a_r)}{\left| \frac{dF}{dx} \big|_{x=a_r} \right|}, \tag{6}$$

   where the sum on r runs over the roots a_r of the equation $F(x) = 0$, evaluate

$$\delta(x^3 - 8x^2 + 17x - 10). \tag{7}$$

5. (**20 points.**) What are the differences between Rayleigh scattering, Thompson scattering, Raman scattering, and Compton scattering. Qualitatively distinguish them, based on elastic and inelastic processes, and low and high energy processes.