Assignment 1: Fields & Waves (ECE230), Winter 2021

Total marks: 30. Deadline: 6 p.m. March 25, 2021

Email your answer script (a single pdf) to instructor. The filename must contain your name and roll number. The subject line of the email will be "Assignment 1 (ECE 230)

Plagiarism policy: ZERO tolerance towards copying assignments from others/ plagiarism from any other sources. Such cases will be dealt strictly according to the institute policy.

Late submission policy: −5/day after the submission deadline (starts immediately after 6 p.m. March 25. NO exceptions).

Other policy: Marking the assignment is going to be strict and heavy penalty 'll be imposed if you do not represent vector quantities, dot products, cross products and vector calculus operators correctly. So, please take good care of what you write on the answer sheets.

Q1. Under what conditions can we have $\nabla^2 \vec{A} = -\mu_0 \vec{J}$? Prove the identity.

$1 + 4 = 5$ points

Q2. Starting from scratch, obtain Gauss's law for an inhomogeneous medium. Obtain $\vec{\nabla}.\vec{E}$ for an inhomogeneous medium carrying a volume charge density ρ.

$5 + 5$ points

Q3. The vector potential of a single magnetic dipole $\vec{m}$ is given by:

$$\vec{A}(r) = \frac{\mu_0}{4\pi} \frac{\vec{m} \times \hat{r}''}{r''^2}$$

[Here, $\vec{r}'' = \vec{r} - \vec{r}'$]

Show that, for a distribution of magnetic dipoles, the total magnetic vector potential can be written in the following form:

$$\vec{A}(r) = \frac{\mu_0}{4\pi} \left[\int_{V'} \frac{\vec{J}_b(r')}{\vec{r}''} dv' + \oint_S \frac{\vec{K}_b(r')}{\vec{r}''} dS' \right]$$

What does $\vec{J}_b$ and $\vec{K}_b$ represent?

10 points

Q4. Suppose, you are standing at the origin of the Cartesian plane and you are given an infinite chain of unit positive point charges. The point-charges are placed at $x = 1m, 2m, 3m...$

What would be the value of the electric field that you would measure? [You must give the shortest possible representation of your answer]

5 points