

Assignment 2: Fields & Waves (ECE230), Winter 2021

Total marks: 24. Deadline: 11 p.m. April 6, 2021

Email your answer scripts to the instructor before the deadline.

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. April 3. 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. (a) What is the source of self-inductance and back emf in a current carrying loop? Remember, I do not want you to write the mathematical definition of self inductance and back emf. Rather I want you to understand and explain the underlying physical mechanism.

(b) Prove that the energy stored in a magnetic field is: $W = \frac{1}{2\mu_0} \int_V B^2 dV$.

3 + 3 = 6 points

Q2. Consider the general form of the frequency dependent relative permittivity of a medium: $\epsilon_r(\omega) = 1 + \frac{Nq^2}{m\epsilon_0} \sum_j \frac{f_j}{\omega_j^2 - \omega^2 + i\omega\gamma_j}$

(a) How does the above expression get modified if we assume that all the electrons have same natural frequency of oscillation?

(b) Under the assumption made in part (a) and considering just one molecule per volume, plot the real and imaginary parts of ϵ_r as functions of frequency of the applied electric field.

(c) Show that under certain assumption, the relative permittivity of a metal can be written as: $\epsilon_r(\omega) = \left(1 - \frac{\omega_p^2}{\omega^2}\right)$.

(d) What is the physical interpretation ω_p for a metal?

2 + (4 + 4) + 5 + 3 = 18 points