THE UNIVERSITY OF TEXAS AT DALLAS

Electromagnetic Engineering I

EE 4301

Spring 2008
Assignment 5

Due Date and Time:

At the **beginning** of class, 9:30 AM, February 11, 2008

Reading:

N. N. Rao, *Elements of Engineering Electromagnetics*, **Sixth Edition**, Chapter 5

Problems:

Please write your answers to the following problems on engineering paper. No credit will be given for work handed in on other types of paper.

1. A long solenoid is wound with 75 turns of wire per centimeter, and can carry a current of 0.1 A. What is the magnetic field strength inside the solenoid? (Please remember to use correct units!)

2. This problem and Problem 3 concern electric and magnetic fields between two parallel, perfectly conducting plates (see Fig. 1). For all values of y, and for all values of x such that $0 \leq x \leq d$,

$$\begin{aligned} \mathbf{E} &= \hat{\mathbf{x}} E_0 \cos(\omega t - kz) \qquad \text{V/m} \\ \mathbf{H} &= \hat{\mathbf{y}} H_0 \cos(\omega t - kz) \qquad \text{A/m}. \end{aligned} \tag{1}$$

   The medium between the plates has dielectric permittivity ϵ and magnetic permittivity μ_0. No sources are present in the medium between the plates ($\rho = 0$, $\mathbf{J} = \mathbf{0}$).

   Write down an equation for the surface charge density ρ_s on the lower surface of the upper plate in Fig. 1 in terms of ϵ and E_0. State the boundary condition from which you found your answer.

3. Given the electric field

$$\mathbf{E}(\mathbf{r}, t) = 30 \sin(2\pi \times 10^8 t - kz)\, \hat{\mathbf{x}} \qquad \text{V/m}, \tag{2}$$

   find the line integral of $\mathbf{E}$ around the rectangular path shown in Fig. 2, in the direction shown by the arrows on the rectangular path. Please note the dimensions given in the caption of Fig. 2 and assume that the path of integration lies entirely between the plates.

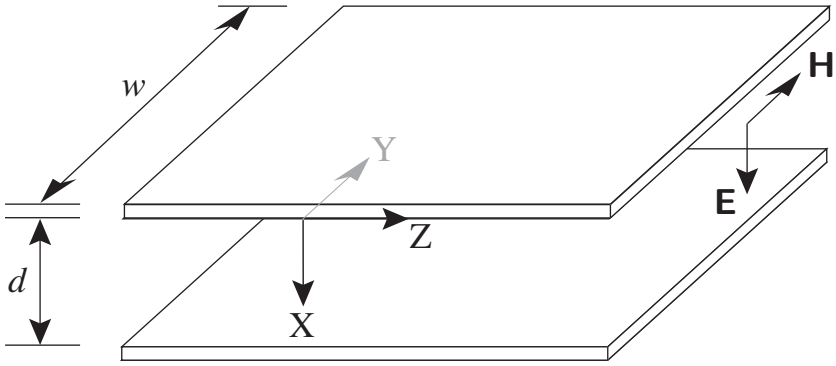

Figure 1: Fields between two perfectly conducting plates.

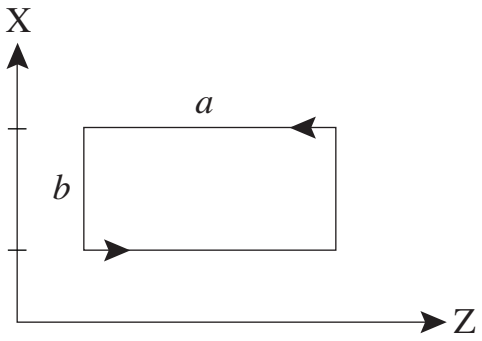

Figure 2: A path in the XZ plane. Dimensions: $a = 6$ m, $b = 3$ m.

4. A charge $Q = 1$ Coulomb is situated in a dielectric medium with relative permittivity $\epsilon_r = 1.0$, at a distance 0.25 m from the surface of a perfectly conducting plate. Find the surface charge density on the surface of the plate, using the method of image charges as described in lecture.