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# Fundamentals of Electromagnetic Fields and Waves: I

Fall 2006, EE 30348, Electrical Engineering, University of Notre Dame

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## Diagnosis: Assignment 1

The following common errors were found in the students' solutions (pointed out by one of the TAs - Yan Yan).

1. The concept of the projection of one vector on another is not clear. For example, the projection of vector  $\mathbf{A}$  on vector  $\mathbf{B}$  is given by  $|\mathbf{A}| \cos \theta$  where  $\theta$  is the angle between  $\mathbf{A}$  and  $\mathbf{B}$ . Since  $\cos \theta = \frac{\mathbf{A} \cdot \mathbf{B}}{|\mathbf{A}||\mathbf{B}|}$ , the projection of vector  $\mathbf{A}$  on vector  $\mathbf{B}$  is given by

$$Proj(\mathbf{A}|\mathbf{B}) = \frac{\mathbf{A} \cdot \mathbf{B}}{|\mathbf{B}|} \quad (1)$$

2. Please practice the use of different coordinate systems by working out problems in the textbook. The only way to learn about them is by practice!!
3. Care needs to be exercised while taking vector cross products of vectors. Specifically, we have seen that the vector product *does not commute*, i.e.,  $\mathbf{A} \times \mathbf{B} = -\mathbf{B} \times \mathbf{A}$ . If you learn quantum mechanics in the future, you will see that the operation  $[a, b] = ab - ba$  is called a commutator and is useful for various fundamental laws.
4. The directions of electric and magnetic fields were not clear. The electric field direction is given by Coulomb's law, and points radially outwards from a positive point charge and radially inwards from a negative point charge. Similarly, the *direction* of the magnetic field due to a current element  $I d\mathbf{l}$  at a point  $\mathbf{R}$  is given by the direction of the vector product  $I d\mathbf{l} \times \mathbf{R}$  (this is given by the Biot-Savart law).
5. Do not cut your steps in arriving at answers to problems too short - give enough steps such that a person who is reading it has no problem following your logic. This is very important for your professional training in general, and goes beyond this class.