Learning Goals

Phys 3310
E&M1

COURSE SCALE

Goal	Comments
1. **Math/physics connection:** Students should be able to translate a physical description of a junior-level electromagnetism problem to a mathematical equation necessary to solve it. Students should be able to explain the physical meaning of the formal and/or mathematical formulation of and/or solution to a junior-level electromagnetism problem.	The word "junior level" is meant to signify that this is at a higher level of mathematical sophistication than 1120.
2. **Visualize the problem:** Students should be able to sketch the physical parameters of a problem (e.g., E or B field, distribution of charges, polarization), as appropriate for a particular problem.	Easily testable
3. **Organized knowledge:** Students should be able to articulate the big ideas from each chapter, section, and/or lecture, thus indicating that they have organized their content knowledge. They should be able to filter this knowledge to access the information that they need to apply to a particular physical problem.	This addresses MD's concern about prioritized knowledge. This is testable primarily through student interviews

4. **Problem-solving techniques:** Students should be able to choose and apply the problem-solving technique that is appropriate to a particular problem. This indicates that they have learned the essential features of different problem-solving techniques (eg., separation of variables, method of images, direct integration). They should be able to apply these problem-solving approaches to novel contexts (i.e., to solve problems which do not map directly to those in the book), indicating that they understand the essential features of the technique rather than just the mechanics of its application. They should be able to justify their approach for solving a particular problem.	This refers to the specific techniques students learn for solving problems, rather than a general problem-solving strategy.
…**4a. Approximations:** Students should be able to recognize when approximations are useful, and use them effectively (eg., when the observer is very far away from or very close to the source). Students should be able to indicate how many terms of a series solution must be retained to obtain a solution of a given order.	We currently have "approximations," "symmetries," and "calculations" as subsets of problem-solving techniques. Indeed, all problem-solving techniques appear to fall into one of these categories.
…**4b. Symmetries:** Students should be able to recognize symmetries and be able to take advantage of them in order to choose the appropriate method for solving a problem (eg., when to use Gauss' Law, when to use separation of variables in a particular coordinate system).	This goal may help students do well on the GRE.
…**4c. Integration:** Given a physical situation, students should be able to write down the required partial differential equation, or line, surface or volume integral, and correctly calculate the answer.	Would we like students to be able to solve numerically as well as analytically?

5. **Problem-solving strategy:** Students should be able to draw upon an organized set of content knowledge (LG#3), and apply problem-solving techniques (LG#4) to that knowledge in order to organize and carry out long analyses of physical problems. They should be able to connect the pieces of a problem to reach the final solution. They should recognize that wrong turns are valuable in learning the material, be able to recover from their mistakes, and persist in working to the solution even though they don't necessarily see the path to the solution when they begin the problem. Students should be able to articulate what it is that needs to be solved in a particular problem and know when they have solved it.	This addresses the general problem-solving technique (eg., "plan of attack") rather than the mechanical technique. They must assimilate goals 3 and 4 in order to succeed at this goal. Do we want something about multiple representations (graphs, diagrams)? Tobin says: problem-solving strategies require you assess what you know, what it is that you want to know, and make a path between them. That path is the math.
6. **Expecting and checking solution:** When appropriate for a given problem, students should be able to articulate their expectations for the solution to a problem, such as direction of the field, dependence on coordinate variables, and behavior at large distances. For all problems, students should be able to justify the reasonableness of a solution they have reached, by methods such as checking the symmetry of the solution, looking at limits, relating to cases with known solutions, checking units, dimensional analysis, and/or checking the scale/order of magnitude of the answer.	The last part of this requires that they have a sense of how big a volt, coulomb, ampere, etc., is. This goal is important in helping students do well on the GRE.
7. **Intellectual maturity:** Students should accept responsibility for their own learning. They should be aware of what they do and don't understand about physical phenomena and classes of problem. This is evidenced by asking	Students can be trained to do this by soliciting questions and working them towards articulating gaps in their knowledge. Testable by examining questions in class, grading

	sophisticated, specific questions; being able to articulate where in a problem they experienced difficulty; and take action to move beyond that difficulty. (SVC)	questions on reading based on level of sophistication, examining what % of the homework do they complete.