Physics 27 Fall 2007

Methods of Theoretical Physics

The course is on mathematical topics that are central to many areas of physics. Two years ago I started a practice that I plan to continue this year, and that is to structure useful mathematical methods around two archetypical physical systems: The Harmonic Oscillator and the Electromagnetic Field. Neither the particle nor the field chosen is the simplest of its kind, but both have enough complexity to serve as models that cover enormous swaths of physics. While our focus will be on the mathematical ideas (in the practical rather than a formal sense), from time to time, we will find it useful to remind ourselves of specific contexts of their applications.

The course meets four times a week for 50 minutes each in Room 315 of Merrill – MWF at 10 and Tu at 9. The first meeting is Tuesday, September 4 at 9 a.m.

The textbook is: R. Shankar, *Basic Training in Mathematics*, Plenum 1995. There is an excellent book by h.m. schey called *div grad curl and all that*, 3rd edition, Norton 1997. (There is a 4th edition from 2005, but the definition of polar angles is the opposite of what is normally used in physics because schey decided conform to mathematical usage). I will place a copy or two of that book on reserve in the Scienec Library. In addition, I received an email from Professor James Nearing of the University of Miami who said that he was tired of the high price of textbooks, and decided to place a math methods text on line. It is free to users, but as a courtesy if you use the following site, please keep a rough tab, and let me know what chapters or sections you consulted and whether you found them useful. I will send a summary of that information with a note of thanks to Professor Nearing at the end of the semester:
http://www.physics.miami.edu/nearing/mathmethods/

You may download the text or print it, but do not distribute it yourself or transmit the files without permission from Professor Nearing.

I did not order copies of the book with the local bookstores this year; let me know if you have trouble finding copies on line or from fellow students. The syllabus is organized in a manner that would require us to jump back and forth among the various chapters and sections of the book. From time to time, this may cause some awkwardness in the problems and readings because the book may presume that earlier sections have been covered. I will try to alert you to such problems as I catch them. Do not hesitate to bring to my attention any difficulties that I might have overlooked.

Communication: Announcements made in class (whether or not you are present when I make the announcement), paper handouts, email, or announcements made in the course web page on Blackboard would each be considered sufficient notice of events, changes, due dates and other requirements pertaining to the course.

Work Load: I plan to assign weekly problem sets of about ten problems each. Your solutions are due on Wednesdays at 4 p.m. in my office. Occasionally my anticipation of what might be covered in class discussions in the week to come is not fulfilled, and we may have to carry a problem or two over to the next week. In addition to the problem sets, there will be two or three mid-term tests and a final, possibly all take-home exams. Your grade in the course is based on all of this work as well as on attendance and class participation.

Intellectual Responsibility: I encourage cooperation among yourselves while you do the homework problems. Even so, when you write up your solutions, do that on your own, and make sure that you identify sources of any important ideas or steps; the exceptions are that you don't have to cite my lectures or office hour discussions, or your own textbooks. On the take-home exams (or in-class ones if we decide to do that) you are strictly on your own. Only authorized materials – typically the two texts for the course, any solutions and notes I hand out or post on Blackboard, your own class notes, your own previous homework and exam solutions, and perhaps a Table of integrals or a specific program like Mathematica – may be used. Consulting classmates, friends, strangers, web sites etc. on the exam would constitute a violation of the code of intellectual responsibility.

Approximate Syllabus

Week 1: The Simple Harmonic Oscillator and the Electromagnetic field	Shankar's book: Chapter 10, sections 1 and 2; Chapter 5, all sections
Week 2: Damping and driving; resonance	Notes on Green's functions
Week 3: Multivariable calculus: differentiation, integration; Lagrange Multipliers	Shankar: Chapter 3
Week 4: Vector and scalar fields; line integrals	Shankar: Chapter 7; First Mid-term
Week 5: Vector calculus (cont.)	Notes
Week 6: Vector calculus (cont.)	Notes on Curvilinear coordinates
Week 7: PDEs and the EM field	Shankar: Chapter 10
Week 8: Couples Oscillators, matrices and determinants	Shankar: Chapter 8
Week 9: Matrices and determinants (cont.)	Second Mid-term exam
Week 10: Linear spaces	Shankar: Chapter 9
Week 11: Linear spaces	
Week 12: Fourier Series	Shankar: Chapter 9
Week 13: Fourier series and integrals	Connection between the oscillator and the field