FALL 2010

Physics 466: METHODS OF THEORETICAL PHYSICS I

M W 2:00-3:15 pm, Rm. 184, P&A Bldg

Instructor: S. PRASAD, Rm 1119 P&A (North Wing); 277-5876; sprasad@unm.edu

The purpose of the course is to introduce you to the basic mathematical concepts and techniques that provide part of the essential mathematical underpinnings of graduate-level physics, astronomy, and optics courses. The course is designed to articulate well with the graduate electrodynamics course taught here, and is thus a mathematical prerequisite for the latter. Mathematical concepts will be developed in physically relevant settings. Proving of abstract theorems will be kept to a minimum, while, by contrast, physical applications and approximations will be stressed. Some use will be made of numerical methods, at the level of MATLAB/MAPLE/MATHEMATICA, for more realistic implementations of mathematical ideas than possible with purely analytical methods.

Texts

G. Arfken and H. Weber, *Mathematical Methods for Physicists* (Academic Press, 2005), 6th edition, will serve as the main text for the course. Other supplementary texts include Morse and Feshbach's *Methods of Theoretical Physics* (McGraw Hill, 1953), 2 volumes; N. Lebedev, *Special Functions and Their Applications* (Dover, 1972); and G. Carrier, M. Krook, and G. Pearson, *Functions of a Complex Variable* (McGraw Hill, 1966). Physical applications will be drawn from the texts used for our graduate courses in classical mechanics, quantum mechanics, electrodynamics, and statistical mechanics.

Lecture Notes

I will post my lecture notes electronically on e-reserves at the UNM Libraries. HW assignments and solution sets will also be posted there, as will the various exams and their solutions (after the exams have been given of course). These postings will be available to you remotely from anywhere, once I provide you the web URL and passwd for accessing e-reserves.

1-Hour Problems Course (Phys 468)

To help you with problem-solving skills, understanding, and occasionally to go deeper into a particular concept than possible during the regular lectures, a 1-hour problems course has been instituted. I will have you work in small groups on pre-announced problems. The class will meet every Monday at 11 am in Rm 5. You are strongly encouraged to register for this course.

Grading

The grading in the course will be based on your performance in homework (HW) assignments (30%), two mid-term (MT) exams (40%), and a final exam (30%). In all, there will be 9 - 10 HW assignments with 4-5 problems each. Each exam will be a closed-book exam. MT Exam I is tentatively scheduled on Sep 15; MT Exam II on Oct 27; and the Finals on Wednesday, Dec 15.

Grader: Julian Antolin; email: jantolin@unm.edu; Rm 1149, P&A; Ph: 277-????

Office Hrs: *Instructor's*: Tu Th 1:00 - 2:00 pm or by appointment
Grader's: To be determined

PHYSICS 466

I. REVIEW OF VECTOR ANALYSIS (∼1 week)

*Scalar and vector products
*Grad, div, curl; Gauss's, Stokes's theorems; tensor notation
*Potential theory, Laplace and Poisson's equations

II. FUNCTIONS OF COMPLEX VARIABLES (∼4.5 weeks)

*Analytic functions, Cauchy's integral theorem, formula
*Taylor and Laurent expansions, convergence, asymptotic series
*Analytic continuation
*Singularities, poles and branch points, Riemann sheets
*Contour integration, calculus of residues, asymptotic methods
*Causality of linear response, Kramers-Kronig dispersion relations

III. DIFFERENTIAL EQUATIONS & LINEAR ALGEBRA (∼5.5 weeks)

*ODEs – especially simple harmonic oscillator
*PDEs of physics, including Laplace, diffusion, wave, and Helmholtz equations
*Separation of variables
*Transform methods – Laplace and Fourier
*Nonhomogeneous equation - Green's function
*Sturm-Liouville theory – eigenfunctions and eigenvalues
*General theory of orthogonal functions
*Applications drawn from electrostatics, QM, heat flow, diffusion
*Introduction to linear vector and function spaces

IV. SPECIAL FUNCTIONS (∼3 weeks)

*Bessel functions (including spherical)
*Legendre functions, polynomials
*Spherical harmonics and angular momentum operators