

FALL 2012

**Physics 300: Topics in Mathematical Methods of Physics**

M 12:00-12:50 pm, Rm. 184; Tu Th 2:00-3:15 pm, Rm. 5

**Instructor:** S. PRASAD, Rm 1119, 277-5876, sprasad@unm.edu

The purpose of this class is to introduce students to two important areas of mathematical physics, linear algebra and partial differential equations (PDEs), and discuss their applications to physical problems in mechanics, E&M, and quantum mechanics at the advanced undergraduate level. This class will provide a physics-based coverage of these mathematical areas in contrast to the more traditional PDE and linear algebra classes offered by the Mathematics department. As a capstone math class for the physics and astrophysics majors, it will serve to provide them with the mathematical tools needed to tackle junior and senior level physics classes. It will build on the foundational concepts of complex algebra, vector analysis, and ordinary differential equations. Numerical calculations based on Matlab, as learned in Phys 290, will be employed whenever purely analytical methods cannot yield simple closed-form expressions.

Please bear in mind that since this class is not cross-listed with Math, it does not qualify as a Math minor class. It may, however, be substituted for the Math 312 and 321 requirements under the BS programs in Physics and Astrophysics. A petition will be necessary to request this substitution until it is approved in the UNM catalog as officially meeting these math requirements for the Physics and Astrophysics majors.

This is a rigorous class that will move at a fast pace through a number of mathematical topics. Try to minimize any absences so you can keep up with this four-credit-hour class.

**Prerequisites** - Math 311, Math 316, and Phys 290. The published (official) list of prerequisites may not be correct, so please ask the instructor (email: sprasad@unm.edu) for a pre-requisites waiver, should you experience any difficulty in registering for the class.

**Problems Class** - Listed officially as Phyc 451.054 (CRN: 41498; M 3-3:50 am, Rm 184), this is an important adjunct to the main lecture class. I strongly encourage you to enroll in the problems class as well since it will provide you additional practice with solving problems beyond your homework assignments and self study. The class also gives you a valuable opportunity to bring your difficulties with any concepts covered in the lecture class to my attention so I can address them in a group setting.

**Web-based Course Materials:**

Course materials, including lecture notes, HW assignments, solutions, problem session notes, supplements, etc., as they become available, will be posted electronically on UNM Library's e-reserves web page for the course at [ereserves.unm.edu](http://ereserves.unm.edu). Once on the main student page, simply search for 300 and then log in to the right course page with the passwd lobo300.

**Grading:** The grading in the course will be based on your performance in homework (HW) assignments (30%), your top 2 of 3 mid-term (MT) exam scores (20% each), and a final exam (30%). There will be 10-12 assignments in all with about 4-5 problems each. Each exam will be closed-book, but you will be allowed the use of a single sheet of personal notes for each MT exam and four sheets for the final exam. The MT exams are tentatively scheduled for three Thursdays, namely Sep 13, Oct 4, and Nov 11, during class time; and the Finals for Tuesday, Dec 11, at 10 am.

**Travel:** I anticipate being unavailable for lectures on Sep 6 and Oct 4. One of the missed lectures (on Oct 4) will be utilized for an exam, and I will make up the remaining missed lecture by extending some of the Monday lectures from their 50-min scheduled time to the full hour.

**Required Text** - *Mathematical Methods in the Physical Sciences* by Mary L. Boas, 3rd ed., with more numerical approaches and examples to tie in with Phys 290.

**TA:** to be announced later.

**Office Hrs:** *Instructor's:* W 3:30-4:30 pm, F 2:30-3:30 pm, or by appointment;  
*TA's* – to be determined

## Schedule of Topics

1 wk = One 50-min lecture + two 75-min lectures

- *Complex numbers* (1 wk)  
Complex plane, complex algebra  
Trigonometric and exponential functions
- *Linear algebra* (5 wks)  
Vectors and matrices  
Determinants, Cramer's rule  
Matrix operations  
Linear operators, linear independence, Gram-Schmidt orthogonalization  
Eigenvalues, eigenvectors, diagonalization, similarity transformation  
Unitary, normal, Hermitian, positive definite matrices  
General vector spaces
- *Review of vector analysis* (1 wk)  
Quick review of vector algebra  
Fields and vector differentiation - grad, div, curl - interpretation and applications  
Gauss/Stokes theorems
- *Fourier series and transforms* (3 wks)  
Periodic functions and Fourier coefficients  
Exponential, sine, and cosine series and transforms  
Partial sums and Gibbs phenomenon  
Discrete and Fast Fourier transform  
Relation to Laplace transform
- *Partial differential equations and special functions* (5 wks)  
Review of general methods for solving ordinary differential equations  
First order quasilinear PDEs and method of characteristics  
Second-order linear PDEs – Laplace, heat, wave, and Schrodinger equations  
Solution via separation of variables  
Frobenius series solution, Legendre polynomials, spherical harmonics, Bessel functions