Class Meeting: **M**, **W** & **F** 10:10-11:30am
Class Location: Heg 106
Office Hours: **TBD**

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Course Description — This course presents mathematical methods that are useful in the physical sciences. While proofs and demonstrations are a core part of the course, we will put the primary emphasis on applications. In a wonderful article the theoretical physicist Eugene Wigner explored what he called the "unreasonable effectiveness of mathematics in the physics sciences". The article concludes

> The miracle of the appropriateness of the language of mathematics for the formulation of the laws of physics is a wonderful gift which we neither understand nor deserve. We should be grateful for it and hope that it will remain valid in future research and that it will extend, for better or for worse, to our pleasure, even though perhaps also to our bafflement, to wide branches of learning.

Our aim will be to explore some of the many branches that this miracle has already extended to: the ubiquitous appearance of oscillations, the geometry and physics of linear transformations, the utility of complex numbers in algebra and in wave physics, the description of unfolding processes through differential equations, and the explicative power of statistics. Not only are these methods of great utility in applications, but their practice in physics has also often led to new discoveries in mathematics!

Text: *Mathematical Methods in the Physical Sciences*, by M. L. Boas (John Wiley & Sons, 2006)
Recommended text: *Mathematical Methods for Physicists*, by G. Arfken, H. Weber, and F. Harris (Academic Press, 2012)

Take home — This will be an unlimited time, open-book exam. You can study as much as you like using any resource up to opening the exam. However, once you have opened the exam only refer to your class notes and our primary text. I ask that you honor your peers and the effort that we all put into the class by not referencing any outside materials.

Grading Structure	
Weekly Homework (due on Fridays)	30%
Guest lecture	10%
Attendance	5%
Quizzes	5%
Paper	10%
In-class exam	20%
Take home exam	20%

Homework — There will be homework due every Friday at 5pm. Complete solutions will be posted. I will grade a portion of the problems on a 0-5 scale. These scores mean roughly the following: 5=clear and complete solution, 4=good solution missing one conceptual point or calculation, 3=clear attempt but with substantive flaw, 2=effort made but incomplete plan, 1=little effort, 0=nothing appearing. I care most about the effort you invest and you can receive credit on this basis. The goal of the homework is for us to engage each other in a discussion of physics regularly, please come and visit as often as you like to discuss. Along these lines, I recommend that you work together; this is invaluable in learning physics. Please write things up yourself to show me and you that you understand it (this helps battle the illusion of explanatory depth, which is worth looking

up). Please do not use the internet as a resource for anything but physics books.

Paper — Several students have told me that they really enjoyed writing a paper in their physics courses. This will give you the opportunity to explore and present one of the topics of our course in a five page paper.

Course website: `http://bohr.physics.berkeley.edu/hal/teaching/phys221Fa16/`

Week	Topics	Chap.
8/31	Sequences & Series	1
9/7	Taylor Series	1
9/14	Complex Numbers	2
9/21	Groups, rings, fields & vector spaces	3
9/28	Inner product spaces	3
10/5	Linear transformations and matrices	3
10/12	Determinants, eigenvalues & eigenvectors	3
10/19	Matrix algebra and dual spaces	3
10/26	Ordinary Differential Equations	8
11/2	Partial derivatives, total differentials, implicit diff., chain rule	4
11/9	Max-min problems with partials. Lagrange multipliers.	4
11/16	Probability theorems	15
11/23	Permutation & Combinations *(Thanksgiving 11/26-27)*	15
11/30	Distributions	15
12/7	Distributions & Statistics	15
12/14	*Completion days begin*	

Note: I reserve the right to adjust this syllabus during the semester

Quizzes — Sporadic brief (10-15min) quizzes will help you keep track of what you should know and the few equations you should memorize.

Lateness and Other Anomalies — I will usually grade your homework over the weekend and return it to you in class on Monday. Late work will be accepted before I have graded that week's assignment with a 20% deduction on the graded score. After a set has been graded I will no longer accept late work. If you tell me about something ahead of time, almost any situation can be accommodated.

Further recommended books: Our class text is all you will need for this course, but if you would like to explore these topics in more depth here are some other books and reference manuals.

A Course in Mathematics for Students of Physics, by P. Bamber & S. Sternberg
This two volume set takes a very different approach then we will, but covers lots of interesting topics in an insightful way.

Handbook of Mathematical Functions, by M. Abramowitz and I. A. Stegun
While much of this material is somewhere on the web now or can be computed in *Mathematica*, this hefty manual is wonderful to flip through and to gain a bird's eye view of some special functions.

Table of Integrals, Series and Products, by I. S. Gradshteyn and I. M. Ryzhik
A famous handbook. Again it is worth flipping through this some time to get a feel for how people with a lot of familiarity doing these manipulations organize their thinking around it.

An Introduction to Tensors and Group Theory for Physicists, by N. Jeevanjee
An outstanding book, written by a friend, that explains with care the mathematics of tensors and groups. The half of the book on tensors is only about 90 pp and well worth your time. The half on groups is accessible and oriented towards physical applications.

Geometry, Topology and Physics, by M. Nakahara
A common book used in a graduate version of this course that focuses more on geometry and topology.

Mathematics of Classical and Quantum Physics, by W. Byron, R. C. Fuller
An inexpensive Dover book that another physics professor, Paul Cadden-Zimansky, has enjoyed. I am interested to look into it.

I have read over this syllabus. I agree not to look at solutions manuals or use the internet for anything other than looking up reference information. Finally, I commit to stick to the parameters of the take home exams.

Signed: Date: