

## PHYSICS 505 Autumn 2010

Time and day: 9:30-10:20 MWF  
Room: A114

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The Class web page is at <http://courses.washington.edu/phys505/>

We will make extensive use of the web to convey and archive information.

Texts: 1) *Theoretical Mechanics of Particles and Continua*, by Alexander L. Fetter and John Dirk Walecka (Dover reprint series); 2) *Chaotic Dynamics: An Introduction* by Gregory L. Baker, J. P. Gollub (Cambridge University Press; 2 edition, 1996).

Comments: These texts together will allow us to cover (“rapidly”) the usual topics of classical mechanics (see the syllabus) and an introduction to chaotic behavior. (The good news is that both books are available in paperback at reasonable prices.) To help you handle the quantity of matter I will provide lecture notes in class and on the web. While some of the material will be familiar, we will want to focus on topics you likely have not seen in the typical undergraduate course. As part of your preparation for the rest of your graduate studies, we will make solving nontrivial physics problems (*i.e.*, the homework and the exams) a high priority. Note that covering classical mechanics in 10 weeks will be a challenge for all of us. I am hoping to proceed somewhat more quickly than last year (to have more time for “Chaos”), but that will depend on our ability to demonstrate mastery of the (“more familiar”) material in the beginning.

The following is a tentative Syllabus for this course: Physics 505, Autumn 2010

1. Introduction & Review – Newtonian Mechanics Chap 1 & 2  
F&W
  - ❖ Central forces, orbits scattering
  - ❖ Inertial and non-inertial reference frames
  
2. Methods of Lagrange (and Hamilton) Chap 3  
F&W
  - ❖ Calculus of variations, Lagrange's equations
  - ❖ Constrained motion, Forces of constraint
  - ❖ Generalized Coordinates
  - ❖ Symmetries and Conserved Quantities
  - ❖ Hamilton's equations
  - ❖ Flows in Phase Space
  
3. Small Oscillations and Normal Modes Chap 4  
F&W
  - ❖ Normal modes
  - ❖ Coupled oscillators
  - ❖ N-body and Continuous systems
  
4. Rigid body motion Chap 5  
F&W
  
5. Hamiltonian Dynamics Chap 6  
F&W
  - ❖ (More on) Hamilton's Equations
  - ❖ Canonical Transformations
  - ❖ Hamilton-Jacobi Equation
  
6. Introduction to Chaos Chap 1  
B&G
  - ❖ Phase space flows
  - ❖ Attractors
  
7. Damped, Driven Pendula (A chaotic example) Chap 3&4  
B&G
  - ❖ Poincare maps
  - ❖ Bifurcation diagrams

- ❖ Period doubling and on to chaos

## 8. Chaotic Systems

Chap 5&6

B&G

- ❖ Self-similarity and fractal dimensions
- ❖ Lyapunov exponents
- ❖ Intermittency

## Physics 505, Autumn 2010 - Proposed Exam/Homework Schedules:

### Exams:

The Final exam is Wednesday, DECEMBER 15, 2010, at 8:30-10:20AM in A114, which we may try to reschedule (since Phys 517 is at 10:30 AM).

The (proposed) date for the Midterm Exam is Friday November 5th. I will try to organize with Professors Karch in Phys 513 and Sharpe in 517 to avoid conflicts for your time. Note that November 11<sup>th</sup> and November 25<sup>th</sup> and 26<sup>th</sup> are holidays. The last day of classes is December 10<sup>th</sup>.

### Homework:

Assignments will be made every week on posted (earlier) on the webpage. We'll start with the assumption that homework is due on Wednesdays and try to coordinate with Phys. 513 and 517 (to avoid too many assignments due on the same day). You are encouraged to discuss the homework with your classmates, but the solutions you turn in must be your own work. Please see me or the TA if you experience difficulty. I will verify office hours as soon as the "beginning-of-year" dust settles, but will likely stay with those on the class webpage. You can stop by anytime I am in my office.

Although the homework is not decisive in determining the final grade, completing the assignments is an essential part of the learning process. The assignments are due on the designed date. Late work will be accepted at the next class meeting (after the stated due date) with a 50% penalty. Nothing will be accepted at an even later date.

### Proposed Grade Mix:

Final Exam    – 50%  
Midterm Exam – 25%  
Homework      – 25%

Solutions for both HW and Exams will be posted on the webpage.

A list of reference texts (including more standard graduate level course texts) is:

Reference Texts for Phys 505 Autumn 2009 (in likely order of usefulness)

**Mechanics:**

**Classical Mechanics (3rd Edition)**

by [Herbert Goldstein](#), [Charles P. Poole](#), [Charles P., Jr. Poole](#), [John L. Safko](#)

Prentice Hall; 3rd edition (January 15, 2002); **ISBN:** 0201657023

**Mechanics**

by [Lev Davidovich Landau](#), [L. D. Landau](#), [E. M. Lifshitz](#)

Butterworth-Heinemann; 3rd edition (September 1976); **ISBN:** 0750628960

**The Variational Principles of Mechanics**

by [Cornelius Lanczos](#)

Dover Pubns; 4th edition (March 1986); **ISBN:** 0486650677

**A Treatise on the Analytical Dynamics of Particles and Rigid Bodies**

by [E. T. Whittaker](#) (Author)

Cambridge University Press; 4th edition (March 1989); **ISBN:** 0521358833

**Classical Mechanics: A Modern Perspective**

by [Vernon Barger](#), [Martin Olsson](#) (Contributor)

McGraw-Hill Science/Engineering/Math; 2nd edition (December 1, 1994); **ASIN:** 0070037345

**Mathematical Methods of Classical Mechanics (Graduate Texts in Mathematics, No 60)**

by [V. I. Arnold](#), [A. Weinstein](#), [K. Vogtmann](#)

Springer Verlag; 2nd edition (August 1989); **ISBN:** 0387968903

## **Chaos:**

### **An Introduction to Chaotic Dynamical Systems, 2nd Edition**

by [Robert L. Devaney](#)

Perseus Books; 2nd edition (January 2003); **ISBN:** 0813340853

### **Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry and Engineering**

by [Steven H. Strogatz](#)

Perseus Books Group; 1st edition (January 15, 2001); **ISBN:** 0738204536

### **Chaos and Nonlinear Dynamics: An Introduction for Scientists and Engineers**

by [Robert C. Hilborn](#)

Oxford University Press; 2nd edition (October 1, 2000); **ISBN:** 0198507232

## **Mathematical Methods:**

### **Mathematical Methods of Physics**

by [Jon Mathews](#), [Robert L. Walker](#)

Addison Wesley; 2 edition (January 1, 1971); **ISBN:** 0805370021