

# Physics 302A      Classical Mechanics I      Fall 2007

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**Meeting Times:** TH 9:30-10:45

**Instructor:** Dr. Todd Timberlake

**Office Hours:** M 9-10, 11-12, 2-4; W 9-10, 11-12, 2-4; F 9-10, 11-12

**Phone:** (706) 368-5622

**Classroom:** SCI 235

**Office:** SCI 338A

**Email:** ttimberlake@berry.edu

**Course Description** This course is intended to expand your knowledge of how macroscopic objects move. Many of the topics covered in PHY 211 will be repeated in this course, but the depth and level of mathematical sophistication will be much greater in this course. In addition, we will cover several advanced topics in classical mechanics that you have not seen before such as chaos and Lagrangian mechanics. To obtain a comprehensive education in classical mechanics at the intermediate level the student is encouraged to take PHY 402 (Classical Mechanics II) immediately after completing this course.

**Textbooks** You will need the following book for this course:

- *Classical Mechanics* (1st Ed.) by John R. Taylor

**Goals of the Course** The primary goals of this course are:

- To familiarize you with the mathematical tools of classical mechanics (vectors and vector calculus, simple differential equations, Taylor series, complex numbers, etc.).
- To enable you to solve problems in classical mechanics. This includes solving realistic problems (for example, problems involving air resistance) as well as problems in areas of current research interest (such as dissipative chaos).
- To introduce you to computational physics using *Mathematica*.
- To give you experience presenting scientific work, as well as critiquing the work of others.

**Why Is This Course Important For You?** After taking this course and its sequel (PHY 402) you should be well-prepared for a graduate course in classical mechanics. This course (along with PHY 402) will also help to prepare you for engineering courses in statics and dynamics. PHY 302 and PHY 402 should also provide you with enough grasp of chaos theory so that you can comprehend articles about chaos theory in popular journals (like *Scientific American*, *American Scientist*, or *Physics Today*). In addition, this course will also expose you to a number of mathematical techniques (Taylor series, complex exponentials, etc.) and computational tools (*Mathematica*) and techniques (ODE solving algorithms, root finding algorithms, etc.) that may be useful to you in other courses or in your future work. Finally, this course will help improve your skill at making scientific presentations.

**Methods of Instruction** You will have the opportunity to learn classical mechanics from a variety of sources during this course, including:

- assigned textbook readings,
- classroom lectures and discussions, supplemented by occasional computer demonstrations,
- homework assignments and in-class presentations of solutions,
- in-class tutorial exercises,
- computational problems,
- take-home tests, and
- discussions with me outside of class.

Note that I will lecture very infrequently. Most of our class time will be focused on *you* rather than on me.

**What You Can Do** Here are some things you can do to get the most out of this course:

- Attend each class meeting and arrive on time. *Participate* in class by paying close attention to what is presented and offering suggestions or corrections when something that is presented is incorrect or confusing. You should do this whether the person presenting is a classmate or the instructor.
- Read the relevant sections of the Taylor text **before** attempting the homework problems. Taylor's text is actually a pretty good read, and it should give you all the information you need to solve the homework problems (though you will need to do some thinking for yourself). Occasionally I will give you handouts that I have written to supplement the text. In addition, I will post a PDF file that contains my class notes from the last time I lectured in this course.
- Complete all homework problems before they are presented in class. If at all possible, complete these problems without assistance from anyone else. This way you will always be prepared to present a homework solution if you are called upon to do so. For more information about homework and presentations see the Homework and Presentations Handout.
- Make your work neat and carefully organized. If I can't follow your solution then you will not receive full credit.
- Complete all computational problems and take-home quizzes on time. You will not receive any credit on these assignments if they are turned in late.
- Come talk to me outside of class if you are having trouble with anything.

**Feedback and Evaluation** In order to provide you with some feedback on your progress and eventually to evaluate your learning I will assign numerical grades on all of your work. Your overall grade will be the average of these individual grades, weighted as follows:

**In-Class Tests** 25 % (3 weighted equally)

**Take-Home Tests** 15 % (3 weighted equally)

**Homework (including Tutorial Homework)** 25 %

**Presentations** 15%

**Computational Problems** 20 % (8 weighted equally)

I may adjust the final grades (upward) at the end of the semester, but otherwise you should expect that you will receive an "A" for a grade in the range 90-100, a "B" for a grade in the range 80-89, etc. I will determine pluses and minuses at the end of the semester by examining the distribution of grades and taking into account my perception of the effort you have put into the course.

**Tests** Each of the three tests will consist of two parts: a take-home part and an in-class part. The take-home part will be given to you one week before the in-class test and will be due when you come to take the in-class test. On the take-home part you can use your textbook, notes, homework, any materials I have posted on VikingWeb, and *Mathematica* or a table of integrals (such as the one in your calculus text). However, you must work *on your own* with no assistance from anyone (except possibly from me to clarify a question). For in-class tests you will not be able to use any materials other than a scientific calculator and a pencil. Again, you must work entirely *on your own* on this portion of the test.

**Homework/Presentations** Homework problems in this class come in two varieties: regular homework and Tutorial homework. Regular homework problems are problems from the Taylor text. Each student will be asked to present solutions to these problems in class (for more details on the procedure, see the Homework and Presentations Handout). Each student is also expected to turn in written solutions for all regular homework problems. Tutorial homework will not be presented in class, but written solutions must be turned in.

**Tutorials** Over the course of the semester we will spend about 7 class days doing in-class tutorial exercises. These tutorials were developed using the results of Physics Education Research to help students overcome difficulties learning important concepts in classical mechanics. Each tutorial will have a follow-up homework assignments (which you should be able to start during class time). You must turn in a written solution for these homework problems and they will be graded the same way as the problems from the text, but you do not have to present these solutions in class.

**Computational Problems** During the course of the semester you will have the opportunity to complete approximately 8 computational problems. These problems will be similar to textbook problems, except that they will all require the use of computer software for their solution (either to generate the solution itself, or to display the solution graphically). We will make use of the *Mathematica* software package (available in the Physics Student Projects Room, the Science Computer Lab, and my lab) for these problems. You will work with a partner on these problems and each group of two students will turn in only one solution to each problem. The printed solution that you turn in should contain a brief explanation of how you performed the calculations (written in complete sentences) as well as the graphical or numerical results that constitute the solution. Each solution should end with a paragraph explaining the results and their significance. You should also email to me a copy of the *Mathematica* notebook you used to carry out the calculations and plot the graphs. Each problem will be graded just like a homework problem. You may discuss these problems with other students, but the work you turn in must be that of you and your partner.

**Americans with Disabilities Act** Students with disabilities who believe that they may need accommodations in this class are encouraged to contact the Academic Support Center in Krannert 326 (Ext. 4080) as soon as possible to ensure that such accommodations are implemented in a timely fashion. No student will receive special accommodations without approval from the Academic Support Center.

**Academic Integrity** All work that you turn in must be your own. You may discuss homework and computational problems with other students, but you may not copy their work or allow them to copy yours. You must complete all other assignments on your own with no assistance from anyone except me. If you are found in violation of Berry's policies on academic integrity (see the Viking Code) I will impose strict penalties (I may give you an automatic "F" for the course).

**Additional References** You may find some of these books helpful during this course, or you may be interested in reading more about classical mechanics and chaos after you have completed this course.

- *Analytical Mechanics* (7th Ed.) by Fowles & Cassiday: A text I have used before.
- *Classical Dynamics of Particles and Systems* (5th Ed.) by Thornton & Marion: Another text I have used before (a bit more advanced).
- *Mechanics* (3rd Ed.) by Symon: Another standard text.
- *Classical Mechanics* (3rd Ed.) by Goldstein: the standard graduate level classical mechanics text.
- *Chaotic Dynamics: an introduction* by Baker & Gollub: semi-technical intro to chaos.
- *The Essence of Chaos* by Edward Lorenz: a popular book on chaos by one of the founders of the subject.
- *Chaos* by James Gleick: a best-selling popular introduction to chaos.

**Course Schedule** A tentative schedule of topics for the course is given below. I reserve the right to make any changes to this schedule that I feel are necessary.

<b>Date</b>	<b>Text Sections</b>	<b>Problems In Class</b>	<b>Other Work Due</b>
Aug. 28	Intro		
30	1.1-1.5	1: 2, 4, 10, 16, 26, 31	
Sep. 4		Tutorial 1	
6		Root Finding Lecture	TutH 1
11	1.6-2.4	1: 38, 46; 2: 4, 8	
13	2.4, 3.1-3.3	2: 26, 38, 40; 3: 2, 11, 16	
18		Tutorial 2	CP 1
20		Tutorial 3	
25		ODE Solvers Lecture	TutH 2, TutH 3
27	3.3-4.3	3: 21, 29; 4: 2, 8, 16	CP 2
Oct. 2		<b>Test 1</b>	<b>TakeHome 1</b>
4	4.3-4.7	4:18, 22, 28, 30, 36	
9	4.7-4.10	4: 41, 42, 48, 52	
11	5.1-5.3	5: 2, 8, 13, 17	
18	5.4-5.6	Tutorial 4	
23		Tutorial 5	TutH 4
25		5: 22, 26, 33, 43	CP 3
30	12.1-12.6	Chaos Lecture 1	TutH 5
Nov. 1		12: 1, 11, 13, 16	CP 4
6	12.7-12.9	Chaos 2, Least Action	CP 5
8	6.1-6.4	12: 21, 22; 6: 1, 11, 16	
13		<b>Test 2</b>	<b>TakeHome2</b>
15		Tutorial 6	CP 6
20		Tutorial 7	TutH 6
27	7.1-7.5	7: 3, 10, 14, 15, 18	TutH 7
29	7.5-7.8	7: 22, 29, 35, 46	CP 7
Dec. 4	8.1-8.4	8: 1, 5, 9, 12	
6	8.5-8.8	8: 18, 19, 29, 32	
14	<b>8-10 AM</b>	<b>Test 3</b>	<b>TakeHome 3, CP 8</b>