# Physics 410: Classical Mechanics
# Spring 2012 — Professor Shawhan

**Course topics:**
Intermediate applications of Newton's laws; momentum and energy; damped and driven oscillations; mechanics in noninertial frames; Lagrangian mechanics; central forces; collision theory; Hamiltonian mechanics; rotational motion of rigid bodies; coupled oscillators and normal modes; chaos; relativity.

**Prerequisites:**
PHYS 374 (Intermediate Theoretical Methods)
MATH 241, 246, and 240 (Calculus III, Differential Equations, and Linear Algebra)
or, alternatively, MATH 340 and 341

**Lectures:**
Mondays and Wednesdays from 11:00–11:50, and Fridays from 10:00–11:50 (including a break!). All lectures will be in room 0405 of the Physics Building. Class attendance is strongly encouraged, of course, but is not strictly required. I do not attempt to keep records of class attendance.

**Required textbook:**
"Classical Mechanics" by John R. Taylor. The ISBN number is 978-1-891389-22-1. We will cover most of the book, but not all sections of every chapter. I will try to remember to be clear about what sections you should be reading and what will be covered on the exams. I have made a complete schedule for the course, but it is subject to change depending on how the course goes.

**Homework:**
There will normally be one homework assignment per week to be turned in and graded. Feel free to work on the homework with one or more classmates; however, to ensure that you really do learn the material (and will therefore do well on the exams), please follow this simple rule: **do not ever look at another student's written solution.** Verbal discussion of how to solve a problem, and sketching together on scratch paper or a blackboard, are fine since they can help you learn while still ensuring that you need to know what you're doing to write out **your own** actual solution.

Don't wait until the last minute to start a homework assignment! In fact, try to start it early so that you can ask for help if you need it. Please do all of the homework and turn it in on time, unless you have a valid excuse (i.e. illness, a religious observance, or some other compelling reason). If you do not have a valid excuse, you can still turn in the homework up to 24 hours late for half credit; after 24 hours, no credit will be given. If the homework was due on Friday, then you can turn it in late up to noon on Saturday by scanning (or photographing) your homework and emailing me the file(s), as long as it is readable.

**Exams:**
There will be two midterm exams and a final exam. The two midterms will be in-class exams; they will be on Fridays so you will have 110 minutes to work. You will not be able to use books or notes, but I will provide copies of the formulae and constants printed on the front and back endpapers of the textbook. The exams must be taken on the scheduled days unless you have a valid excuse. If you know in advance that you will have to miss an exam, please inform me as soon as possible so that we can arrange a make-up. Note that the make-up exam will be identical to the regular exam; I will trust you and your classmates to not allow the contents of the exam to leak out to someone who still has to take it.

The final exam will be a take-home exam which you will have 24 hours to work on; you'll have some flexibility to choose your 24-hour window. I will be happy to distribute the exam by email and will accept good-quality scanned images in place of paper if you don't want to come to campus just to turn in the exam. You may use the textbook, your notes, and your past homeworks and exams while working on the final exam. However, **do not consult with any other person while working on the final exam, and do not use other books or the Internet**. Detailed rules will be printed on the exam. I am counting on you to preserve the integrity of the exam to represent the purely *individual* work of you and your classmates.

**Course grade:**

| | |
|---|---|
| 30% | Homework |
| 20% | First midterm |
| 20% | Second midterm |
| 30% | Final exam |

**Contact Information:**

Prof. Peter S. Shawhan, room 4205B in the Physics Building, 301-405-1580, pshawhan@umd.edu
Office hours: Mondays/Tuesdays/Wednesdays 2:00-3:45; Thursdays 1:00-2:00 and 3:00-3:45
Exceptions will be posted on the main course information page

TA/Grader: Zhixin Lu, zhixinlu@umd.edu
No regular office hours, but available for consultation by request

*** NOTE: Office hours are subject to change – watch for announcements. And occasionally something may come up that takes me out of my office during the scheduled time; I apologize in advance.

**Piazza:**

Piazza is a free web service (http://piazza.com) that lets students and instructors post notes, ask questions, and get helpful answers from other students and from instructors. I have set up a Piazza area for our class; please use it freely to ask for clarification of material in the lectures or the textbook, hints on how to do the homework problems, questions about the course, or general physics discussions. Any time the answer to a question could benefit other students in the class, Piazza makes it easy to share and improve that information. And if you have an answer, go ahead and reply with it! Every question can have a Student Response which is editable, kind of like a Wikipedia article. Zhixin and I will monitor questions/posts from time to time and endorse good Student Responses and/or add our own Instructor Response. If you contribute regularly, Piazza will occasionally pop up a note in my window to highlight that, and I'll think good thoughts in your direction.

**Course Evaluations:**

As you probably know, the University of Maryland has a system called CourseEvalUM which collects information from students about the quality of courses and the effectiveness of instructors, and provides online summaries at Testudo for students to view when they are preparing to register for future semesters. This can be a valuable resource for you and for other students, and helps me to improve the class from one year to the next, but it depends on your participation! Your feedback is confidential and important to the improvement of teaching and learning at the University as well as to the faculty tenure and promotion process.

**Honor Code:**
The University of Maryland has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards, and as your instructor I am responsible for reporting any violations. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://shc.umd.edu .

**Religious observances**:
If you need to miss class, a homework deadline, or an exam due to a religious observance, please notify me in advance—preferably at the beginning of the semester.

**Students with disabilities:**
Accommodations will be provided to enable students with disabilities to participate fully in the course. Please discuss any needs with me at the beginning of the semester so that appropriate arrangements can be made.

**Weather and emergency closures:**
If the University is closed due to weather or some emergency situation on a day when homework is due, then that homework must be turned in at the beginning of the next class when the University is open. If the University is closed on the scheduled date of an exam, then the exam will be given during the next class period when the University is open. If the University is closed on any non-exam day, including a review session (the class immediately before an exam), then the exam will still be given according to the original schedule. In these or other exceptional circumstances, I will attempt to send out information by email.

# PHYS 410 – Spring 2012 (Version 2)

| | | | |
|---|---|---|---|
| Wed Jan 25 | | Chapter 1: Newton's Laws of Motion | Review of basic mechanics |
| Fri Jan 27 | | | Drag; Numerical solutions workshop |
| Mon Jan 30 | | Chapter 2: Projectiles & Charged Particles | Analytic solutions for projectile motion |
| Wed Feb 1 | HW 1 | | Charged particle in B and E fields |
| Fri Feb 3 | | Chapter 3: Momentum & Angular Momentum | Conservation of momentum; rockets<br>Angular momentum, moment of inertia |
| Mon Feb 6 | | Chapter 4: Energy | Impulse, work, kinetic and potential energy |
| Wed Feb 8 | HW 2 | | Potential energy functions and what they're good for |
| Fri Feb 10 | | Chapter 5: Oscillations | Applications of energy conservation; Damped oscillators |
| Mon Feb 13 | | | Driven damped oscillators; resonance |
| Wed Feb 15 | HW 3 | | Frequency domain analysis and applications |
| Fri Feb 17 | | Chapter 9: Mechanics in Noninertial Frames | Apparent forces in accelerating and rotating reference frames |
| Mon Feb 20 | | | Tides |
| Wed Feb 22 | HW 4 | Review and discussion | |
| Fri Feb 24 | | Exam | |
| Mon Feb 27 | | Chapter 6: Calculus of Variations | Euler-Lagrange equation |
| Wed Feb 29 | | | The brachistochrone |
| Fri Mar 2 | HW 5 | Chapter 7: Lagrange's Equations | Lagrange's equations; basic applications |
| Mon Mar 5 | | | More applications of Lagrange's equations |
| Wed Mar 7 | | | Lagrangian problem-solving workshop |
| Fri Mar 9 | HW 6 | | Dealing with constraints; conservation laws |
| Mon Mar 12 | | Chapter 8: Two-body Central Force Problems | Equivalent one-dimensional problem |
| Wed Mar 14 | | | Conservation of angular momentum and energy |
| Fri Mar 16 | HW 7 | | All about orbits |
| Spring Break | | | |
| Mon Mar 26 | | Chapter 14: Collision Theory | Impact parameter and scattering angle |
| Wed Mar 28 | | | Total and differential cross sections |
| Fri Mar 30 | HW 8 | | Rutherford scattering; Hamilton's equations |
| Mon Apr 2 | | Chapter 13: Hamiltonian Mech. | Applications of Hamiltonian mechanics |
| Wed Apr 4 | HW 9 | Chapter 10: Rotational Motion of Rigid Bodies | Total angular momentum; rotation about a fixed axis |
| Fri Apr 6 | | | The moment-of-inertia tensor; principal axes<br>Precession of a top |
| Mon Apr 9 | | | Free precession |
| Wed Apr 11 | HW 10 | Review and discussion | |
| Fri Apr 13 | | Exam | |
| Mon Apr 16 | | Chapter 11: Coupled Oscillators | Linear examples; normal modes |
| Wed Apr 18 | | | The double pendulum and other applications |
| Fri Apr 20 | HW 11 | Chapter 12: Nonlinear Mechanics & Chaos | Period doubling; chaos, and how we can characterize it |
| Mon Apr 23 | | | State-space orbits and Poincaré sections |
| Wed Apr 25 | HW 12 | Chapter 15: Relativity | Postulates; time dilation; length contraction |
| Fri Apr 27 | | | Spacetime diagrams; the Lorentz transformation; four-vectors and their properties |
| Mon Apr 30 | | | Relativistic momentum and energy |
| Wed May 2 | HW 13 | | Particle interactions and decays |
| Fri May 4 | | | Tensors and the spacetime metric; electrodynamics and relativity |
| Mon May 7 | | | General relativity |
| Wed May 9 | HW 14 | Review and discussion | |
| Final exam: take-home, 24 hour period, Time window TBD | | | |