Physics 33-332
Physical Mechanics II

Spring 2004
Carnegie Mellon University

Meeting Times and Places

Lectures:	MWF	1:30pm to 2:20pm	WEH 7316
Recitations:	W	8:30am to 9:20am	DH 1212

Instructor: Prof. C. Morningstar

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Course web site: `http://www.andrew.cmu.edu/course/33-332`

Course Overview:

Physical Mechanics II is the second course in a two-semester sequence on advanced classical mechanics for physics majors. The course will begin with a review of coordinate systems, frames of reference, Newton's laws, and the concepts of energy, momentum, and angular momentum. Motion in noninertial reference frames and perturbation theory will then be studied, followed by the dynamics of rigid bodies, coupled oscillations, and nonlinear oscillations and chaos. Time permitting, Hamiltonian dynamics will be introduced. As in the first semester, this course is a quantitative one and will require the use of advanced mathematics to solve more difficult physical problems.

Prerequisites:

33-331 Physical Mechanics I (and its prerequisites)

Text Book:

Jerry B. Marion and Stephen T. Thorton,
Classical Dynamics of Particles and Systems, Fifth Edition (Harcourt)
(Fourth edition still okay.)

Office Hours:

Any time my office door is open; questions submitted via email are welcome at any time

Other recommended texts:

- John R. Taylor, *Classical Mechanics*, Pre-Publication Edition (University Science)
- H. Goldstein,*Classical Mechanics,* Second Edition (Addison-Wesley)
- D.G. Ivey and J.N.P. Hume, *Physics, Volume 1*, (Wiley & Sons)
- P.A. Tipler, *Physics for scientists and engineers, Volume 1,* Fourth Edition (Freeman)

Grader: Hee Kyoung Ko

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Course Outline:

Review (Chapters 1 & 2)
- ☐ frames of reference and coordinate systems
- ☐ vectors and vector calculus
- ☐ velocity and acceleration
- ☐ Newton's laws
- ☐ energy, momentum, angular momentum, force, torque
- ☐ Lagrangian methods, principle of least action
- ☐ friction, drag, gravitation

Motion in a noninertial reference frame (Chapter 10)
- ☐ rotating and accelerating frames of reference
- ☐ centrifugal and coriolis forces
- ☐ motion relative to the earth
- ☐ perturbation theory

Dynamics of rigid bodies (Chapter 11)
- ☐ inertia tensor
- ☐ angular momentum
- ☐ principal axes of inertia
- ☐ moments of inertia
- ☐ rotations and Eulerian angles
- ☐ Euler's equations for a rigid body
- ☐ the symmetric top (force-free and subject to gravity)
- ☐ stability of rigid body rotations

Coupled small oscillations (Chapter 12)
- ☐ general problem of coupled small oscillations
- ☐ characteristic frequencies and normal modes

Nonlinear oscillations and chaos (Chapter 4)
- ☐ butterfly effect and sensitivity to initial conditions
- ☐ phase space and trajectories
- ☐ dissipative systems and attractors
- ☐ Poincaré surfaces of section
- ☐ logistic map and period doubling route to chaos
- ☐ identification of chaos, Lyapunov exponents
- ☐ fractals
- ☐ damped, sinusoidally-driven pendulum
- ☐ forced and damped inverted pendulum (Duffing oscillator)

Hamiltonian dynamics (Chapter 7)
- ☐ Hamilton's equations
- ☐ Poisson brackets
- ☐ canonical transformations

Grading Overview:

Grades will be based on three mid-term tests (each 50 minutes in duration), six take-home assignments, a recitation grade, and a comprehensive three-hour final exam. The grades will be weighted as follows:

Homework assignments	20%
Recitations	10%
Test I (Feb 9)	10%
Test II (Mar 22)	10%
Test III (Apr 12)	10%
Comprehensive final exam	40%

Homework assignments:

There will be six homework assignments during the semester. The due dates will be announced at the time that the assignments are given. The purpose of these assignments is two-fold:

- to help you learn the material and prepare for the tests and examinations,
- to help you gain experience in solving more difficult and challenging problems.

Some of the questions are meant to challenge you beyond what would be expected in a test situation. You may consult with others in the class, but the work handed in should be your own. Assignments handed in after their due dates will not be graded. Solutions to the problems will be made available after the assignments are returned. All questions in each assignment must be answered, but only selected problems will be chosen for grading (you will not be told which ones). The portion of the final grade from the take-home assignments will be determined by equally weighting *all* of the assignments.

Recitations:

Recitations will be very informal. Sometimes you will work on simple exercises for practice. Other times, larger example problems will be solved. Small quizzes may sometimes be given. The recitations are meant to help you better understand the material and improve your problem-solving skills. They also provide me with valuable feedback on your progress. The recitation grade will be mainly based on your attendance in recitations, but partly on your participation and performance.

Mid-term Tests and the Final Exam:

The mid-term tests and the final examination will be a combination of short and long worked problems. All tests must be taken on the scheduled date. Makeup tests will be given only in exceptional circumstances which are supported with acceptable documentation.