PHYSICS 5210

LAGRANGIAN MECHANICS

WINTER 2015

Dynamics of particles and systems including central force motion, coupled oscillations and waves in elastic media Prerequisites: PHY5200, and PHY5100. This is a 3 credit course.

Instructor:	Prof. Robert Harr	**Office:**	262 Physics
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Office Hours:	4:00 to 5:00 MWF, or by appointment.		
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Textbook: *Classical Mechanics* by John R. Taylor, University Science Books, (2005); ISBN 1-891389-22-X. Try this link to get a price comparison from a number of online bookstores: Classical Mechanics.

We will be using this text for both PHY5200 and PHY5210. The course will follow the text, and appropriate sections for reading will be given at the start of lecture.

Lectures: MWF 3:00pm to 3:55pm, Physics Research Building, room 177.

Lecture attendance is strongly encouraged as it is a good indicator of performance. We will spend a little time each week reviewing homework problems, but mostly we will be discussing the course material. You are encouraged to ask questions; if something isn't clear to you, it likely isn't clear to others in the class as well.

Homework: The practice of Physics requires problem solving skills. In this course you will learn and practice problem solving skills with weekly homework assignments. You may discuss and collaborate with classmates on the problems, but the final solution must be your own. Copying of solutions will result in failure for all parties involved. Your solutions will be collected, graded, and contribute to your final grade. Homework must include **explanatory text** and be **neatly written** or it will be given zero credit. The best 10 of 12 homework scores will be used in calculating your grade.

Exams: There will be two mid-terms and a final exam. The mid-term exams will be given during a lecture period, 60 min., and the final is 2.5 hours. The final exam is scheduled for Friday, May 1, 1:20pm to 3:50pm. Exams are closed book.

Portfolio: You will keep a portfolio consisting of four parts: (i) the syllabus, handouts, material you find on the internet, and my lecture notes; (ii) your notes from class; (iii) homework problems, your solutions, and corrected solutions as needed; and (iv) graded exams and any corrections you add to them. The material should be kept in a binder. It will be looked at and graded three times during the semester.

Grading:

Homework	50%	weekly
Reading Quizzes	6%	Every lecture
Portfolio	6%	Graded on January 30, March 4, and April 17
Mid-term 1	10%	February 9 (tentative)

Mid-term 2	10%	March 13 (tentative)
Final Exam	18%	May 1, 1:20pm -- 3:50pm
TOTAL	100%	

The grade scale is as follows:

A+	95 -- 100%
A	90 -- 95%
A-	85 -- 90%
B+	80 -- 85%
B	75 -- 80%
B-	70 -- 75%
C+	65 -- 70%
C	60 -- 65%
C-	55 -- 60%
D+	50 -- 55%
D	45 -- 50%
F	< 45%

Written Work: The skill of scientific writing is important. The problem sets, and exams present opportunities to practice this skill. Instead of writing down formulas and numbers only, try treating each problem as a mini-essay, something that you will use when studying for exams. Motivate the method of calculation and explain the variables. Write in complete sentences using proper grammar. Don't confuse good writing with verbose writing. Make your writing brief and to the point. It is a very rare problem that can stand as just mathematical equations. As an incentive to improve your problem solutions, homework problems will be graded on presentation and neatness as well as correctness. Problems lacking any explanatory text will earn zero.

Policies: Late work is not accepted. The lowest homework score will be dropped. You are allowed and encouraged to discuss problems together, but what you turn in must be your own work -- do not copy problem solutions and turn them in as your own work. As a general rule, your classmates should not see the solutions you will turn in, and you should not see their solutions. Please remind yourself of Wayne State University's policy on academic integrigy.

Course Content

1. **Mechanics in Noninertial Frames**

   The mechanics of objects in linearly acclerating and rotating frames, the centrifugal force, the coriolis force, tides, and the Foucault pendulum.

2. **Calculus of Variations**

3. **Lagrange's Equations**

4. **Rotational Motion of Rigid Bodies**

Center of mass and relative coordinates, angular momentum, kinetic energy, and potential energy; rotation about a fixed axis, moment of inertia; rotation about any axis and the moment of inertia tensor; principal axes, eigenvalue equations, matrices; precession; Euler's equations; nutation

5. **Coupled Oscillators and Normal Modes**

   Simple systems of 2 masses and 3 springs; weakly coupled systems; solving the general case

6. **Nonlinear Mechanics and Chaos**

   At most one lecture. You are encouraged to read this chapter on your own.

7. **Collision Theory**

   Impact parameter; cross section; scattering angle; solid angle; differential scattering cross section; Rutherford scattering

8. **Special Relativity**

   Postulates of special relativity; time dilation; length contraction; Lorentz transformation; four vectors; invariants; relativistic mass and energy

9. **Mechanics of Continuous Media**

   Vibrations on a string; wave equation; stress; strain; Young's modulus; stress tensor; general Hooke's law

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Robert Harr

December 26, 2014