Syllabus for Special Topics in Advanced Classical Mechanics  
(PHY 4932)  
University of Central Florida  
Department of Physics  
Fall 2015

Basics  
Instructor: Dr. Eduardo Mucciolo  
Office: PS 457  
Contact information: mucciolo@ucf.edu, 407-823-1882  
Lectures: Tuesdays and Thursdays, 9:00 – 10:20 am, ENG1, room 286  
Office hours: TBA  
Course website: in Webcourses (UCF student access only)

Course Information  
Course Description: Part I: Constraints and generalized coordinates; D’Alembert principle; Lagrange’s equations; Hamilton’s principle; Euler-Lagrange equations; Hamiltonians; Legendre transformations; Canonical systems and transformations; Symmetries and conservation laws, Noether’s theorem; Infinitesimal transformations; Canonical transformations; Liouville’s theorem: Poisson brackets; Integrals of motion; Hamilton-Jacobi equations: Angle and action variables; Integrability; Symmetry groups. Part II: Dynamical systems; Equilibrium points, linearization, and stability; Flows in phase space, long-time behavior; Poincaré maps, attractors; Bifurcations and critical points; Chaos and routes to chaos and KAM theorem; Lyapunov exponents; Strange attractors; Fractals; Chaotic motion in celestial mechanics. Part III (TBA by the instructor): special relativity; or mechanics of continuous media; or fundamentals of fluid mechanics.

Credit hours: 3

Goals and philosophy: The primary goals are to (a) have the student understand advanced mechanics concepts in preparation for future studies and future work in physics, astronomy, and sciences in general, and (b) have the student become familiar and comfortable with problem-solving techniques. With these goals in mind, the course is designed to provide the student with ample opportunity to practice working on and demonstrate understanding of mechanics concepts.

Prerequisites: PHY 3101 (Physics for Engineering and Science III) and PHY 3220 (Mechanics I)

Textbook and course materials: Mechanics, 5th edition, by Florian Scheck (Springer-Verlag, 2010). Notice that all UCF students have free on-line access to this book! The URL is http://link.springer.com/book/10.1007/978-3-642-05370-2 (free access only from a campus IP or through UCF’s library website).
UCF students can download a pdf copy for personal use, as well as order their own hardcopy for just $25.

Other recommended books are:


**Expectations, Evaluations, Grading**

Course grade: The student’s grade will be based on the homework average (20%), two mid-term exams (20% each), and a final exam (40%). About twelve homework assignments will be handed out (typically due on Mondays). Grading will be done over a scale from 0 to 100, with letter grades distributed as: A (100-90), B (89-76), C (75-66), D (65-50), and F (49-0). Pluses and minuses may be used. All grades from assignments and exams will be posted in Webcourses.

Examinations: There will be two mid-term exams and one comprehensive final exam. These exams will test knowledge of aspects of the course material and students ability to apply that knowledge to new situations. The mid-term exams will happen approximately every 4 to 5 weeks on days TBA. Each exam will emphasize the material covered in the immediately-preceding weeks, but may also make use of material earlier in the semester. The exams will happen during class periods.

Homework Assignments: There will be about 10 homework assignments during the semester. Homework should be written up neatly, or typeset. Poor handwriting will result in a lower grade. All graded homework assignments will be returned to the students. Problem solutions will be provided after the assignment is graded and will be made available through Webcourses.

**Tentative weekly schedule – Fall 2015** (section numbers refer to the textbook)

- **Week 1 (Aug 24 – Aug 28)**: Constraints and generalized coordinates, D’Alembert principle, Lagrange’s equations (Sec. 2.1 – 2.4).

- **Week 2 (Aug 31 – Sep 4)**: Hamilton’s principle, Euler-Lagrange equations, Hamiltonians (Sec. 2.5 – 2.11). **HW #1**

- **Week 3 (Sep 8 – Sep 11)**: Legendre transformations, canonical systems and transformations, symmetries and conservation laws, Noether’s theorem (Sec. 2.12 – 2.19). **HW #2**

- **Week 4 (Sep 14 – Sep 18)**: Infinitesimal transformations, canonical transformations, Liouville’s theorem (Sec. 2.20 – 2.30). **HW #3**
• **Week 5 (Sep 21 – Sep 25)**: Poisson brackets, integrals of motion; Hamilton-Jacobi equations, angle and action variables, integrability; Symmetry groups (Sec. 2.31 – 2.37). **HW #4**

• **Week 6 (Sep 28 – Oct 2)**: Dynamical systems, equilibrium points, linearization, and stability (Sec. 6.1, 6.2). **mid-term exam #1**

• **Week 7 (Oct 5 – Oct 9)**: Flows in phase space, long-time behavior; Poincaré maps, attractors (Sec. 6.3).

• **Week 8 (Oct 12 – Oct 16)**: Bifurcations and critical points (Sec. 6.3). **HW #5**

• **Week 9 (Oct 19 – Oct 23)**: Chaos and routes to chaos and KAM theorem (Sec. 6.4, 2.38 – 2.40). **HW #6**

• **Week 10 (Oct 26 – Oct 30)**: Liapunov exponents, strange attractors, fractals (Sec. 6.5). **HW #7**

• **Week 11 (Nov 2 – Nov 6)**: Chaotic motion in celestial mechanics (Sec. 6.6). **mid-term exam #2**

• **Week 13 (Nov 9 – Nov 13)**: Topics in special relativity, or mechanics of continuous media, or fundamentals of fluid mechanics (TBA). **HW #8**

• **Week 14 (Nov 16 – Nov 20)**: Topics in special relativity, or mechanics of continuous media, or fundamentals of fluid mechanics (TBA). **HW #9**

• **Week 15 (Nov 23 – Nov 25)**: Topics in special relativity, or mechanics of continuous media, or fundamentals of fluid mechanics (TBA).

• **Week 16 (Nov 30 – Dec 4)**: Topics in special relativity, or mechanics of continuous media, or fundamentals of fluid mechanics (TBA). **HW #10**

• **Weeks 17, 18 (Dec 7 – Dec 15)**: Revision. **final exam**

**Other Policies**

**Missed work policy:** It is the policy of the Department of Physics that making up missed work will only be permitted for University-sanctioned activities and bona fide medical or family reasons. Authentic justifying documentation must be provided in every case (and in advance for University-sanctioned activities). At the discretion of the instructor, the make-up may take any reasonable and appropriate form including (but not limited to) the following: giving a replacement exam, replacing the missed work with the same score as a later exam, allowing a dropped exam, replacing the missed work with the homework average.

**Late homework:** Homework that if handed in late because of an excusable absence will receive zero points and will be counted toward the average. An excusable absence is one that can be documented to be caused by illness, death in the immediate family, serious family emergencies, travel related to your graduate work, court-imposed legal obligations,
or observation of a religious holiday. In case of an excusable absence, late homework will be accepted by the instructor no more than one week after the official due time.

Golden Rule: Many incidents of plagiarism result from students’ lack of understanding about what constitutes plagiarism. However, they are expected to familiarize themselves with UCF’s policy. Please read this information at the website

[http://goldenrule.sdes.ucf.edu](http://goldenrule.sdes.ucf.edu)

UCF Creed: Please read this information at the website

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Disabilities and access statement: The University of Central Florida is committed to providing reasonable accommodations for all persons with disabilities. This syllabus is available in alternative formats upon request. Students with disabilities who need accommodations in this course must contact the professor at the beginning of the semester to discuss needed accommodations. No accommodations will be provided until the student has met with the professor to request accommodations. Students who need accommodations must be registered with Student Disability Services, Student Resource Center Room 132, phone (407) 823-2371, TTY/TDD only phone (407) 823-2116, before requesting accommodations from the professor.

Collaboration policy: Students are encouraged to discuss assignments and form study groups, but must develop and write their own solutions to problems and questions. It must be obvious on that paper that the result has not been copied from another source. In particular, if a student collaborates with someone to work on problem sets, the onus is on the student to prove to the grader that he/she wrote down his/her derivations and answers independently. Copying from another student's paper is very obvious in a class of this size, and will immediately result in zeros on the assignment for all parties involved.