

Advanced Mechanics — PHY7200

Syllabus - Pruneau — Fall 2014

Prerequisites:

Successful completion of PHY5200, PHY5210 or equivalent

Intended audience:

Physics and Astronomy Graduate students

Synopsis:

This course is an advanced course in classical mechanics, it covers a wide range of topics and techniques of interest for professional physicists and astronomers, including advanced lagrangian formalism, conservation laws, variational principle, scattering, oscillations, hamilton formalism, continuous systems and fields, and basic elements of fluid dynamics.

Instructor

Professor Claude A. Pruneau, B.S., M.S., Ph.D.

Rm 322, Physics Building,

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Office hours: Any day, by appointment

Textbook

No textbook purchase is required in this class.

I will use materials from a variety of books, most particularly those by Landau, and Goldstein.

Evaluation and Assessment of learning

Homework (once per week):	33%
Two partial/hourly exams (early october, early november):	17% for each exam
Final exam (Finals week):	33%
Total	100%

Homeworks will be assigned on Monday and due 7 days later. Late work will not be accepted. They will consist of problem solving in material areas covered in class.

Exam makeup can be arranged under extremely special circumstances - but you must inform me at least one week prior to the exam.

Final grades letters will be attributed according to the following table.

A 95 - 100 %

A- 90 - 94

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B+	85 - 89
B	80 - 84
B-	75 - 79
C+	70 - 74
C	65 - 69
C-	60 - 64
D+	50 - 59
D-	<50
F	if two or more exams are missing.

Course outline

Approximate timeline indicated in parentheses.

1. Lagrangian formalism. (1 week)
 1. Generalized coordinates.
 2. The principle of least action.
 3. Euler-Lagrange Equations
 4. Equations of motion.
 5. Lagrangian for a free particle and for a system of particles.
2. Conservation Laws and Various Applications. (1 week)
 1. Integration of the equations of motion.
 2. Basic laws of conservation of energy, momentum, angular momentum.
 3. Mechanical similarity.
 4. Equilibrium and small oscillations.
 5. Potential energy from period of oscillations.
3. Variational analysis with constraints. (1 week)
 1. Constraints.
 2. Forces of constraints.
 3. Brachistochrone problem.
 4. Isoperimeter constraints.
 5. Catenary problem.
4. Scattering. (1 week)
 1. Motion in a central field.
 2. Particle decays.
 3. Elastic and inelastic collisions.
 4. Differential and total cross section.
 5. Small-angle scattering.
5. Oscillations. (1 week)
 1. Small Oscillations
 2. Damped and forced Oscillations
 3. Coupled oscillators.
 4. Parametric resonance.
 5. Motion in fast oscillating field.
6. Hamiltonian formalism. (1 week)
 1. Hamiltonian.
 2. Hamilton equations.
 3. Poisson brackets.

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4. The action as a function of the coordinates.
5. Canonical transformations.
6. The Hamilton-Jacobi equations.
7. Adiabatic invariants.
7. Continuous systems and fields. (2 weeks)
 1. The Lagrangian density.
 2. Field equations of motion.
 3. Energy-momentum tensor.
 4. Noether theorem.
8. Fluid dynamics. (2 weeks)
 1. Continuity equation.
 2. Euler equations.
 3. Bernoulli equation.
 4. Potential flow.
 5. Navier-Stokes equations.

Learning Outcomes

- Deep understanding and mastery of the concepts of Lagrangian, Hamiltonian, Laws of conservation and their origin,
 - Proficiency towards the analysis and solution of practical systems
- Understanding of the variational principle and its application towards the solution of problems.
 - Proficiency towards the analysis and solution of practical systems
- Mastery of methods used for the solution of systems small and not so small oscillations, as well as coupled systems
 - Proficiency towards the analysis and solution of practical systems
- Understanding of methods and formalism used to describe continuous systems and fluids
 - Proficiency towards the analysis and solution of practical systems

Religious holidays

Because of the extraordinary variety of religious affiliations of the University student body and staff, the Academic Calendar makes no provisions for religious holidays. However, it is University policy to respect the faith and religious obligations of the individual. Students with classes or examinations that conflict with their religious observances are expected to notify their instructors well in advance so that mutually agreeable alternatives may be worked out.

Students with Disabilities

If you have a documented disability that requires accommodations, you will need to register with Student Disability Services for coordination of your academic accommodations. The Student Disability Services (SDS) office is located at 1600 David Adamany Undergraduate Library in the Student Academic Success Services department. SDS telephone number is 313-577-1851 or 313-577-3365 (TTY: telecommunication device for the deaf; phone for hearing impaired students only). Once you have your accommodations in place, I will be glad to meet with you privately during my office hours to discuss your special needs. Student Disability Services' mission is to assist the university in creating an accessible community where students with

disabilities have an equal opportunity to fully participate in their educational experience at Wayne State University.

See the SDS website for more information: <http://studentdisability.wayne.edu/>

Academic Dishonesty

Plagiarism and Cheating (edited statement from the DOSO's web site):

Academic misbehavior means any activity that tends to compromise the academic integrity of the institution or subvert the education process. All forms of academic misbehavior are prohibited at Wayne State University, as outlined in the Student Code of Conduct (<http://www.doso.wayne.edu/student-conduct-services.html>).

Students who commit or assist in committing dishonest acts are subject to downgrading (to a failing grade for the test, paper, or other course-related activity in question, or for the entire course) and/or additional sanctions as described in the Student Code of Conduct.

Cheating:

Intentionally using or attempting to use, or intentionally providing or attempting to provide, unauthorized materials, information or assistance in any academic exercise. Examples include: (a) copying from another student's test paper; (b) allowing another student to copy from a test paper; (c) using unauthorized material such as a "cheat sheet" during an exam.

Fabrication:

Intentional and unauthorized falsification of any information or citation. Examples include: (a) citation of information not taken from the source indicated; (b) listing sources in a bibliography not used in a research paper.

Plagiarism:

To take and use another's words or ideas as one's own. Examples include: (a) failure to use appropriate referencing when using the words or ideas of other persons; (b) altering the language, paraphrasing, omitting, rearranging, or forming new combinations of words in an attempt to make the thoughts of another appear as your own.

Other forms of academic misbehavior include, but are not limited to: (a) unauthorized use of resources, or any attempt to limit another student's access to educational resources, or any attempt to alter equipment so as to lead to an incorrect answer for subsequent users; (b) enlisting the assistance of a substitute in the taking of examinations; (c) violating course rules as defined in the course syllabus or other written information provided to the student; (d) selling, buying or stealing all or part of an un-administered test or answers to the test; (e) changing or altering a grade on a test or other academic grade records.

Course Drops and Withdrawals:

In the first two weeks of the (full) term, students can drop this class and receive 100% tuition and course fee cancellation. After the end of the second week there is no tuition or fee cancellation. Students who wish to withdraw from the class can initiate a withdrawal request on Pipeline. You will receive a transcript notation of WP (passing), WF (failing), or WN (no graded

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work) at the time of withdrawal. No withdrawals can be initiated after the end of the tenth week. Students enrolled in the 10th week and beyond will receive a grade. Because withdrawing from courses may have negative academic and financial consequences, students considering course withdrawal should make sure they fully understand all the consequences before taking this step. More information on this can be found at: <http://reg.wayne.edu/pdf-policies/students.pdf>