Advanced Mechanics, Phys 623

Instructor: Prof. Tom DeLillo, Department of Mathematics, Statistics, and Physics, JB 348, `delillo@math.wichita.edu`, x3974
Office hours: 2:00-3:00 TTh or by appointment.

When and Where: Spring 2012, MW, 5:35–6:50 PM, Jabara Hall 021.

Introduction: This class is a continuation of Phys 621, Analytical mechanics. The material should also be accessible to students of mathematics and engineering who have had some experience with differential equations, applied mathematics, or dynamical problems in engineering. Background material will be reviewed, as needed.

Objectives:
1) Deepen understanding of Lagrangian and Hamiltonian formulations of classical mechanics, strengthen mathematical technique.
2) Extend Newtonian mechanics to continuous media
3) Develop additional applications such as vibrations, wave propagation, and scattering.

Prerequisites: Phys 621 or Math 555 or 553 or permission of instructor.

Texts (both required):
1) Alexander L. Fetter and John Dirk Walecka, *Theoretical Mechanics of Particles and Continua*, 1980, Dover paperback edition, 2003 (about $34.95).
2) Alcxander L. Fetter and John Dirk Walecka, *Nonlinear Mechnaics: A Supplement to Theoretical Mechanics of Particles and Continua*, Dover paperback, 2003 (about $14.95).

Additional references:
1) Keith R. Symon, *Mechanics*, Addison-Wesley, Reading, MA, 1960, (downloadable copy avaiable).
2) John R. Taylor, *Classical Mechanics*, University Science Books, Sausalito, CA, 2005.
3) Atam P. Arya, *Introduction to Classical Mechanics*, second ed., Prentice-Hall, Upper Saddle River, NJ, 1998.
4) Cornelius Lanczos, *The Variational Principles of Mechanics* fourth ed., Dover, 1970.
5) Alexander L. Fetter and John Dirk Walecka, *Theoretical Mechanics of Particles and Continua*, Dover, 1980.
6) H. C. Corben and Philip Stehle, *Classical Mechanics*, second ed., Dover, 1960.

7) H. Goldstein, *Classical Mechnics*, Addison-Wesley, graduate level reference.

8) Joseph L. McCauley, *Classical Mechanics: Transformations, Flows, Integrable and Chaotic Dynamics*, Cambridge, 1997, reference for integrable systems and chaos.

9) Vladimir Arnold, *Mathematical Methods of Classical Mechanics*, second ed., Springer, NY, 1989, mathematical approach to the subject.

Grading:
Your grade will be made up of the following parts:

40% homework and class work

30% midterm

30% final

The exams will consist of problems similar to the homework or class notes. Your attendance in class is expected. Every homework is due before we go over it in class.

The following grading scale (or a "curved" version) will be used for this course:

	A 93.0% and above	A- 90.0% to 92.9%
B+ 87% to 89.9%	B 83.0% to 86.9%	B- 80.0
C+ 77% to 79.9%	C 73.0% to 76.9%	C- 70.0% to 72.9%
D+ 67% to 69.9%	D 63.0% to 66.9%	D- 60.0% to 62.9%
F below 60.0%		

Homework and class work:
The homework is due at the beginning of class on the due-date. Partial credit will be given for late homework handed in before solutions are distributed or discussed in class.

Midterm:
The midterm will be taken in class.

Final:
The final will be comprehensive. It is an in-class closed book exam and will be given as specified in the official exam schedule.

Additional assignment for graduate students:
Graduate students will be expected to demonstrate a higher level of performance in this course. To accomplish this, an extra problem set, project, or presentation chosen from the advanced material or selected topics will be assigned to them. Their grade on this will be averaged into the homework and classwork grade.

Special Needs:
If you have a physical, psychiatric/emotional, medical, or learning disability that may impact on your ability to carry out assigned course work, I would encourage you to contact the Office of Disability Services (DS). The office is located in Grace Wilkie Annex, Room 173. (Voice mail number is 978- 3309; TTY phone number is 978-3067). DS will review your concerns and determine, with you, what accommodations are necessary and appropriate for you. All information and documentation of your disability is confidential and will not be released by DS without your written permission.

Cell phones:
Student cell phones and pagers must be turned off during class times. Faculty may approve an exception for special circumstances.

Academic Dishonesty: (cf. http://webs.wichita.edu/senate/pol63.htm) Students who compromise the integrity of the classroom are subject to disciplinary action on the part of the University. Violations of classroom standards include:

a) Cheating in any form, whether in formal examinations or elsewhere.

b) Plagiarism, using the work of others as one's own without assigning proper credit to the source.

c) Misrepresentation of any work done in the classroom or in preparation for class.

d) Falsification, forgery, or alteration of any documents pertaining to academic records.

e) Disruptive behavior in a course of study or abusiveness toward faculty or fellow students.

A standard of honesty, fairly applied to all students, is essential to a learning environment. Students violating such standards must accept the consequences, and penalties are assessed by appropriate classroom instructors or other designated persons. Serious cases may result in discipline at the college/school or university level and may result in suspension or dismissal. Students accused of abridging a standard of integrity may protect themselves through established academic appeal procedures and are assured due process and the right of appeal from accusations or penalties felt to be unjust.

My Policy in short: Any breach of academic integrity will result in a zero for the affected assignment(s)–serious/repeated breaches will result in a grade of "F" for the course.

Tentative Outline (advanced topics selected from texts according to interests of intructor and class):

Weeks 1–3 <u>Lagrangian and Hamiltonian mechanics</u>
    — Brief review of variational methods
    — The Lagrangian and the Euler–Lagrangian equations
    — Noether's theorem
    — Hamilton's equations
    — Liouville's Theorem

Weeks 4–6 <u>Dynamics of a system of particles</u>
    — Conservation of linear and angular momentum, energy
    — Collision problems
    — Rutherford scattering
    — The N-body problem

Weeks 7–9 <u>Mechanics of continuous media</u>
    — Equations of motion of a vibrating string
    — The string as a limiting case of a system of particles
    — Wave propagation, the wave equation
    — Stress and strain tensors, Hooke's law
    — Equations of motion of an elastic solid
    — Equations of motion of a fluid
    — Derivation of Lorenz equations

Weeks 10–11 <u>Theory of small vibrations</u>
    — Linear stability near an equilibrium configuration
    — Normal modes of vibration
    — Perturbation theory
    — Small vibrations
    — Betatron oscillations in an accelerator

Weeks 12–15 <u>Selected topics (time permitting)</u>
    — Special relativity
    — Gravitation
    — Nonlinear mechanics and chaos
    — Hamilton-Jacobi theory
    — Integrable systems
    — KAM theory