Advanced Classical Mechanics
PHYSICS 331
Fall 2009

Instructor: Sally Koutsoliotas, Olin 169, 7-3105, *koutslts@bucknell.edu*

Hours: Lectures: Monday, Wednesday, Friday 9:00–10:00, Olin 264.

Web site: `http://www.eg.bucknell.edu/~koutslts/Ph331/`

Description: Classical mechanics is at the core of our understanding of the natural world. While introduced to most students in the form of Newton's laws (that were built on the foundation of Galileo's work), we will explore its elegant reformulations by Lagrange and Hamilton in the eighteenth and nineteenth centuries.

For centuries after the work of Newton, it was believed that classical mechanics was the *only* form of mechanics–the laws that describe the motion of objects in the universe. However, the two great revolutions of the twentieth century–relativistic mechanics and quantum mechanics–revealed the existence of other laws of nature. The physics of objects travelling close to the speed of light and that of sub-atomic particles, while distinct from the traditional 'classical' mechanics, were shown to be consistent in the limits of everyday speeds and everyday size. As such, classical mechanics is at the core of our understanding of the laws governing motion.

Classical mechanics has seen a resurgence in the past three decades with the flourishing of the field of non-linear dynamics. Spurred by the ever-increasing computing power, solutions unattainable analytically become accessible through simulation and approximation. Examples such as simple harmonic motion, $F(x) = -k\ x^2$ have solvable, stable solutions, non-linear motion such as $F(x) = -c\ x^3$ reveal unpredictable behaviour known as deterministic chaos. As it turns out, many everyday systems exhibit non-linear behaviour and are susceptible to this erratic type of motion.

There will be three hour-long meetings each week. While the majority will be lectures, there will also be opportunities for problem sessions, experimental projects, and small group activities. These activities will complement the material introduced in lectures, and provide another opportunity to reinforce concepts. The mathematical tools needed to study this subject will also be developed and accompanied by a practical guide to using *Mathematica*.

Where possible, the reading associated with each lecture has been indicated in the course schedule. **It is expected that you will do the reading BEFORE coming to class.** Class lectures will focus on presenting the context for the material detailed in the text, and not on specifics relating to derivations. You are expected to work through the derivations during your reading, and come to office hours when further clarification is needed.

Required Textbook: Classical Dynamics of Particles and Systems, 5^{th} *edition* by Stephen T. Thornton and Jerry B. Marion.

Alternate References (On Reserve):

Classical Mechanics, by John R. Taylor.
Newtonian Mechanics, by A.P. French.

Useful Introductory Texts:

Physics (4^{th} edition), by Resnick, Halliday and Walker.
Physics for Scientists and Engineers (5^{th} edition), by Tipler and Mosca.

Related Books of Interest:

Feynman Lectures on Physics, by Feynman, Leighton, and Sands.
Six Ideas That Shaped Physics, by Thomas A. Moore.
The Flying Circus of Physics (with Answers), by J. Walker.
Div, Grad, Curl, And All That, by H.M. Schey.

Office Hours: To be determined.

Problem Sets:
Problem sets will be assigned at each class meeting; assignments will be collected in class and graded before the next meeting. The goal of daily assignments is to keep you up-to-date with work and it gives both you and me feedback on how well the material is being understood. As such, late assignments will NOT be accepted. Solutions will be made available online. Collaboration in the analysis of problems is encouraged, but the final write–up must be your own work entirely. Collaborators' names should be noted at the top of the first page. Discussing questions arising from the problem sets during office hours is also encouraged, especially before the work is submitted.

Class Meetings:
It is anticipated that class meetings will be somewhat flexible in this course. We will plan to spend time in class discussing aspects that are interesting to you or difficult to comprehend. I would like to avoid taking class time to discuss straightforward or less interesting points that you could easily get from the reading. To accomplish this, we will have regular reading assignments and journal entries.

Reading Assignments:
Reading assignments will be given at each meeting. It is expected that the reading be done BEFORE coming to the next class.

Journal Assignments:
You will be required to submit regular journal entries via email with comments about the reading assignments (and about any other aspect of the course that you wish to discuss). I do not want you to spend a lot of time on the entries. I want you to briefly tell me

(a) the material you found most interesting in the reading;

(b) the parts you think you understood;

(c) the parts you had difficulty understanding; and

(d) anything else about the course that you would like to include, such as, "I think we need to spend more time on the Euler-Lagrange relation."

You are expected to submit journal entries for each class in which there is a reading assignment. Recognising that there may be days when you could really use a break, your three lowest grades for the journal entries will be dropped. Scoring on the journal entries will be based on a 2–point scale (with a possible '3' in exceptional circumstances).

0. if nothing is sent on time or there is no evidence that the reading has actually been done (e.g. "The reading was fine. See you tomorrow.")
1. if there is some evidence that you performed the reading, but not a lot of reflection or thought was given to it
2. if you submit an entry that indicates that you did the reading and put in a reasonable effort.

Please submit your journal entries before 8:00 AM on the day of the class. In that way, I will have an opportunity to read them and plan our class accordingly. Of course, submitting on the previous night would be especially helpful.

Assessment:
The overall grade will be made up of the following components:

Problem Sets	20%
Journal Entries	10%
Test 1	15%
Test 2	15%
Test 3	15%
Final Examination	25%
TOTAL	100%

The percentage on your final exam will replace the lowest test score, if that will help your grade.