Physics 330
Nonlinear Dynamics and Differential Equations
Spring 2010

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Course Objectives: The official learning objective for this course is:

1. use a symbolic mathematics program and programming in MATLAB to analyze physics problems in terms of ordinary differential equations and solve them numerically.

You are expected to learn how to use computational methods in both MATHEMATICA (or MAPLE) and MATLAB to demonstrate the basic ideas of nonlinear dynamics. This means that paying attention to the behavior of the physical system being modeled is equally important with the programming techniques used. The exams will include short-answer questions related to the physics of the problems as well as short programming exercises in which you will demonstrate that you have mastered basic programming in MATLAB.

The first six labs will involve simpler systems such as a simple harmonic oscillator or a moving baseball as you learn the syntax and techniques of programming in MATLAB. The later labs will then use these skills to study the behavior of nonlinear dynamics. It is important to read and understand the material on nonlinear dynamics in order to understand the behavior of the system you are simulating. This class is an extension of Physics 321 - we can look at more difficult problems with the added capability provided by MATLAB.

Texts: There are three texts for this course:

1. *Computational Physics 330*, the lab manual for the course, is available at the BYU Bookstore. This text contains explanations and the assignments for each laboratory period. As you work through the manual you will learn how to solve problems involving ordinary differential equations. We will work on both linear and non-linear systems. You will also more fully develop your programming skills. This text is also available online. If you want a paper copy it is generally cheaper to buy the packet from the Bookstore than it is to print your own (it is inappropriate for you to print a copy of this manual on department printers without paying for the printing costs).

2. *Introduction to Matlab*, available at the BYU Bookstore (it is generally bundled with the first text if you buy the packet from the Bookstore). This will be a useful language reference manual to help you as you program in Matlab. Again, this manual is available online.

3. *Introduction to Mathematica* or *Introduction to Maple*, the online manual for Physics 230. We will also use the MATHEMATICA notebook *Differential Equations in Mathematica* from the class web page in the first lesson.

Course Structure:

**Showing up ready:** The lab material in this course is more difficult than the material in Physics 230, so you will need to spend 1/2 hour, or so, reading each lab before you come to class. If you just show up and try to learn as you go, you will most likely fall behind.

**Quizzes:** We will have a short quiz at the start of each lab period. This quiz will primarily cover simple concepts, the main results, and skills from the previous lab. The material may also be drawn from earlier labs when it is pertinent. There is a list of key concepts that you should be acquainted with on the class web page.
**Laboratory work:** The reason that this course is taught as a lab instead of as a lecture/homework course is that it can take hours to find and fix simple programming mistakes without the help of trained professionals. Furthermore, the lab setting provides an active learning environment where problems are encountered, discussed by lab partners, TAs, and the instructor, then solved. Occasionally mini-lectures at the board in the classroom will be given to explain difficult concepts or to teach good programming practice.

**So come to class.** Experience has shown that if you don’t, you will almost certainly do poorly in the class. A grade of E is the usual result of not showing up.

You must work in pairs and pass off sections of labs in pairs. You can pair up any way you like, but you must sit next to your partner and you must pass off the labs together. This makes efficient use of the TA and instructor’s time so that you can complete and pass off your labs as soon as possible without waiting. More importantly, it is a much more efficient approach to learning (which is, of course, an objective of the class). *This may not be the most efficient way to leave class early, depending on who you choose as a partner, but leaving early is not listed as an objective of this class.*

**Checkpoints:** We have learned by sad experience that it is the nature of nearly all 330 students to fall behind. On the course calendar are listed three checkpoints. *All lab work must be caught up by the end of the class period on the checkpoint day.*

**Grading:** Your grade in the course will be determined by three things.

1. Your performance on the laboratory exercises. You will be graded mostly on how many you complete, but I will also assess your understanding of the lab material as the course progresses by periodically asking questions.

2. There will be two short take-home problems given during the semester. These will consist of a problem, or two, to be solved using the computational methods you have learned up to that point in the course. These problems will be open book, open notes, open previous work, but closed lab partner. After you complete the problem you will email your work to me.

3. There will not be a final exam. The quizzes at the start of each class period will take the place of the final exam. Their weight of all the quizzes combined will be equal to one take-home problem.

The approximate weighting of the class materials in calculating the grade will be

<table>
<thead>
<tr>
<th>Labs</th>
<th>55%</th>
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</thead>
<tbody>
<tr>
<td>Exams</td>
<td>30%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>15%</td>
</tr>
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Most of the grades in the course will be A and A-. An A means that you have completed all of the laboratory exercises and have shown that you have mastered the material. An A- means either that you got behind and missed a lab, or two, or that your performance on the exams has shown that you aren’t proficient at writing good code and at finding and fixing programming mistakes. Not understanding the basic physical concepts associated with partial differential equations will also lower your grade. Poor performance on the exams might lower your grade into the B range (or lower).

**Academic Honesty:**

The first injunction of the BYU Honor Code is the call to be honest. Students come to the university not only to improve their minds, gain knowledge, and develop skills that will assist them in their life’s work, but also to build character. President David O. McKay taught that “character is the highest aim of education” (The Aims of a BYU Education, p. 6). It is the purpose of the BYU Academic Honesty Policy to assist in fulfilling that aim. BYU students should seek to be totally honest in their dealings with others. They should complete their own work and be evaluated based upon that work. They should avoid academic dishonesty and misconduct in all its forms, including but not limited to plagiarism, fabrication or falsification, cheating, and other academic misconduct.
Honor Code Standards:

In keeping with the principles of the BYU Honor Code, students are expected to be honest in their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university.

Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university’s expectation, and my own expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have any questions about those standards.

Preventing Sexual Harassment:

Title IX of the Education Amendments of 1972 prohibits sex discrimination against any participant in an educational program or activity that receives federal funds. The act is intended to eliminate sex discrimination in education. Title IX covers discrimination in programs, admissions, and student-to-student sexual harassment. BYU’s policy against sexual harassment extends not only to employees of the university but to students as well. If you encounter sexual harassment or gender-based discrimination, please talk to your professor; contact the Equal Opportunity Office at 422-5895 or 367-5689 (24-hours), D285 ASB; or contact the Honor Code Office at 422-2847, 4440 WSC.

Students With Disabilities:

BYU is committed to providing a working and learning atmosphere that reasonably accommodates qualified persons with disabilities. If you have any disability that may impair your ability to complete this course successfully, please contact the Services for Students with Disabilities Office (2170 WSC, 422-2767). Reasonable academic accommodations are reviewed for all students who have qualified, documented disabilities. Services are coordinated with the student and instructor by the SSD Office. If you need assistance or if you feel you have been unlawfully discriminated against on the basis of disability, you may seek resolution through established grievance policy and procedures by contacting the Equal Employment Office at 422-5895, D285 ASB.

Children in the Classroom:

The serious study of the physical and mathematical sciences requires uninterrupted concentration and focus in the classroom. Having small children in class is often a distraction that degrades the educational experience for the entire class. Please make other arrangements for child care rather than bringing children to class with you. If there are extenuating circumstances, please talk with your instructor in advance.