

Course Outline

Math 3860-031, Spring 02

Paul Hewitt

February 28, 2002

Introduction

Welcome to Differential Equations! A differential equation is an equation relating a variable quantity to its derivatives. The “unknown” in a differential equation represents a function, not a number. The most basic differential equations are the integration problems you studied in calc II: integrating a function $f(t)$ is the same as solving the equation $y' = f(t)$ (y is the unknown). In fact, even for more general differential equations the solution is called the integral, and its graph is called an integral curve.

The study of differential equations is not so much the study of a general theory, as was much of calculus, but of special examples. There are two reasons for this. First of all, differential equations are interesting mainly because they ideally express real-world relationships between dynamic quantities. Almost any analysis of forces or energy leads to a differential equation, for example.

Second, explicitly integrating general differential equations is essentially impossible. If you look back at integral calculus you will see that, despite the fact that the Fundamental Theorem guarantees an antiderivative for every continuous function, there are very few techniques for finding formulas for these antiderivatives. Even relatively innocent looking functions such as $f(t) = \sin(t^2)$ do not have antiderivatives which can be written out in explicit formulas.

However, we often need to answer qualitative questions in real-world applications, and often these can be answered without knowing explicit formulas for the solutions. In fact, it is often the case that the formula for the solution is so complicated it doesn't help us answer our questions. Thus much of this semester will focus on methods for analyzing the solutions of a differential equation without using qualitative techniques, especially graphical techniques.

Moreover, there are very good methods for quickly approximating the solutions of differential equations. So, we will also spend a fair amount of time looking at some of these approximation schemes.

Keep this in mind. The point of studying differential equations is to gain insight into some dynamic processes. Hence you should expect some of the exam questions to come directly from applications, and to require answers at least partly in complete sentences, not simply mathematical formulas.

Office hours

My office is UH 4080e. The phone number is 419 530 2975. My email address is paul@livetoad.com. The web page for this course can be found at <http://livetoad.com/>. Below are my official office hours.

Mon, Wed, Fri 9–11am UH 4080e

Mon, Wed 12–12:30pm UH 4080e

This means that you can call or stop at these times without an appointment and I am sure to be there. I am also available at other times, but for these you must make an appointment. Feel free to ask for office hour appointments at other times if you cannot make it to my official office hours. If you call me when I am not in my office then you can leave a voice mail message and I will get back to you as soon as I can. I tend to list to my voice mail messages only on Monday, Wednesday, or Friday mornings, so at times email is a faster way to get in touch with me.

I would like to bring to your attention that the Math Learning Center is open throughout the day and into the early evening. This is an especially good place to get help with your review of basic calc.

Calendar

Review sessions	Wednesday	16 January and 23 January
	6–8pm	UH 3008
ML King Day (no classes)	Monday	21 January
Last Day to Add/Drop	Friday	28 January
Last Day to Withdraw	Friday	8 March
Spring Break		11–15 March
Exam 1:	Tuesday	19 March
Chapters 1, 2, 7, 8	6–8pm	GH 4414
Last Day of Classes	Friday	3 May
Exam 2:	Friday	10 May
Chapters 3, 5, 6, 9	10:15–12:15	BO 2049

Text and syllabus

We will cover much — but not all! — of the the material in chapters 1–9 of *Elementary Differential Equations*, 7th edition, by W Boyce and R DiPrima. In order, we will study first-order equations (chapters 1 and 2), numerical methods (chapters 2 and 8), and then first-order systems (chapter 7). This will be the material for exam 1. After exam 1 we will study stability of systems (chapter 9), second-order linear equations (chapter 3), power series techniques (chapter 5), and the Heaviside method (chapter 6).

We will not cover every section in every chapter. Some sections will have more emphasis than others. In class I will give explicit directions about what sections I expect you to read, and which sections merit more of your study time. I do indeed expect you to read the assigned sections. We will learn a lot of new terminology this semester, especially at the beginning, and I will expect you to know the terminology, as well as the principal definitions and theorems. Moreover, the text has some excellent examples in almost every section, and you will learn a lot by trying to work thru their examples, filling in the details for yourself.

Prerequisites

I think you will find that this course is not very difficult, and even enjoyable, provided you are comfortable with the prerequisite calculus. The main difficulty students have in this course is with derivatives and integrals. This is material you are supposed to have learned in calc I and calc II. (Almost nothing from calc III is necessary for this course.) It is entirely possible that you are out of practice with derivatives, integrals, or other skills or concepts from basic calc. If this is so you should identify your weaknesses immediately and come see me about strengthening these points. Because of the demands of the syllabus this semester we cannot devote any class time to prerequisite material. However, I have plenty of time in my office hours to help you catch up. It is up to you to make some effort to come to me for help. If you fail to shore up your weaknesses until the time the exam is imminent you will find that it is too late, and you will probably fail what otherwise would be a successful exam for you.

In addition to my office hours I will hold two evening review sessions during the first two weeks of class (see the calendar above). These sessions are entirely optional, but if you find that you are weak on any points from basic calc I strongly urge you to attend these review sessions.

Assignments and quizzes

Once or twice per week, perhaps more often, we will begin work in class on a problem from the text, and then you will complete this problem at home and turn your solution in for grade the following class. In your solutions I expect neat work, showing all details, accompanied by written explanations, in complete sentences.

Each of these assignments will consist of exactly one problem from the text, but I will also assign other, similar problems from the text, to practice at home. You will not turn these in for grade, but you should work on all of the problems since I will draw exam questions from the assigned problems.

Also once or twice per week we will have a short quiz, with two or three questions, worth 1 point each. Periodically I will give you a list of sample questions to practice at home, and on quiz days (which will *not* be announced ahead of time) I will choose a couple from the current list (altering them slightly). Typically the quiz problems will cover things like definitions, terminology, important theorems, and so forth. Some questions may involve short computations; some may be true/false or multiple-choice questions; some may ask you for examples or explanations.

Exams

We will have two 2-hour exams, each worth 100 points. The exam questions will be taken directly from the practice questions I give you in class. This includes all practice quiz questions, both those we use in class and those we do not use in class, and all practice problems from the text, both those that are collected for grade and those not collected. Please note that exam 1 is scheduled in the evening (see the calendar). If you cannot take the exam at the scheduled time you must make arrangements with me as soon as possible. You will not be allowed to use a calculator of any kind on any of the exams or quizzes.

Attendance

I will not give make-up quizzes nor allow assignments to be turned in late, under any circumstances. If you miss class on a quiz day then you miss a couple of points. This will not affect your final grade if you miss class once or twice per semester. However, if you are in the habit of missing class regularly then history shows that you will probably fail, and that making up missed quizzes will not help. Thus, I will save both of us a lot of hassle by sticking to the no make-up rule. There will be no exceptions. Don't ask.

I will give make-up exams only in case of a documented emergency, such as illness or a funeral. If you are sick the day of the exam then you must call or email that same day if you expect to be able to make up the exam. If I am not in my office then you can leave a voice mail message. If you have a funeral or other emergency then you must arrange for a make-up exam ahead of time. If you fail to show up for an exam and do not contact me about it until afterwards then you will not be able to make up that exam — you will get a 0 for that exam.

Grades

I will determine final grades based on the class-wide distribution of points earned. Exams contribute 200 possible points, quizzes and assignments contribute approximately 100 possible points altogether. I want to emphasize that you are not in direct competition with each other. I do not feel obligated to give any grades of F, or any grades of A for that matter. I will not split hairs. I do not have a set grade scale. You will find that the grade distribution breaks into obvious groups. Historically in my classes it takes 85–90% of the points to earn an A; around 70–75% for a B; and around 60% for a C. However, these are not rigid targets, just historical observations. After the first exam I will post a histogram of total points earned, and this should give you a clearer idea of where you stand.

If you want me to post your grades under a nickname, bring me a 3 × 5 card with your name, an email address, and the nickname you want to use — preferably something not obvious!