Course Outline: Math 3860-004, Fall 02

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 (say) $\sin^2(t)$ is the same as solving the equation $y' = \sin^2(t)$ for the unknown y. For this reason the solution of a differential equations 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, integrating most differential equations is essentially impossible, at least explicitly. If you look back at integral calculus then 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 of a differential equation is so complicated it doesn't help us answer our qualitative, real-worl questions. Thus much of this semester will focus on methods for analyzing the solutions of a differential equation using only qualitative techniques, especially graphical techniques.

Moreover, when quantitative results are needed 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/**. My official office hours: **Mon and Wed, from 4:00 to 5:30 pm, in 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 afternoons, so at times email is a faster way to get in touch with me.

Calendar

Review sessions	Wed	28 Aug, 4 Sep	7–9pm	UH 3008
Labor Day	Mon	2 Sep		
Exam 1: Chap 1, 2, 8	Wed	25 Sep		
Last Day to Withdraw	Fri	18 Oct		
Fall Break	Mon–Tue	21–22 Oct		
Exam 2: Chap 2, 7, 9	Wed	4 Nov		
Thanksgiving	Wed–Fri	27–29 Nov		
Exam 3: Chap 3, 5, 6	Mon	16 Dec	5–7pm	SM 2160

Text and syllabus

The material in this course is coverd in chapters 1–3 and 5–9 of *Elementary Differential Equations*, 7th edition, by W Boyce and R DiPrima. For the first third of the course we will study first-order equations (chapters 1 and 2), numerical methods (chapters 2 and 8). This will be the material for exam 1. In the second third of the course we will study applications of first-order equations (chapter 2), first-order systems (chapter 7) and stability (chapter 9). This will be the material for exam 2. In the last third of the course we will study second-order linear equations (chapter 3), power series techniques (chapter 5), and the Heaviside method (chapter 6). We will not follow the book very closely. Nevertheless it is a valuable supplemental resource, with many excellent worked examples. At any rate the syllabus for this course, the specific topics for which you will be responsible, will be detailed in a set of lecture notes which I will post on the web.

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.) Perhaps because of co-op or because you are coming back to school after a break you might be out of practice with derivatives, integrals, power series, graphing, or other skills or concepts from basic calculus. Many students are. If this is so then 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.

Review sessions

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 calculus then I strongly urge you to attend these review sessions.

Math Learning Center

I would also like to point out that the Math Learning Center, in UH 2050, is open every day. You may or may not find that the MLC useful for differential equations, but it is an excellent place to review derivatives, integrals, power series, and other elements of basic calculus.

Assignments and quizzes

I will post notes for each class, at least two days in advance. You are expected to read the notes before class and be prepared to answer questions based on the reading. In each set of notes you will find the questions for the reading quiz and a set of exercises. Each class will begin with a quiz, with 2 or 3 questions of 1 point each. At least 1 question will come from the *current* reading assignment and at least 1 question will come from the exercises from the *previous* class. After the quiz we will cover the new material, and begin work on some of the exercises. The entire exercise set, including your in-class work, will be due at the beginning of the *following* class.

Exams

We will have three 2-hour exams, each with 10 questions worth 10 points each. The exam questions will be taken directly from the questions in the lecture notes. This includes both the reading quizzes and the exercises. I may change the numbers, functions, and parameters in the questions but I will not change the form of the questions.

Calculators

You may not 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 afterwords 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 then bring me a 3×5 card with your name, an email address, and the nickname you want to use — preferably something not obvious!