

# Course Outline: Math 3860-005, Spring 04

## 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: for example, integrating  $\sin^2(t)$  is the same as solving the equation  $y' = \sin^2(t)$  for the unknown  $y$ . For this reason the solution of a differential equation is called the integral, and its graph is called an integral curve.

This is a fun course. 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, expressing the integral of a differential equation in a formula is usually impossible. 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 qualitative, real-world questions. So, 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.hewitt at utledo.edu. The web page for this course can be found at <http://livetoad.org/>. My office hours: Monday, Wednesday, and Friday, 12:30–12:50 and 14:00–14:30, in UH 4080e. This means that you can call or stop by 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 listen to my voice mail messages only on Monday, Wednesday, or Friday mornings before class, so often email is a faster way to get in touch with me.

## Text and syllabus

We will cover chapters 1–3 and 5–9 of *Elementary Differential Equations*, 7th edition, by W Boyce and R DiPrima. Here is a detailed calendar.

	<i>ML King Day</i>	Mon	19 Jan	
Exam 1:	Calculus review	Wed	21 Jan	
Exam 2:	1.1–1.3, 2.1–2.6	Fri	13 Feb	
Exam 3:	2.7–2.8, 8.1–8.4	Fri	5 Mar	<i>last day to withdraw</i>
	<i>Spring Break</i>		8–12 Mar	
Exam 4:	7.1–7.6, 9.1–9.5	Fri	2 Apr	
Exam 5:	3.1–3.9, 5.1–5.4, 6.1–6.5	Wed	5 May	12:30–14:30

## Prerequisites

If students have any difficulty in this course it 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.) However, for any number of reasons you might be out of practice with derivatives, integrals, power series, graphing, or other skills or concepts from basic calculus. So, we will spend the first two days reviewing techniques and concepts from basic calculus. The first exam, on Wednesday, 21 January, will cover this prerequisite material. The problems for this exam will be chosen from a list of review problems that I have posted on the web. Your score on this first exam should give you a clear picture of how well you can expect to do in this class.

## Assignments, Quizzes, Exams

I will post homework assignments on the web, due at the beginning of class Wednesdays. The grader will grade 5 problems, chosen at random, each worth 1 point. Your solutions must be neat and show all work. If you do not show your work then you will not receive credit for your solution. When you turn in your assignment fold your papers lengthwise, and write your name, the course number, and due date on the outside. I will drop your 2 lowest homework scores.

We will have 10 quizzes, each with 5 1-point, multiple-choice questions. The questions will be chosen from the Reading Quiz and Exercises sections from the lecture notes, which I will post on the web. I will not announce quiz dates ahead of time. I will drop your 2 lowest quiz scores.

We will have 5 short exams, each with 6 10-point questions. You may not use a calculator of any kind on any of the exams except exam 3. On exam 3 you can use a *nongraphing, nonprogrammable calculator*. The exam questions will be based on the homework assignments and quizzes, except for exam 1, whose questions will be taken from the calculus review problems posted on the web. *Note:* The calc review exam is in the second week of classes!

## Attendance

I will not accept late assignments, nor will I give make-up quizzes, under any circumstances. It will not affect your final grade if you miss one or two assignments or quizzes, since I drop your 2 lowest scores. However, if you are in the habit of missing classes and assignments regularly then probably you will fail. Making up missed assignments or quizzes will not help. There will be no exceptions to this rule. Ever. 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. Otherwise you must arrange for a make-up exam ahead of time. If I am not in my office then you can leave a voice mail message. 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.

If, prior to 26 March, you stop coming to class for more than a week without contacting me then I will give you an IW (instructor's withdrawal). If you stop attending after that date then you will get an F. If you need an IW because you are unable to finish the class for some reason then you must contact me before 26 March, since that is the last day that IW grades can be assigned.

## Grades

I will determine final grades based on the class-wide distribution of points earned. 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  $3 \times 5$  card with your name, an email address, and the nickname you want to use — preferably something not obvious!