# MATH 320: Differential Equations  (3 credits)

Fall 2017,  MWF 10-10:50am,  CST 318

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<tr>
<th>Instructor</th>
<th>Anand L. Pardhanani</th>
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<tbody>
<tr>
<td>Email</td>
<td><a href="mailto:pardhan@earlham.edu">pardhan@earlham.edu</a></td>
</tr>
<tr>
<td>Phone</td>
<td>765-983-1683</td>
</tr>
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<tr>
<th>Office hours</th>
<th>The following hours are tentative - I'll finalize office hours after the 1st week</th>
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**Open door policy:** I keep my posted office hours to a bare minimum, to avoid being locked into a rigid schedule all semester. However, I am happy to assist students well beyond my office hours. Students are encouraged to just drop by whenever needed. Anytime my office door is open you're welcome to stop by and check whether I am available. Also, please do not hesitate to make an appointment if my posted office hours don't work for you.

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<tr>
<th>Class website</th>
<th><a href="http://www.earlham.edu/~pardhan/courses/de/">http://www.earlham.edu/~pardhan/courses/de/</a></th>
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<td>The website</td>
<td>is a central component of this class, and you are responsible for regularly checking it for announcements, homework assignments and various supplementary handouts. I prepare for class with the assumption that students have reviewed the website and followed through on posted instructions.</td>
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**Textbook**


**Description & objectives**

Differential equations have completely transformed our ability to understand the world around us, and have played a central (indeed, revolutionary) role in numerous modern scientific and technological innovations! They continue to be at the leading edge of research in virtually all scientific disciplines, as well as in various other liberal arts disciplines. It is natural, then, to wonder "Why?" and "How?" and "What?"!

Differential equations (DEs) are constructed from derivatives, and can be used for modeling various real-life phenomena. They are also useful for modeling or exploring a variety of purely mathematical ideas and curiosities. The use of derivatives in modeling is somewhat like the use of computers in research and data analysis: it provides a quantum leap in analytical power, and it opens up a vast new world of possibilities that was previously impossible to imagine! For example, models based on DEs exist for applications in nature, science, society, the stock market, the environment, warfare, poverty, romantic love affairs, and more! The task of developing effective models based on DEs is a combination of mathematics, science and art. After building a DE-based model, the next major task is to find its solution. This is done with the help of another foundational concept from calculus, i.e. integration, together with some new theoretical and computational strategies.

A course in differential equations is the logical next-step after completing the Calculus A and B sequence. Indeed, the single most important reason for learning calculus is to be able to enter the world of differential equations!
The present course is designed to introduce students to basic concepts, models, solution methods and applications of ordinary differential equations. A key purpose of the course is to give students an appreciation of the power, beauty and practical value of DEs, and to gain comfort in exploring and using them. Main topics in this course include: elementary concepts and classification systems; overview of modeling via DEs; qualitative methods, such as direction fields and phase plane methods; analytical solution methods such as separation of variables, integrating factors, variation of parameters; select numerical methods; basic existence and uniqueness theorems; systems of DEs and their analysis; and series solution methods. We will study a variety of modeling strategies and interdisciplinary applications throughout the course.

This class fulfills the Analytical Reasoning component of Earlham's General Education requirements.

**Student learning outcomes:** Upon successful completion of this course, students will be able to

1. Understand fundamental concepts and terminology pertaining to differential equations, their solutions, and their use in mathematical modeling.
2. Solve certain classes of first, second, and higher order differential equations using qualitative, analytical, and numerical methods.
4. Use software tools to analyze and solve differential equations, and to graphically display results.
5. Apply differential equations to model and solve a broad range of problems in various disciplines.
6. Strengthen logic, reasoning, and quantitative skills through extensive use of those faculties throughout this course.

**Prerequisites:** Calculus A and Calculus B (MATH 180 and 280), taken within the past year.

**Assessment & grading policy**

In my approach to grading, correct process and method receive far more credit than correct answers. I always ask you to show all your work, and I grade all of your work!

Your final grade will be based on combined performance on: (1) problem sets, (2) lab projects; (3) three exams during the semester, and (4) a comprehensive final exam. Each will contribute the following proportions:

<table>
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<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Problem sets</td>
<td>20%</td>
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<tr>
<td>Lab projects</td>
<td>20%</td>
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<tr>
<td>Three exams</td>
<td>15% + 15% + 15% = 45%</td>
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<tr>
<td>Final exam</td>
<td>15%</td>
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Letter grades will be assigned according to the following scale (%):
- A+: 97.0-100;  A: 93.0-96.9;  A-: 90.0-92.9;
- B+: 87.0-89.9;  B: 83.0-86.9;  B-: 80.0-82.9;
- C+: 77.0-79.9;  C: 73.0-76.9;  C-: 70.0-72.9;
- D+: 67.0-69.9;  D: 63.0-66.9;  D-: 60.0-62.9;  F: below 60.

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NOTE that all students must also satisfy the following minimum requirements to receive a grade of C- or better:

* Take all the exams (3 during the semester, plus the final).
* Turn in at least 75% of the problem sets.
* Complete and turn in all assigned lab projects.

Exams
There will be three exams during the semester, plus a final exam at the end of the semester. The tentative dates of the in-semester exams are:

Exam 1: September 20.
Exam 2: October 25.
Exam 3: December 1.

Final exam: The final exam date and time is set by the registrar's office. According to their calendar, the final exam will be held Monday, December 11, in CST 318 at 8 am.

Other assignments

Note: All assignments will be posted on the class website - they will not be handed out in class.

Reading: These will be assigned for each day of class, to be completed before class on that day. Reading ahead is a critical element for learning the material in this course. The time you invest reading for each class pays off in two different ways. One, your performance improves because you understand the material better, you ask questions, and attain a higher comprehension level. Two, you understand the material faster, so you spend less time later reviewing elementary ideas and introductory material when preparing for quizzes and exams.

Problem sets: Exercises will be assigned for each topic that we cover, and must be turned in at the beginning of class on the indicated due dates. Problem sets will collectively account for 20% of your total grade. I will drop your lowest grade when computing your average.

Lab projects and explorations: These will involve conceptual experiments and/or applying your understanding of differential equations to various real-life application problems. Each lab will require submitting a comprehensive, well-written report.

Important dates

* Last day to add this course: August 29.
* Last day to drop: November 3.
* Date of final exam: December 11.

NOTE: Last drop date applies to Earlham students only. Students cross-registered through IU-East or other institutions must follow the dates and rules of their own institution.

Academic integrity
We are each responsible for helping preserve an environment of mutual support and trust by acting with integrity and honesty in all of our dealings with one another. In this spirit, students are reminded of the following excerpt from the Earlham Academic Integrity Policy:
"The College trusts students who enroll at Earlham to be honest seekers of truth and knowledge. This trust is extended to all students by other students and by teachers ... Giving or receiving aid inappropriately on assignments and tests, or plagiarizing by using another person's words or ideas without credit, constitutes a serious breach of our trust in one another and in the integrity of the search for truth. Those who believe they have witnessed violations of academic integrity should feel the obligation to speak about this to the suspected offender. The witness also should feel obligated to report the suspected offender to the instructor if the person fails to offer a satisfactory explanation and refuses to report him or herself. ... Violations of academic integrity, because they
undermine our trust in one another and in the credibility of the academic enterprise, are taken very seriously. Penalties for violations range from failing assignments or tests to suspension or expulsion from the College."

**Makeups**

- **Homework and lab projects:** Past-due assignments will not be accepted except in rare circumstances, provided the student receives prior consent from the instructor.
- **Exams:** Make-up exams will not be given except in the case of a documented emergency.

**Academic accommodations**

Students with a documented disability (e.g., physical, learning, psychiatric, visual, hearing, etc.) who need to arrange reasonable classroom accommodations must request accommodation memos from the Academic Enrichment Center (main floor of Lilly Library) and contact their instructors each semester. For greater success, students are strongly encouraged to visit the Academic Enrichment Center within the first two weeks of each semester to begin the process. For further details, please visit [https://www.earlham.edu/academic-enrichment-center/disability-services/](https://www.earlham.edu/academic-enrichment-center/disability-services/)

**Other sources of help**

1. **The Academic Enrichment Center:** The Academic Enrichment Center (AEC), located in Lilly Library, provides assistance with study habits and skills as well as a peer tutoring service. The AEC is staffed by trained peer tutors for either pre-arranged group tutoring sessions (provided for many math, science and social science courses) or one-on-one tutoring sessions for other courses. Peer tutoring is a free service offered to all Earlham students. Please visit [http://www.earlham.edu/academic-enrichment-center/peer-tutoring/](http://www.earlham.edu/academic-enrichment-center/peer-tutoring/) for more information.

2. **The Earlham Writing Center:** The Writing Center is dedicated to providing students with advice and resources about writing. Students can meet one-on-one with trained consultants who will contribute feedback to writers at any stage of the writing process: brainstorming, drafting, researching, revising, and polishing. This is a free, walk-in service on the main level of Lilly Library from 7-10 pm Sunday through Thursday, with additional hours on Sunday, 2-5 pm. In addition to dropping by, students may also schedule an appointment in advance using the online scheduler found at: [http://www.earlham.edu/writing-center/](http://www.earlham.edu/writing-center/). If you have questions, please contact Laura Leavitt, The Writing Center Director at [taborla@earlham.edu](mailto:taborla@earlham.edu).