

# Math 411 Spring 2023

## Topics in Differential Equations: *Partial Differential Equations*

MWF 11:00-11:50PM Davis 217

**Professor:** Evan Randles  
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**Office Hours:** Monday 2:00-3:30PM, Tuesday 5:00-6:00PM,  
Friday 12:00-1:00PM, & by appointment

**Course Website:** <http://personal.colby.edu/~erandles/M411.html>  
**Personal Website:** <http://personal.colby.edu/~erandles/>

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*Among all mathematical disciplines the theory of differential equations is the most important. It furnishes the explanation of all those elementary manifestations of nature which involve time.* – Sophus Lie

*“Do you know,” he confided, “not even the best mathematicians on other planets – all far ahead of yours – have solved it? Why, there’s a chap on Saturn – he looks something like a mushroom on stilts – who solves partial differential equations mentally; and even he’s given up.”* – Arthur Porges

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**Course Description:** Welcome to the beautiful and fascinating world of partial differential equations! As mathematics is said to be the language of nature, differential equations are a fundamental part of its grammar. Partial differential equations (PDEs) appear in just about every quantitative discipline, from economics to engineering to mathematics to physics. In fact, the most important equations of mathematical physics, including the laws of gravitation (both of Newton and Einstein) and the laws of electricity and magnetism are PDEs. In this course, we will learn techniques to formulate and solve certain important and special PDEs – many of these techniques will involve reducing a given PDE into a collection of ordinary differential equations (ODEs) which we already know how to solve. Through the material covered will ultimately depend on our progress and our collective interests, I plan to cover the following topics: Classification of linear PDEs, separation of variables, Duhamel’s Principal, Fourier series, Sturm–Liouville theory, Fourier and Laplace transform techniques, spherical harmonics, the method of characteristics, and numerical methods.

**Prerequisites:** Mathematics 311.

**Textbook:** Partial Differential Equations for Scientists and Engineers by S. J. Farlow.

**Supplementary Course Material:** When creating material for this course (lecture notes and homework), I like to draw from many different sources. In addition to the textbook listed above, I will also use *Partial Differential Equations: An Introduction* by W. Strauss, *Applied Partial Differential Equations with Fourier Series and Boundary Value Problems* by R. Haberman and *Partial*

*Differential Equations* by L. C. Evans. While you are not required to obtain these texts, you may want to take a look at them, especially if you plan to continue your studies of PDE beyond this course.

**Grading:** Your grade will be calculated as follows:

Class participation and engagement:	5%
Weekly homework assignments:	30%
Minimum of Midterms 1 & 2:	15%
Maximum of Midterms 1 & 2:	25%
Final project:	25%

**Exams:** This course will have two midterms exams at the following dates and times:

Midterm 1	Wednesday, March 8th from 7:00-9:00PM
Midterm 2	Wednesday, April 12th from 7:00-9:00PM

The exams will be held in Lovejoy 100. It is crucial that you reserve these time slots for these exams. In the event that you are unable to attend a midterm exam, you must let me know at least **two weeks** prior to the exam date.

**Attendance and Class Participation:** As participation is a big part of this course, class attendance is strongly encouraged and expected whenever possible. To learn mathematics, it is essential to communicate it and to discuss it with others. You will be required to participate in class discussion and you will frequently be called on during lecture. Of course, we may all need to miss class from time to time (e.g., COVID isolation). If, at any point during the course of the semester, you need to isolate and/or will miss two or more consecutive class meetings, please send me a short email so that we can coordinate things to make sure that you have everything you need (e.g., course materials) while you are not able to attend class.

**Homework:** Homework is the most important part of this course. It is where you will grapple with new ideas, come up with creative solutions and communicate your thoughts and understanding to others. Consequently, it is crucial that you take homework very seriously. You should start homework early and work diligently. If you are having substantial difficulty with a particular exercise, please come talk to me during office hours. I am here to help! You are permitted and encouraged to discuss homework with your classmates, however, when it comes time to write up your solutions, you are required to do so independently and away from your peers (in another room, preferably). You are also permitted to consult other textbooks and, in this case, please give full details (beyond what's in our textbook). If you work with peers or consult material outside the textbook, you are required to cite your sources (including naming the peers with whom you worked); failure to do so is a matter of academic dishonesty and will result in grade penalties and/or reports of academic negligence/dishonesty. Your solutions should communicate your individual process and understanding of the material. What you turn in must be your own.

I expect homework solutions to be written out correctly and presented in good mathematical prose. Your grade will depend on the correctness of your solutions and the quality of your writing. This means that your writing should follow a coherent logical structure which makes use of complete sentences and follows standard rules of grammar. Please do not submit solutions containing incoherent and unstructured calculations. You should be proud of the material you turn in!

*Homework Structure and Schedule:* Assignments will be posted to the course website and are to be submitted in class on their due date (which usually falls on a Wednesday). It is crucial to keep up with the homework in this course. Therefore, short of the circumstances discussed in the attendance policy above, late homework will not be accepted. I will drop your lowest homework score on the condition that you attend one department colloquium and write a short (one paragraph) summary.

*Homework Policies:*

1. All write-ups are to be submitted in hard copy. They should be single-sided with no more than one problem per page, i.e., if a homework assignment has 5 problems, you should turn in at least 5 pieces of paper.
2. You are encouraged to typeset your write-ups (and paper for the project) in L<sup>A</sup>T<sub>E</sub>X (I can help you set this up if you are interested and unfamiliar with L<sup>A</sup>T<sub>E</sub>X). It is however completely acceptable to submit handwritten write-ups provide your handwriting is clear and legible.
3. Each paper you turn in should have your name and the due date printed clearly at the top.
4. Your write-ups should be stapled. It is your responsibility to make sure that your homework is complete and all pages are accounted for.
5. If you used technology in the solution of the problem, please provide the complete printout showing all code, inputs and outputs in sequence, and annotate the printout with comments explaining what is being done in each step.

**Final project:** An important part of this course is a project to be completed by the end of the semester. The primary goal of the project is to give you an opportunity to demonstrate what you've learned throughout the semester and to experiment with new ideas beyond what we've covered in class. Toward the middle of the semester, we will meet to discuss and select a project aligned with your interests. Though the nature (and specifics) of each project will differ from student to student, the projects will culminate in a paper and presentation.

**Office Hours:** As advertised above, there are a number of times during the week that I have reserved for office hours. Some of these time slots are dedicated for MA411 (e.g., Tuesday 5:00-6:00PM) and some are open to all of my students. The practices of learning and doing mathematics benefit from interacting with others – discussing it, asking questions, and explaining it to others – and my office hours are designed for exactly this. Please come frequently and interact with me and your peers and be ready to ask questions, exchange ideas, and be challenged. In this way, we will all learn together!

*Open Door Policy:* I maintain an “open door policy.” This means that, if you find my (inner) office door open and I'm inside, I am likely available to chat and help. In that case, please knock on my door and ask if I am available.

**My email policy:** I love talking about mathematics and I always prefer to do it in person. For this reason, I like to, whenever possible, reserve email for logistical things. However, when you are stuck and cannot come see me in person, please feel free to email me. I am here to help!

As my life is busy and I have many responsibilities, I usually only check and respond to email once per day and sometimes not at all on weekends. For this reason, I try to uphold the following 24-48 hour rule: If you send an email Sunday through Thursday, I will do my best to respond within 24 hours. If you send an email on Friday or Saturday, I will do my best to respond within 48 hours. If I do not respond within these windows, feel free to email me again as I may have missed it.

**Academic Integrity:** Honesty, integrity, and personal responsibility are cornerstones of a Colby education and provide the foundation for scholarly inquiry, intellectual discourse, and an open and welcoming campus community. These values are articulated in the Colby Affirmation and are central to this course. You are expected to demonstrate academic honesty in all aspects of this course. If you are clear about course expectations, give credit to those whose work you rely on, and submit your best work, you are highly unlikely to commit an act of academic dishonesty.

Academic dishonesty includes, but is not limited to: violating clearly stated rules for taking an exam or completing homework; plagiarism (including material from sources without a citation and quotation marks around any borrowed words); claiming another's work or a modification of another's work as one's own; buying or attempting to buy papers or projects for a course; fabricating information or citations; knowingly assisting others in acts of academic dishonesty; misrepresentations to faculty within the context of a course; and submitting the same work, including an essay that you wrote, in more than one course without the permission of the instructors.

Academic dishonesty is a serious offense against the college. Sanctions for academic dishonesty are assigned by an academic review board and may include failure on the assignment, failure in the course, or suspension or expulsion from the College.

For more on recognizing and avoiding plagiarism, see the library guide: [libguides.colby.edu/avoidingplagiarism](http://libguides.colby.edu/avoidingplagiarism)

### *The Colby Affirmation*

Colby College is a community dedicated to learning and committed to the growth and well-being of all its members.

As a community devoted to intellectual growth, we value academic integrity. We agree to take ownership of our academic work, to submit only work that is our own, to fully acknowledge the research and ideas of others in our work, and to abide by the instructions and regulations governing academic work established by the faculty.

As a community built on respect for ourselves, each other, and our physical environment, we recognize the diversity of people that have gathered here and that genuine inclusivity requires active, honest, and compassionate engagement with one another. We agree to respect each other, to honor community expectations, and to comply with college policies.

As a member of this community, I pledge to hold myself and others accountable to these values.