MATH 3140-004 Spring 2021:
Vector Calculus and Partial Differential Equations for Engineers
Lecture: MTWF 10:45 - 11:35 AM on Zoom
Lab: Thursdays, either 10:45 - 11:35 AM or 11:50 AM - 12:40 PM on Zoom

Course Instructor: Claire Plunkett (she/her)
Email: plunkett@math.utah.edu (preferred method of contact)
Office Hours: TBA on Zoom
Office Hours Zoom Link: TBA, same as lecture link

Lab Instructor: Kaitlin O’Dell (she/her)
Email: odell@math.utah.edu
Office Hours: TBD Office Hours Zoom Link: TBA

Zoom Live Lecture Link: TBA
Recorded Zoom lecture videos are shared later in the Pages link on the left sidebar of the course Canvas page.

Final Exam Day and Time: May 5, 10:30 AM - 12:30 PM

Course Web Page:
All course information and announcements will be posted on the Canvas page, which can be accessed through your CIS. It also contains material that may help you succeed in this course. I shall assume that you are keeping up to date with its contents.

Textbooks:
- Calculus: Concepts and Contexts, 4th Edition, by James Stewart (ISBN-13: 978-0495557425). There is an e-text available in Canvas if students wish to rent the e-text through the inclusive access program (see more below).
- Partial Differential Equations for Scientists and Engineers, by William H. Nesse. – a free-to-use .pdf text that will be distributed to students.

E-textbook for Calculus: Concepts and Contexts available through the Inclusive Access program. Students should receive an email to their email account a week prior to class start that gives them the options to OPT OUT if they do not wished to be charged the textbook fee. If students do nothing they will be automatically OPTED IN and charged the fee.
Alternatively, if students don’t already own the calculus text, students can save money by obtaining the shorter multivariable version of the calculus text: Multivariable Calculus: Concepts and Contexts (ISBN-13: 978-0495560548), in lieu of the full text.

Prerequisites:
- C or better in either Math 2250 or 2280, AND
- C or better in Math 1260 OR Math 1320 OR Math 1321 OR Math 2210
Course Description: Integration and its applications in several variables, vector fields and line, surface, and volume integrals. Green’s and Stokes’ theorems. Building partial differential equations from conservation principles, Fourier series and boundary-value problems for the wave, heat, and Laplace equations, separation of variables.

Course Learning Objectives:

Basic topics:

Students will be introduced to the tools of integration of multivariate functions over areas and volumes and will learn the use of iterated multiple integration. Similar to single-variable integration, students will learn the technique of multidimensional change-of-variables to transform the coordinates over which integration proceeds by utilizing the Jacobian. Specifically, students will learn how to transform between an integral over an area or volume in Cartesian coordinates to polar or spherical coordinates, respectively.

Students will become familiar with vector functions that define vector fields in the plane and 3D space, particularly conservative vector fields, represented by the gradient of a scalar function, which are important for gravitation and electrostatics. When masses or charged particles are pushed through fields such as these along curved paths, the work done can be computed as a line integral. Students will learn how the fundamental theorem for line integrals for conservative vector fields reduces the integral to valuation of the potential at the endpoints of the path.

Students will learn the fundamental vector calculus integral theorems of Green, Stokes’, and Divergence. The notion that one-dimensional integrals of functions can be computed from evaluation of a related function (e.g., an antiderivative or a potential function) on the end-points of the interval of integration generalizes to integration over areas, surfaces and 3D domains. Integration over these domains can be computed by evaluation on the boundary of an area, surface, or volume of the appropriate function. Students will learn meaning and computation of the curl and divergence of a vector field and utilize them to compute area and volume integrals using Green’s and Stokes’, and the Divergence theorems, respectively. Students will also learn how these theorems represent conservation principles for physical vector fields important in gravitation and electric fields.

Students will become knowledgeable about partial differential equations (PDEs) and how they can serve as models for physical processes such as mechanical vibrations, transport phenomena including diffusion, heat transfer, and electrostatics. Students will be able to derive heat and wave equations in 2D and 3D using the divergence theorem.

Students will master how solutions of PDEs is determined by conditions at the boundary of the spatial domain and initial conditions at time zero.

Students will be able to understand and use inner product spaces and the property of orthogonality of functions to determine Fourier coefficients, and solution of PDEs using separation of variables. Students will master the method of separation of variables to solve the heat and wave equation under a variety of boundary conditions. Students will be familiar with the use of Fourier series for representation of functions, and the conditions for series convergence.

Students will be able to solve for the electric potential in an area or volume region by specifying the charge distribution on the boundary of the region (i.e., boundary conditions) and use separation of variables to obtain the solution. Students will be able to derive basic properties of these electric potentials, including points of minimum/maximum potentials, and use Stokes’ theorem to determine work done moving charges in a closed path through the potential.

Students will also master the use of the Fourier transform and integral convolution to solve the heat equation on the real line using the heat kernel.

Problem solving fluency:

Students will gain experience and further mastery of complete problem solving fluency. Students will be able to read and interpret problem objectives, be able to select and execute appropriate methods to achieve objectives, and finally, be able to interpret and communicate results.
Course Work and Evaluation

Grading: The grades of homework, in-class assignments, exams, and finals will weight as follows in your overall average.

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<tbody>
<tr>
<td>Homework</td>
<td>15%</td>
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<tr>
<td>In-class Assignments</td>
<td>5%</td>
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<tr>
<td>Labs</td>
<td>17%</td>
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<td>Lab Attendance</td>
<td>3%</td>
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<tr>
<td>Midterm Exams</td>
<td>35%</td>
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<tr>
<td>Final</td>
<td>25%</td>
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Using the above weights, letter grades will be assigned as follows: If $X$ is your percentage total grade listed in Canvas, then

\[
X \geq 93\% \Rightarrow A, X \geq 90\% \Rightarrow A-, \\
X \geq 87\% \Rightarrow B+, X \geq 83\% \Rightarrow B, X \geq 80\% \Rightarrow B-, \\
X \geq 77\% \Rightarrow C+, X \geq 73\% \Rightarrow C, X \geq 70\% \Rightarrow C-, \\
X \geq 67\% \Rightarrow D+, X \geq 63\% \Rightarrow D, X \geq 60\% \Rightarrow D-, \\
X < 60\% \Rightarrow E.
\]

Any student earning lower than 60% (after score adjustments [curving]) on the final exam may only earn a maximum grade of C- in the course.

I reserve the right to change the grade scheme as I see fit. Any other grade schemes will only be beneficial to your grade as compared to the above standard.

Homework: Homework will be assigned weekly. Homeworks will be assigned on Fridays and due the following Friday. All homework assignments and due dates will be posted on the course webpage. Homeworks will be completed outside of class and all students must turn in their own homework assignments. All homeworks will be submitted via Gradescope. The lowest two homework scores will be dropped. No late homeworks will be accepted.

In-Class Assignments: There will be in-class participation assignments once per week. In-class assignments will be graded for participation and effort. Two in-class assignments will be dropped. There will be no makeups for in-class assignments.

Labs: There are two components to the labs: attendance (3% of total grade) and lab assignments (17% of total grade). The Engineering Mathematics sequence incorporates one laboratory hour every week in addition to lecture time, where students participate in teaching assistant facilitated problem solving sessions. These sessions are specifically designed to aid the problem solving fluency learning objective (see above), as well as basic skills practice. Labs will be assigned during the lab section on Thursday and will be due at the beginning of lab the following Thursday.
Exams: There will be two midterm exams and one final exam. Midterm 1 will cover the material from weeks 1-5; Midterm 2 will cover material from weeks 6-11; the Final exam will be cumulative. Exam dates and times are listed on the course schedule. There will be no makeup exams.

Gradescope: Assignments and exams will be scored on gradescope.com. Regrade requests (in gradescope, not email) must be lodged in a timely fashion within a week of grade posting. Final exams will be posted and three days will be allotted to lodge regrade requests before final scores are posted. Regrade requests may involve crafting an argument for why you deserve more points. All regrade requests will be considered but should be based on the facts of the problem, the rubric employed, and the work given on the page of the exam, but not what you intended to write, or thought, or any other excuses. The goal of grading is to fairly apply a grading procedure to every student, so, a regrade request may result in an increase, decrease, or no change in score.

Online Course Considerations: Due to the ongoing epidemic this course is fully conducted in the virtual space through interactive video conferencing (IVC) via the Zoom App. All assignments and exams will be submitted via Gradescope.com.

- Students must have a reliable internet connection from which to participate on Zoom and submit via Gradescope.
- Lectures will be given via Zoom during the scheduled class time. Attendance, interaction, and questions are highly encouraged. The lecture notes and video will be recorded and posted later each day as a resource.
- Thursday laboratory sessions will entail working in small groups of fellow students that will be administered using the Zoom breakout rooms.
- Students must abide by the Student Honor Code. During exams and quizzes, students are not permitted to collaborate with each other, or communicate or seek help from third parties in-person or on the web. All work must be original, solely performed by the student.
- Exams are expected to be completed in roughly 55 minutes, but roughly an extra 10 minutes are allowed for students to complete the upload process (65 minutes total). Many assignments will be given prior to the exam in which to practice the upload process.
- Students are highly encouraged to collaborate together on homeworks or lab assignments to enhance their knowledge. However, the work a student writes on their submitted assignment must reflect their own knowledge (i.e., no copying others’ work).

Important Dates:

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<tr>
<th>Event</th>
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<tr>
<td>Drop Deadline</td>
<td>Friday, January 29</td>
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<tr>
<td>Presidents’ Day Holiday (NO CLASS)</td>
<td>Monday, February 15</td>
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<td><strong>First Midterm</strong></td>
<td><strong>Friday, February 19</strong></td>
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<td>Non-Instructional Day (NO CLASS)</td>
<td>Friday, March 5</td>
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<td>Last Day to Withdraw from Classes</td>
<td>Friday, March 12</td>
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<td><strong>Second Midterm</strong></td>
<td><strong>Friday, March 26</strong></td>
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<tr>
<td>Non-Instructional Day (NO CLASS)</td>
<td>Monday, April 5</td>
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<td>Last Day to Elect CR/NC</td>
<td>Friday, April 9</td>
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<td>Last Day to Reverse CR/NC Option</td>
<td>Friday, April 23</td>
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<tr>
<td>Reading Day (NO CLASS)</td>
<td>Wednesday, April 28</td>
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<td><strong>Course Final</strong></td>
<td><strong>Wednesday, May 5, 10:30 AM - 12:30 PM</strong></td>
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Mandatory Online Instruction Periods: All classes will be online the weeks of March 1-14. This course will continue to meet via Zoom.
Course Schedule:

Week 1: 12.5-7: Applications to probability, Surface area, Triple integrals

Week 2: 12.8-9, 13.1-2: Cylindrical/spherical coordinate integrals, Change of variables, Jacobians, Vector fields, Line integrals

Week 2: 13.3-6: Fundamental theorem of line integrals, Green’s theorem, Curl and divergence, Surface integrals

Week 4: 13.7-8: Stokes’ theorem, Divergence theorem

Week 5: Switch to Nesse text: 1.1-2: Transport/flux, Continuity equation, Midterm exam 1

Week 6: 1.3-4, 2.2: Flux rules, DEs

Week 7: 2.3-5: Eigenfunctions, Inner products spaces.

Week 8: 2.6-7: Orthogonal functions, Least squares function approximation

Week 9: 3.1-3: Fourier series, Convergence, Sine and cosine series

Week 10: 3.4, 4.1: The energy spectrum, Thermal energy in a rod, Boundary conditions, Midterm exam 2

Week 11: 4.2-4: Diffusion, Equilibrium solutions

Week 12: 4.5-6: Separation of variables and series solutions, 1D, More heat equation solutions–insulated ends, periodic ends

Week 13: 5.1-3: Wave equation, What are waves?, D’Alembert’s formula

Week 14: 6.1-3: Fourier series in 2D, Laplace’s equation

Week 15: 6.4-5: Laplace’s equation on the disk, properties of harmonic functions

Note: The schedule of topics is not set in stone. I may adjust the pace as necessary for the learning needs of the class.
Other Policies and Resources


Math Tutoring Center: Do not hesitate to come to my office hours or to make an appointment to discuss a homework problem or any aspect of the course. Additionally, the T. Benny Rushing Mathematics Tutoring Center offers free online tutoring. Beginning the second week of classes, tutoring will be available from 8am to 8pm Monday through Thursday and 8am to 6pm on Friday. Please visit the center’s webpage for information on how to access tutoring: https://utah.instructure.com/courses/613503/.

Inclusivity Statement: It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students’ learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: age, color, disability, gender, gender identity, gender expression, national origin, political affiliation, race, religion, sexual orientation, and veteran status, and other unique identities. gender, sexuality, disability, age, socioeconomic status, ethnicity, race, culture, and other unique identities. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

LGBT Resource Center: If you are a member of the LGBTQ+ community, I want you to know that my classroom is a safe zone. Additionally, the University of Utah has an LGBT Resource Center on campus. They are located in Room 409 in the Olpin Union Building. Hours: M-F 8-5pm. You can visit their website to find more information about the support they can offer, a list of events through the center and links to additional resources: https://lgbt.utah.edu/. Please also let me know if there is any additional support you need in this class.

Names/Pronouns: Canvas allows students to change the name that is displayed AND allows them to add their pronouns to their Canvas name. Class rosters are provided to the instructor with the student’s legal name as well as “Preferred first name” (if previously entered by you in the Student Profile section of your CIS account, which managed can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the LGBT Resource Center: https://lgbt.utah.edu/.

English Language Learners: If you are an English language learner, please be aware of several resources on campus that will support you with your language and writing development. These resources include: the Writing Center (http://writingcenter.utah.edu/); the Writing Program (http://writing-program.utah.edu/); the English Language Institute (http://continue.utah.edu/eli/). Please let me know if there is any additional support you would like to discuss for this class.

Undocumented Student Support: Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support un-
documented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801.213.3697 or visit dream.utah.edu.

**Veteran’s Center:** If you are a student veteran, the University of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 8-5pm. Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: http://veteranscenter.utah.edu/. Please also let me know if you need any additional support in this class.

**Wellness Statement:** Personal concerns such as stress, anxiety, relationship difficulties, depression, cross-cultural differences, etc., can interfere with a student’s ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at www.wellness.utah.edu or 801-581-7776.

**Student Success Advocates:** The mission of Student Success Advocates is to support students in making the most of their University of Utah experience (ssa.utah.edu). They can assist with mentoring, resources, etc. Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact a Student Success Advocate for support (https://asuutah.edu/displaced-students).

**The Americans with Disabilities Act:** The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability & Access, 162 Olpin Union Building, 801-581-5020. CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability & Access.

**Addressing Sexual Misconduct:** Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veterans status or genetic information. If you or someone you know has been harassed or assaulted on the basis of your sex, including sexual orientation or gender identity/expression, you are encouraged to report it to the University’s Title IX Coordinator; Director, Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or to the Office of the Dean of Students, 270 Union Building, 801-581-7066. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to police, contact the Department of Public Safety, 801-585-2677(COPS).

**Campus Safety:** The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safetu.utah.edu.

**University Counseling Center:** The University Counseling Center (UCC) provides developmental, preventive, and therapeutic services and programs that promote the intellectual, emotional, cultural, and social development of University of Utah students. They advocate a philosophy of acceptance, compassion, and support for those they serve, as well as for each other. They aspire to respect cultural, individual and role differences as they continually work toward creating a safe and affirming climate for individuals of all ages, cultures, ethnicities, genders, gender identities, languages, mental and physical abilities, national origins, races, religions, sexual orientations, sizes and socioeconomic statuses.
Office of the Dean of Students: The Office of the Dean of Students is dedicated to being a resource to students through support, advocacy, involvement, and accountability. It serves as a support for students facing challenges to their success as students, and assists with the interpretation of University policy and regulations. Please consider reaching out to the Office of Dean of Students for any questions, issues and concerns. 200 South Central Campus Dr., Suite 270. Monday-Friday 8 am-5 pm.