

Syllabus for Math 3140-001

Engineers Vector Calculus & PDE

Fall 2021

General Course Information:

Course: Math 3140 - Engineers Vector Calculus & Partial Differential Equations.

Class Time: Mondays, Tuesdays, Wednesdays, and Fridays 7:30am - 8:20am.

Class Location: WEB 1230

Course Website: We use Canvas: <https://gate.acs.utah.edu/>. To log in, use the same student ID and password that you use for Campus Information System.

Thursday Laboratory: There are lab sessions on Thursdays. See below.

Instructor: Keyvan Yaghmayi.

Email: yaghmayi@math.utah.edu.

Office: JWB 104.

Office Hours: Tuesdays 8:30am - 9:20am and Fridays 11:00am - 11:50am, or by appointment.

Textbook:

- Calculus, Concepts and contexts, fourth edition, by James Stewart (ISBN-978-0495557425). An e-text is available, view-able in Canvas if students participate in the Inclusive access program. 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 (978-0495560548), in lieu of the full text.
- Partial Differential Equations for Scientists and Engineers, by William H. Nesse. A free-to-use .pdf text that will be distributed to students.

Important Dates: Classes begin Monday, January 23. Last day to add, drop, or audit classes is Friday, September 3, and last day to withdraw is Friday, October 22. Final Exam will be on Thursday, December 16, 8:00am – 10:00am.

Essential Course Information:

Prerequisites: “C” or better in ((MATH 2250 AND (MATH 1320 OR MATH 1321 OR MATH 2210 OR MATH 1260)) OR MATH 2280)

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.

Expected Learning Outcomes: The goal of Math 2310 & Math 3140 is to master the basic tools and problem solving techniques important in Multivariable Calculus & Partial Differential Equations. These basic tools and problem solving skills are:

1. 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 multi-dimensional 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.
2. 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.
3. 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.
4. 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.

5. 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.
6. Students will master how solutions of PDEs is determined by conditions at the boundary of the spatial domain and initial conditions at time zero.
7. 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.
8. 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.
9. 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.

Week-by-Week Course Roadmap: Below is an outline and rough schedule of the sections and topics that we will cover in this course:

Week 1: 12.5 - 12.7: Applications to probability, Surface area, Triple integrals.

Week 2: 12.8 - 12.9 & 13.1 - 13.2: Cylindrical and spherical coordinate integrals, Change of variables, Jacobians, Vector fields, Line integrals. **Friday, September 3 is the last day to drop.**

Week 3: 13.3 - 13.6: Fundamental theorem of line integrals, Green's theorem, Curl and divergence, Surface integrals. **Monday, September 6 is Labor Day Holiday.**

Week 4: 13.7 & 13.8: Stokes' theorem, Divergence theorem.

Week 5: Switch to Nesse text: 1.1 - 1.2: Transport/flux, the continuity equation. **Midterm 1 is on Friday, September 24, on Material we cover Week 1-4.**

Week 6: 1.3 - 1.4 & 2.2: Flux rules, DEs

Week 7: 2.3 - 2.5: Eigenfunctions, Inner products spaces.

Fall Break: October 10-17

Week 8: 2.6 - 2.7: Orthogonal functions, Least squares function approximation. **Friday, October 22 is the last day to withdraw.**

Week 9: 3.1 - 3.3: Fourier series, Convergence, Sine and cosine series.

Week 10: 3.4 & 4.1 - 4.2: The energy spectrum, Thermal energy in a rod and boundary conditions, Diffusion.

Week 11: 4.3 - 4.4: Equilibrium solutions, More Equilibrium solutions. **Midterm 2 is on Friday, November 12, on Material we cover Week 6-10.**

Week 12: 4.5 - 4.6: Separation of variables and series solutions, 1D More heat equation solutions—insulated ends, periodic ends.

Week 13: 5.1 - 5.3: Wave equation, What are waves?, D'Alembert's formula. **Thanksgiving Break: Thursday - Sunday, November 25-28.**

Week 14: 6.1 - 6.3: Fourier series in 2D, Laplace's equation.

Week 15: 6.4 - 6.5: Laplace's equation on the disk, properties of harmonic functions.

Week 16: Review and comprehensive Final Exam. **Final Exam is on Thursday, December 16, 8:00am – 10:00am.**

Homework:

Homework problems and due dates will be posted on Canvas regularly. You upload/submit a single PDF file of your work into the Canvas. In homework assignments please show work. The lowest homework score will be dropped at the end of the semester. Your homework assignments will be graded in Canvas.

I will make most of HW assignments due Fridays 11:59pm (There might be exceptions, like the Thanksgiving Break). There will be 5 hours grace period to submit late. That means you can upload your HW late until Saturdays early morning at 5:00am.

I encourage you to discuss your homework problems with one another, ask help from tutors in the *math center* (see below), or talk to me during office hours. The other way that you can get help with homework assignments is posting discussions in Canvas.

Lab Session:

You are required to register and attend one of the lab sessions:

- Lab Section 3140-002: Thursdays 7:30am - 8:20am CSC 13
- Lab Section 3140-003: Thursdays 8:35am - 9:25am CSC 13

In the lab session, Anil Cengiz, the lab instructor, gives you 2-3 challenging and more involved “story” problems. In fact, these problems often revolve around engineering and physics applications and are a little harder but as a bonus you get to do it in class with the lab instructor.

The policies, grading criteria, and expectations of the lab will be communicated by Anil during the first week. Questions about the content or grading of the lab should also be directed toward Anil.

Quizzes:

There will be weekly (group) quizzes every Friday in class. It should take approximately 15-20 minutes to complete the quiz. I will upload the solutions and grades on canvas. Quizzes will not be excused due to absences or lateness so please be prompt and present. At the end of the semester, your lowest quiz score will be dropped and will not count toward your overall grade.

You are encouraged to work together on quizzes by making small groups of 2, 3 or 4 with friends/neighbors in class and discussing problems and your possible solutions within the group. You should write your answer based on your own understanding and in your own words. It is totally fine if someone likes to work individually.

Tests:

There will be two midterms along with a comprehensive Final Exam. All of them are in the scheduled classroom (WEB 1230) and at the class time.

Midterm One: Friday, September 24, on material we cover Week 1-4.

Midterm Two: Friday, November 12, on material we cover Week 6-10.

Comprehensive Final Exam: Thursday, December 16, 8:00am – 10:00am.

It is essential that you show all your work. Credit won't be given without proper work and partial credit will be awarded if you show correct steps even if you do not obtain the final correct number.

Grading:

The grades will be calculated as follows:

Homework 15%
Lab Session 15%
Quizzes 15%
Midterm One 15%
Midterm Two 15%
Final Exam 25%

The grade scale will be the usual: A (93-100), A- (90-92), B+ (87-89), B (83-86), B- (80-82), C+ (77-79), C (73-76), C- (70-72), D+ (67-69), D (63-66), D- (60-62), E (0-59).

If I do need to curve the grades, I will simply shift your overall percentage up by a few points (whatever is necessary).

Tutoring and Extra Help:

- **Math Student Center:** The math tutoring center is available free of charge to all university students. It is located in room 155 of the T. Benny Rushing Mathematics Center (adjacent to the LCB and JWB). The tutoring center is open Monday-Thursday 8:00am-8:00pm, and Friday 8:00am-6:00pm. Please take advantage of the tutoring center as needed throughout the semester. They are also offering group tutoring sessions. If you're interested, inquire at <https://www.math.utah.edu/undergraduate/mathcenter.php>
- **ASUU Tutoring Center:** University Tutoring Services, 330 SSB. They offer inexpensive tutoring, please see their website: <http://tutoringcenter.utah.edu>
- **Khan Academy:** It is a non-profit, free, educational organization for anyone, anywhere. They have some amazing videos in the Youtube. Check them out: <https://www.khanacademy.org/>
- **Canvas Discussion:** If you have questions about logistics of the class, course material and assignments, and anything else your classmates may wonder as well, please post a question on the Discussions Board in Canvas. This way the information is shared quickly to the entire class, and each of you can benefit from seeing other classmates' questions.
- **Discord and/or GroupMe:** You are welcome to create a page for our class and help each other with questions in HW and Lab assignments.

COVID-19 Fall 2021 Statement:

University leadership has urged all faculty, students, and staff to model the vaccination, testing, and masking behaviors we want to see in our campus community. These include:

Vaccination:

- Get a COVID-19 vaccination if you have not already done so. Vaccination is proving highly effective in preventing severe COVID-19 symptoms, hospitalization and death from coronavirus. Vaccination is the single best way to stop this COVID resurgence in its tracks.
- Many in the campus community already have gotten vaccinated:
 - More than 80% of U employees
 - Over 70% of U students
- Visit <http://mychart.med.utah.edu/> or <http://vaccines.gov/> to schedule your vaccination.

Masking:

- While masks are no longer required outside of Health Sciences facilities, UTA buses and campus shuttles, CDC guidelines now call for everyone to wear face masks indoors.
 - Check the CDC website periodically for masking updates <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinated-guidance.html>.
 - Treat masks like seasonal clothing (i.e. during community surges in COVID transmission, masks are strongly encouraged indoors and in close groups outside).

Testing:

- If you are not yet vaccinated, get weekly asymptomatic coronavirus tests. This is a helpful way to protect yourself and those around you because asymptomatic individuals can unknowingly spread the coronavirus to others.
- Asymptomatic testing centers are open and convenient:
 - Online scheduling
 - Saliva test (no nasal swabs)
 - Free to all students returning to campus (required for students in University housing)

- Results often within 24 hours: Visit <http://mychart.med.utah.edu/>
- Remember: Students must self-report if they test positive for COVID-19 via this website: <https://coronavirus.utah.edu/>

Some Policies and Comments:

- For quizzes and exams, you are allowed to use a “scientific calculator”. Other types of calculators like programmable calculators or graphing calculators are not allowed. I will make tests and quizzes to evaluate your mathematical skills and not your calculator skills. For homework assignments, it is okay that you check your answer by advanced calculators or other preferred technology.
- Please check Canvas regularly (every day or every other day). I will use the following features of Canvas frequently: Pages, Assignments, Announcements, Modules, Discussions, Gradescope, Files, and Grades.
- If there is something that I want to inform you, I will reach out to you by emailing you through Canvas. That is usually your default UMail address (uNID@utah.edu) that you have in the CIS. If you are using other emails more frequently than your UMail, then you can set your UMail to forward to your preferred email address. Also the fastest way to reach me is my email: yaghmayi@math.utah.edu.
- If your preferred name is different than your legal first name (the preferred name you chose does indeed show up in CIS on my roll sheet, but not yet in Canvas), please log into Canvas and go to “Account” (on far left) then “Settings” and change your “Display Name” to be the name you prefer to be addressed by. This will help me greatly to know students’ names, and to address you correctly when responding to Canvas comments.
- If you have any thoughts, ideas, or suggestion, please feel free to contact me. I promise to do everything in my power to help.

University of Utah Resources and Policies:

- **Center for Disability & Access:** is dedicated to students with disabilities by providing the opportunity for success and equal access at the University of Utah. They are committed to providing reasonable accommodations as outlined by Federal and State law. The Center for Disability & Access (CDA) also strive to create an inclusive, safe and respectful environment. By promoting awareness, knowledge and equity, they aspire to impact positive change within individuals and the campus community. Please visit <http://disability.utah.edu/> for the latest information.

- **A.D.A. Statement:** 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.
- **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 <https://safeu.utah.edu/>.
- **Student Responsibilities:** All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. You have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, collusion, fraud, theft, etc. Students should read the Code carefully and know you are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, beginning with verbal warnings and progressing to dismissal from class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee. <http://regulations.utah.edu/academics/6-400.php>
- **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, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or 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 the police, contact the Department of Public Safety, 801-585-2677(COPS).
- **Veterans Support Center:** The Center is staffed by student Veterans who are committed to providing their fellow Veterans with the most useful and current information available. The Mission of the Veteran Support Center is to improve and enhance the success of student Veterans; to help them receive the benefits

they deserve; to serve as a liaison between the Veteran student community and the University; and to increase their academic success. Additionally to provide an opportunity to continue the relationships built through the service in civilian life. Please see <https://veteranscenter.utah.edu/>

- **Student Names and Personal Pronouns:** Class rosters are provided to the instructor with the students legal name as well as preferred first name (if previously entered by you in the Student Profile section of your CIS account). 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, on papers, exams, group projects, etc. Please advise me of any name or pronoun changes (and update CIS) so I can help create a learning environment in which you, your name, and your pronoun will be respected. If you need assistance getting your preferred name on your U-ID card, please visit the LGBT Resource Center Room 409 in the Olpin Union Building, or email bpeacock@sa.utah.edu to schedule a time to drop by. The LGBT Resource Center hours are M-F 8am-5pm, and 8am-6pm on Tuesdays.
- **Women's Resource Center:** The Women's Resource Center (WRC) at the University of Utah serves as the central resource for educational and support services for women. Honoring the complexities of women's identities, the WRC facilitates choices and changes through programs, counseling, and training grounded in a commitment to advance social justice and equality. <https://womenscenter.utah.edu/>
- **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 <https://wellness.utah.edu/> or 801-581-7776.

Disclaimer: This syllabus is meant to serve as an outline and guide for our course. All information on this syllabus is subject to change. If any changes on this syllabus, course policies or course outline arise throughout the semester, then I will announce it in class and post it on Canvas.