

Vector Calculus and Partial Differential Equations for Engineers
Math 3140 -001
Fall 2015

Lectures: MTWF 7:30am-8:20am - JFB 102
Laboratory: H 7:30am-8:20am - JWB 333 - Section 2
H 8:35am-9:25am - MCD 130 - Section 3
Instructor: Dr. Varun Shankar
Office: LCB 313
Phone: (385) 259-8400
E-mail: vshankar@math.utah.edu
Webpage: <http://www.math.utah.edu/~vshankar>
TA: Andrew Basinski - SB321 - basinski@math.utah.edu
Course webpage: <http://www.math.utah.edu/~vshankar/3140.html>
Office Hours: By appointment

Textbooks:

1. *Calculus: Concepts and Contexts*, by James Stewart, 4th edition; BROOKS/COLE CENGAGE Learning, 2010; ISBN-13: 0-495-55742-0; price is about \$195. The textbook comes with an accompanying website with homework hints.

http://www.stewartcalculus.com/media/9_home.php

This is the same textbook as the one used in Engineering Calculus I and II (MATH 1310-1311, MATH 1320-1321). Alternatively, you can obtain the shorter multivariable version of the calculus text: *Multivariable Calculus: Concepts and Contexts* (ISBN13: 978-0-495-56054-8), in lieu of the full text.

2. *Differential Equations and Linear Algebra With Introductory Partial Differential Equations and Fourier Series* (Custom Edition for the University of Utah), by C. Henry Edwards, David E. Penney, and Richard Haberman; PEARSON Learning Solutions, 2013; ISBN-13: 978-1-269-42557-5; price is about \$195.

This is the same textbook as the newest custom edition of the one used in MATH 2250.

Updates: Topics covered and assignments are listed on the class webpage and will be updated regularly based on the pace of the lectures. You are responsible for checking it. Announcements are occasionally posted on Canvas.

Mathematics Tutoring Center: Free tutorial is available in room 155 of the T. Benny Rushing Mathematics Center (adjacent to the LCB and JWB). The tutoring center will open on September 2nd and hours are 8am-8pm Monday-Thursday and 8am-6pm on Friday. The tutoring center is closed during semester breaks, weekends, and University holidays. You should check the schedule to see when a tutor who can help you with this class is available. You also have access to the computer lab. You have a Math Department computer account by virtue of being enrolled in a Math class and may print related material for free. The tutoring center offers group tutoring for 5 or more students who must commit to a weekly tutoring session (same time). For more information consult the website.

<http://www.math.utah.edu/ugrad/mathcenter.html>

You might find the videos and problems from the website of the Khan Academy helpful.

<https://www.khanacademy.org/>

The math department has videos available online of the regular calculus classes from Intermediate Algebra to Calculus III.

<http://www.math.utah.edu/lectures/>

Prerequisites: “C” or better in MATH 1320 and MATH 2250.

Description: The course will cover essential multivariable vector calculus and partial differential equations (PDEs) used for engineering applications. The goal is to master the basic tools and problem solving techniques important in PDEs and vector calculus. The course is structured into four lecture hours per week, and one lab hour per week. The lecture class incorporates instructor lectures, including content on applications, weekly short quizzes and random pop quizzes. Lab sections comprise group problem solving sessions led by the teaching assistant, weekly homework discussion and students participation. The work you will complete in Math 3140 comprises weekly homework and quizzes, two midterm exams, a comprehensive final exam, and a group project. Homework will be turned in on Thursday and quizzes will be given every Friday except during exam days and holidays.

Learning Objectives:

- You 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, you will learn the technique of multidimensional change-of-variables to transform the coordinates over which integration proceeds by utilizing the Jacobian. Specifically, you will learn how to transform between an integral over an area or volume in Cartesian coordinates to polar or spherical coordinates, respectively.
- You 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. You 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.
- You will learn the fundamental vector calculus integral theorems of Green, Stokes', and Gauss'. 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. You 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 Gauss' theorems, respectively. You will also learn how these theorems represent conservation principles for physical vector fields important in gravitation and electric fields.
- You 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. You will be able to derive heat and wave equations using the divergence theorem.
- You will master how solutions of PDEs is determined by conditions at the boundary of the spatial domain and initial conditions at time zero.

- You 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. You will master the method of separation of variables to solve the heat and wave equation under a variety of boundary conditions.
- You 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.

In addition, you will also gain further mastery of complete problem solving fluency. You will be able to read and interpret problem objectives, to select and execute appropriate methods to achieve objectives, and finally, to interpret and communicate results.

Reading and videos: You are expected to have read the corresponding textbook section prior to each class. We will cover about three sections per week. Even if you spend as little as ten minutes on this, it will make the discussion in class much clearer, and overall you will save time. Additionally, Will Nesse has posted videos on many topics. The videos (about 25 minutes long) can be found on his YouTube channel.

<http://www.youtube.com/playlist?list=PLkfmUPOLLnthHE9ICNdGgdgIi16-M80ZS>

Attendance to the lab is mandatory and will be recorded. Quizzes, super quizzes and exams will take place in lecture. Homework and lab worksheets will be due in your respective lab section.

Lab: Every Thursday, a Teaching Assistant-directed lab section will be held. These lab sections, which have smaller class sizes, consist of working on lab worksheet-reports. The worksheet tend to cover longer, more in-depth problems than those found in homework and exams, and will sometimes require use of Maple or Matlab software to complete. The TA will be there to help guide you through the problems and help with any computer challenges. Completion of worksheet-reports will require work outside of the lab hour. The group work will also help you prepare for the quizzes, and exams given the next day. Credit will be given for both lab attendance and completed worksheets. Lab worksheets will be turned in during the following lab. The

lowest two worksheet scores will be dropped. Acceptance of late homework is at the discretion of the TA.

Quizzes: At the *beginning* of every Friday class (except when an exam or super quiz is scheduled), a 1-2 problem quiz will be given, taking roughly 10 minutes to complete. The quiz will cover relevant topics discussed in the week's lectures, in the homework and in the lab. The lowest score will be dropped. No make-up quiz will be given.

Homework: Roughly three textbook sections are due on most Thursdays at the *beginning* of your lab section from lectures covering material through the preceding week. The grading will be based on completion and correctness of the graded problems. The assignments may be updated dynamically through the course, so be sure to check the class webpage regularly to see the specific problems due each week. The lowest three homework scores will be dropped. Only hardcopy assignments will be accepted (no digital copies) and no late homework (past the first fifteen minutes of lab) will be accepted.

Group project: During the last week of class, you will be working in 3-4 people group on a project using the knowledge you have developed during the entire calculus sequence. There are four components to the project: 1) problem set-up (transform a word problem to a set of equations), 2) problem solving both on paper and with technology 3) problem write-up (provide the rest of a class with a solution) and 4) problem presentation (in class). Detailed instructions and topics will be discussed half-way through the semester. Topics presented last semester included atrial contraction waves in the heart, shallow water equations, tumor modeling, chemical reaction as a first passage time problem, vibration in a beam, and traffic dynamics.

Midterm exams: There will be two in-class exams (50 minutes). No books, notes, formula sheets, calculators (scientific or not), computers, phones (smart or not) or electronic device will be allowed. Watch the website for the date.

Final Exam: The two-hour final exam is *comprehensive*. Watch the website for the date.

Make-up and regrading: Any conflict leading to missed exams or super quizzes are your responsibility and must be arranged ahead of time or within a week past the test. Failure to do so may result in a zero for the corresponding

test. Regrading inquiries must be submitted in writing within a week of the test being returned.

Students with Disabilities: 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 Services, 162 Olpin Union Building, 581-5020. CDS will work with you and us to make arrangements for accommodations.

Grading: Grades are determined as a weighted average as follows

Lab	Quizzes	Homework	Project	Midterms	Final
20	10	20	10	20	20

Letter grades will be determined by a curve at the end of the semester.

Honor Code: You are expected to abide by the University of Utah Honor Code and to avoid any instances of academic misconduct, including but not limited to: (1) possessing, using, or exchanging improperly acquired written or oral information during an exam, (2) substitution of material that is wholly or substantially identical to that created or published by another individual(s), and (3) false claims of performance or work.