MA 302	Vector Calculus	Spring 2010
Section A	MWF 11 - 11:50	Keyes 103

Professor:	Scott Taylor
Office Hours:	MWF 2 - 3:30 PM R 10 - 11 AM, 2 - 3:30 PM *and by appointment!*
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Prerequisites:	MA 122 or permission of instructor
Text:	Colley, *Vector Calculus* 3/e, Pearson.

The Course:

MA 302, building off the content of MA 122, develops the calculus of functions in all dimensions. The main goal of the course is to relate the concepts of "derivative" and "integral" in all dimensions by generalizing the Fundamental Theorem of Calculus. Along the way you will become adept at using the language and notation of vectors to express key ideas in geometry and physics.

Objectives for increasing mathematical maturity:

- Develop an intuition for higher dimensions by comparing high dimensional geometry and calculus to low dimensional geometry and calculus.
- Use vectors and vector fields to solve problems in geometry and physics.
- Use geometric and physical intuition to understand mathematical objects.
- Increase understanding of the relationship between definitions, examples, theorems, and proofs in mathematics.
- Begin to explore the intrinsic nature of many geometric definitions (eg. curvature).
- Begin to explore the relationship between geometry and topology by discussing notions such as orientation and path-independence.
- Engage in significant self-teaching of mathematics.
- Effectively communicate mathematics.

Major Course Content Objectives

- Use linear algebra to understand the definition and behaviour of the derivatives of functions $f\colon \mathbb{R}^n \to \mathbb{R}^m$.
- Use derivatives to understand intrinsic properties of curves in $\mathbb{R}^2$ and $\mathbb{R}^3$. These include arc length, curvature, and unit tangent vectors.
- Use the calculus of space curves to solve the 2-body problem.
- Understand the mathematical and physical significance of the gradient, divergence, and curl of a vector field.
- Understand the mathematical and physical significance of path integrals of scalar and vector fields.
- Understand the mathematical and physical significance of surface integrals of scalar and vector fields.
- Understand the statements of Greens', Gauss', and Stokes' theorems.
- Understand the main ideas in the proofs of Greens', Gauss', and Stokes' theorems.
- Understand the concepts of conservative vector fields and their potential functions.

Attendance: I value your involvement in the class, therefore class attendance is mandatory. Absence for official Colby activities requires prior approval. Absence for religious reasons will be considered excused if the policy in the college catalogue is followed. I reserve the right to take attendance. More than 3 recorded unexcused absences will result in the reduction by 1/3 of the final course grade. Excessive tardiness or early departure may also result in such a reduction.

Computing Resources: On quizzes and exams you may use a graphing calculator. The point of an exam is to test for understanding – such understanding must come through clearly in your answers.

You will be required to use the software to complete homework and projects throughout the semester. *Mathematica* is available on many computers at Colby, including the computers in Mudd 415 and Olin 323. From Colby's fileserver you may also download and install *Mathematica* on your personal computer for use while on campus. Details will be distributed later.

Upon occasion you may also wish to make use of two other free pieces of software:

- *WolframAlpha* (wolframalpha.com) is a web-based computational knowledge engine. It can compute most of the integrals and evaluate

most of the limits which we will encounter in the course. It can be a bit tricky to use, so you will need think about whatever response it gives you.

- *Grapher* is software which comes bundled with every modern Macintosh. (It can be found under Utilities). It is very easy to use and can draw almost every imaginable type of 2 and 3 dimensional graph. (Including solutions to differential equations and vector fields.) I highly recommend it – it is particularly easy to use.

Evaluation: The numerical course grade will be a weighted average of the cumulative grades with weightings as follows:

25%	Weekly Homework	5%	Mathematical Engagement
10%	Term Project	10/15%	Exam 1
15%	Quizzes	10/15%	Exam 2
20%	Final Exam.		

The maximum of your scores for Exams 1 and 2 will count at 15% of your grade. The minimum of your scores on Exams 1 and 2 will count as 10% of your grade.

Caveat: earning less than 50% on all three exams, will result in a grade of "F" for the course.

Course letter grades will be assigned (subject to the above caveat) according to the following scale. Any curve will be determined at the end of the course according to the discretion of the instructor.

93 – 100 % A	90 – 93 % A-	87 – 90 % B+	83 – 87% B
80 – 83 % B-	77 – 80 % C+	73 – 77 % C	70 – 73% C-
67 – 70 % D+	63 – 67 % D	60 – 63 % D-	below 60% F

Homework: Homework is probably the most important part of this course – it's when you get to put into practice the concepts you've played with during class. Some of the homework questions may require you to explore some topic which we didn't discuss in class. The purpose of such questions is to help you develop the ability to read and learn mathematics on your own. If you go into a mathematical or scientific career, there will undoubtedly be times when you need to teach yourself some mathematics. If, however, all the homework problems fall into this category, you should check to make sure that you are working on the correct assignment.

Weekly homework will generally be due on Fridays and will always be posted on the course webpage. You are responsible for checking the webpage. If no homework assignment is posted, you should refresh the webpage on your browser and, if that doesn't work, email me to let me know. In the special circumstance that there is no new homework, the webpage will make note of that. If you will not be in class on the day that homework is due you should arrange to turn it in at my office or to have a friend bring it to class. Late homework may be penalized.

You should start the homework early, some problems will require multiple attempts and careful thought. If you are having substantial difficulty with a particular problem or the entire homework set you should email me or come to office hours. I am eager to help you!

You are encouraged to work with a partner on the homework, but all work should be your own. In other words, you may discuss particular problems but you may not copy someone else's solution. Doing so violates academic honesty. As the course progresses, the question of how much work to show will arise. I encourage you to use common sense. If the work pertains to concepts discussed in class or in the reading, you should show it. If the work requires substantial effort and thought, you should show it. If the work is simply evaluating an integral using methods learned in MA 121, you do not need to show it. If the work is simply elementary algebra, you do not need to show it (although showing it may help the grader follow your work). You may even use *Mathematica* or other software to evaluate the 1-variable integrals or derivatives that arise.

In general, your work is your answer. It is possible for someone to obtain a correct answer but to not receive full credit because their work is incorrect. Conversely, (almost entirely) correct work with an incorrect answer may receive full credit.

Homework must be very neat. This means: no messy scratchwork, no cramped writing, no huge eraser marks. Multiple pages should be stapled and the problems should be in order with section and problem number clearly indicated. If these guidelines are not followed you may be penalized. If you are incapable of writing neatly, you should type your solutions. LaTex is the most popular mathematical typesetting software, but you may also use programs like *Scientific Word* or *Mathematica*.

You will occasionally have a reading assignment due in class. These assignments will require that you do a certain amount of reading and answer one or two fairly easy questions. Usually the reading will cover material we have not yet or will not discuss in class. I will always assume that you have

done the reading by the time that it is due and will not regurgitate in class material you have read on your own.

Quizzes: You will be given a quiz at least once every two weeks and frequently once per week. Quizzes will be announced at least one day before they are given (possibly by email). If you are absent on the day a quiz is given, it may be made up within one week of when it was given. You are responsible for requesting a make-up quiz. The lowest quiz score will be dropped from the computation of the course grade.

Mathematical Engagement: Half of your "Mathematical Engagemen" grade will be based on your class participation. I expect that you will volunteer answers to questions posed to the class as a whole and that you will be prepared to make a contribution to the discussion if specifically called upon. In the event, that I call on you specifically you do not necessarily need to be able to answer the question I ask, but you should be prepared to give a partial answer, an intelligent guess, or to ask a relevant question. The other half of your "Mathematical Engagement" grade will be based on two activities designed to have you encounter mathematics outside the classroom. You can complete an activity in one of two ways:

(1) Attend a Mathematics/Statistics Colloquium or the IBM Public Lecture and write a page summarizing and reacting to the lecture. As colloquium co-organizer, I am particularly interested in your reaction.
(2) Read an article on reserve in the Library and write a page summarizing and reacting to the article.

Projects: In a group of 2 - 4 people you will complete a substantial project. The content of the project will be related to applications of course material to other scientific disciplines or to other mathematical ideas. The projects will require that you learn the relevant background, extract the most important points, write a summary of your findings and present your findings to the class. More details will be distributed later.

Exams: There will be two in-class exams and a final exam. Each exam is cumulative, although the final exam is "more cumulative". Exams will be designed to test your understanding of the course material, not just your computational abilities. You must understand, and communicate your understanding of the material. Computers, textbooks, notes, and other people may not be used on the exam. The in-class exams will be given on **March 17** and **April 16**. The final exam is during exam period **3** on **Wednesday, May 12** at **3:30 PM**. It may not be rescheduled for personal convenience (including airline reservations).