$$\mathbf{M}\cup\boldsymbol{\lambda\tau}\sqrt{-\mathbf{1}}\vee\Delta\mathbb{R}\sqrt{-\mathbf{1}}\boldsymbol{\alpha\beta\lambda\epsilon}\ \mathbb{C}\boldsymbol{\alpha\lambda}\subset\cup\boldsymbol{\lambda}\cup\int_{\textbf{June 30}}^{\textbf{August 12}}$$

COURSE SYLLABUS

Instructor: Andrew Spieker **Course E-mail**: multivariablecalc@gmail.com

My E-mail: spieker.a@husky.neu.edu **Course Website**: esp.mit.edu/Junction/multivar.html

Course Time: Monday through Thursday from 5:00 – 7:00 PM **Location**: 5-217

As you know, or could guess, multivariable calculus extends what you learned in single variable calculus to higher dimensions. As so many things in our world depend on more than one variable, the study of multivariable calculus opens many new doors to physical and practical applications, including the four laws that govern electricity and magnetism. You will find that the first half of this course (namely the material on differential calculus and integral calculus) will have a very similar flavor to what you covered in single variable calculus. The second half of the course focuses on calculus on paths and surfaces in space, and paths and surfaces in vector fields; this will lack that familiar flavor you'll have grown to enjoy. We will culminate with a beautiful way of capturing the fundamental theorem of calculus in arbitrary dimensions, known as the generalized Stokes' Theorem.

ASSIGNMENTS

Homework: There will be fifteen homework assignments. Each homework sheet will contain two sections; the first section will consist of required problems which are to be written out with all work shown, stapled together, and handed in on the due date. The second section consists of extra problems; these are not to be handed in, but may serve as practice for quizzes and mathematical amusement.

Problem Sets: There will be three "problem sets" in which you will wrestle with new concepts. This is a chance for you to develop mathematical independence in preparation for your project.

Final Project: Throughout the course, you will work on a mathematical project of your choice (and approved by me.)

Tests: There will be four tests; each will last about an hour. Topical review sheets will be given—the extra problems on your homework assignments serve as practice problems.

GRADES

If you wish to receive a final letter grade from me in an acceptable form for high school or college credit/exemption from a course, see me as soon as possible so that can be arranged. I intend to weigh the assessments in the following way to compute your average.

Homework – 15%	Tests/Quizzes – 40%	Attendance – 10%
Problem Sets – 15%	Final Project – 15%	Participation – 5%

If S is your score computed by the percentages above, then your letter grade is represented below:

Lower Bound	$55 \leq S$	$60 \leq S$	$65 \leq S$	$70 \leq S$	$75 \leq S$	$80 \leq S$	$85 \leq S$	$90 \leq S$	$95 \leq S$
Upper Bound	$S < 60$	$S < 65$	$S < 70$	$S < 75$	$S < 80$	$S < 85$	$S < 90$	$S < 95$	$S < \infty$
Letter Grade	$C-$	C	$C+$	$B-$	B	$B+$	$A-$	A	$A+$

EXPECTATIONS

You can expect me to…	**I expect you to…**
-Show up to class, on time, and prepared to teach.	-Have taken and mastered ($\geq$ B– on average) one semester of single variable calculus.
-Grade assignments in a timely fashion.	-Show up to class on time, ready to learn.
-Respond to your e-mails in a timely fashion.	-Hand in assignments on time.
-Have a to-date grade calculated for you at any given time.	-Have a graphing calculator.
-Discuss a grade with you before and after class, or via e-mail.	-Speak up if you are having trouble. In the words of Professor Albus Dumbledore, you will find that help will always be given to those who *ask* for it!
-Be willing to answer your questions about things you don't understand in class.	-Actively participate in classroom activities.
-Be polite and respectful to each other, to you, to the classroom, and the property.	-Be polite and respectful of each other, me, the classroom, and the property.
-Make you feel safe in the classroom.	-Be safe in the classroom.

Most importantly, I expect that this will be a fun and exciting journey for all of us!

POLICIES

Attendance: Please do not miss class. Each class period amounts to a whole week of material; consequently, students are expected to have a justifiable reason to not be in class.

Extra Help: You may always feel free to e-mail either the course e-mail address or my school e-mail address. I will be happy to help. In addition to that, I will also be posting web videos with my good friend Mike Garcia, with whom I have taught classes before. Having examples to watch outside of class with another person's perspective is a wonderful way to get extra help, so you should definitely take advantage of that opportunity. Furthermore, lecture notes will be posted on our website.

Late Work: Late homework and problem sets will generally not be accepted, unless you have a reason I consider to be justifiable. There will be no make-ups for in-class tests as solutions will go up on our website right after class.

Academic ~~Integration~~ Integrity: It is okay to use other sources for homework and problem sets as long as you understand the material and give a reference to the source—i.e., website URL, or book/author. I have a general idea of textbook language, so I'll pretty much know if you're using outside material—no, I won't be mad if you use an outside source, but you have to tell me what you're doing! The same goes if you work in groups—you should include the names of the students with whom you worked.

And while we're on the subject of academic integrity, I'll just point out that I've taught many a class for ESP, and no one has ever cheated in my classroom before. It would be really, really embarrassing for you if you were first one to do it. That won't happen though—I anticipate no problems.

Topical Course Outline*
(By Week and Day)

Week 1: Understanding the language and structure of three dimensions

Wednesday, June 30:	Vectors and the dot product Matrices, the determinant, and the cross product of vectors
Thursday, July 1:	Vector-valued functions; parametric equations, polar coordinates

Week 2: Describing surfaces; understanding local behavior of functions of many variables

Monday, July 5:	Equations and representations of lines, planes, and surfaces in space
Tuesday, July 6:	Multivariable functions; their graphs and representations Limits and continuity
Wednesday, July 7:	The definition of the partial derivative Finding and interpreting the partial derivative; second/mixed partials
Thursday, July 8:	Tangent planes and linear approximations

Week 3: Rate of change in any direction; understanding extreme behavior of functions of many variables

Monday, July 12:	The multivariable chain rule and implicit functions
Tuesday, July 13:	The gradient vector and directional derivatives
Wednesday, July 14:	Finding and classifying extreme values of functions
Thursday, July 15:	Lagrange multipliers

Week 4: Multiple integrals in various coordinate systems

Monday, July 19:	Double integrals
Tuesday, July 20:	Double integrals over general regions and in polar coordinates
Wednesday, July 21:	Triple integrals
Thursday, July 22:	Cylindrical and spherical coordinates Triple integrals in cylindrical and spherical coordinates

Week 5: Contour integrals in the plane and in space; surface integrals in space; vector fields

Monday, July 26:	Arc length & contour integrals in the plane and in space
Tuesday, July 27:	Surface area & surface integrals in space
Wednesday, July 28:	Functions from $\mathbb{R}^2 \to \mathbb{R}^2$ and $\mathbb{R}^3 \to \mathbb{R}^3$; vector fields Contour integrals in vector fields
Thursday, July 29:	NO CLASS!!! Enjoy the long weekend ☺

Week 6: Vector fields; contour and surface integrals in vector fields

Monday, August 2:	The Fundamental Theorem for contour integrals Flow and Flux
Tuesday, August 3:	Green's Theorem in the plane
Wednesday, August 4:	Surface integrals in vector fields The Divergence Theorem
Thursday, August 5:	Stokes' Theorem

Week 7: Enrichment Material, Project Presentations, and Course Summary

Monday, August 9:	Short Topic – Maxwell's equations Project presentations
Tuesday, August 10:	Short Topic – Differential Calculus for Mappings from $\mathbb{R}^m \to \mathbb{R}^n$ Project Presentations
Wednesday, August 11:	Short Topic – The Inverse and Implicit Function Theorems Project Presentations
Thursday, August 12:	Last Day ☺ / ☹ Review of Course (Summary) Course Evaluations and Reflection

*This is a suggested outline; I will speed up or slow down with the material as necessary. It will be *my* responsibility to inform you of changes by announcing them in class, writing the changes explicitly on the board, and by updating a copy of this outline and posting it. It will be *your* responsibility to keep up with any changes that may occur, even if you are absent from class.

Important Dates (Tests, Problem Sets, Project)

Tests	Date	Topics Covered (Everything from…)
1	Class 6—Thursday, 7/8	Wednesday, June 30 to Wednesday, July 7
2	Class 11—Monday, 7/19	Thursday, July 8 to Wednesday, July 14
3	Class 19—Tuesday, 8/3	Thursday, July 15 to Tuesday, July 27
4	Class 23—Tuesday, 8/10	Monday, August 2 to Monday, August 9

PSets	Due Date	Topic
1	Class 7 – Monday, 7/12	Metric Spaces
2	Class 17 – Wednesday, 7/28	Coordinate changes and applications to integration
3	Class 24 – Tuesday, 8/10	Differential forms and the generalized Stokes' Theorem

Project Component	Date	Description
1	Class 7 – Monday, 7/12	Project proposal due
2	Classes 23, 24, 25… Monday, 8/9–Thursday, 8/12	Presentations!