MATH 211: Multivariable Calculus

Fall 2016

Instructor: Dr. Benjamin Purkis

MWTF 12:00-12:50pm, Seney Hall 208

Instructor Information:

Email: benjamin.purkis@emory.edu
Office: Pierce 121
Office Hours: Thursday 2-4 or by appointment; drop-ins are encouraged!
Drop-in policy: If my office door is open, you are always welcome to come in and ask whatever questions you may have. If my office door is closed, you are welcome to knock; I may answer, but I may also ask that you come back at another time. The best way to see me is to come during office hours or email me to set up an appointment.

Course Information and Policies:

Description: Roughly speaking, calculus is the mathematics of *change*. In particular, calculus is a powerful tool for understanding change in physical quantities and phenomena that *depend on*, or are *related to*, each other. The dependence of a given quantity upon another (or others) is often described mathematically by a *function*. Thus, the heart of calculus *is* the study of functions, and how they change. Differential calculus studies the instantaneous change of a function as quantities vary, and integral calculus measures the cumulative effect of the change of a function.

Course Objectives: At the end of this course, students will be able to...

- Evaluate limits of, differentiate, and integrate multivariable functions.
- Apply these processes of multivariable calculus to solving a variety of problems.
- Visualize and analyze complex three-dimensional shapes and surfaces.
- Better understand the topics from single-variable calculus.
- Generalize concepts from single-variable calculus to higher dimensions.

Textbook: *Vector Calculus*, 4th Edition, by Susan Jane Colley
Software: *Mathematica*. Instructions for obtaining Mathematica are available at `it.emory.edu/software/mathematica_access%20.html`.

Content: We will cover chapters 1-7 of the textbook, including:

1. **Vectors** - We will introduce three-dimensional space and the concept of vectors, including dot and cross products. Vector functions will be utilized to describe curves and surfaces in 3-space. We will also consider functions of several variables.

2. **Partial Derivatives** - We will extend the familiar concept of derivative into 3-space by considering partial derivatives. We will briefly consider limits and continuity in 3-space, as well as applications of partial derivatives, including tangent planes, directional derivatives and the gradient, and optimization in multiple variables.

3. **Multiple Integration** - We will extend integration to 3-space by considering double, triple, and iterated integrals. Topics include alternate coordinate systems for 2- and 3-space, namely polar, cylindrical, and spherical coordinates, as well as change of variables to arbitrary coordinate systems.

4. **Vector Calculus** - As time permits, we will examine several versions of the Fundamental Theorem of Calculus for multiple dimensions, including Green's Theorem, Stokes' Theorem, and Gauss's Theorem. Along the way we will see related topics such as vector fields, parametrized surfaces, line and surface integrals, and curl and divergence.

Structure: There will be two types of class days in this course:

- **Material:** On material days (usually Mondays, Wednesdays, and Fridays), I will lecture for 20 to 25 minutes on one or more sections from the textbook; afterwards, you will split into your teams for the remainder of the period and work on assigned worksheets.
- **Quizzes:** Thursday class periods will be devoted to team quizzes, where you must work together with your team to complete a quiz in the allotted class time.

Course Expectations:

Grading: Quizzes and exams will be graded based on *correctness*, *completeness*, and *legibility*. Your grade for this course will be calculated as follows:

Team Quizzes: Best 10 of 11 quizzes at 20 points each	200 points
Practice Worksheets: Calculated as a percentage	80 points
Graphing Portfolio:	120 points
Midterms: Two exams at 120 points each	240 points
Final Exam:	160 points
Total:	800 points

Grades will be assigned by the following scale:

A	≥ 740	A-	716-739	B+	692-715
B	660-691	B-	636-659	C+	612-635
C	580-611	C-	556-579	D+	532-555
D	476-531			F	≤ 475

Classes: While attendance will not be taken directly, it is essential that you come to class on time every day, *having read the sections to be covered.* Your ability to get the most out of a class lecture is greatly hampered if you are not prepared. Calculus is a class that builds on itself very quickly, so if you miss even one class period, you can get behind very quickly. You are responsible for all the material covered in class, even if you are absent.

Teams: On the second day of class, you will be assigned to a team of four or five of your classmates. You will work with this team every day in class, and are encouraged to work with them outside of class as well! Teams will receive the same score on quizzes (see below), so make sure you are prepared!

Practice Worksheets: Every day in class, your team will be assigned a practice worksheet. These worksheets will contain practice exercises to help build your skills and understanding of the topics covered in class that day. You should do four things with these worksheets:

1. In class, work on and discuss the problems with your teammates. You will likely not finish the worksheet, but see if you can come up with a plan of attack for each problem, and perhaps finish a few of them.
2. That night, make sure you have attempted each problem once. You are welcome to collaborate with your team members still, but try to work the problems through on your own. You do *not* have to get every problem correct!
3. Compare your answers with the solution key on the class website. In a different color than you wrote in, mark the problems you got right and wrong, and for those you got wrong, write a short note about where you went wrong.
4. Hand in your self-checked worksheet at the beginning of the next class period. These worksheets will be graded for completion; namely, did you attempt each problem, and did you check your work appropriately?

Calculators may be used where appropriate, but be aware that they are *not* allowed on quizzes or exams. Therefore you should not be dependent on a calculator! Keep in mind the end goal is for you to be able to solve problems unaided by notes, the textbook, a calculator, or other people. In general, you should spend at least 8 hours a week on study, not counting the time spent in class or reviewing for tests.

Quizzes: All quizzes will take place on Thursdays. Each team will get a single copy of the quiz, and will receive the same score on that quiz. Quizzes will be worth 20 points, and the best 10 out of 11 total quizzes will count towards your score. All quizzes are closed book and notes, and *calculators are banned.*

Graphing Project: Each student will prepare a portfolio of at least 2 three-dimensional images created with *Mathematica*. The portfolio should exhibit all the types of graphs encountered in the course: Cartesian coordinates, polar/cylindrical coordinates, spherical coordinates, parametrized curves, and parametrized surfaces. A screen cast that can help you get started is located at
`http://www.wolfram.com/broadcast/screencasts/abbybrown/3D_Graphing/`.

Exams: You will have two midterm exams and a cumulative final exam this semester. Your exam dates are:

- Midterm 1: **Thursday, October 6th from 6-8pm**
- Midterm 2: **Thursday, November 10th from 6-8pm**
- Final Exam: **Tuesday, December 13th at 7pm**

Midterm exams are not cumulative and are held in the evening on the specified day. Should you have a conflict with the evening exam times, let me know **in advance** and we will arrange an alternate time. The final exam will be cumulative. All exams are closed book and notes, and *calculators are banned.*

Other Information and Policies:

Makeups: In general, makeups are not allowed for exams or assignments. However, if you have a valid reason for a makeup exam, inform me as soon as possible. Valid reasons include medical emergency, a death in the family, or religious observations. Extensions will only be granted for emergency situations.

A Word on Technology: Please leave all iPods, MP3 players, netbooks, etc. stowed and off for the duration of the class. Cell phones should be silenced. Return all seats and tray tables to the upright and locked position.

Honor Code: The Honor Code of Oxford College applies to all work submitted for credit in this course. In order to receive credit for your work, you must place your name on it. By placing your name on submitted work, you pledge that the work has been done in accordance with the given instructions and that you have witnessed no Honor Code violations in the conduct of the assignment.

Academic Accommodations: Access, Disability Services and Resources (ADSR) works with students who have disabilities to provide reasonable accommodations. In order to receive consideration for reasonable accommodations, students must contact ADSR and complete the registration process. Faculty may not provide disability accommodations until an accommodation letter has been processed; accommodations are not retroactive. Students registered with ADSR who receive a letter outlining specific academic accommodations are strongly encouraged to coordinate a meeting time with their professor to discuss a protocol to implement the accommodation as needed throughout the semester. This meeting should occur as early in the semester as possible. Contact Access, Disability Services and Resources for more information at (770) 784-4690 or `adsroxford@emory.edu`. Additional information is available at the ADSR website at
`http://equityandinclusion.emory.edu/access/students/index.html`.

Religious Holidays: Instructors are encouraged, not required, to accommodate students' academic needs related to religious holidays. Please make every effort to negotiate your

religious holiday needs within the first two weeks of the semester; waiting longer may compromise your instructor's ability to extend satisfactory arrangements. If you need guidance negotiating your needs related to a religious holiday, the College Chaplain, Rev. Lyn Pace, `ppace@emory.edu`, Candler Hall 202, is willing and available to help.

**Please be aware that Rev. Pace is not tasked with excusing students from classes or writing excuses for students to take to their professors.*

Emory's official list of religious holidays may be found at:
`http://www.religiouslife.emory.edu/faith_traditions/holidays.html`.

This syllabus is a guide for effective learning in this class; it is not a legal contract. The instructor reserves the right to modify the syllabus as needed.

Tentative Course Schedule: This schedule is tentative in the sense that, while the topics covered for the course are fixed, the specific topics and activities on a given day may vary.

Unit 1: Vectors, Multivariable Functions, and Partial Derivatives

Date	Topics	Sections
Wed, Aug 24	Vectors	1.1
Thu, Aug 25	Team Assignments; Introduction to *Mathematica*	
Fri, Aug 26	Parametrizations	1.2
Mon, Aug 29	The Dot Product and Applications	1.3
Wed, Aug 31	The Cross Product and Applications	1.4
Thu, Sep 1	**Team Quiz 1**	1.1-1.3
Fri, Sep 2	Equations for Planes	1.5
Mon, Sep 5	*Labor Day Holiday*	
Wed, Sep 7	Distance Problems	1.5
Thu, Sep 8	**Team Quiz 2**	1.4-1.5
Fri, Sep 9	n-dimensional Geometry	1.6
Mon, Sep 12	New Coordinate Systems	1.7
Wed, Sep 14	Functions of Several Variables	2.1
Thu, Sep 15	**Team Quiz 3**	1.6-1.7
Fri, Sep 16	Limits	2.2
Mon, Sep 19	Limits and Continuity	2.2
Wed, Sep 21	The Partial Derivative	2.3
Thu, Sep 22	**Team Quiz 4**	2.1-2.2
Fri, Sep 23	Differentiability	2.3
Mon, Sep 26	Higher-order Partial Derivatives	2.4
Wed, Sep 28	The Chain Rule	2.5
Thu, Sep 29	**Team Quiz 5**	2.3-2.5
Fri, Sep 30	Directional Derivatives	2.6
Mon, Oct 3	Paths and Parametrized Curves	3.1
Wed, Oct 5	Review for Exam 1	
Thu, Oct 6	Review; **Midterm Exam 1, 6pm**	Ch. 1-2

Unit 2: Vector Fields, Optimization, and Integration

Date	Topics	Sections
Fri, Oct 7	Differential Geometry	3.2
Mon, Oct 10	*Fall Break*	
Wed, Oct 12	Vector Fields	3.3
Thu, Oct 13	**Team Quiz 6**	3.1-3.3
Fri, Oct 14	The Del Operator, Divergence, and Curl	3.4
Mon, Oct 17	Taylor's Theorem and Differentials	4.1
Wed, Oct 19	Optimization	4.2
Thu, Oct 20	**Team Quiz 7**	3.4, 4.1
Fri, Oct 21	Optimization	4.2
Mon, Oct 24	Lagrange Multipliers	4.3
Wed, Oct 26	Intro to Multiple Integration; Double Integrals	5.1-5.2
Thu, Oct 27	**Team Quiz 8**	4.2-4.3
Fri, Oct 28	Double Integrals; Changing Order of Integration	5.2-5.3
Mon, Oct 31	Triple Integrals	5.4
Wed, Nov 2	Jacobians and Change of Variables	5.5
Thu, Nov 3	**Team Quiz 9**	5.1-5.4
Fri, Nov 4	Integrals in Other Coordinate Systems	5.5
Mon, Nov 7	Mass Integrals	5.6
Wed, Nov 9	Review for Exam 2	
Thu, Nov 10	Review; **Midterm Exam 2 at 6pm**	Chs. 3-5

Unit 3: Vector Calculus

Date	Topics	Sections
Fri, Nov 11	Scalar and Vector Line Integrals	6.1
Mon, Nov 14	Green's Theorem	6.2
Wed, Nov 16	The FTC for Line Integrals	6.3
Thu, Nov 17	**Team Quiz 10**	6.1-6.2
Fri, Nov 18	Conservative Vector Fields	6.3
Mon, Nov 21	Parametrized Surfaces	7.1
Wed, Nov 23	*Thanksgiving Holiday*	
Thu, Nov 24	*Thanksgiving Holiday*	
Fri, Nov 25	*Thanksgiving Holiday*	
Mon, Nov 28	Surface Integrals and Surface Area	7.2
Wed, Nov 30	Flux Integrals	7.2
Thu, Dec 1	**Team Quiz 11**	7.1-7.2
Fri, Dec 4	Stokes' and Gauss' Theorems	7.3
Mon, Dec 7	Geometric Divergence and Curl; The Holistic FTC	
Tue, Dec 13	**Final Exam at 7pm**	Ch. 1-7