MATH 211: Multivariable Calculus

Spring 2017

Instructor: Dr. Benjamin Purkis

MWF 1:15-2:20pm, Humanities Hall 206

Instructor Information:

Email: benjamin.purkis@emory.edu
Office: Modular Unit, Quad Side
Office Hours: Tuesday 3-5 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, you will be able to...

- Understand, visualize, and describe objects in three dimensions.
- Analyze these objects using the techniques of calculus.
- Compare, contrast, and connect the techniques of multivariable calculus to those of single-variable calculus.
- Apply the techniques of vector calculus to solve real-life problems.
- Work independently and with others to solve complex problems through organized critical thinking.

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: Class periods in this course are generally split into two parts:

- **Lecture:** For the first 30 or so minutes of each class period, I will highlight important topics from the sections or material to be covered that day.
- **Group Work:** The remainder of the class time will be devoted to group work with your assigned team. Once a week this will be a group quiz; the other days these will be practice worksheets.

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: 10 quizzes at 20 points each	200 points
Practice Worksheets: Calculated as a percentage	100 points
Graphing Portfolio:	125 points
Midterms: Three exams at 125 points each	375 points
Final Exam:	200 points
Total:	1000 points

Grades will be assigned by the following scale:

A	≥ 925	A-	895-924	B+	865-894
B	825-864	B-	795-824	C+	765-794
C	725-764	C-	695-724	D+	665-694
D	595-664			F	≤ 594

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: Quizzes will generally take place on Wednesdays. 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 no quizzes may be dropped; however, quizzes may contain bonus points in some cases. All quizzes are closed book and notes, and *calculators are banned.*

Graphing Project: Each student will prepare a portfolio of 3 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 three midterm exams and a cumulative final exam this semester. Your exam dates are:

- Midterm 1: **Thursday, February 9th from 8-10am**
- Midterm 2: **Thursday, March 23rd from 8-10am**
- Midterm 3: **Thursday, April 20th from 8-10am**
- Final Exam: **Wednesday, April 26th from 9am-12pm**

Midterm exams are not cumulative and are held in the morning on the specified day. Should you have a conflict with the morning 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: Living in Three Dimensions

Date	Topics	Tests	Sections
Wed, Jan 11	Coordinate Systems		1.7
Fri, Jan 13	Functions of Several Variables		2.1
Mon, Jan 16	*Martin Luther King, Jr. Holiday*		
Wed, Jan 18	Vector Operations	**Quiz 1**	1.1, 1.3, 1.4
Fri, Jan 20	Applications of Dot and Cross Products		1.3, 1.4
Mon, Jan 23	Parametrizations		1.2, 7.1
Wed, Jan 25	Quadric Surfaces	**Quiz 2**	1.7
Fri, Jan 27	Plane Equations and Distance Problems		1.5
Mon, Jan 30	n-dimensional Geometry		1.6
Wed, Feb 1	Calculus of Paths	**Quiz 3**	3.1
Fri, Feb 3	Differential Geometry		3.2
Mon, Feb 6	The Moving Frame		3.2
Wed, Feb 8	Review		1.1-1.7, 3.1, 3.2, 7.1
Thu, Feb 9	**Exam 1 - 8am**	**Exam 1**	1.1-1.7, 3.1, 3.2, 7.1

Unit 2: Calculus in Three Dimensions

Date	Topics	Tests	Sections
Fri, Feb 10	Limits		2.2
Mon, Feb 13	Continuity		2.2
Wed, Feb 15	Partial Derivatives	**Quiz 4**	2.3, 2.4
Fri, Feb 17	Chain Rule		2.5
Mon, Feb 20	Directional Derivatives and the Gradient		2.6
Wed, Feb 22	Taylor's Theorem and Differentials	**Quiz 5**	4.1
Fri, Feb 24	Optimization		4.2
Mon, Feb 27	Optimization and Lagrange Multipliers		4.2, 4.3
Wed, Mar 1	Iterated and Double Integrals	**Quiz 6**	5.1, 5.2
Fri, Mar 3	Graphing Portfolio Day	**Portfolio**	
Mar 6-10	*Spring Break*		
Mon, Mar 13	Changing Order of Integration		5.3
Wed, Mar 15	Triple Integrals		5.4
Fri, Mar 17	Jacobians and Change of Variables	**Quiz 7**	5.5
Mon, Mar 20	Mass Integrals		5.6
Wed, Mar 22	Review		2.2-2.6, 4.1-4.3, 5.1-5.5
Thu, Mar 23	**Exam 2 at 8am**	**Exam 2**	2.2-2.6, 4.1-4.3, 5.1-5.5

Unit 3: Vector Calculus

Date	Topics	Tests	Sections
Fri, Mar 24	Vector Fields		3.3
Mon, Mar 27	The Del Operator, Div and Curl		3.4
Wed, Mar 29	Conservative Vector Fields	**Quiz 8**	6.3
Fri, Mar 31	Scalar and Vector Line Integrals		6.1
Mon, Apr 3	Green's Theorem		6.2
Wed, Apr 5	The FTC for Line Integrals	**Quiz 9**	6.3
Fri, Apr 7	Parametrized Surfaces and Surface Area		7.1
Mon, Apr 10	Surface Integrals		7.2
Wed, Apr 12	Flux Integrals	**Quiz 10**	7.2
Fri, Apr 14	Stokes' Theorem		7.3
Mon, Apr 17	Gauss's Theorem		7.3
Wed, Apr 19	Review		3.3-3.4, Ch.6, Ch.7
Thu, Apr 20	**Exam 3 at 8am**	**Exam 3**	3.3-3.4, Ch.6, Ch.7
Fri, Apr 21	Geometric Div & Curl; The Holistic FTC		
Mon, Apr 24	Review for Final Exam		Chapters 1-7
Wed, Apr 26	**Final Exam at 9am**	**Final Exam**	Chapters 1-7