Emory University Department of Mathematics & CS
Math 211 Multivariable Calculus
Spring 2012

Instructor:	Dr. Asher Auel	**Office:**	MSC W425
Room:	MSC W301	**Time:**	Tue Thu 10:00 - 11:15 am
Text:	*Calculus: Multivariable, 5th ed.*, McCallum, Hughes-Hallet, Gleason, et al., John Wiley & Sons, 2008. ISBN: 978–0470–13158–9		
Web-site:	`www.mathcs.emory.edu/~auel/courses/211s12/`		

Introduction: Calculus is the study of rates of change (derivatives) and rates of accumulation (integrals). A "fundamental theorem" of calculus is any statement relating these two rates.

For example, in single variable calculus, if $f : \mathbb{R} \to \mathbb{R}$ is a real valued differentiable function, then the derivative $f'(a)$ at a is the slope of the tangent line of the graph of f at $x = a$. So, the derivative f' thought of as a real valued function of x, measures the "rate of change" of the slope of the tangent line of the graph of f. The definite integral $\int_a^b f$ is the area under the curve of the graph of f from a to b. So, the function $x \mapsto \int_0^x f$ measures the "rate of accumulation" of the area under the graph of f. One of the fundamental theorems of (single variable) calculus states that $\int_0^x f' = f(x) - f(0)$, i.e. that the rate of accumulation of the rate of change of the tangent line of f is measured by the function f itself.

Many real world problems cannot be modeled by single variable functions and must be modeled by multi-variable functions. For example, the function $f(x, y)$ that takes a latitude x and a longitude y and outputs the elevation of the point (x, y) on the earth. But now what is the "rate of change" of f? We can now measure it in many ways, namely, along different paths, and the rate of change is the "steepness" of the ascent or descent along that path. This is the notion of *directional derivative.* All the directional derivatives can be packaged together into the *total derivative* , which measures the change of the tangent plane (a multi-dimensional version of the tangent line). What is the "rate of accumulation" of f? We can also measure it in many ways, along different paths (line integrals), and also along solid regions (multiple integrals). The relationship between rates of change and rates of accumulation is the subject of Green's Theorem, the Divergence Theorem, and Stokes' Theorem.

On the way, we'll study the geometry of curves, surfaces, and solids in 2- and 3-space, multi-variable functions (vector fields) on them, tangent planes, techniques of multi-variable differentiation and integration, and applications to real world problems.

Grading: Your final grade will be calculated according to the table at right. Notice that more emphasis is placed on exams than on weekly homework assignments. On the other hand, completing your homework on a weekly basis is the most sure way to succeed on exams.

Homework	25 %
Quizzes	9 %
Midterm 1 (Tue 21 Feb)	18 %
Midterm 2 (Tue 05 Apr)	18 %
Final Exam (Tue 08 May)	30 %
Extra Credit	5 %

Exams: There will be 3 short quizzes spread throughout the semester. The date of each quiz will be announced three days in advance. Midterms 1 and 2 will be held in class on Tuesday 21 February and Tuesday 03 April. The final exam will be held at 8:30-11:00 am on Tuesday 08 May, 2012. Make-up exams/quizzes may only be scheduled in case of health/family emergencies or religious holidays (in which case they must be scheduled *before the exam*). The use of electronic devices during exams is strictly forbidden and anyway pointless. Unless otherwise stated, you will always need to show your work on exams.

Homework: You will be assigned a weekly problem set, which is due to the mathematics department mail box of Anastassia Etropolski, no later than 4:00 pm on Friday. There will be nothing due the Fridays following the midterm exams. The problem set will be posted on the course web-site

the Wednesday of the week before it's due. Your lowest problem set score will be dropped from your final grade calculation.
Late or improperly submitted homework will not be accepted. Period. If you know in advance that you will be unable to submit your homework at the correct time and place, you must make special arrangements ahead of time (e.g. for religious holidays).

Even if you haven't completed all the homework problems for the week, it is advisable to hand in what you have. A selection of problems with complete solutions is preferable to shaky and poorly written-up solutions to all the problems. Your homework must be stapled, with your name and the date clearly written on the top. Consider (as you would for any other class) the pieces of paper you turn in as a final copy: written neatly and straight across the page, on clean paper, with nice margins, lots of space, and well organized. *If it's not readable, it won't be graded.* You should stongly consider starting with a rough draft. You need to show your work.

Group work, honestly: Working with other people on mathematics is not only allowable, but is highly encouraged and fun. You may work with anyone (other students in the course, students not in the course, tutors, bums on the street) on the rough draft of your problem sets. If done right, you'll learn the material better and more efficiently working in groups. The golden rule is:

> you may work with anyone on *solving* your homework problems,
> but you must *write* up your final draft by yourself.

Writing up the final draft is as important a process as figuring out the problems on scratch paper with your friends. Mathematical writing is very idiosyncratic – it is easy to tell if papers have been copied – just don't do it! In particular, it's in violation of the Emory College Honor Code. You will not learn by copying solutions from others! Also, if you work with people on a particular assignment, you *must list your collaborators at the top of the paper*, as well as any resources (e.g. Wikipedia) used beside the text book. Make the process fun, transparent, and honest.

Prerequisites: You must have a strong foundation in algebra, geometry, and single variable calculus to succeed in this course: vectors (coordinates, magnitude), trigonometry (trig functions, unit circle, angle formulas), area/volume, graphs of standard functions ($x^2, 1/x, \ln x, e^x, \cos\theta, \sin\theta$), solving linear equations, differentiation (chain rule, quotient rule), integration (by parts, substitution), fundamental theorems of calculus, analysis of critical points, equations of tangent lines.

Topics covered: Subject to change.

(1) Introduction, review of single variable calculus, vectors, affine space, multi-variable functions, linear functions, matrices. *Calculus: Multivariable, 5th ed* (CM) 12.1,4, 13.1,2.
(2) Geometry of 3-space ($\cdot$ and $\times$ products), equations for lines and planes, graphs, level-sets, limits and continuity, parametrized curves. CM 12.3,5,6, 13.3,4. 17.1,2.
(3) Partial/directional derivatives, gradients, total derivatives, tangent planes. CM 14.1–5.
(4) Velocity/acceleration, arc length, vector fields, line integrals, work. CM 17.1–3, 18.1,2.
(5) Conservative/path-independent/gradient fields, Green's theorem. CM 18.3,4.
(6) Multiple integrals, Fubini's theorem, order of integration, midterm. CM 16.1–3.
(7) Chain rule, change of variables formula, polar/cylindrical/spherical coordinates. CM 14.6, 16.4,5,7.
(8) Examples of change of coordinate systems. CM 16.4,5,7.
(9) Parametrized surfaces, conic surfaces, surface integrals. CM 17.5, 19.1.
(10) Flux, divergence, and curl of vector fields, midterm. CM 19.1, 20.1,3.
(11) Examples of surface integrals. CM 19.2,3.
(12) Divergence theorem, spherically symmetric vector fields, examples. CM 20.1,2.
(13) Stokes' theorem. CM 20.4,5.

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