Math 251 Sections 31-33: Multivariable Calculus

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Office Hours: W 9-10, F 1-2 over Zoom via Canvas integration

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Location and Time: Lecture: MW 2:00-3:20 pm in Hill 116. Recitations: T SEC-220 (Section 31 3:50-5:10, Section 32 5:40-7:00, Section 33 7:30-8:50).

Coordinated Course Syllabus: https://math.rutgers.edu/academics/undergraduate/course-descriptions/949-01-640-251-multivariable-calculus

Prerequisites: Calculus 2 (Math 152, 154, or 192)

Notes: My folder of lecture notes for this course is accessible from the front page of Canvas. Typically notes will appear at least a few hours before lecture, and be updated with any typo corrections or other changes shortly afterward.

Textbook and MyLab: The text for the course is *Calculus, Early Transcendentals, 15th* Edition by Hass, Heil and Weir (ISBN: 978-0137559756). An electronic edition of the text is provided through the online homework system MyLab, to which you must purchase access. Acquisition of a physical copy of the text is optional.

- ⇨ You will be able to access your MyLab course directly through the Canvas site for our course.
- ⇨ In the Canvas site, navigate to Access Pearson and follow the on-screen instructions to create a Pearson account or link an existing Pearson account to your Canvas account.
- ⇨ You will then automatically be enrolled in the MyLab course.

Topics: We will cover the following topics:

- ⇨ Ch. 12: Vectors and Space Geometry [12.1, 12.2, 12.3, 12.4, 12.5, 12.6]
- ⇨ Ch. 13: Vector-Valued Functions and Motion in Space [13.1, 13.2, 13.3]
- ⇨ Ch. 14: Partial Derivatives [14.1, 14.2, 14.3, 14.4, 14.5, 14.6, 14.7, 14.8]
- ⇨ Ch. 15: Multiple Integrals [15.1, 15.2, 15.3, 15.4, 15.5, 15.7, 15.8]
- ⇨ Ch. 16: Integrals and Vector Fields [16.1, 16.2, 16.3, 16.4, 16.5, 16.6, 16.7, 16.8]

Exams: There will be eighty-minute in-class midterms on **Wednesday October 8** and **Wednesday November 12**. There will also be a final exam at a time and date scheduled by the registrar, likely Monday December 15.

Assignments: Assignments in this course take the following forms.

- Electronic homework assignments in MyLab. Full credit on the MyLab assignments is eighty percent of the problems completed correctly over the span of the course. Assignments will typically be due one week after we cover the corresponding material during class.

- Recitation worksheets, to be completed during recitation section. There will be ten recitation worksheets, and your eight best scores will count.
- Canvas assignments, typically of a more conceptual nature. These assignments will typically be due every other Friday.

Projected Calendar:

Week	M	T	W	Th	F
Sept 1-5		(Optional)	12.1, 12.2		
Sep 8-12	12.3	Worksheet 1	12.4		
Sep 15-19	12.5	Worksheet 2	12.5, 12.6		Canvas Assignment 1
Sep 22-26	13.1	Worksheet 3	13.2, 13.3		
Sep 29-Oct 3	14.1	Worksheet 4	14.2		Canvas Assignment 2
Oct 6 – Oct 10	14.3,14.4	Exam Review	Midterm 1		
Oct 13-17	14.5	Worksheet 5	14.6		Canvas Assignment 3
Oct 20-24	14.7	Worksheet 6	14.8		
Oct 27-Oct 31	15.1, 15.2	Worksheet 7	15.2, 15.3		Canvas Assignment 4
Nov 3- Nov 7	15.4	Worksheet 8	15.8		
Nov 10-14	15.5, 15.7	Exam Review	Midterm 2		
Nov 17-21	15.7	Worksheet 9	16.1, 16.2		Canvas Assignment 5
Nov 24-28	16.2, 16.3	Th Schedule	F Schedule		
Dec 1-5	16.4	Worksheet 10	16.5, 16.6		Canvas Assignment 6
Dec 8-12	16.7	Exam Review	16.8		
Dec 15-19	Common Final – Scheduled by Registrar				

Grading Criteria: Your grade will be computed using two "tracks"; you will receive whichever of the two scores is higher.

Grade Category	Weight – Track 1
Recitation Worksheets	10%
Canvas Assignments	5%
MyLab Assignments	5%
Midterm 1	24%
Midterm 2	24%
Final	32%

Grade Category	Weight – Track 2
Recitation Worksheets	10%
Canvas Assignments	5%
MyLab Assignments	5%
Midterm 1	20%
Midterm 2	20%
Final	40%

Letter Grade Cutoffs: Students will receive a grade at least as high as the one indicated by the following ranges. Recall that your score will be computed with tracks 1 and 2, and you will receive the higher grade of the two.

A: 88%<= X <= 100%
B+: 80%<= X < 88%
B: 72%<= X < 80%
C+: 64%<= X < 72%
C: 56%<= X < 64%
D: 54%<= X < 56%
F: X < 54%

These percentages may be adjusted at the end of the course based on our analysis of grade data collected throughout the course, and the adjustment might be different for each class. But as indicated previously, the grade you receive will be at least as high as indicated by the above table. That is, you might get a higher grade at the end of the course than the table indicates; you will not get a grade lower than the table indicates.

Some Coursewide Policies:

- Calculators are not allowed on exams. Formula sheets will be provided.

- All students in the course are expected to be familiar with and abide by the Rutgers Academic Integrity Policy (see academicintegrity.rutgers.edu). Violations of the policy are taken very seriously.

- Rutgers is fully committed to compliance with the American with Disabilities Act; policies and procedures are indicated at ods.rutgers.edu. Students who wish to request special accommodations must present a Letter of Accommodations to the instructor as early in the term as possible (see https://ods.rutgers.edu/letter-accommodation).

- If for any reason a student will not be able to take an exam, or finds themselves in a situation, medical or otherwise, in which they will not be able to perform at their usual proficiency, they should notify the instructor right away and explain the situation. The instructor must be notified as soon as possible, and in any event *before* the exam. In the case of midterms, this does not guarantee a make-up, and the most likely solution will involve re-weighting the other exams in the course.

More Help: The Math Help Center is available in SEC-106 MTWTh 11-8 and F 11-5. A great place to go before or after class to finish your homework!

Course Overview:

Up to this point your math courses have mostly studied functions of one variable, for example, $y = f(x) = x^2$. When trying to interpret such a function geometrically one draws the graph of $y = x^2$, which in this case corresponds to the typical parabola.

Usually in a first calculus course such a graph is considered as a static object. Namely, the graph corresponds to some fixed curve on the xy-plane, and then the tools of calculus allow us to find geometric properties of this curve, such as the slope of the tangent line at a point of the curve (which uses the derivative), or the area under the curve between two points (which uses the integral).

The first thing we will do in this course is shift our point of view towards a kinematical interpretation of the same object. More concretely, we will think of the graph of a function like $y = x^2$ as the path a particles traces out in space as it moves over time. In other words, a curve such as $y = x^2$ will represent the total trajectory of a particle over a given time interval. From this point of view both x and y will keep track of the position of this particle as it moves, which is why we will regard both variables as functions of time, that is, $x = x(t)$ and $y = y(t)$. The most convenient way to keep track of this data is using **vectors**, which you should regard as a new kind of mathematical object. In this case, there will be a position vector $\boldsymbol{r}(t) = \big(x(t), y(t)\big)$ which at time t gives us the coordinates (x, y) of the particle.

A significant portion of this course will be about trying to understand the properties of vectors. For example, it is possible to add and multiply vectors, though there is more than one reasonable way to do the latter.

The second part of the course deals with functions or vectors which depend on more than one variable, which are usually known as **scalar** or **vector fields**. An example of a scalar field will be a function like $h(x, y)$, which represents the height h of some mountain with respect to ground level at the point (x, y). For example, such a function could be something like $h(x, y) = 1 - x^2 - y^2$, and the graph of $h(x, y)$ will be a surface instead of a curve (which will look like an inverted bowl in this case). We will learn how to find tangent planes (instead of tangent lines) to points on such a surface, and how these are related to optimization problems.

The concept of a vector field is harder to explain, since we have to understand what vectors are in the first place, but a good example to keep in mind will be the velocity vector field of a river moving downstream. In this case a vector field like $v(x, y, z)$ would represent the velocity (not speed!) of the water at some point (x, y, z). This is different from the previous example since now we need to specify the *direction* of motion of the water, in addition to how fast it is moving. That is why we need to use vectors: they are required whenever we need to specify properties that have a sense of directionality as well as a magnitude. The last part of this class will consist on understanding different ways to integrate such vector fields, and what meaning these integrals carry.

University-Level Resources:

Counseling, ADAP & Psychiatric Services (CAPS)
(848) 932-7884 / 17 Senior Street, New Brunswick, NJ 08901/ http://health.rutgers.edu/medical-counseling-services/counseling/
CAPS is a University mental health support service that includes counseling, alcohol and other drug assistance, and psychiatric services staffed by a team of professional within Rutgers Health services to support students' efforts to succeed at Rutgers University. CAPS offers a variety of services that include: individual therapy, group therapy and workshops, crisis intervention, referral to specialists in the community and consultation and collaboration with campus partners.

Violence Prevention & Victim Assistance (VPVA)
(848) 932-1181 / 3 Bartlett Street, New Brunswick, NJ 08901/ www.vpva.rutgers.edu/
The Office for Violence Prevention and Victim Assistance provides confidential crisis intervention, counseling, and advocacy for victims of sexual and relationship violence and stalking to students, staff and faculty. To reach staff during office hours when the university is open or to reach an advocate after hours, call 848-932-1181.

Disability Services
(848) 445-6800 / Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854 / https://ods.rutgers.edu/
Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: https://ods.rutgers.edu/students/documentation-guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: https://ods.rutgers.edu/students/registration-form.

Scarlet Listeners
(732) 214-9069 / https://rutgers.campuslabs.com/engage/organization/scarletlisteners
Free and confidential peer counseling and referral hotline, providing a comforting and supportive safe space.