Acknowledgment

UBC's Point Grey Campus is located on the traditional, ancestral, and unceded territory of the xʷməθkʷəy̓əm (Musqueam) people. The land it is situated on has always been a place of learning for the Musqueam people, who for millennia have passed on in their culture, history, and traditions from one generation to the next on this site.

Course Information

Course Title	Course Code Number	Section
Multivariable Calculus	Math 253	10R

Prerequisites

Pre-reqs: One of MATH 101, MATH 103, MATH 105, MATH 121, SCIE 001.

Contacts

Course Instructor(s)	Contact Details	Office Hours
Mark Mac Lean (IIC)	`maclean[at]math.ubc.ca`	TBA

Questions about course management should be directed by email to Mark Mac Lean; please put MATH 253 at the start of the email subject line. Questions about course material are best posted on the discussion forum (Piazza) as your question may be of general interest.

Other Instructional Staff

Other people (such as teaching assistants) are also involved in the teaching of this course. You may meet some of them over the course of the term and/or interact with them online. However, any concerns about grading should come to your instructor via mechanisms outlined on Canvas (namely, the grade change request form).

Course Structure

The instructional format for the course will consist mainly of synchronous lectures at the scheduled times. The lectures will be delivered by livestream and recordings will be posted for your later use. Course Instructor lecture notes will not be provided.

There will be WeBWorK homework to help you practice technical skills and also develop understanding of the main concepts. You are encouraged to do problems from the text on your own as WeBWorK assignments are not intended to be sufficient to master the course material for many students. You are encouraged to be active on our forum (Piazza)—asking questions and providing answers (and generally discussing mathematics with your colleagues) is an excellent way to learn!

There will be comparative judgement assignments in this course managed through the application ComPAIR. These assignments are designed to help you improve your conceptual understanding of course content.

Schedule of Topics

This is an approximate week-by-week outline of topics for the course. An online version on Canvas will be updated as the course progresses.

Order	Topics	CLP-3 Sections
1	Three-dimensional coordinate systems, vectors, dot product	1.1, 1.2.1, 1.2.2
2	cross product, equations of lines and planes	1.2.5, 1.4, 1.5
3	Curves and their tangent vector, cylinders and quadric surfaces, functions of several variables: domain, range, graphs, level curves/surfaces	1.6, 1.7, 1.8, 1.9
4	Limits and continuity, partial derivatives	2.1, 2.2, 2.3
5	Chain rule, Tangent planes and linear approximations	2.4, 2.5, 2.6
6	directional derivatives and the gradient vector	2.7
7	maximum and minimum values, Lagrange multipliers	2.9, 2.10
8	Lagrange multipliers (cont.), double integrals over rectangles	2.10, 3.1
9	Double integrals over general regions, double integrals in polar coordinates	3.1, 3.2
10	Double integrals in polar coordinates (cont.), applications of double integrals	3.2, 3.3
11	Surface area, triple integrals	3.4, 3.5
12	Triple integrals (cont.), triple integrals in cylindrical coordinates	3.5, 3.6
13	Triple integrals in spherical coordinates	3.7

Learning Outcomes

Multivariable calculus provides the language and tools to analyze outcomes that depend on more than one parameter (i.e., most situations in our world). Multivariable calculus is used in many fields of natural science, social science, computer science, and (obviously most importantly) engineering.

The main goal of the course is to develop an understanding of the fundamental concepts of

multivariable calculus and the skills necessary for its applications. Upon completion of this course, students should be able to:

1. Manipulate vectors to perform geometric calculations in three dimensions.
2. Calculate, interpret, and apply derivatives of functions of several variables.
3. Integrate functions of several variables.

Learning Activities and Assessments of Learning

The course mark will be based on WeBWorK homework assignments (10%), online quizzes (5%), comparative judgement assignments (5%), tests (30%), and the final exam (50%). The final exam covers material from the entire course.

Homework and Forums There will be online homework which must be accessed from the common Canvas page. The main goal of the homework is to help you learn the material. You are encouraged to work in groups on the more difficult problems, but then complete your individualized problems yourself. Do post questions and answers about homework (and other parts of the course) on our forums, but when posting the answers, refrain from solving the problem completely, instead, point out relevant ideas from the course or suggest the next step, etc.

We will drop the *two lowest* WeBWorK scores.

These cover incidents involving flaky internet, very-busy-this-week, etc. No further concessions are generally possible.

Online Quizzes There will be a number of short online quizzes throughout the term. These will typically be one or two problems similar to the suggested exercises in the text.

Comparative Judgement Assignments There will be a number of comparative judgement assignments done using ComPAIR. Students will submit their individual answers to conceptual questions and then judge pairs of their peers' answers to decide which of the pair is the better answer. TAs and a natural language AI will also provide expert comparisons and feedback on student answers. Grading will be based on participation for these assignments.

Tests There will some number of tests, the dates of which are subject to change but will be announced near the start of the term and posted on Canvas. Generally, you will be able to write these tests in scheduled class time but we might have alternative arrangements as well. Please be aware of Student Conduct during Examinations. Following a test or other assessed work, we may schedule a follow-up meeting or video conference call with you and ask you to explain your answers. We could do this via random class sample or any other means.

Concessions There will be no make-up quizzes or tests, and no late homework will be accepted. Students with concessions will have the weight of a test transferred to other aspects of the course, usually the final exam. You can receive **one** concession during the term by submitting the concession request form (it can be downloaded at: `https://www.math.ubc.ca/undergraduate/advising-and-resources/exams`) to your instructor. Further concessions or missed final exams need to be discussed with the Academic Advisors of your Faculty. There cannot be exceptions to these university-wide policies. Please note there are *already* mechanisms mentioned earlier and

it is anticipated that these should cover all but the very rarest concession circumstances.

Final Exam The final exam will be scheduled during the standard examination period. Please be aware of Student Conduct during Examinations.

Scaling Grades may be scaled to be in line with historical standards and to ensure fairness in assessing students' mastery of the course material. No scaling will be decided upon until all assessments are completed.

Learning Materials

All course materials are available online at no cost and some are under free licenses that explicitly allow reuse or encourage community development.

- Lectures will happen live online during scheduled class time. Course information, materials and resources can be found on the common Canvas page.
- Our main discussion forum is Piazza. Instructors and TAs will be active on Piazza, so please use this forum as the regular discussion arena for this course.

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise and harsh sanctions are imposed. Be sure you understand UBC's expectations: see the UBC Calendar entries on "Academic Honesty", "Academic Misconduct", and "Disciplinary Measures", and the Student Declaration and Responsibility.

University Policies

UBC provides resources to support student learning and to maintain healthy lifestyles but recognizes that sometimes crises arise and so there are additional resources to access including those for survivors of sexual violence. UBC values respect for the person and ideas of all members of the academic community. Harassment and discrimination are not tolerated nor is suppression of academic freedom. UBC provides appropriate accommodation for students with disabilities and for religious observances. UBC values academic honesty and students are expected to acknowledge the ideas generated by others and to uphold the highest academic standards in all of their actions. Details of the policies and how to access support are available on the UBC Senate website.

Learning Analytics

This course will be using the following learning technologies: Canvas, Piazza, WeBWorK, ComPAIR, and perhaps others as needed. Many of these tools capture data about your activity and provide information that can be used to improve the quality of teaching and learning. In this course, we may use analytics data to:

- View overall class progress
- Track your progress in order, e.g., to provide you with feedback or advice
- Review statistics on course content being accessed to support improvements in the course
- Track participation in discussion forums
- Assess your participation in the course

This course generally avoids technologies that collect data primarily or secondarily for the profit of third-party entities. This should be considered an aspirational goal rather than a promise.

Copyright

All materials of this course (course handouts, notes, slides, assessments, readings, recordings, etc.) are either copyright of the Course Instructor or licensed to be used in this course by the copyright holder. Redistribution of these materials by any means without permission of the copyright holder(s) constitutes a breach of copyright and may lead to academic discipline. This sounds more draconian than the reality: many materials explicitly allow or encourage redistribution.

Lecture recordings, if provided, are for use by registered students only.

It would be at the very least *impolite* to record your colleagues without their permission. Your instructors' recordings—if provided—will strive to be respectful in this manner and we ask that you do the same.

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This document is based on work by Brian Wetton, Philip Loewen, Ailana Fraser, and Colin Macdonald. Sections on Academic Integrity are influenced by the document "Approaches to Addressing Academic Integrity in the Syllabus" by Jaclyn Stewart, Laurie McNeill, Simon Albon and others (Creative Commons Attribution-NonCommercial).