Acknowledgement

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	Credit Value
Calculus III – Multivariable	Math 200	3

Textbook:

- CLP-3 online textbook (`http://www.math.ubc.ca/ CLP/CLP3/`) by Profs. Feldman, Rechnitzer and Yeager.
- See the common course website for additional references.

Prerequisites

One of MATH 101, MATH 103, MATH 105, MATH 121, SCIE 001.

Contact

Please contact your section's instructor (see below) for all day-to-day matters related to the course. In exceptional circumstances, you can contact the Instructor-in-charge:

Name	Contact Details	Office Location	Office Hours
Julia Gordon	email: `gor "at" math.ubc.ca`. (you can expect a response within 48 hours)	MATH 217	To be determined

Website

Common course page: `www.math.ubc.ca/~gor/Math200/math200w2020.html` ;

The most current **common** course information will be posted on this course website (not on Canvas).

Sections/ Instructional Staff

Math 200 is a coordinated class consisting of 4 different sections. The sections are taught by different instructors, but they share homework and final exam. The instructors coordinate to teach roughly the same topics at roughly the same time. The course consists of in-person lectures with no labs or workshops. Lecture styles may differ between instructors.

- Section 201, MWF 9-10am in CHEM-D200, Samer Dweik
- Section 202, MWF 11am-12, in MATH 100, Brian Freidin
- Section 203, Tue Th 12:30 – 2pm, in LSK 201, Julia Gordon
- Section 204, MWF 3-4pm in MATH 100, Antonio Alfieri

Tongou Yang is the graduate TA who will administer the course-wide Piazza forum and answer all Webwork questions. **Please post your questions on Piazza** rather than press the "email Instructor" button in Webwork.

We will also have other TAs helping mark the term tests and exams.

Course description and Learning Outcomes

Multivariable calculus provides the language and tools to analyze the outcomes that depend on more than one parameter (which means, most situations in our world). It is important for anyone planning to use the scientific method in Chemistry and Life Sciences; the part that addresses integration is also essential for further development of probability theory, and applications to Commerce and Economics. This course builds on single-variable calculus, and its natural follow-up courses are Math 317 (Vector Calculus), various courses on differential equations, or courses in Statistics/Probability. For some students, this is the last mathematics course (as it does teach sufficient mathematics background for many applications). No need to say, this is also an essential part of the basis for Physics an Engineering, but Physics and Engineering students are advised to take MATH 253, which includes slightly more material.

The course will consist of lectures, but you will be frequently asked to think of problems during the lectures (the format will depend on your section). There will be ample (challenging) Webwork to help you practice technical skills and also develop understanding of the main concepts. You are strongly encouraged to be active on Piazza – asking questions and providing answers (and generally discussing the mathematics with your friends) is an excellent way to learn!

Learning Objectives

The main goal of the course is to enable you to recognize situations that require techniques from this course. Some scenarios will need differentiation, while others will rely on integration. For example:

- Do you have an experiment where the outcome depends on some parameters? How will the result change if you fix all the parameters except one? How to find the parameters giving

you optimal results? How to maximize the rate of change? How to find the combinations of parameters that keep the results constant? All these questions require differentiation of functions of several variables. By the end of the course you should be able to confidently reconginze questions of this kind, write down the functions responsible, and reduce the above questions to solving systems of equations (which then can be delegated to a computer).

- Are you interested in the total amount of snowfall over the North Shore? Or a total amount of light illuminating the solar panel? Or the joint distribution of two random variables that control particular stock prices? All of these questions require integration in more than one variable. By the end of the course you should be able to express questions of this kind in the form of finding an integral of a function of several variables.

In the first three weeks of the course we will also discuss vectors, lines and planes in 3-dimensional space. You will find new appreciation for various problems of 3-dimensional geometry and for your linear algebra course (if you are taking one or took it recently).

List of specific topics covered is below (under Syllabus).

Course syllabus

Course syllabus

The course will cover approximately the whole CLP-III textbook (with some sections omitted). In particular, the main topics will be:

Part I: Vectors and geometry of space

1. Geometry of 3-dimensional Euclidean space; vectors; cross product and dot product.
2. Equations of lines and planes in space.
3. Cylinders and quadric surfaces.

Part II: Functions of several variables – differentiation

4. Functions of two and three variables: domain, range, continuity, level curves and level surfaces
5. Partial derivatives
6. the differential and linear approximation
7. Directional derivatives
8. the gradient vector; tangent planes
9. critical points
10. optimization problems; Lagrange multipliers.

Part III: Integration of functions of several variables

11. The notion of area and integral of a function of two variables
12. Iterated integrals
13. integration in polar coordinates
14. Volume and triple integrals
15. integration in space using cylindrical and spherical coordinates

Learning Activities and Assessments of Learning

Course mark will be based on the Webwork (10%), four in-class test (10% each), and the final exam (50%). The final exam will cover the entire course.

Webwork and Piazza

The main goal of Webwork is to help you learn the material. You are strongly encouraged to work in groups on the more difficult problems, but then complete your individualized problems yourself. Do post questions and answers about Webwork (and other parts of the course) on Piazza, but when posting the answers, refrain from solving the problem completely, instead, point out relevant ideas from the course. Five students who are the most active on Piazza will receive 1 point bonus added to their final mark.

Concessions

There will be no make-up term tests, and no late homework accepted. Students with concessions (e.g. for illness or family emergencies) will have the weight of a term tests transferred to the other tests and the final exam; the weight of a WeBWorK assignment will be transferred to the other WeBWorK assignments. You can receive **one** concession during the term, by submitting the Concession request form (it can be downloaded at: https://www.math.ubc.ca/Ugrad/ugradForm/) to your instructor. Further concessions or missed final exams need to be discussed with the Academic Advisors of your Faculty. There cannot be any exception to this university-wide policy.

Final Exam Requirements

For a full description of the final exam regulations, see the UBC Calendar page on Student Conduct during Examinations. In particular, notes, calculators, cell phones and other electronic devices are strictly prohibited from use during the exam. This includes use of cell phones for checking the time. The same regulations apply for the in-class tests.

Scaling

Term marks may be scaled, and the scaling may differ between sections. No scaling will be decided upon until all assessments are marked. Because WeBWorK historically has very high averages, the midterm and final might be written to have slightly lower averages. Average marks for assessments are not always shared with students. If you are unhappy with your mark, rather than comparing it to your classmates, consult with your instructor about ways to improve your studying. Sections will not necessarily be scaled so their averages match other sections. Differences between sections are often an indirect consequence of their meeting times.

Learning Materials

All the course materials and learning resources are available online and free.

- The course website `www.math.ubc.ca/~gor/Math200/math200w2020.html` will have links to the textbook and supplementary references, as well as the exam review materials.
- Wolfram Alpha: `www.wolframalpha.com` .

This is a wonderful tool for plotting graphs of functions of two variables, for example. If you want to visualize, for example, the surface $x^2 + xy - y^2 + 3z = 0$, just type in "plot (x^2+xy-y^2+3z=0)". A note about Webwork and Wolfram Alpha: there will be many problems in Webwork which require thinking and which Wolfram Alpha cannot do; for the more mechanical ones that it can do, if you just use the software and copy the answers, it detracts from your learning. You might get a few extra points for the webwork problem, but you'll certainly lose much more on the exam for not having that skill. So use this great software to your advantage (to help you visualize the objects we study, and to learn), not to your disadvantage (to cheat on Webwork). However, it is reasonable to use Wolfram Alpha to check your computations or to complete the last step of tedious Webwork problems.

- Math Learning Centre drop-in tutoring is available: see the schedule at `http://www.math.ubc.ca/~MLC/`.
- Each section will have an individual website (on Canvas or otherwise) where you will find section-specific information and possibly lecture scans and other materials. You can see the lecture scans for Section 203 at this section's website at: `http://www.math.ubc.ca/~gor/Math200/sec203.html` .

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 `https://senate.ubc.ca/policies-resources-support-student-success`UBC Senate website.

Learning Analytics

Learning analytics includes the collection and analysis of data about learners to improve teaching and learning. This course will be using the following learning technologies: Canvas, Webwork, and Piazza. 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, I plan to use analytics data to:

- View overall class progress
- Track your progress in order to provide you with personalized feedback
- Review statistics on course content being accessed to support improvements in the course

- Track participation in discussion forums
- Assess your participation in the course

Absence from Piazza will not affect your mark negatively; on the other hand, the top 5 contributors will be rewarded with 1 extra point.

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