

University of Toronto Scarborough
Department of Computer and Mathematical Science
MATH B41H – Techniques of the Calculus of Several Variables I

Instructor: Parker Glynn-Adey

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Office: IC 467

Lecture Schedule:

| | | | |
|--------|-----------|--------------|--------|
| LEC 30 | Tuesdays | 8:00–9:00pm | IC 130 |
| | Thursdays | 9:00–11:00am | SY 110 |

Office Hours: Tuesday and Thursday in IC 404 by appointment: <http://pgadey.youcanbook.me>

Textbook: Marsden and Tromba. *Vector calculus*. 6th Edition¹

Prerequisites

This course requires Linear Algebra (MATA22H3 or MATA23H3 or MAT223H) and Calculus (MATA36H3 or MATA37H3 or MAT137Y or MAT157Y). This course will be very difficult if you do not have the pre-requisites. If you want to attempt the course without these courses, please contact Parker immediately.

Note that this course excludes: MAT232H, MAT235Y, MAT237Y, and MAT257Y.

Course Outline:

- Review: linear algebra and functions of several variables
- Differentiation of functions $f : \mathbb{R}^n \rightarrow \mathbb{R}^k$
- Multivariate chain rule
- Quadratic forms, Hessian matrices, and extrema of multivariate functions
- Constrained optimization and Lagrange multipliers
- Approximation by polynomials
- Integration of functions $f : \mathbb{R}^n \rightarrow \mathbb{R}$
- Change of Coordinates: spherical and polar coordinates

Course Objectives: Students will develop familiarity with: “partial derivatives, gradient, tangent plane, Jacobian matrix and chain rule, Taylor series, extremal problems, extremal problems with constraints and Lagrange multipliers, multiple integrals, spherical and cylindrical coordinates, law of transformation of variables.”

¹All homework will be assigned from the sixth edition. Get a copy and be sure to do the right questions!

Course Schedule

Please print this page for reference throughout the course.

| Week / Dates | Textbook material to be covered | Comments |
|-------------------------|---|--|
| Week 1 / May 7–11 | §1.1 Vectors in Two- and Three-Dimensional Space §1.2 The Inner Product, Length, and Distance | Class Survey Tue. night |
| Week 2 / May 14–18 | §1.3 Matrices, Determinants, and the Cross Product | Tutorials start |
| Week 3 / May 21–25 | §1.5 n -Dimensional Euclidean Space §2.2 Limits and Continuity | Homework 1 |
| Week 4 / May 28–June 1 | §2.3 Differentiation §2.5 Properties of Derivatives §2.6 Gradients and Directional Derivatives | Homework 2 |
| Week 5 / June 4–8 | §3.1 Iterated Partial Derivatives §3.2 Taylor's Theorem | Homework 3 |
| Week 6 / June 11–15 | Summary, Catch Up, and Test Review | Class Survey Thu. morning |
| June 19–23 | READING WEEK | |
| Week 7 / June 25–29 | Summary and Introduction to Optimization | |
| Week 8 / July 2–6 | Course Notes: Quadratic forms and determinants §3.3 Extrema of Real-Valued Functions | Class Survey Tue. night |
| Week 9 / July 9–13 | §3.4 Constrained Extrema and Lagrange Multipliers | Homework 4 |
| Week 10 / July 16–20 | §5.2 The Double Integral over a Rectangle §5.3 Double Integrals over More General Regions | Homework 5 (Drop deadline next week.) |
| Week 11 / July 23–27 | §5.4 Changing the Order of Integration §5.5 The Triple Integral | Homework 6 |
| Week 12 / July 30–Aug 3 | §6.1 Geometry of Maps from \mathbb{R}^2 to \mathbb{R}^2 §6.2 Change of Variables / §6.3 Applications | Class Survey Thu. morning |

First Class Tuesday May 7th at 8:00pm
 Summer reading week Tuesday June 19 – Saturday June 23rd
 Drop deadline Wednesday July 23rd
 Last Class Tuesday August 7th

Assignments will be posted on the course homepage, and will be due five minutes after the exact starting time of your tutorial. TAs will enforce this policy. For example: if your tutorial is scheduled to start at 12:10pm, you may hand an assignment in until 12:15pm. After that point, at 12:16pm, your assignment will be considered late and will receive zero marks. Do not attempt to hand in the assignment later in the tutorial. Please plan an early arrival for tutorial on weeks when assignments are due. You may e-mail your assignment to your TA to ensure it will be received on time.

You must hand in your homework in your own tutorial. Do not attempt to hand in homework at a different tutorial. Material handed in to an incorrect tutorial will receive zero marks with no option to appeal.

Complete every question on the assignments. No marks will be given to answers that the TA cannot read easily. Write clearly and neatly. These assignments are the most important part of the course; you should aim for a perfect presentation. Although you may work with other students, and discuss the assignments with them, all work must be handed in individually. Group work will not be accepted. See the policy on Academic Misconduct below.

The Term Test will be written outside of regular lecture hours. The date will be determined soon. The term test may happen on a Friday or Saturday. If you cannot attend for reasons of creed or religion, then you must contact Parker as early as possible to arrange for an alternative sitting.

If you miss the midterm test for medical reasons, you must contact Parker within 24 hours of the test. You will need to send a UTSC Verification of Student Illness or Injury form:

http://www.utsc.utoronto.ca/~Eregistrar/resources/pdf_general/UTSCmedicalcertificate.pdf

Students who miss the midterm test will be asked to provide the Verification Form and a timetable for the next five days.

You will be given only one opportunity to write the make-up test.

The Exam will be written during the summer exam period: August 11–24th and will be conducted according to official [UTSC Exam Regulations](#).

Grade Distribution:

| | | |
|-------------|------------------|-----|
| Assignments | $6 \times 5\% =$ | 30% |
| Test | | 30% |
| Exam | | 40% |

AccessAbility: Students with all learning styles and needs are welcome in this course. If you have any reason to believe that you may require accommodations contact Parker and/or the AccessAbility Services as soon as possible. We can discuss the particulars of your situation and, if needed, get you registered with AccessAbility Services. AccessAbility Services staff (located in SW 302) are available by appointment to: assess specific needs, interact with professors, provide referrals to medical professionals, and arrange appropriate accommodations. You can reach AccessAbility at: ability@utsc.utoronto.ca.

Academic Integrity

The [Code of Behaviour on Academic Matters](#) states:

“It shall be an offence for a student knowingly:

1. to forge or in any other way alter or falsify any document or evidence required by the University, or to utter, circulate or make use of any such forged, altered or falsified document, whether the record be in print or electronic form;
2. to use or possess an unauthorized aid or aids or obtain unauthorized assistance in any academic examination or term test or in connection with any other form of academic work;
3. to personate another person, or to have another person personate, at any academic examination or term test or in connection with any other form of academic work;
4. to represent as one’s own any idea or expression of an idea or work of another in any academic examination or term test or in connection with any other form of academic work, i.e. to commit plagiarism (for a more detailed account of plagiarism, see [Appendix A](#));
5. to submit, without the knowledge and approval of the instructor to whom it is submitted, any academic work for which credit has previously been obtained or is being sought in another course or program of study in the University or elsewhere;
6. to submit any academic work containing a purported statement of fact or reference to a source which has been concocted”

Summary: Do not manipulate document, use unauthorized aids, impersonate² someone else, copy solutions, or submit your own work from other courses. Simply put, do not cheat in this course.

Be careful!

1. Don’t let people photograph your work. Make them write their own summary.
2. Don’t hire a tutor to complete your assignments. Ask them to check your work.
3. Don’t reproduce solutions found online. Discuss potential solutions with your TA or Parker.
4. Don’t let a TA do your assignment. Try the questions before tutorial or office hours.
5. Don’t bring unauthorized items to evaluations. Leave your phone and watch at home.

Helpful Resources:

- The Math Help Room (IC404) is always helpful. The TAs and Parker hold office hours there.
- [The Centre for Teaching and Learning](#) has numeracy workshops.
- Khan Academy has helpful videos about [Multivariable Calculus](#)
- GeoGebra has a free online [3D Graphing Calculator](#).

²Believe it or not, people do this. Don’t hire an imposter off Craig’s List to write your test.

Recommended Problems

Please print this page for reference throughout the course.

Name: _____ Student Number: _____

Circle all problems that you have completed.

| Week | Suggested Exercises |
|------|---|
| 1 | <p>§1.1 <i>Vectors in Two- and Three-Dimensional Space:</i> 1, 4, 7, 10, 11, 13, 15, 25, 27, 28</p> <p>§1.2 <i>The Inner Product, Length, and Distance:</i> 1, 6, 7, 8, 15, 19, 25</p> |
| 2 | <p>§1.3 <i>Matrices, Determinants, and the Cross Product:</i> 1, 2, 3, 4, 5, 6, 7, 8, 16, 17, 28, 29, 35</p> |
| 3 | <p>§1.5 <i>n-Dimensional Euclidean Space:</i> 1, 2, 7, 9, 10, 11, 15, 16, 17</p> <p>§2.2 <i>Limits and Continuity:</i> 1, 2, 4b, 8, 11a, 16, 18, 20, 32, 33</p> |
| 4 | <p>§2.3 <i>Differentiation:</i> 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 19, 22, 24, 25 (Do as much as possible.)</p> <p>§2.5 <i>Properties of Derivatives:</i> 2, 3, 6, 14, 17</p> <p>§2.6 <i>Gradients and Directional Derivatives:</i> 1, 4, 6, 10, 11, 19</p> |
| 5 | <p>§3.1 <i>Iterated Partial Derivatives:</i> 1, 2, 3, 4, 5, 6, 7, 12, 14, 15, 16</p> <p>§3.2 <i>Taylor's Theorem:</i> 1, 2, 5, 9</p> |

Record how many hours you spend on the course here.

| Week 1 | Week 2 | Week 3 | Week 4 | Week 5 | Week 6 |
|--------|--------|--------|--------|--------|--------|
| | | | | | |

Record your homework and test grades here. Parker will mark Seminars and Office Hours.

| Homework 1 | Homework 2 | Homework 3 | Term Test | Seminars | Office Hours |
|------------|------------|------------|-----------|----------|--------------|
| | | | | | |

Marks for this course will not be posted online. Every student must record their own course marks as they receive them. Use the sheet provided with this syllabus to record your marks. Please circle all homework problems that you yourself have completed, and fill in the table of homework and test marks.

Homework and Test Solutions will not be provided for this course. There are many solutions available online, and in the textbook solution manual. The solution manual is available in the UTSC library. Students are encouraged to consult Eric Moore's website: <http://www.math.utsc.utoronto.ca/b41/> for past tests and solutions. If you would like to check your work, please come to office hours.

Office hours are held in IC 467 on Tuesdays and Thursdays.
You must book an appointment here: <https://pgadey.youcanbook.me>

Each appointment lasts fifteen minutes. You may book one or several. Bring a question or material to discuss at office hours. All questions are welcome. We can meet privately, or you can bring friends to your appointment. Parker will sign your syllabus everytime you come to an office hours appointment.

E-Mail must be from an official University of Toronto account. You must include [MAT B41] in the subject line, or your e-mail might get lost. Please include your name and student number in every e-mail that you send. Be sure to include the precise question, and the problem or difficulty.

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To: parker.glynn.adey@utoronto.ca
From: joe.schmoe@utoronto.ca
Subject: [MAT B41] Help request!

Hi! I am Joe Schmoe (12932188) from MAT B41.
I need help with this question: Find the derivative of  $f(x)=x^2$ .
My problem is this: I don't know what the word "derivative" means.

Thanks!
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Anonymous Feedback is welcome in this course. All feedback is welcome.
You can submit anonymous feedback here: <http://pgadey.ca/feedback.html>.

You may use the form to comment on lecture, ask questions about the course, or give me tips. You do not need to enter your name or email address unless you want a private response from Parker. Note that your anonymous feedback may be discussed (and answered) in lecture, or on the course blog.

Electronic Aids including: calculators, laptops, phones, smart watches, and any device capable of sending and receiving messages or performing calculations will not be permitted during the term test or final exam. Possession of any electronic device during the term test or final exam is an academic offense. You may use these aids only for homework and study.