Math 147 – Advanced Calculus I (Section 1)

Instructor: Michael Brannan
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Course Website: `https://learn.uwaterloo.ca/`

Lectures: MWF 2:30–3:20 in AHS 1689
TAs: Jacob Campbell `j48campb@uwaterloo.ca`, Joaco Prandi `jgprandi@uwaterloo.ca`, Aidan Patterson `ae2patte@uwaterloo.ca`.
Weekly office hours: To be announced (will be held over zoom/teams for the time being), or by appointment. Links and times will be posted online. Office hour begin in week 2.

Textbook:

- Online Course Notes: *Math 147 - Honours Calculus 1 Advanced Course Notes*, written by B.A. Forrest and B.E. Forrest. They are available at
`http://www.math.uwaterloo.ca/~beforres/M147/CourseNotes/Forrest_M147CN_F20.pdf`
Students also have access to videos also prepared by B.A. Forrest and B.E. Forrest at
`https://www.math.uwaterloo.ca/~beforres/M147/Lectures/BriansM147F20Lectures.html`

Other resources:

- Peter R. Mercer, *More calculus of a single variable*,
Undergraduate Texts in Mathematics, Springer Verlag, 2014.
This book is available as a pdf file through the library via SpringerLink. (Find the book in library catalogue and click on 'Online resource'.)
- Wade, William R., An introduction to Analysis, 4th ed., Prentice-Hall, 2009.

Assignments, Solutions and Supplementary Material: Will be available on the course web site. Download assignments there if you want a single sheet with all of the questions.

Course Outline

1. Introduction to mathematical proofs
2. The real numbers
3. Sequences and limits
4. Logarithms, exponentials and other important functions
5. Functions, limits and continuity
6. Intermediate Value and Extreme Value Theorems
7. Derivatives and curve sketching
8. The Mean Value Theorem and applications
9. Approximations (Taylor's Theorem, Newton's method)

Course Description: This course will focus on the foundations of Differential Calculus.

The course begins with a short overview of the rules of mathematical logic, and of the basic properties of the Natural and Real numbers, with an emphasis on the important role to be played by the Least Upper Bound Property.

The concept of a limit is investigated first for sequences and then for functions. In both cases, the formal definition is examined and used to derive several key results. A brief introduction to series is motivated by Zeno's Paradox of Achilles and the Tortoise.

Properties of continuous functions on closed intervals are exploited as a means of showing the existence of solutions to various fundamental types of equations, numerically approximating such solutions, and establishing the existence of extrema.

The definition of the derivative leads to the concept of linear approximation. Linear approximations are used to provide a geometric interpretation of the Chain Rule and the Inverse Function Theorem.

The course includes a thorough treatment of the Mean Value Theorem and its many applications. Included are the Increasing Function Theorem and the First and Second Derivative Test.

The course culminates with an introduction to Taylor polynomials and Taylor's Theorem.

Tentative Class Schedule:

- Sept 8-10 – Logic, proofs (Chapter 1)
- Sept 13-17 – Sets, functions, mathematical induction (Chapter 2)
- Sept 20-24 – Real numbers, convergent and divergent sequences (Chapter 3, Sections 4.1.1-4.1.5)
- Sept 27-Oct 1 – Arithmetic of sequences, Squeeze Theorem (Sections 4.1.6, 4.2)
- Oct 4-8 – Monotone Convergence Theorem, series, Bolzano-Weierstrass Theorem, limit points, Cauchy sequences (Sections 4.3-4.7)
- Oct 11-15 – Reading Week (Break)
- Oct 18-22 – Limits of functions, one-sided limits, limits at infinity, infinite limits (Sections 5.1-5.7)
- Oct 25-29 – Continuity, Intermediate Value Theorem, Extreme Value Theorem (Sections 5.8-5.10)
- Nov 1-5 – Instantaneous velocity, derivatives, linear approximations, Newton's Method (Sections 6.1-6.6)
- Nov 8-12 – Rules for differentiation, implicit differentiation, related rates (Sections 6.7-6.12, 6.14)
- Nov 15-19 – Local extrema, Mean Value Theorem, Antiderivatives, classification of critical points (Sections 6.13, 7.1, 7.2)
- Nov 22-26 – L'Hôpital's Rule, Cauchy's Mean Value Theorem, uniform continuity, curve sketching (Sections 7.3-7.6, 5.11, 5.12)
- Nov 29-Dec 3 – Taylor polynomials, Taylor's Theorem, Big-O notation (Chapter 8)
- Dec 6-7 – Review.

Grading	Homework	35 %
	Midterm	30 %
	Final Exam	35 %

Examinations: The midterm and final examinations will take place in-person.

- MIDTERM EXAM: Monday, October 25, 7:00PM-9:00PM. Location: To be determined.
- FINAL EXAM: To be scheduled by the registrar. The final exam schedule is to to be released on October 1.

Do not miss the midterm unless it is a medical emergency. Documentation is required and could consist of a self-declaration of illness:
https://uwaterloo.ca/quest/help/students/how-do-i/self-declare-my-illness

Homework: There will be approximately 5 regular assignments, due every other week. These will be posted on the course Learn site. In general they will be due on Wednesdays, with the first one due on September 22. You are expected to hand in all assignments. There will be many opportunities to pick up *extra* points for bonus questions. All assignments should uploaded to the CrowdMark (see page 3) site for MATH 147 by the deadline (11:59PM on the due date). An assigment is considered late if it is submitted more than 24 hours past the deadline.

Late assignments will be penalized, and possibly not be graded.

Solutions will be posted on our course Learn site.

Missed final exam: An incomplete is only an option if there is a legitimate reason for missing the exam (generally a medical emergency) *and* the term work has been satisfactory.

Missed lectures: Students are expected to attend every lecture. If a lecture is missed due to an illness, or for purposes of self-isolation due to COVID-19 exposure, lecture notes will be made available to the student upon request.

Crowdmark: You sign in to Crowdmark using Learn. Crowdmark is a system for uploading questions online so that graders have easy access to your solutions, and you have easy access to their comments. Each question should be scanned or photographed separately, and uploaded into the appropriate section for that question. Students experience serious time delays when they attempt to do this close to deadline, resulting in late work. I recommend uploading each question once you think it is complete. If you change something, you can delete and add a new solution as long as you have not submitted. Be sure to save after each change. For more information, see:
https://crowdmark.com/help/categories/support-for-students/
Note: When uploading to crowdmark, you can delete and resubmit solutions to questions as many times as you like. However, once the deadline has passed, you can only upload your solution once.

The University Senate mandates that every course outline must contain the following text.

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. Check
www.uwaterloo.ca/academicintegrity/
for more information.

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read *Policy 70, Student Petitions and Grievances, Section 4*,
http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm.
When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing academic offenses and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to *Policy 71, Student Discipline*,
http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm.
For typical penalties check *Guidelines for the Assessment of Penalties*,
http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.

Appeals: A decision made or penalty imposed under *Policy 70, Student Petitions and Grievances* (other than a petition) or *Policy 71, Student Discipline* may be appealed if there is a ground. A student who believes he/she has grounds for an appeal should refer to *Policy 72, Student Appeals*,
http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

Students with disabilities: The *Office for Persons with Disabilities* (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.