

Syllabus and Outline

Syllabus

Instructor: Andrew Irwin, Chase 225, a.irwin@dal.ca.

Office hours: By appointment.

Class meeting times: MWF 9:35 in McCain 2176.

Textbook: Burden, Faires, and Burden (2016) Numerical Analysis, 10th edition. Thompson. Book website (<http://www.as.ysu.edu/~fares/Numerical%20Analysis/>)

Code for computer demonstrations performed in class will be added to the course web page. I plan to cover topics from chapters 2, 3, 4, 5, 8, and maybe 9. Specific details will appear on the course web page.

Course Overview and Learning outcomes

Numerical analysis is a fusion of mathematical analysis and computing. The course is a combination of mathematics, computer science, and the development of practical skills in equal proportion.

You will learn

- to identify and avoid common problems and unexpected results associated with finite precision numerical calculations,
- to perform calculations reliably and consistently and check for errors,
- to analyze computational methods mathematically,
- to write computer code to implement the algorithms you learn.

You will learn techniques to solve a broad range of problems including:

- root finding,
- interpolation and polynomial approximation,
- differentiation and integration of functions,
- numerical solutions of differential equations (initial value problems and boundary value problems).

At the end of the course, you should have working knowledge of important numerical problems, be able to describe and use several standard algorithms, and have a set of skills for performing computations of your own.

Computers and software

We will use Julia (<https://www.julialang.org/>) to develop computer tools to solve problems.

Course activities and evaluation scheme

- Lectures
- Labs (4 in total, 15%)
- Assignments (4 in total, 25%)
- Test (20%, Monday 25 February, in class)
- Final exam (40%)

Labs will be computer-focussed work to ensure you are developing computing skills necessary to master course material. Assignments will be textbook-style questions focussed on mathematics and computing solutions to numerical analysis problems. The test will be written in class, without notes, emphasizing ideas, definitions, and theorems with a few simple computations. The final exam will synthesize the three main aspects of the course: theory, examples, and computing skills. I have not yet decided on the exact form of the final exam, but you should expect it to consist of a regular exam component and a take home computing component.

Please submit labs and homework as PDFs on brightspace.

If you miss one of these deadlines, or anticipate missing one, please complete the 'Student declaration of absence' form on Brightspace under Assessments > Assignments.

Numerical grades will be converted to letter grades using the Dalhousie Common Grade Scale (https://www.dal.ca/campus_life/academic-support/grades-and-student-records/grade-scale-and-definitions.html).

Prerequisites

Calculus is an essential prerequisite. Courses in computer science, multivariable calculus, and differential equations are helpful but not essential.

Academic honesty

You must write your own solutions to everything you submit for evaluation in this course. You may discuss questions with others, but all work must be your own. You may use a variety of resources to help with your homework, e.g., code from class, material from textbooks, or expository information on the internet, but you must acknowledge the sources explicitly. You may not solicit answers to homework questions on online forums or use any prepared solutions you may find in any source!

Detailed list of course topics

Introduction: Overview of the course, Review (Mean Value Theorem, Taylor's Theorem), Numbers (floating point, round-off error, loss of precision from subtracting approximately equal numbers, quadratic formula) (BFB Chapter 1)

Root-finding of one variable functions: fixed point iteration, fixed point theorem, measuring errors, stability, and convergence, Bisection, Newton, Secant, False position, Polynomials (representation, Horner, deflation) (BFB Chapter 2)

Differentiation and Integration: finite difference methods, Richardson's extrapolation, Newton-Coates integration, Gaussian quadrature, Improper integrals (BRB Chapter 4)

Initial value problems: Euler, Taylor, Runge-Kutta, Adaptive methods, Stability, Stiffness (BRB Chapter 5)

Interpolation: Polynomial interpolation, cubic splines, Bezier curves, Trigonometric interpolation, FFT

(possibly, depending on time) Linear algebra: PLU decomposition, condition number, linear regression, QR decomposition

Interspersed throughout: computing topics as they arise (introduction to Julia, notebooks and communicating your work, writing functions & loops, plotting, using differential equations and linear algebra libraries)

University policies and statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate.

- Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity.

Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

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- Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia). Information: https://www.dal.ca/campus_life/academic-support/accessibility.html (https://www.dal.ca/campus_life/academic-support/accessibility.html)

- Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html (https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

- Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness. Statement:

<http://www.dal.ca/cultureofrespect.html> (<http://www.dal.ca/cultureofrespect.html>)

- Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit the office (Rm 3037, McCain Building), e-mail (elders@dal.ca (<mailto:elders@dal.ca>)) or leave message (902-494-6803). Information: https://www.dal.ca/campus_life/communities/indigenous.html (https://www.dal.ca/campus_life/communities/indigenous.html)

- Important Dates in the Academic Year (including add/drop dates)

https://www.dal.ca/academics/important_dates.html (https://www.dal.ca/academics/important_dates.html)

- University Grading Practices

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

(https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html)

Student Resources and Support

Advising

- General Advising https://www.dal.ca/campus_life/academic-support/advising.html
(https://www.dal.ca/campus_life/academic-support/advising.html)
- Science Program Advisors: <https://www.dal.ca/faculty/science/current-students/academic-advising.html>
(<https://www.dal.ca/faculty/science/current-students/academic-advising.html>)
- Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html
(https://www.dal.ca/campus_life/communities/indigenous.html)
- Black Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html
(https://www.dal.ca/campus_life/communities/black-student-advising.html)
- International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html
(https://www.dal.ca/campus_life/international-centre/current-students.html)

Academic supports

- Library: <https://libraries.dal.ca/> (<https://libraries.dal.ca/>)
- Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html
(https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html)
- Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html
(https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html)
- Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>
(<https://libraries.dal.ca/services/copyright-office.html>)
- Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>
(<https://libraries.dal.ca/services/copyright-office/fair-dealing.html>)

Other supports and services

- Student Health Services: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html (https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html)
- Counselling: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness/make-an-appointment (https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness/make-an-appointment).
- Student Advocacy: <https://www.dsu.ca/services/community-student-services/student-advocacy-service>
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- Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html (https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html) error

Safety

- Research Lab Safety
https://www.dal.ca/content/dam/dalhousie/pdf/dept/safety/lab_policy_manual_2007.pdf
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- Biosafety: <https://www.dal.ca/dept/safety/programs-services/biosafety.html>
(<https://www.dal.ca/dept/safety/programs-services/biosafety.html>)
- Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>
(<https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>)
- Radiation Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>
(<https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>)
- Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>
(<https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>)