Curves and Surfaces Syllabus

Department of Mathematics and Statistics

MATH 3045 Winter 2025

Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.

Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.

Course Instructor(s)

Name	Email	Office Hours
Roman Smirnov	Roman.Smirnov@dal.ca	Mondays, Fridays, 1:00-2:00pm and by appointment, Chase324

Course Description

The course is designed as an introduction to differential geometry, the study of geometric objects by means of analysis. It presents a comprehensive study of curves and surfaces in Euclidean space. Topics include: Frenet frame and equations, curvature, torsion, first and second fundamental forms, shape operator, Gauss-Weingarten equations.

Course Prerequisites

MATH 2002.03 and (MATH 2040.03 or MATH 2135.03) or consent of instructor

Course Exclusions

None

Student Resources

The Math & Stats Learning Centre in the Chase Building is **not** set up to deal with questions related to this course. Instead, visiting office hours is encouraged.

Course Structure

Course Delivery

Course Delivery: In-person only. Classes will not be recorded.

Lectures: Tuesdays, Thursdays 10:05–11:25 am, Chase319.

First class: Tuesday, January 7.

Course Materials

- The main textbook for the class is **Differential Geometry and Its Applications** by John Oprea, 2nd ed. Washington, D. C. : Mathematical Association of America. 2007. The book is available in an e-form at the Killam Library.
- Further resources will be posted on Brightspace when they are needed. This will always be announced in class.

Assessment

Assignments *30%, 5 bi-weekly assignments (due in class on Thursdays)*

Tests/quizzes *20% Midterm test TBA, to be held in class*

Final exam *50%* *(Scheduled exam period)*

Other course requirements

There will be an in-class midterm and a final exam. The midterm is TBA. The final exam will be scheduled by the registrar's office. There will also be bi-weekly homework assignments, to be handed in at the beginning of class on Thursdays. Late homework will not be accepted except with my prior permission. Each week, you will also be assigned some reading from the textbook.

Conversion of numerical grades to final letter grades follows the Dalhousie Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

Course Policies on Missed or Late Academic Requirements

A missed midterm cannot be written at another time. If you miss the midterm without my prior permission, then it will count as a 0. Exceptions are made in two cases: (1) if you obtain my prior permission to miss a midterm, or (2) if you have an officially valid excuse such as a medical doctor's note. In these cases, the weight of the missed midterm will be shifted to the final exam (i.e., the final exam will then count 70% instead of 50%). A missed final exam can only be made up if there is a valid medical excuse.

Course Policies related to Academic Integrity

The students are allowed and encouraged to work together on the homework assignments (e.g., discuss the problems for better understanding). However, the homework must be written and submitted by each student individually. Work that is too similar to another student's will not be accepted. Please note that on the midterm and final exams the students will be permittee to work only individually. For the Dalhousie policies regarding Academic Integrity see the relevant paragraph below. As far as generative AI is concerned, it will not be helpful for this course.

Learning Objectives

Learn about the properties of curves and surfaces defined In Euclidean space from the standpoint of the introductory differential geometry.

Course Content

The main textbook for the course is "Differential Geometry and Its Applications" (DGIA) by John Oprea. We will be following it quite closely but not verbatim.

Tentative content of lectures:

- January 7: The Geometry of Curves. Introduction DGIA 1.1.
- January 9: Arclength Parametrization. DGIA 1.2.
- January 14: Frenet Formulas. DGIA 1.3.
- January 16: Non-Unit Speed Curves. DGIA 1.4.
- January 21: Some Implications of Curvature and Torsion. DGIA 1.5.
- January 23: Green's Theorem and the Isoperimetric Inequality. DGIA 1.6.
- January 28: Surfaces. Introduction. DGIA 2.1.
- January 30: The Geometry of Surfaces. DGIA 2.2.
- February 4: The Linear Algebra of Surfaces. DGIA 2.3.
- February 6: Normal Curvature. DGIA 3.2
- February 11: Curvatures. Introduction. DGIA 3.1.
- February 13: Midterm (tentatively).
- February 25: Calculating Curvature. DGIA 3.2.
- February 27: Surfaces of Revolution. DGIA 3.3.
- March 4: A Formula for Gauss Curvature. DGIA 3.4.
- March 6: Surfaces of Delaunay. DGIA 3.5.
- March 11: Geodesics, Metrics, and Isometries. Introduction. DGIA 5.1.
- March 13: The Geodesic Equations and the Clairaut Relation. DGIA 5.2.
- March 18: A Glimpse at Higher Dimensions. DGIA 8.1.
- March 20: Manifolds. DGIA 8.2.
- March 25: The Covariant Derivative. DGIA 8.3.
- March 27: Christoffel Symbols. DGIA 8.4.
- April 1: Curvatures. DGIA 8.5
- April 3: The Charming Doubleness. DGIA 8.6.
- April 6: Review

University Policies and Statements

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 or e-mail the Indigenous Student Centre at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all 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. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

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 (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.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. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: https://www.dal.ca/about/leadership-governance/academic-integrity/faculty-resources/ouriginal-plagiarism-detection.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.