



THE UNIVERSITY OF BRITISH COLUMBIA

Land Acknowledgement

We respectfully acknowledge the Syilx Okanagan Nation and their peoples, in whose traditional, ancestral, unceded territory UBC Okanagan is situated.

MATH 103: Integral Calculus with Applications to Life Sciences

Faculty: Irving K. Barber Faculty of Science

Department: Computer Science, Mathematics, Physics, and Statistics

Instructor(s): Paul Tsopméné

Instructor(s) Email: paul.tsopmene@ubc.ca

Instructor(s) Office: SCI 259

Duration: Term 2 Winter 2022 (Jan – Apr 2023)

Delivery Modality: In-Person

Course Location: EME 0050

Course Days: Wed/Fri

Class Hours: 11:00 AM - 12:30 PM

Office hours: Monday and Wednesday: 3:00 pm – 5:00 pm. I am also available by email or appointment if these times do not work for you.

Other Instructional Staff

1	Course Support/Marking, Ian Chambers, Email: ian.ja.chambers@gmail.com
2	Course Support/Marking, Hongda Li, Email: alto@mail.ubc.ca
3	Course Support/Marking, Amirhossein Salami, Email: ahsalami@mail.ubc.ca
4	Lab Instructor, Amirhossein Salami, Section: L01, Wed, 8:00 AM - 9:00 AM, Email: ahsalami@mail.ubc.ca
5	Lab Instructor, Stephanie Busse, Sections: L02 (Mon, 3:00 PM - 4:00 PM), L05 (Mon, 12:00 PM – 1:00 PM), Email: sbusse@student.ubc.ca

6	Lab Instructor, Puneet Kaur Aulakh, Sections: L03 (Tue, 1:00 PM - 2:00 PM), L04 (Fri, 8:00 AM - 9:00 AM), L06 (Wed, 3:00 PM - 4:00 PM) Email: puneetk1@mail.ubc.ca
7	Lab Instructor, Michael Zhao, Section: L07, Wed, 10:00 AM - 11:00 AM, Email: mzhao002@student.ubc.ca

Course Description

Antiderivatives, the definite integral, integration techniques, numerical integration, infinite series, applications of integration to differential equations and probability, linear algebra. Credit will be granted for only one of MATH 101, MATH 103, or MATH 142. [3-1-0]

Prerequisite: One of MATH 100, MATH 116.

Course Format

Lectures and labs.

Lecture Format: Each week (except holidays), there will be two lectures. During a typical lecture, the instructor will present one or more concepts, cover examples, and answer questions. The focus will be on applications of the concepts rather than proofs.

Lab Format: Most weeks, students will meet with their lab section and Teaching Assistant, and they will either review and practice course material or write a Lab Test. **Labs will start on Monday, January 16.** Attendance is not mandatory. But every student must be registered in one of the lab sections.

Course Overview, Content and Objectives

Course Overview: This course will focus predominantly on single-variable integration and its applications. While the list of topics aligns well with a general calculus course, most of the concepts will be presented through applications in life sciences, including applications in Biology. The course will start off with integration. In this first chapter, we will learn how to integrate using the substitution rule, find the area between two curves, and use integration to calculate cumulative rates of change and average values. In the second chapter, we will learn how to integrate using integration by parts, integrate by using partial fractions, find improper integrals, and integrate numerically. In the third chapter, we will learn how to use integrals to solve separable differential equations and describe the behavior of solutions. In the fourth chapter, we will learn how to solve a system of linear equations (2 equations and 2 unknowns), perform algebraic operations on 2×2 matrices, and find the eigenvalues and eigenvectors of 2×2 matrices. In chapter 5, we will learn how to calculate the sum of a geometric series and find the Taylor series of a function. In the last chapter, we will learn how to calculate probabilities for continuous random variables, find the expected value, variance, and standard deviation of a continuous random variable, and find the linear regression line.

Content: Topics include

- Integration: antiderivatives and indefinite integrals, area and the definite integral, the fundamental theorem of calculus, applications of integration (areas, net change, average values).
- Techniques of Integration and Computational Methods: integration by parts, integration using partial fractions, improper integrals, numerical integration (the trapezoidal rule and Simpson's rule).
- Differential Equations: solving first-order separable differential equations, equilibria and their stability, integrating factors, applications (population models, one-compartment models, and more).
- Linear Algebra: systems of linear equations, matrix operations, eigenvectors and eigenvalues, an application: the Leslie matrix. (We restrict ourselves to 2×2 matrices.)
- Infinite Series: geometric series, Taylor series.
- Continuous Probability Distributions and Linear Regression: probability density functions, expected value and variance, normal distribution, linear regression.

Objectives:

- To acquire a working knowledge of a broad range of mathematical concepts which are foundational to biology and data analysis in biology.
- Specific objectives:

- to understand the essential calculus concepts and techniques at the same level as the general calculus course.
- to gain some exposure to more advanced calculus concepts from a computational viewpoint as opposed to a full mathematically rigorous treatment.
- to appreciate the connection between biological phenomena and mathematical models by using linear algebra and differential equations.
- to understand some basic statistical methods to understand a set of data.

Learning Outcomes

Upon successful completion of this course, students will be able to...

- Understand the basic idea of integral calculus: finding the area under a curve.
- Approximate the area under a curve by using the left, right, or midpoint Riemann sums.
- Evaluate integrals by using basic antiderivative formulas.
- Evaluate integrals by using techniques such as substitution, integration by parts, and partial fraction decomposition.
- Use integrals to find the area between two curves, the cumulative/net change, and the average value of a function.
- Approximate the value of a definite integral using the midpoint rule and the trapezoidal rule.
- Determine whether an improper integral converges or diverges and evaluate it if it is convergent.
- Solve and analyze first-order separable differential equations. Specifically, students should be able to:

- Use integrals to solve separable differential equations;
 - Find equilibria and determine their stability graphically and analytically;
 - Describe the behaviour of solutions of differential equations starting from different initial conditions.
 - Construct a differential equation modelling a quantity described in a problem.
- Compute the eigenvalues and eigenvectors of 2 x 2 matrices, and apply this to the study of Leslie matrices, which are used extensively in ecology to model the changes in the population of organisms over a period of time.
- Find the sum of a geometric series or determine that a geometric series is divergent.
- Find the Taylor (or Maclaurin) series of a function.
- Calculate probabilities for continuous variables, find the expected values and the standard deviation, and find the linear regression line.

Assessments of Learning

Assignments	20%
Lab Tests	40%
Final Exam	40%

Assignments: There will be five assignments throughout the semester. These will be posted on Canvas on Fridays, and the due date will be next Friday at 11:59 PM. (Assignments will be released on the dates mentioned in the table below titled “course schedule”.) To submit your assignment, you will have to upload the assignment as a single .pdf file on Canvas. Once you submit your work on Canvas, make sure to go back to the submission box on Canvas and check that your submission is uploaded correctly, and confirm that there are no missing pages. The lowest assignment grade will be dropped.

Lab Tests: Instead of midterms, you will have five lab tests that will take place during your labs. Each test will last about 50 minutes. I will post the lab test topics on Canvas about a week before the date of each lab test. The lowest lab test grade will be dropped.

Lab Tests – Schedule

Section	Lab Test 1	Lab Test 2	Lab Test 3	Lab Test 4	Lab Test 5
L01	Wed, Feb 1 8:00 – 8:50 Room: ART 204	Wed, Feb 15 8:00 – 8:50 Room: ART 204	Wed, Mar 1 8:00 – 8:50 Room: ART 204	Wed, Mar 15 8:00 – 8:50 Room: ART 204	Wed, Mar 29 8:00 – 8:50 Room: ART 204
L02	Mon, Jan 30 15:00 – 15:50 Room: ART 374	Mon, Feb 13 15:00 – 15:50 Room: ART 374	Mon, Feb 27 15:00 – 15:50 Room: ART 374	Mon, Mar 13 15:00 – 15:50 Room: ART 374	Mon, Mar 27 15:00 – 15:50 Room: ART 374
L03	Tue, Jan 31 13:00 – 13:50 Room: ART 365	Tue, Feb 14 13:00 – 13:50 Room: ART 365	Tue, Feb 28 13:00 – 13:50 Room: ART 365	Tue, Mar 14 13:00 – 13:50 Room: ART 365	Tue, Mar 28 13:00 – 13:50 Room: ART 365

L04	Fri, Feb 3 8:00 – 8:50 Room: SCI 236	Fri, Feb 17 8:00 – 8:50 Room: SCI 236	Fri, Mar 3 8:00 – 8:50 Room: SCI 236	Fri, Mar 17 8:00 – 8:50 Room: SCI 236	Fri, Mar 31 8:00 – 8:50 Room: SCI 236
L05	Mon, Jan 30 12:00 – 12:50 Room: ART 106	Mon, Feb 13 12:00 – 12:50 Room: ART 106	Mon, Feb 27 12:00 – 12:50 Room: ART 106	Mon, Mar 13 12:00 – 12:50 Room: ART 106	Mon, Mar 27 12:00 – 12:50 Room: ART 106
L06	Wed, Feb 1 15:00 – 15:50 Room: ART 204	Wed, Feb 15 15:00 – 15:50 Room: ART 204	Wed, Mar 1 15:00 – 15:50 Room: ART 204	Wed, Mar 15 15:00 – 15:50 Room: ART 204	Wed, Mar 29 15:00 – 15:50 Room: ART 204
L07	Wed, Feb 1 10:00 – 10:50 Room: ART 202	Wed, Feb 15 10:00 – 10:50 Room: ART 202	Wed, Mar 1 10:00 – 10:50 Room: ART 202	Wed, Mar 15 10:00 – 10:50 Room: ART 202	Wed, Mar 29 10:00 – 10:50 Room: ART 202

Final Exam: There is a 2.5-hours comprehensive final exam during the final examination period of April 17 – 28. Date: To Be Announced. This is a cumulative final exam.

Learning Activities

N/A

Course schedule

Tentative course schedule: The following course schedule is subject to change.

Lecture Week	Topics, Assignments, and Midterms
Jan 9 – 13	Antiderivatives, Indefinite Integrals
Jan 16 – 20	Indefinite Integrals of Trigonometric Functions, Substitution January 20: Assignment 1 will be released
Jan 23 – 27	Definite Integrals, The Fundamental Theorem of Calculus
Jan 30 – Feb 3	The Area Between Two Curves, Net Change and Average Values Lab Test 1 (this will take place during your lab)

	February 3: Assignment 2 will be released
Feb 6 – 10	Integration by Parts, Integration Using Partial Fractions
Feb 13 – 17	Improper Integrals, Numerical Integration Lab Test 2 (this will take place during your lab)
Feb 20 – 24	Midterm Break (no classes)
Feb 27 – Mar 3	Separable Differential Equations and Applications Lab Test 3 (this will take place during your lab) March 3: Assignment 3 will be released
Mar 6 – 10	Equilibria and Their Stability, Integrating Factors
Mar 13 – 17	Systems of Linear Equations, Matrix Operations Lab Test 4 (this will take place during your lab) March 17: Assignment 4 will be released
Mar 20 – 24	Eigenvalues and Eigenvectors
Mar 27 – 31	Geometric Series, Taylor Series, Probability Density Functions Lab Test 5 (this will take place during your lab) March 31: Assignment 5 will be released
Apr 3 – 7	Expected Value, Variance of Continuous Random Variables, Normal Distribution Friday, April 7: Holiday (Good Friday) – no classes
Apr 10 – 14	Linear Regression

Late policy

Assignments: Late submissions won't be considered. No extensions or make-up assignments. If an assignment is missed for a valid reason (e.g., religious, medical or compassionate reasons, with documentation), the final exam will be weighted more heavily to compensate.

Missed exam policy

Lab Tests: No make-up lab tests will be given. If a lab test is missed for a valid reason (e.g., religious, medical or compassionate reasons, with documentation), the final exam will be weighted more heavily to compensate.

Missed Activity Policy:

N/A

Passing/Grading Criteria

In order to pass the course, you MUST attain a grade of at least 40% on the final exam AND your overall final grade has to be greater than or equal to 50%.

Note: In the event you do not get at least 40% on the final exam AND your final grade is less than 50%, your final grade will be recorded. In the event you do not attain at least 40% on the final exam AND your final grade is greater than or equal to 50%, a maximum grade of 47% will be recorded.

Learning Materials

Textbook (optional): Calculus for Biology and Medicine, by Claudia Neuhauser, 3rd edition, Pearson. It is available in the bookstore. (If you have the 4th edition instead, that's fine.)

Exercise Book: Integral Calculus with Applications to Life Sciences, by Paul Tsopméné. This is free and contains problems with very detailed solutions. Summaries of concepts are included, making the book self-contained. It is available on Canvas.

Calculators: The use of a scientific calculator (non-graphing, non-programmable) is permitted.

Course Website: Course materials are available at <https://canvas.ubc.ca>. My primary method of communication is through Canvas messages/emails. Make sure you check this website regularly.

Learning Resources

N/A

Other Course Policies

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious

consequences arise and harsh sanctions are imposed. **For example, incidences of plagiarism or cheating usually result in a failing grade or mark of zero on the assignment or in the course.** Careful records are kept to monitor and prevent recidivism.

The use of artificial intelligence (AI) assistance for any assessed portions of this course is not permitted.

A more detailed description of academic integrity, including the University's policies and procedures, may be found in the Academic Calendar at:

<http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,54,111,0>

Final Examinations

You can find the [Senate-approved term and examination dates here](#). Except in the case of examination clashes and hardships (three or more formal examinations scheduled within a 27-hour period) or unforeseen events, students will be permitted to apply for out-of-time final examinations only if they are representing the University, the province, or the country in a competition or performance; serving in the Canadian military; observing a religious rite; working to support themselves or their family; or caring for a family member. Unforeseen events include (but may not be limited to) the following: ill health or other personal challenges that arise during a term and changes in the requirements of an ongoing job.

Further information on Academic Concession can be found under Policies and Regulation in the Okanagan Academic Calendar <http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0>

Grading Practices

Faculties, departments, and schools reserve the right to scale grades in order to maintain equity among sections and conformity to University, faculty, department, or school norms. Students should therefore note that an unofficial grade given by an instructor might be changed by the faculty, department, or school. Grades are not official until they appear on a student's academic record.

<http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,41,90,1014>

Resources to Support Student Success:

UBC Okanagan Disability Resource Centre

The DRC facilitates disability-related accommodations and programming initiatives to remove barriers for students with disabilities and ongoing medical conditions. If you require academic accommodations to achieve the objectives of a course please contact the DRC at:

UNC 215 250.807.8053

Email: drc.questions@ubc.ca

Web: www.students.ok.ubc.ca/drc

UBC Okanagan Equity and Inclusion Office

Through leadership, vision, and collaborative action, the Equity & Inclusion Office (EIO) develops action strategies in support of efforts to embed equity and inclusion in the daily operations across the campus. The EIO provides education and training from cultivating respectful, inclusive spaces and communities to understanding unconscious/implicit bias and its operation within in campus environments. UBC Policy 3 prohibits discrimination and harassment on the basis of BC's Human Rights Code. If you require assistance related to an issue of equity, educational programs, discrimination or harassment please contact the EIO.

UNC 325H 250.807.9291

Email: equity.ubco@ubc.ca

Web: www.equity.ok.ubc.ca

Student Wellness

At UBC Okanagan health services to students are provided by Student Wellness. Nurses, physicians and counsellors provide health care and counselling related to physical health, emotional/mental health and sexual/reproductive health concerns. As well, health promotion, education and research activities are provided to the campus community. If you require assistance with your health, please contact Student Wellness for more information or to book an appointment.

UNC 337 250.807.9270

Email: healthwellness.okanagan@ubc.ca

Web: www.students.ok.ubc.ca/health-wellness

Office of the Ombudperson

The Office of the Ombudperson for Students is an independent, confidential and impartial resource to ensure students are treated fairly. The Ombuds Office helps students navigate campus-related fairness concerns. They work with UBC community members individually and at the systemic level to ensure students are treated fairly and can learn, work and live in a fair, equitable and respectful environment. Ombuds helps students gain clarity on UBC policies and procedures, explore options, identify next steps, recommend resources, plan strategies and receive objective feedback to promote constructive problem solving. If you require assistance, please feel free to reach out for more information or to arrange an appointment.

UNC 328 250.807.9818

Email: ombuds.office.ok@ubc.ca

Web: www.ombudsoffice.ubc.ca

Student Learning Hub

The Student Learning Hub is your go-to resource for free math, science, writing, and language learning support. The Hub welcomes undergraduate students from all disciplines and year levels to access a range of supports that include **tutoring in math, sciences, languages, and writing, as well as help with**

study skills and learning strategies. Students are encouraged to visit often and early to build the skills, strategies and behaviors that are essential to being a confident and independent learner. For more information, please visit the Hub's website.

LIB 237 250.807.8491

Email: learning.hub@ubc.ca

Web: www.students.ok.ubc.ca/slh

The Global Engagement Office

The Global Engagement Office provides advising and resources to assist International students in navigating immigration, health insurance, and settlement matters, as well as opportunities for intercultural learning, and resources for Go Global experiences available to all UBC Okanagan students, and more.

Come and see us – we are here to help! You may also contact geo.ubco@ubc.ca

Safewalk

*Don't want to walk alone at night? Not too sure how to get somewhere on campus? Call Safewalk at **250-807-8076.***

For more information, see: www.security.ok.ubc.ca