MATH 103 - 103
Integral Calculus with Applications to Life Sciences
W2021 T-2 (Jan. – April 2022)
Course Outline

_____

Course Information

Instructor: Dr. Paul Tsopméné

E-mail: paul.tsopmene@ubc.ca

Office: SCI 259

Phone: 250-807-8386

Classroom Schedule: Tue & Thu: 2:00 PM – 3:30 PM

Location: FIP 204

Mode of Delivery (Course and Labs): In-Person

Requires In-Person Attendance: Yes

NOTE: As has been indicated by the University administration, classes will be held online until February 7, 2022. Labs and office hours will also be held online until February 7. The zoom links for lectures, office hours, and labs are available on Canvas under Announcements.

Office Hours: Tue & Thu: 5:00 PM – 6:30 PM. I am also available by email or by appointment if these times do not work for you.

Course Website: Course material on our Canvas learning management system. My primary method of communication is through Canvas messages/emails. Make sure you check this website regularly.

TA's Names and Contacts:

- **Lab Instructors:** Kelly Spriggs (kelly_spriggs@hotmail.com), Dhruv Bihani (dhruvbihani@gmail.com)
- **Grading and Course Support:** Avneet Kaur (thisisavneet0001@gmail.com), Alex (Xiaoyu) Mao (alexmau967@gmail.com), Mohammad Mosaffa (mohammadmosaffa78@gmail.com)

Textbooks and Calculators

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.)

As a **secondary reference**, we are using the following textbook: *Integral Calculus with Applications to Life Sciences* (free download), by Leah Edelstein-Keshet, Department of Mathematics, UBC, Vancouver. This is posted on Canvas.

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

Calendar Course Description

MATH 103 (3) Integral Calculus with Applications to Life Sciences
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 (excepting 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 Wed., January 19. Note:** The attendance is not mandatory. But **every student <u>must</u> 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 system of linear equations (2 equations and 2 unknowns), perform algebraic operations on 2 x 2 matrices, and find the eigenvalues and eigenvectors of 2 x 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.

Contents: 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 x 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.

Course 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 for 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

After completing 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 behavior 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 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.

Evaluation

Written Assignments	15%
Lab Tests	35%
Final Exam	50%

Final grades will be based on the evaluations listed above and the final grade will be assigned according to the standardized grading system outlined in the UBC Okanagan Calendar.

Note:

- **Students MUST attain a grade of at least 40% on the Final Exam in order to pass the course.**

  - In the event a student does not get at least 40% on the final exam AND the final grade is less than 50%, the final grade will be recorded.

  - In the event a student does not attain at least 40% on the final exam AND the final grade is greater than or equal to 50%, the maximum grade of 47% will be recorded.

- **Passing 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%.

- **Mode of Delivery for Exams:** In-Person

- **Examination Period:** The final exam will be given during the regularly scheduled examination period (April 14 – 29, 2022).

Practice Problems, Assignments, Midterms, and Final Exam

- **Practice Problems:** Practice problems along with complete solutions will be posted on Canvas every week. While completion of these problems is essential for the success in this course, **you do not hand them in for grading.**

- **Written Assignments:** There will be 5 assignments throughout the semester. These will be posted on Canvas on Fridays and the **due date will be on the next Friday at 11:59 PM. 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 properly and confirm no missing pages. Try to complete and submit your work at least 12 hours before the due date. **Remember:** Always start the assigned work early. Do not leave things until the last minute. I will be available for help during my office hours or by emails.
  Late Policy: Late submissions won't be considered. No extensions or make up assignments. If an assignment/notes 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**.**
  Your worst assignment grade will be dropped from the total.

Assignment #	Will be posted on	Due date
1	January 21	January 28 (by 11:59 PM)
2	February 4	February 11 (by 11:59 PM)
3	March 4	March 11 (by 11:59 PM)
4	March 18	March 25 (by 11:59 PM)
5	April 1	April 8 (by 11:59 PM)

- **Lab Tests:** Instead of midterms, you will have 5 lab tests that will take place during your labs. Each test will last about **45 minutes**. I will send you the lab test topics by email about a week before the date of each lab test. The lab tests will be written during your labs (in-person). **No make-up lab test will be given. If a lab test is missed for a valid reason (e.g., religious, medical or compassionate reasons, with documentation), the other lab tests and/or final exam will be weighted more heavily to compensate**. Travel or work are usually not acceptable excuses.
  Your worst lab test grade will be dropped from the total.

Lab Test #	Week
1	January 31 – February 4
2	February 14 – February 18
3	February 28 – March 4
4	March 14 – March 18
5	March 28 – April 1

  A detailed schedule of the lab tests is posted on Canvas.

- **Final Exam (in-person):** There is a 2.5-hours comprehensive final exam during the final examination period April 14 – 29. Date: TBA**.** This is a cumulative final exam. **You MUST attain a grade of at least 40% on the final exam in order to pass the course**.

Important Dates

Monday, January 10	Term 2 of Winter Session 2021/22 semester starts
Friday, January 21	Last day for withdrawal without receiving a ``W'' standing
February 21 – 25	Winter session term 2 midterm break (no classes)
Friday, March 18	Last day for withdrawal with a ``W'' standing
Monday, April 11	Last day of classes
April 14 – 29	Final examination period

Other calendar dates can be found at http://okanagan.students.ubc.ca/calendar/

Tentative Course Schedule

This is subject to change.

Lecture Week	Topics, Lab Tests, and Assignments
Jan. 10 – 14	Antiderivatives, Indefinite Integrals
Jan. 17 – 21	Substitution, Definite Integrals **January 21: Release Assignment 1**
Jan. 24 – 28	The Fundamental Theorem of Calculus
Jan. 31. – Feb 4	The Area Between Two Curves, Net Change and Average Values **Lab Test 1** (this will take place during your lab) **February 4: Release Assignment 2**
Feb. 7 – 11	Integration by Parts, Integration Using Partial Fractions
Feb. 14 - 18	Improper Integrals, Numerical Integration **Lab Test 2** (this will take place during your lab)
Feb. 21 – 25	**Winter Break (no classes)**
Feb 28 – Mar. 4	Separable Differential Equations and Applications **Lab Test 3** (this will take place during your lab) **March 4: Release Assignment 3**
Mar. 7 – 11	Equilibria and Their Stability, Integrating Factors
Mar. 14 – 18	Systems of Linear Equations, Matrix Operations **Lab Test 4** (this will take place during your lab) **March 18: Release Assignment 4**
Mar. 21 – 25	Eigenvalues and Eigenvectors
Mar. 28 – April 1	Geometric Series, Taylor Series, Probability Density Functions **Lab Test 5** (this will take place during your lab) **April 1: Release Assignment 5**
April 4 - 8	Expected Value, Variance of Continuous Random Variables, Normal Distribution, Linear Regression

Potential Restrictions to International Students' Online Learning Experiences

During this pandemic, the shift to online learning has greatly altered teaching and studying at UBC, including changes to health and safety considerations. Keep in mind that some UBC courses might cover topics that are censored or considered illegal by non-Canadian governments. This may include, but is not limited to, human rights, representative government, defamation, obscenity, gender or sexuality, and historical or current geopolitical controversies. If you are a student living abroad, you will be subject to the laws of your local jurisdiction, and your local authorities might limit your access to course material or take punitive action against you. UBC is strongly committed to academic freedom, but has no control over foreign authorities (please visit: http://www.calendar.ubc.ca/vancouver/index.cfm?tree=3,33,86,0 for an articulation of the values of the University conveyed in the Senate Statement on Academic Freedom). Thus, we recognize that students will have legitimate reason to exercise caution in studying certain subjects. If you have concerns regarding your personal situation, consider postponing taking a course with manifest risks, until you are back on campus or reach out to your academic advisor to find substitute courses. For further information and support, please visit: http://academic.ubc.ca/supportresources/freedom-expression

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

Final Examinations

The examination period for **W2021 T-2 is April 14 - 29, 2022**. 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

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 may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

A more detailed description of academic integrity, including the University's policies and procedures, may be found in the Academic Calendar at: http://okanagan.students.ubc.ca/calendar/index.cfm?tree=3,54,111,0.

Cooperation vs. Cheating

Working with others on assignments is a good way to learn the material and we encourage it. However, there are limits to the degree of cooperation that we will permit. Any level of cooperation beyond what is permitted is considered cheating.

When working on programming assignments, you must work only with others whose understanding of the material is approximately equal to yours. In this situation, working together to find a good approach for solving a programming problem is cooperation; listening while someone dictates a solution is cheating. You must limit collaboration to a high-level discussion of solution strategies, and stop short of actually writing down a group answer. Anything that you hand in, whether it is a written problem or a computer program, must be written by you, from scratch, in your own words. If you base your solution on any other written solution, you are cheating. If you provide your solution for others to use, you are also cheating.

Copyright Disclaimer

Diagrams and figures included in lecture presentations adhere to Copyright Guidelines for UBC Faculty, Staff and Students http://copyright.ubc.ca/requirements/copyright-guidelines/ and UBC Fair Dealing Requirements for Faculty and Staff http://copyright.ubc.ca/requirements/fair-dealing/. Some of these figures and images are subject to copyright and will not be posted to *Canvas.* All material uploaded to *Canvas* that contain diagrams and figures are used with permission of the publisher; are in the public domain; are licensed by Creative Commons; meet the permitted terms of use of UBC's library license agreements for electronic items; and/or adhere to the UBC Fair Dealing Requirements for Faculty and Staff. Access to the *Canvas* course site is limited to students currently registered in this course. Under no circumstance are students permitted to provide any other person with means to access this material. Anyone violating these restrictions may be subject to legal action. Permission to electronically record any course materials must be granted by the instructor. Distribution of this material to a third party is forbidden.

Grievances and Complaints Procedures

A student who has a complaint related to this course should follow the procedures summarized below:

- The student should attempt to resolve the matter with the instructor first. Students may talk first to someone other than the instructor if they do not feel, for whatever reason, that they can directly approach the instructor.
- If the complaint is not resolved to the student's satisfaction, the student should e-mail the Associate Head, Dr. Sylvie Desjardins at sylvie.desjardins@ubc.ca or the Department Head, Dr. John Braun at john.braun@ubc.ca

Student Service Resources

Disability Assistance
The Disability Resource Centre ensures educational equity for students with disabilities, injuries or illness. If you are disabled, have an injury or illness and require academic accommodations to meet the course objectives, e-mail us or visit our website for more information.
Web: http://students.ok.ubc.ca/drc/welcome.html   **E-mail** DRC at: drc.questions@ubc.ca

Equity, Human Rights, Discrimination and Harassment
UBC Okanagan is a place where every student, staff and faculty member should be able to study and work in an environment that is free from human rights-based discrimination and harassment. If you require assistance related to an issue of equity, discrimination or harassment, please contact the Equity Office, your administrative head of unit, and/or your unit's equity representative.   **UBC Okanagan Equity Advisor: ph. 250-807-9291**
Web: https://equity.ok.ubc.ca/   **E-mail:** equity.ubco@ubc.ca

Health & Wellness - UNC 337
At UBC Okanagan health services to students are provided by Health and 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 Health and Wellness for more information or to book an appointment.
Web: www.students.ok.ubc.ca/health-wellness   **Email:** healthwellness.okanagan@ubc.ca

Sexual Violence Prevention and Response Office (SVPRO)
A safe and confidential place for UBC students, staff and faculty who have experienced sexual   violence regardless of when or where it took place. Just want to talk? We are here to listen and help you explore your options. We can help you find a safe place to stay, explain your reporting options (UBC or police), accompany you to the hospital, or support you with academic accommodations. You have the right to choose what happens next. We support your decision, whatever you decide.   Visit svpro.ok.ubc.ca or call us at 250-807-9640

Independent Investigations Office (IIO)
If you or someone you know has experienced sexual assault or some other form of sexual misconduct by a UBC community member and you want the Independent Investigations Office (IIO) at UBC to investigate, please contact the **IIO**. Investigations are conducted in a trauma informed, confidential and respectful manner in accordance with the principles of procedural fairness. You can report your experience directly to the **IIO by** calling 604-827-2060.
Web: https://investigationsoffice.ubc.ca/   **E-mail:** director.of.investigations@ubc.ca

The Hub
The Student Learning Hub (LIB 237) 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. **Web:** (https://students.ok.ubc.ca/student-learning-hub/) **Ph:** 250-807-9185.

SAFEWALK - Download the UBC SAFE – Okanagan app.
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: https://security.ok.ubc.ca/safewalk/