THE UNIVERSITY OF BRITISH COLUMBIA

Department of Computer Science, Mathematics, Physics and Statistics
Okanagan Campus

Math 319 Section 001
Introduction to Partial Differential Equations
2021 Winter Term 1

Instructor:
<u>Name</u>: Eric Foxall (he, him).
You can address me as Eric, Dr. Foxall, professor, whatever is comfortable for you.
<u>Office</u>: SCI 115
<u>Email</u>: eric.foxall@ubc.ca

Office Hours: Mon 9:30-10:20am, Fri 10:30-11:20am, and by appointment.

<u>Note</u>: Lectures will be delivered in person. I will be recording these lectures (just record my screen and my own voice through a headphone mic, so if you come to class you won't be in the recording except maybe as a distant voice asking a question), so if you can't make it to class one day you can watch the recording. Tutorials will be synchronous but online, and will also be recorded.

Course Description:

MATH 319 (3) Introduction to Partial Differential Equations
Methods of separation of variable, Fourier series, heat, wave and Laplace's equations, boundary value problems, eigenfunction expansions, and Sturm-Liouville problems. [3-0-1]
Prerequisite: All of MATH 200, MATH 225.

This course is a first glance at "PDEs", the types of equations that are used to describe all manner of changing quantities, from the weather on our planet (the Navier-Stokes equations) to the fabric of spacetime (Einstein field equations). We will be focusing mostly on linear equations describing simple physical processes such as advection, heat transfer and wave motion taking place over various 1- and 2-dimensional domains, with an emphasis on finding solutions by reducing the PDE to an infinite collectionof ODEs using either (i) the method of characteristics, or (ii) eigenfunction expansion. We may also discuss fundamental solutions. The bulk of our time will be spent on method (ii), eigenfunction expansion, which is well-suited to boundary value problems.

Course Format:

Lecture schedule: three lectures per week: Mon Wed Fri 8-9 am, on campus in room ART 376.

Two of our lectures (dates below under "Course Evaluation") will be reserved for midterms. They will be in person. In general, I'm not taking attendance during lectures so if you want to just watch them after they're recorded, that's fine with me. If you want to show up and ask lots of questions, that's fine as well!

Will lectures be recorded? Yes, all lectures will be recorded. I also have a set of types lecture notes that I'll post on Canvas.

Labs: registration in a lab section is required for this course. There will be weekly lab sessions, beginning in week 2 of class, that will take place online. For the schedule, see your individual lab section. The labs will be hosted by your TA, who will go over practice problems / previously submitted homework or tests, and will be available for questions.

Note: Labs will be online, at the time posted in the schedule. I'll put a link on Canvas to access the labs.

Midterm break and other important calendar dates can be found at
http://okanagan.students.ubc.ca/calendar/

Learning Outcomes: After completing this course, you will be able to:

• Formulate physical processes such as advection, heat transfer, vibration and wave motion, and physical fields such as electrostatic potential, using partial differential equations (PDEs).

• Recognize the role of the domain and boundary conditions in the formulation and solution of a PDE.

• Solve advection equations and other first-order PDEs using the method of characteristics.

• Use the method of separation of variables to attempt solution of a PDE.

• Solve the heat equation, the wave equation, and Laplace's equation on simple domains such as an interval, an infinite line, a rectangle and a disk, using separation of variables.

• Understand the meaning of eigenvalues and eigenfunctions in the context of linear PDEs.

• Interpret eigenfunctions as the natural modes of the corresponding system.

• Understand the meaning of orthogonality and completeness of the Fourier series on an interval.

• Compute the Fourier series of a function defined on an interval, and understand how the properties of that function relate to the convergence of its Fourier series.

• Understand how elements of a Fourier series correspond to eigenfunctions of the heat and wave equations on an interval, and use them to obtain solutions of those equations.

• Understand the formulation of Sturm-Liouville (St-Li) boundary value problems (BVPs) from the perspective of heat transfer.

• Derive the eigenvalue problem of a St-Li BVP and compute the eigenvalues and corresponding eigenvectors in certain cases.

• Establish self-adjointness of Sturm-Liouville operators, and recognize the implications of self-adjointness on the eigenvalues and eigenfunctions of the operator.

• Use the Fredholm alternative to assess existence of solutions to nonhomogeneous BVPs.

• Solve Sturm-Liouville BVPs by eigenfunction expansion.

• Determine whether or not a given singular St-Li BVP is self-adjoint.

Passing Criteria: a grade of 50% or more will constitute a passing grade for this course. It represents at least a partial working knowledge of the topics covered.

Required Materials:
With the exception of advection equations, the method of characteristics and fundamental solutions, this course mostly follows material from Chapters 10 and 11 of the following textbook:

Fundamentals of Differential Equations and Boundary Value Problems,

Nagle, Saff and Snyder.

Any edition from 4th or later will do. Note that the same authors have a similarly named textbook but without the "boundary value problems", which is not the one you want. I listed the textbook as optional, since the typed notes will contain all required lecture material, however the textbook is a good source of practice problems. If you are unable to find a copy of a suitable edition online or elsewhere, you can pay about $50 to the bookstore for temporary (180-day) access, through the link below:

https://www.campusebookstore.com/integration/AccessCodes/default.aspx?bookseller_id=240&Course=MATH+319.001&frame=YES&t=permalink

Course Evaluation:

Evaluation will consist of the following components:

Assignments (6 total)	28%	See below
Midterm #1	16%	Oct 8
Midterm #2	16%	Nov 5
Final	40%	TBA
Total	100%	

Assignments: Assignments will be due every second week (skipping over the week of fall break, Nov 8-12), on Thursday at 11pm Pacific Daylight Time. So, assignment due dates will be Sep 16, Sep 30, Oct 14, Oct 28, Nov 18 and Dec 2. Assignments will be available on Canvas at least one week ahead of the due date and will be submitted on Canvas by uploading your work.

Group work on assignments: you can submit your assignments in groups of up to four students. You can also work on your assignments alone or in smaller groups if you prefer. If working in a group, add all your names to the assignment, and choose one representative to submit your assignment.

Midterms: there will be two midterms, that will take place during Friday lecture (8am-9am) on the days listed above, and will occur in person, in class. If you cannot make it to class on either of the midterm days, please let me know in advance so that we can make alternate arrangements.

<u>Final exam:</u> should occur on campus unless some pandemic-related reason prevents it, date and time TBA.

<u>Mode of delivery of exams:</u> both the midterms and final exam will occur on campus, in person, unless the university itself closes in-person meetings. If you can't make it to an exam in person, please let me know ahead of time so we can make alternate arrangements.

<u>Formats for online submissions:</u> please ensure you can upload your work in an easily recognizable file format, such as .pdf, .jpg or .jpeg, and .png. Please avoid formats such as .HEIC (default image file type for certain phones) as these need to be individually converted before they can be read. There are many apps you can use to convert image files of arbitrary formats into one of the three recommended formats above. This will help to save myself and the TA(s) time when grading your work and is much appreciated.

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: Any requests for changes to final exams must be sent to the office of the Associate Dean of Students (bsasdeansoffice.ubco@ubc.ca).

Missed Assignments and Exams (if applicable)

If you think you might miss an assignment or a test, please *get in touch with me right away!* It may not be guaranteed to have it omitted, but it's much easier to sort it out if you tell me before the due date. See the link in the paragraph below for an explanation of the valid reasons for which you can have an assignment or a test omitted (with the weight shifted to the remainder of your evaluated material).

If ill health is an issue, students are encouraged to seek attention from a health professional. Campus Health and Counselling will normally provide documentation only to students who have been seen previously at these offices for treatment or counselling specific to conditions associated with their academic difficulties. Students who feel that requests for consideration have not been dealt with fairly by their instructors may take their concerns

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first to the Head of the discipline, and if not resolved, to the Office of the Dean. Further information can be found at: http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0.

Late Policy

Except in cases of academic concessions (see link above), no late assignments will be accepted. With this in mind, please ensure that you leave yourself enough time to scan/photograph and upload your assignments before the deadline.

Outline of Lectures

I'll post a "typed notes" file on Canvas that contains all of our course notes for the semester and is organized by week according to the approximate schedule that we'll follow.

Note: the remainder of this outline consists of standard material that you should find on every course outline

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 Term 1 is Dec 11-22. Except in the case of examination clashes and hardships (three or more formal examinations scheduled within a 24-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;

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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

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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 of Mathematics, Sylvie Desjardins at sylvie.desjardins@ubc.ca or the Department Head pro tem, Dr. Andrew Jirasek at andrew.jirasek@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/