Syllabus for APM 346 (Winter 2019)
Partial Differential Equations

Sections and Contact Information

Lecture Sections:

LEC0101 (Instructor — Richard Derryberry)

Lectures: Tuesday 10-12pm and Thursday 11-12pm (LM 162)
Email: derryberry.teaching@gmail.com
Office: PG 107
Office Hours: Thursday 10-11am and 1-2pm
NB: You may see me listed in some places as "Richard Hughes". Rest assured, both names refer to me.

LEC0201 (Instructor — Victor Ivrii)

Lectures: Monday 2-3pm (BA 1180) and Thursday 1–3pm (MP 203)
Email: ivrii@math.toronto.edu
Phone: 416-978-4031
Office: HU 1008
Office Hours: Monday and Wednesday 3-4pm (HU 1008)

Tutorial Sections:

TUT0101 & TUT0201 (Teaching Assistant — Tristan Milne)

Tutorials: Thursday 12-1pm (SS 1069) **— TUT0101**
Thursday 1-2pm (BA 1200) **— TUT0201**
Email: tristan.milne@mail.utoronto.ca
Office Hours: Wednesday February 13, 2-4pm (PG 101) **— before Term Test 1**
Wednesday March 20, 2-4pm (PG 101) **— before Term Test 2**
Office hours before final exam TBD

TUT0301 (Teaching Assistant — Justin Ko)

Tutorial: Tuesday 11-12pm (LM 157)
Email: justinp.ko@mail.utoronto.ca
Office Hours: Tuesday 12-1pm (Huron 10th Floor Lounge)

TUT5101 (Teaching Assistant — Ivan Telpukhovskiy)

Tutorial: Wednesday 5-6pm (BA1220)
Email: ivantelp@math.utoronto.ca
Office Hours: Wednesday 4-5pm (Huron 10th Floor Lounge)

Other Contact Details:

Course Coordinator

The coordinator for this course is Richard Derryberry.

Office Hours

Students are encouraged to attend the office hours of any instructor or TA, regardless of which section they are enrolled in.

Quercus

Quercus will be used for announcements and for distributing marks. As such I highly recommend making sure that you are set up to receive email notifications from Quercus (managed via the “Account” tab on Quercus).

Course Overview

The information deemed relevant according to the Faculty of Arts and Science Calendar is as follows (verbatim from said calendar):

Course Description:

Sturm-Liouville problems, Green’s functions, special functions (Bessel, Legendre), partial differential equations of second order, integral equations, Fourier transform, stationary phase method.

Prerequisite:

MAT235Y1/MAT237Y1/MAT257Y1, MAT244H1/MAT267H1

Exclusion:

MAT351Y1

Distribution Requirement:

Science

Breadth Requirement:

The Physical and Mathematical Universes (5)

Course Objectives

At the conclusion of this course, students are expected to:

- Be able to define the terms “partial differential equation (PDE)”, “initial value problem (IVP)”, “boundary value problem (BVP)”, and “well-posed problem”.
- Be able to show existence and/or uniqueness of solutions to some examples of well-posed problems.
- Recognize important examples of PDEs, including the transport equation, heat equation, wave equation, and Laplace equation.

- Be able to apply a variety of techniques to the solution of PDEs, including the method of characteristics, separation of variables, the Fourier transform, and Green's functions.
- Be able to apply variational methods to the derivation of partial differential equations, including applications to physics.

References

The primary text for this course is the online textbook by Prof. Ivrii, which can be found at http://www.math.toronto.edu/courses/apm346h1/20181/PDE-textbook/contents.html.

Students who wish to consult a secondary text should consider *Walter A. Strauss, Partial differential equations. An Introduction (Second edition, Wiley, 2008)*; note that purchase of this book is **not** required for this class. Additionally, there are many resources on PDEs available online and through the library.

Academic Integrity

This course is intended to provide students with knowledge and techniques that will be useful in future courses and professional careers; as part of this the course instructors are committed to fair and accurate assessment of all students. Academic misconduct undermines both of these aspects of the course, and will be subject to penalty as per the procedures outlined in the *Code of Behaviour on Academic Matters* (http://www.governingcouncil.utoronto.ca/Assets/Governing+Council+Digital+Assets/Policies/PDF/ppjun011995.pdf).

Academic misconduct includes, but is not limited to:

- Using or possessing any unauthorized aid during quizzes and exams, including a cell phone.
- Looking at someone else's answers, or letting someone look at your answers.
- Misrepresenting your identity.
- Submitting an altered test for re-grading.
- Falsifying or altering any documentation required by the University (for instance, doctor's notes).
- Falsifying institutional documents or grades.

For more information, see the Office of Student Academic Integrity's *Information for Students* (http://www.artsci.utoronto.ca/osai/students).

Assessment

Marking Scheme:

15% from 7 in-class quizzes, each worth 3% of the total grade, worst 2 scores dropped
40% from 2 midterm tests, each worth 20% of the total grade
45% from the final exam

Some bonus marks are available, to be worth up to a maximum of 6 points extra towards your final mark. Bonus marks may be awarded for lecture participation, tutorial participation, participation in office hours, and exceptional work on tests and exams.

Bonus marks are awarded at the discretion of the instructors, on the recommendation

of the TAs. Students should not lobby for bonus marks — any student who lobbies for bonus marks should not be surprised when their request is denied.

Assessment Schedule:

Quizzes:	To be held during selected weeks — see below for schedule.
Midterm I:	14th February, 1610-1800 (110 minutes), room EX100
Midterm II:	21st March, 1610-1800 (110 minutes), room EX100
Final exam:	Date, time and location TBD, duration 3 hours

Quizzes will be held during class time, either in a lecture or during tutorials, and will be based on the assigned (ungraded) homework exercises. The week of each quiz is known in advance, however the exact class will be a surprise.

Assessment Weights and Return Dates:

The last day to drop an S section code course from your academic record and GPA is **March 17 2019**. Per university policy, by the classes on **Thursday March 14** students will have been returned marked assessments worth at least 10% of their final grade, including Midterm I and various quizzes.

Absentee Policies:

Quizzes: There will be no second sittings for quizzes — a quiz missed for any reason will simply be counted as one of the low scores to be dropped. Students who miss three or more quizzes for legitimate documented reasons may request that the weight of the third missed quiz onwards be added to the weight of the next midterm test or final exam.

Midterms: Students who are unable to sit a midterm test for a legitimate documented reason (e.g. the verification of illness or injury form found at http://www.illnessverification.utoronto.ca) will be given the opportunity to sit a deferred exam at a different time.

Students must report their illness by email to the class coordinator (Richard Derryberry) within three days from the test date, and must present a doctor's note to their class instructor within one week of the test date.

As the midterm tests are scheduled out of regular hours, one or two early or late sittings will be offered to those with a scheduling conflict (number and time to be determined by need and student availability).

If a student cannot sit an exam at an alternate time for a legitimate reason and cannot take a deferred test, the weight of the midterm will be added to the weight of the final. Students who are absent from a midterm test without providing a valid reason will receive a mark of 0, with no option to sit a deferred exam.

Final exam: This is governed by the Faculty of Arts & Science Rules and Regulations. See http://calendar.artsci.utoronto.ca/Rules_&_Regulations.html.

Medical notes documenting that a student was ill or injured at the time of an assessment should either be delivered in person or scanned and sent by email to Richard Derryberry within one week of the missed assessment. Students who send scanned medical notes should be prepared to bring in the original upon request. For file size and legibility reasons, photographs will **not** be accepted.

In addition to the above, the instructors reserve the right to exercise discretion in case of exceptional circumstances. Note that in the verification of illness or injury **you are not required to divulge any personal medical information**.

Use of Crowdmark:

This course will use Crowdmark for the grading of quizzes, tests and exams.

Regrade Requests:

If a student believes that a quiz or midterm test has been graded incorrectly, they may request a regrade. Each quiz and test will have one instructor designated as supervisor, and requests for a regrade must be made **within one week of the date the quiz or exam was returned, to the designated supervisor**. The result of any regrade will be recorded as the official mark, whether the regrade results in a higher grade, a lower grade, or an unchanged grade.

Lost Assignments:

If a student believes that their quiz or midterm has been lost they must bring this to the attention of their instructor **within one week of the date that grades for the quiz or midterm were posted**.

If the instructor determines on the balance of probabilities that the quiz or midterm has been lost, the student will be given the option of having the weight of that quiz or midterm added to or distributed between the weights of future assessments. If at any point before the final exam the lost assessment is recovered it will be graded and the marking scheme will revert to the standard one described in this syllabus.

Lecture and Tutorial Attendance

Students are expected to attend all lectures and tutorials that they are enrolled in. While attendance at lecture and tutorials is not technically compulsory, students who do not attend are at risk of missing important course information and content. If a student misses a lecture, they are responsible for discovering what information and material they missed. Furthermore, since quizzes will be administered during class time, **any student who misses a lecture is liable to also miss a quiz**.

Students **are** required to attend only the lecture and tutorial section that they are enrolled in, to avoid overcapacity classrooms and (when a quiz is being held) to ensure that there are enough quizzes to distribute. If there is a week in which a student wishes to attend a different lecture or

tutorial section, **they must petition to do so by 11 am of the previous Thursday**, to ensure that seats are available and that the correct number of quizzes are printed.

Accessibility Services

The University of Toronto is committed to providing an accessible learning environment for all students. If you have a disability or health consideration that may require accommodations, we encourage you to approach Accessibility Services at (416) 978 8060; accessibility.utoronto.ca.

To request accommodations students **must register** with Accessibility Services. Students are also welcome (though not required) to approach their instructor, but should be aware that unless they are registered with Accessibility Services they may be unable to secure accommodations for the final exam.

Requests for accommodation will be kept confidential by both Accessibility Services and the course instructors. Accessibility Services is permitted to disclose to course instructors the impact of any disability or health concern on a student's learning for the purpose of determining specific accommodations, however will not disclose a diagnosis or specifics of a disability without the student's permission.

Course Schedule

	Topics	Textbook Sections	Assessments
Week 1 7/1 - 11/1	What is a PDE? Initial/Boundary Value Problems Types and examples of PDEs	Chapter 1	
Week 2 14/1 - 18/1	First order PDEs Method of characteristics	Sections 2.1—2	
Week 3 21/1 - 25/1	The 1D wave equation Duhamel's principle Domains of dependence and influence Method of continuation	Sections 2.3—6	Quiz 1 **Lecture or Tutorial**
Week 4 28/1 - 1/2	The 1D heat equation The heat kernel The maximum principle	Chapter 3	Quiz 2 **Lecture or Tutorial**
Week 5 4/2 - 8/2	Separation of variables (wave equation) Eigenvalue problems Fourier series	Sections 4.1—2	Quiz 3 **Lecture or Tutorial**
Week 6 11/2 - 15/2	Complete orthogonal systems Application to Fourier series	Sections 4.3—4	Midterm I **14/2, 1610-1800, EX100**
Reading Week 18/2 - 22/2	*Lecture-free week*		
Week 7 25/2 - 1/3	Even, odd and complex Fourier series The Fourier transform	Section 4.5 Sections 5.1—2	Quiz 4 **Lecture or Tutorial**
Week 8 4/3 - 8/3	Applications of Fourier transform to PDEs Separation of variables	Section 5.3 Sections 6.1—2	Quiz 5 **Lecture or Tutorial**
Week 9 11/3 - 15/3	The spherical and cylindrical Laplacians The Laplace operator on the disc Laplace BVP on a bounded domain	Sections 6.3—5 Section 7.1	Quiz 6 **Lecture or Tutorial**
Week 10 18/3 - 22/3	Potential theory (harmonic functions) Green's functions Spherical harmonics	Sections 7.2—3 Section 8.1	Midterm II **21/3, 1610-1800, EX100**
Week 11 25/3 - 29/3	The wave equation in 2D and 3D The energy method and causality	Chapter 9	
Week 12 1/4 - 5/4	Variational methods Euler-Lagrange equations Application to physics	Chapter 10	Quiz 7 **Lecture or Tutorial**
Exam Period 6/4 - 30/4			Final Exam **TBD**