APM 346, Partial Differential Equations

Summer 2019

Course Information

Instructor: Nathan Carruth, ncarruth@math.toronto.edu. [**NB: I do not check e-mail on Sundays.**]
Course Location and Times: Tuesday, 4–5, Thursday, 3–5, Bahen 1190.
Instructor Office Hours: Tuesday, 1–2, Thursday, 2–3, in Bahen 2139 (exception: on Thursday, May 30, office hours will be 2–3 in Bahen 2175); other times by appointment.
Course Website: http://www.math.toronto.edu/ncarruth/APM346_S19/. All links given in this syllabus are available on the course website. Quercus will also be used for announcements (so please make sure you get e-mails when announcements are posted!), submitting homework assignments (see below), and posting marks.
TA: Dmitri Chouchkov, dmitri.chouchkov@mail.utoronto.ca.
Tutorial Locations and Times: Tuesday, 2–3, Bahen 2175; Tuesday, 3–4, Wallberg 219. Tutorials will start the second week of class. You must register for a tutorial and write your quiz in the tutorial section in which you are registered.
TA Office Hours (MAC Hours): TBA (see course webpage for updates).
Textbook: Pinsky, Mark A. Partial Differential Equations and Boundary-Value Problems with Applications, 3rd ed. Providence, Rhode Island: American Mathematical Society, 2011.
I will assume you have access to the textbook. It is on order at the bookstore.

Course Outline

The aim of this course is to provide an introduction to the qualitative and quantitative study of partial differential equations, with emphasis on the types of equations which arise in applications. These two aspects may be broken down as follows.

- Quantitative: We shall study the classical second-order linear equations (Laplace's and Poisson's equations, the heat or diffusion equation, and the wave equation), together with related equations, and show how the method of separation of variables can be used to obtain the solutions of these equations as series in solutions of certain ordinary differential equations. In doing so we shall be introduced to such important mathematical concepts (some of which have applications far removed from the study of partial differential equations) as Sturm-Liouville problems, special functions, orthogonality in function spaces, and Fourier series. We shall also study how boundary or initial conditions determine the coefficients in the series expansion, and how Green's functions can be used to treat inhomogeneous equations.

- Qualitative: We shall study how properties of solutions to partial differential equations can be proven directly from the equations themselves, without the necessity of finding expressions for the solutions. We shall see how these qualitative properties relate to the quantitative expressions we obtain for the solutions. We shall also study qualitative (e.g., asymptotic) properties of these quantitative expressions themselves, and discuss how these qualitative properties can be interpreted in applications.

Course Goals

By the end of this course, you should be able to give series or integral representations for the solutions for the (homogeneous and inhomogeneous) classical second-order linear equations and related equations, for various types of boundary conditions and in various geometries (rectangular, polar/cylindrical, and spherical). You should understand the procedures for obtaining these expressions, the basic properties of the special functions (Legendre, Bessel, etc.) which are used, and the basics of the theory of function spaces which underlie these methods. Finally, you should understand some of the qualitative properties of these solutions, and how these relate to their series and integral representations.

Note.

There are two other topics which have been covered in this course in previous years: first-order equations and nonlinear equations. We will discuss first-order equations towards the end of the course if there is time. If there is sufficient interest and time, some basic material on nonlinear equations may be covered as well, but I do not intend for it to be examinable material.

Prerequisites

I assume that you have had a year-long course in multivariable calculus (MAT235 on St George campus or its equivalent), as well as semester courses in linear algebra and differential equations (on St George campus, MAT223 and 240 or their equivalents). The first homework assignment will give some problems to review concepts from these classes. In order to do well in this course it is necessary to have a good grasp of the material covered in these courses; if you feel uncertain about your preparation, or have difficulty with the first assignment, please come talk to me.

Classes and Tutorials

Formal attendance will not be taken in either lecture or tutorial, but you are responsible for the material covered in both; and it is hoped that you will attend as often as you are able. In class I will go over the material and give examples as far as time permits; tutorials will be focussed on answering questions, going over examples and writing quizzes (see below).

I will generally post lecture notes shortly after the end of each class. Please note that these do not obviate your responsibility to attend lecture! They are merely intended as an aid to studying, and are not guaranteed to be comprehensive. After the first week, I will also post recommended readings in the textbook, and will generally assume that you have at least glanced through them before lecture.

A working schedule of what has been covered so far and what the plan is going forwards will be kept on the course webpage.

Assessment

There will be one term test worth 28% of the final mark and a final exam worth 40% of the final mark. There will be approximately 9 quizzes, of which only the best 8 will count, with each worth 4% of the final mark. Finally, for bonus marks there will be 10 homework assignments (roughly one per week) which will be marked as completed/not completed[1] or turned in/not turned in (each assignment will specify clearly in which way it will be marked), and each will be worth an additional 0.4% of the final mark. (Since it is not possible to achieve an overall mark higher than 100%, bonus marks only count until the final mark reaches 100%.)

Homework assignments will be posted on the course website (listed above) by 11.59 PM Monday evening of each week (including week 1) and will be due by 6 AM Eastern Daylight Time on Monday morning of the following week. They are to be submitted electronically (picture or scan is fine, as long as it is legible) via Quercus and (where possible) will be marked by the evening of the day they are due, so that they can be used to study for the next day's quiz. Quizzes will be 10–15 minutes long and administered in tutorial sections each week. The term test will be held during the F session exam week (June 19–June 26). The final exam will be held during the exam period, August 15–22. The exact dates and times for the term test and the final will be announced as soon as they are known.

Problems for quizzes will be similar (though not identical) to problems on the homework assignments, and generally those of the assignment due the previous day. Problems on the term test and the final will be similar to problems given on quizzes.

Late homework assignments will not receive any bonus marks, and will only receive feedback at the discretion of the instructor or TA.

Course work plays an important part in learning as well as assessment. We will strive to give useful feedback on all submitted course work to help you better understand the material and also see places for

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[1] 'Completed' means that you have made at least an attempt to solve every required problem on the assignment.

improvement.

Missed Coursework and Accommodations

If a student misses a quiz or the term test for reasons beyond his or her control, he or she must contact the instructor as soon as possible but no later than one week after returning to class. Appropriate documentation (such as a doctor's note written on the University of Toronto Verification of Illness or Injury Form, available at www.illnessverification.utoronto.ca) will be required (except in the case of requests for religious accommodations). If the term test is missed the student will be given the opportunity to write a make-up test, which (if needed) is tentatively planned for the first week of July. If the make-up test is also missed for a legitimate reason, the weight of the term test will be shifted to the final exam.

For missed quizzes, the weight will be shifted to the remaining quizzes, to a maximum of 8% of the final mark per quiz; if further quizzes are missed, their weight will shift to the final exam. (Alternatively, at the student's option, any one missed quiz may be counted as the one which is dropped. In this case, no special communication with the instructor or TA is required.)

Missed homework assignments cannot be made up for credit, though they may receive feedback at the discretion of the instructor or TA.

Requests for accommodations for absences which are planned in advance should be made as early as possible.

Marking, returning and remarking of course work

Homework assignments, quizzes, and the term test will be marked jointly by the instructor and the TA.

Feedback on homework assignments will be given directly on Quercus. Quizzes and the term test will be returned either before or after (not during) tutorial or class, or during office hours.

A student who wishes to request a remark of a quiz or the term test must return the paper to be remarked to the TA or instructor at the time he or she receives it; work taken out of the area cannot be returned for a remark later. The student should then contact the marker (instructor or TA) and indicate that he or she would like to request a remark, the question or questions to be remarked, and any supporting information as to why the student felt the question was marked incorrectly. The question or questions will then be remarked and the new mark (higher, lower, or the same as the original) will become the mark for that question or questions.

Please note that "I deserve more marks for this solution" is very rarely a valid reason to ask for a remark.

In the event that a student feels that an arithmetic (rather than marking) error has been made (for example, the wrong mark was entered online, or the total mark on the test was calculated incorrectly), the above policy should be followed (including the requirement that the paper in question not be removed from the area), except that no particular explanation is required, and the error will be corrected without the paper being remarked.

Important dates

May 20	Victoria Day.
June 18	No class (study break); office hours still held.
June 19–July 1	No class (the term test will be held sometime between June 19–26).
July 1	Canada Day.
July 15	Last day to drop course from academic record and GPA.
August 5	Civic holiday.
August 8	Last day of class.
August 15–22	The final exam will be held during this week.

(The following passages are from statements suggested by the Faculty of Arts and Sciences.)

Academic Integrity

All students, faculty and staff are expected to follow the University's guidelines and policies on academic integrity. For students, this means following the standards of academic honesty when writing assignments, collaborating with fellow students, and writing tests and exams. Ensure that the work you submit for grading represents your own honest efforts. Plagiarism – representing someone else's work as your own or submitting work that you have previously submitted for marks in another class or program – is a serious offence that can result in sanctions. Speak to me or the TA for advice on anything that you find unclear. To learn more about how to cite and use source material appropriately and for other writing support, see the U of T writing support website at http://www.writing.utoronto.ca. Consult the Code of Behaviour on Academic Matters for a complete outline of the University's policy and expectations. For more information, please see http://www.artsci.utoronto.ca/osai and http://academicintegrity.utoronto.ca.

Within the context of this course, the above policy includes the following. You are allowed to work in groups on homework assignments, prior to the process of doing a final write-up, which you must do on your own. In particular, you are not allowed under any circumstances to simply copy another student's write-up. The assignments must also represent your own work, meaning that they cannot be simply copied from anything you find online; and if you use online resources you must cite them in your write-up, unless the contrary is explicitly indicated in the assignment. (Even so, I strongly advise against using online sources. The problems which I assign should be doable using the textbook, any additional resources from the course website, and utilising the instructor and TA office hours. It is easy to find ways of doing problems online which however leave one with no greater understanding of the problem than one had in the first place.) The only exception is for any materials or links directly posted on the course website, which do not need to be explicitly referenced.

No aids (including electronic aids and notes) are allowed in quizzes, the term test, or the final exam, unless explicitly stated on the quiz, test, or exam paper.

Religious Accommodation

As a student at the University of Toronto, you are part of a diverse community that welcomes and includes students and faculty from a wide range of cultural and religious traditions. For my part, I will make every reasonable effort to avoid scheduling tests, examinations, or other compulsory activities on religious holy days not captured by statutory holidays. In accordance with university policy, if you anticipate being absent from class or missing a quiz or test due to a religious observance, please let me know as early in the course as possible, and with sufficient notice (at least two to three weeks) to allow us to work together to make alternate arrangements.

Accessibility Statement

Students with diverse learning styles and needs are welcome in this course. If you have an acute or ongoing disability issue or accommodation need, you should register with Accessibility Services (AS) at the beginning of the academic year by visiting http://www.studentlife.utoronto.ca/as/new-registration. Without registration, you will not be able to verify your situation with your instructors, and instructors will not be advised about your accommodation needs. AS will assess your situation, develop an accommodation plan with you, and supprot you in requesting accommodation for your course work. Remember that the process of acommodation is private: AS will not share details of your needs or condition with any instructor, and your instructors will not reveal that you are registered with AS.

Accommodations for non-medical reasons

There may be times when you are unable to complete course work on time due to non-medical reasons. If you have concerns, speak to me or to an advisor in your College Registrar's office; they can help you to decide if you want to request an extension or accommodation. They may be able to provide you with a College Registrar's letter of support to give to your instructors, and importantly, connect you with other resources on campus for help with your situation.