MAT 334H1Y, Complex Variables

Summer 2020

Course Information

Instructors: Nathan Carruth, ncarruth@math.toronto.edu, LEC 5101.
(Please note that Nathan does not check or reply to e-mails on Sundays.)
Matthew Sourisseau, sourisse@math.utoronto.ca, LEC 0101.
Adminstrative questions should be addressed to Nathan at the e-mail above.

Lecture times: LEC 5101: Tuesday 6 – 7 PM, Thursday 6 – 8 PM
LEC 0101: Wednesday 11 AM – 12 PM, Friday 11 AM – 1 PM.
[NB All times are in Eastern Daylight Time, which is UTC-4.]
Lectures will be live-streamed and you are expected to be in attendance at your scheduled lecture time. Recordings of lectures will not be available except possibly for students in exceptional circumstances. See 'Expectations about attendance' below.

Instructor Office Hours: TBA. Please see the course webpage, including poll.

Course Webpage: http://www.math.toronto.edu/ncarruth/MAT334_S20/. [This text is not a live link.] All links given in this syllabus are available on the course webpage. Quercus will also be used for announcements (so please make sure you get e-mails when announcements are posted!) and giving marks, and may also be used for parts of the assessments.

TAs: Stanislav Balchev, stanislav.balchev@mail.utoronto.ca
Etienne Bilocq, etienne.bilocq@mail.utoronto.ca
Yucong Jiang, jiangyc@math.utoronto.ca
Ren Zhu, ren.zhu@mail.utoronto.ca

Tutorial Times: Tuesday, 4 – 5 PM (0101) and 5 – 6 PM (5101);
Thursday, 4 – 5 PM (0201) and 5 – 6 PM (5201).
Wednesday, 10 – 11 AM (0301); Friday, 10 – 11 AM (0401).
As with lectures, you are expected to be in attendance at your scheduled tutorial time. See 'Expectations about attendance' below.

TA Office Hours: TBA (see course webpage for updates, including poll).

Textbook: Goursat, Édouard. Functions of a Complex Variable. Hedrick, Earle Raymond and Dunkel, Otto, translators. Ginn and Company: Boston, 1916.
I believe this book is now public domain; scans are available online. I plan to produce a typescript of the sections we cover as the course progresses; see the course webpage.

Information specific to this term (please read carefully!)

Expectations about attendance. The lectures and tutorials in this class will be delivered live, and this course should not be thought of primarily as an 'online' course which you can do on your own time but rather as a normal course, temporarily delivered via online methods.

With that said, we understand that timezone issues in particular may cause difficulties with live participation. On the other hand, there are a range of tutorial and lecture times available, and we expect you to be willing to make an effort to participate live regardless of your timezone. (Nathan has stayed up until almost midnight before to hold office hours and will do so again if needed.) We also understand that circumstances caused by the Covid-19 pandemic (for example, stress or other circumstances caused by the need to live at home with family) may impact your ability to participate live.

Exceptions to the attendance policy require case-by-case approval by Nathan. If you are facing these or similar circumstances and are unable to participate live, or otherwise feel that your situation warrants an exception to the attendance policy, you must contact Nathan as soon as possible, and no later than the end of the first week of classes (May 8). Our policy is to be as accommodating as reasonably possible, while balancing accommodations against the need to be fair to all students in the class and to ensure your ability to perform well in the course.

Covid-19 situation. While the ongoing Covid-19 pandemic makes all plans contingent to a certain extent, we are confident that major unforeseen interruptions like those during winter term can be avoided.

Please remember that you are a student even if you are not living in Toronto, and please do not plan unnecessary activities (such as unnecessary travel) which you would not plan under ordinary circumstances, or which under the present circumstances present a high likelihood of severely compromising your ability to carry out your studies.

Minimum electronics requirements. Lectures, tutorials, and office hours will be held online either via Blackboard Collaborate or Quercus Conferences (a similar tool), both accessed through Quercus, or through Zoom. Quizzes and the final assessment will be downloaded from Quercus or Crowdmark. This means that you must have electronic equipment capable of accessing those resources. The University has produced a list of recommended minimum system requirements (please see the list which is available here: https://www.viceprovoststudents.utoronto.ca/covid-19/tech-requirements-online-learning/). Note that for this course, access to (at the very least) a computer with speakers is required, as well as a camera or scanner or other method for producing digital versions of hand-written work. If you have any concerns about these requirements, please discuss them with Nathan as soon as possible.

Note. Please note that the platforms used may change during the term depending on circumstances.

Course outline

The aim of this course is to provide a solid foundation in the basic theory of analytic functions of a complex variable, and a sampling of the applications of this theory. These two aspects may be broken down as follows.

- Theory: The condition of differentiability of a function of a complex variable gives rise to deep and far-reaching consequences. Two main topics we shall discuss are *integral theorems*, which are mainly analytic, and *conformal mapping properties*, which are mainly geometric.
- Applications: We shall show how results arising from the integral theorems allow us to compute definite integrals which are totally intractable by the normal methods of real-variable calculus. We shall also show how the conformal mapping properties of analytic functions allow us to find solutions to certain partial differential equations. Time permitting, we shall discuss the applications of the theory to the study of so-called *special functions*.

We shall cover most of chapters I and II and parts of chapter IV of the text by Goursat.

While the applications to definite integrals are probably the most easily appreciated and widely known applications of the material in this course, we will see that the study of functions of a complex variable is a rich and deep subject with connections to many other parts of mathematics, both pure and applied.

Course goals

By the end of this course, you should understand how differentiability of a function of a complex variable leads to the Cauchy-Riemann equations and the Cauchy integral theorem and integral formula; how these results give rise to Taylor and Laurent series; the significance of branch points and branch cuts; and how knowledge of the complex singularities of a function as encoded in its Laurent series and branch points allows us to choose appropriate contours in the complex plane for the evaluation of definite integrals of real-variable functions. You should also understand the geometric interpretation of the derivative and its role in the theory of conformal maps, and applications of conformal maps to the solution of Laplace's equation in two variables.

More generally, successfully completing this course should give you the knowledge and appreciation of functions of a complex variable necessary for further applications in (for example) ordinary and partial differential equations, special function theory, transform theory, number theory, and so forth.

Prerequisites

The formal prerequisites for this course are multivariable calculus and at least one semester of linear algebra. In particular, we shall assume a strong grasp of partial differentiation and line integrals. Review notes on these topics will be posted to the course webpage; if you feel at all shaky with either of these after reviewing the notes please talk to one of the instructors sometime during the first week of class.

Classes and Tutorials

Formal attendance will not be taken in classes or tutorials, but you are responsible for the material discussed in both and cannot expect the instructors or TAs to re-teach you the material later (though you are welcome and strongly encouraged to bring questions about the material to tutorials and office hours). You must write the weekly quiz in your registered tutorial section (unless you have been given an accommodation as discussed in 'Expectations about attendance' on p. 1 above).

While not required, we highly recommend registering in a tutorial section on the same day as your lecture section where possible; i.e., if you are registered in LEC0101, we highly recommend you enroll in either the Wednesday or the Friday tutorial (TUT0301 or 0401), while if you are in LEC5101, we highly recommend that you enroll in one of the Tuesday or Thursday tutorials (TUT0101, 5101, 0201, or 5201). This will allow for maximum coordination between tutorials and lectures.

Assessment

All assessments will be administered online via either Quercus or Crowdmark.* You will not need a printer but you will need a way to produce an electronic copy of your answers (e.g., using a camera or a scanner). See 'Minimum electronics requirements' above.

On all assessments, you are allowed to use the course text, lecture notes posted by either Nathan or Matt, and any notes you have written yourself. You are not allowed to use any other aids (including notes written by anyone else). Please see the sections 'Cheating' and 'Academic Integrity' below.

This courses consists of 2 quizzes and 8 homework assignments, each worth 6% of the final course mark, one term test (to be written during the June assessment period) worth 20% of the final course mark, and one final assessment (to be written during the final exam period in August) worth 20% of the final course mark. The marks on the quizzes may be replaced by the marks on the indicated portions of the term test if the latter are higher. Homework marks will not be replaced by marks on the term test or final assessment except as indicated in 'Missed coursework and accommodations', next.

The mark on the final assessment will replace the mark on the term test if it is higher. This will not have any effect on the quiz marks, even if those were replaced by the marks on the term test. The final assessment will in principle cover all of the material in the course, mostly (though not necessarily exclusively) via problems drawn from the applications in the second half.

Missed coursework and accommodations

If you miss a quiz, the term test, or the final assessment for reasons beyond your control, you must contact your instructor as soon as possible, but no later than one week after your situation returns to normal. (Usually this would be when you return to class.) Doctor's notes are no longer required, but in addition to contacting your instructor you must also register your absence using the Absence Declaration Tool on ACORN. If you miss a quiz under such circumstances, your mark will be replaced by your mark on the corresponding part of the term test. Since assignments are to be done over a period of a week or more, only very rare circumstances could warrant an excusal from submitting an assignment; accommodations in such a circumstance will be on a case-by-case basis but may involve, for example, shifting the weight of the assignment to the term test or the final.

If you are not able to write the term test during the originally scheduled time for acceptable reasons, you will be given the chance to write a make-up test (probably during the second week of July). If you are unable to write the make-up test for acceptable reasons, the weight of the term test will be transferred to the final assessment. If you are not able to write the final assessment for acceptable reasons, you will be given an opportunity to write a make-up assessment, probably later on in August.

(Slightly different accommodations may also be offered for students who are unable to write the term test or final assessment due to issues such as those discussed in 'Expectations about attendance' on p. 1 above. These will be communicated separately.)

If you are aware of potential absences ahead of time (for example, related to religious observances), please advise your instructor as far in advance as possible.

* Large picture files can take a long time to load when we go to mark your solutions, so please do your best to upload pictures that are as small as possible; for example, by writing in black and then uploading pictures which are black and white rather than color or grayscale. Feel free to let Nathan know if you can't figure out how to do this.

Marking, returning and remarking of course work

Quizzes, assignments, and the term test will be marked by the TAs working together (not necessarily your section TA), assisted by the instructors as needed. The final assessment will be marked by the instructors, assisted by the TAs as needed.

Quizzes, assignments, and the term test will be given marks and feedback on Quercus or Crowdmark as appropriate. We will aim for quizzes to be marked within one week of writing. Solutions may be provided as considered appropriate, generally no sooner than one week after the quiz. Assignment solutions will be provided sometime after the submission deadline, and rubrics will be provided after marking is completed.

Remark requests for quizzes, assignments, or the term test or final assessment should be submitted as soon after the item is returned as possible, but (with the exception of the final assessment) must be submitted no more than one week after the item is returned. If you feel that an arithmetic error was made in determining your mark, please contact your TA with the relevant information. If you feel that your work was marked unfairly, please contact Nathan, indicate that you would like to request a remark, and justify why you think the mark given was incorrect. The item will then be remarked. In either case, the new mark (which may be higher or lower than 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. Also, please do not argue with your TAs about your marks. If you believe your TA does not understand your concern, please bring it directly to Nathan's attention.

Cheating

The course policy on this heading can be summarised in three words:

DON'T DO IT!!!

First, some pyrotechnics. We will not mince words: Cheating is a direct insult to your instructor, your TAs and your fellow students. Your instructors and TAs work hard to design, prepare, and deliver course material, provide feedback and guidance, and assess course performance. Your fellow students, who do not cheat, are doing their best to earn the grade they desire by actually putting in the required effort to learn the material. Cheating denigrates all of this and is totally unacceptable.

Cheating in the context of this course includes, but is not limited to, any of the following activities:

- Working with any other individual, inside or outside of the class, on any of the quizzes, the term test, or the final assessment.
- Posting course material to the internet without the **explicit** permission of your instructor.
- Using any aids or resources (including online and paper resources) during a quiz, the term test, or the final assessment, other than those explicitly listed in 'Assessment', paragraph 3, above.
- Allowing someone else to write a quiz, the term test, or the final assessment for you, or doing the same for someone else.
- Submitting any work which is not entirely your own independent work.

All cases of cheating will be taken very seriously and referred to the University for potential disciplinary action. **Disciplinary action for academic misconduct, which includes cheating, can be severe, up to and including expulsion from the University.**

Pyrotechnics hopefully having now had their desired effect, we want to emphasise that our main interest in this class is to help you actually learn the material, not to be police officers. If at any point in the term you are becoming concerned about your performance in the course, please talk to your TA or instructor. We will do what we can to help you learn the course material and get the best mark you can. If you feel that your performance is less than you wanted, the solution is to work hard and ask for help, not to cheat.

For us to be able to offer meaningful accommodations it is essential that we be able to trust the information that we are given. Cheating therefore also includes trying to claim exemptions or accommodations for which you are not eligible (for example, by willfully misrepresenting your circumstances when asking for one).

Please also see the statement on academic integrity immediately below.

Miscellaneous

Please see the course webpage listed on p. 1 for additional information about the course, including some comments on the choice of textbook.

(The following four passages are general information from statements suggested by the Faculty of Arts and Sciences. They are supplementary to the foregoing specific course information.)

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.

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 our part, we 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 support you in requesting accommodation for your course work. Remember that the process of accommodation 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.

Important dates

May 4	First day of classes (LEC5101 starts on May 5; LEC01010 on May 6)
May 18	Victoria Day (no office hours)
June 16	No class (LEC5101 and Tuesday tutorials)
June 17 – July 5	No classes (the term test will be held sometime between June 17–25)
July 6	Classes start again (LEC5101 on July 7; LEC0101 on July 8)
July 20	Last day to drop course
August 3	Civic holiday (no office hours)

August 17	Classes end (LEC5101 on August 13; LEC0101 on August 14)
August 19–27	The final assessment will be held during this week