PMATH 950 -- Topics in Analysis, Section 1: Riemann Surfaces
Course outline − Winter 2022

Instructor: Ruxandra Moraru
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Office hours: Th 2:30-4:30, or by appointment; delivered via Zoom.
Zoom link for office hours:
https://us02web.zoom.us/meeting/register/tZckcuyhrT8vHdFdMd6OAVPAu9f8Ja91ZqAH. You need to register to the meetings.

Lectures: MW 2:30 - 3:50 (DWE 3517)

Course webpage: Can be found at https://learn.uwaterloo.ca. This page contains course handouts (assignments and other) and is used to make announcements to the class. It is important that you register to the site and enter your email address to receive announcements.

Piazza page: All discussion forums for the course will be on the course's Piazza page. You can sign-up for the page at http://piazza.com/uwaterloo.ca/winter2022/pmath950001.

Overview: Riemann surfaces can be defined in several different, equivalent ways, for example as one-dimensional complex manifolds, or as oriented two-dimensional real manifolds. In addition, any compact Riemann surface can be embedded in projective space, thus giving it the structure of an algebraic curve. Riemann surfaces therefore appear in many areas of mathematics, from complex analysis, algebraic and differential geometry, to algebraic topology and number theory. This course will cover fundamentals of the theory of compact Riemann surfaces from an analytic and topological perspective.

Outline of topics: Riemann surfaces (definitions and examples, algebraic curves, quotients, modular curves); holomorphic maps; elliptic functions (Weierstrass and theta functions); sheaves and analytic continuation; maps between Riemann surfaces (basic properties, covering maps, monodromy and the Riemann Existence Theorem); holomorphic and meromorphic forms; de Rham and Dolbeault cohomology; harmonic forms and the Hodge decomposition; cohomology of sheaves; Riemann-Roch; Serre duality; maps to projective space; Riemann-Hurwitz formula; curves and their Jacobian; factors of automorphy and line bundles; the Uniformisation Theorem (time permitting).

Prerequisites: The course should be accessible to students who have taken PMATH 352 (Complex Analysis) or an equivalent course.

Required text (available online through the University of Waterloo library):

- O. Forster, *Lectures on Riemann Surfaces*, Springer-Verlag, 1981

Additional references:

- S. K. Donaldson, *Riemann Surfaces*, Oxford University Press, 2011
- R. Narasimhan, *Compact Riemann Surfaces*, Birhäuser, 1992

- H. M. Farkas and I. Kra, *Riemann Surfaces*, Springer-Verlag, 1992
- W. Schlag, *A course in complex analysis and Riemann surfaces*, American Mathematical Society, 2014
- F. Kirwan, *Complex Algebraic Curves*, Cambride University Press, 1992
- P. Griffiths, *Introduction to algebraic curves,* American Mathematical Society, 1989
- P. Griffiths and J. Harris, *Principles of Algebraic Geometry*, Wiley Interscience, 1978
- E. Arbarello, M. Cornalba, P. Griffiths and J. Harris, *Geometry of Algebraic Curves: Volume I*, Springer, 1985

We will also be using *Piazza* for online discussion of the course material and assignments.

Method of evaluation: Your final grade will be based on 3 assignments, to be handed in via crowdmark roughly every four weeks. Assignments will be posted on the course webpage and distributed via crowdmark.

(Tentative) schedule of assignments:

Monday, 31 Jan: Assignment 1
Monday, 7 Mar: Assignment 2
Monday, 4 Apr: Assignment 3

Academic Integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility. [Check http://www.uwaterloo.ca/academicintegrity/for more information.]

Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4, http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

Discipline: A student is expected to know what constitutes academic integrity to avoid committing academic offenses and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course professor, academic advisor, or the undergraduate associate dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, Student Discipline, http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm. For typical penalties check Guidelines for the Assessment of Penalties, http://www.adm.uwaterloo.ca/infosec/guidelines/penaltyguidelines.htm.
Appeals: A decision made or penalty imposed under Policy 70, Student Petitions and Grievances (other than a petition) or Policy 71, Student Discipline may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, Student Appeals, http://www.adm.uwaterloo.ca/infosec/Policies/policy72.htm.

Note for students with disabilities: The Office for Persons with Disabilities (OPD), located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate

accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the OPD at the beginning of each academic term.

Mental Health Support: The Faculty of Math encourages students to seek out mental health support if needed.

On-campus Resources:

- Campus Wellness https://uwaterloo.ca/campus-wellness/
- Counselling Services: counselling.services@uwaterloo.ca/ 519-888-4567 ext 32655
- MATES: one-to-one peer support program offered by Federation of Students (FEDS) and Counselling Services: mates@uwaterloo.ca
- Health Services: located across the creek from the Student Life Centre, 519-888-4096.

Off-campus Resources:

- Good2Talk (24/7): Free confidential help line for post-secondary students. Phone: 1-866-925-5454
- Here 24/7: Mental Health and Crisis Service Team. Phone: 1-844-437-3247
- OK2BME: set of support services for lesbian, gay, bisexual, transgender or questioning teens in Waterloo. Phone: 519-884-0000 extension 213

Diversity: It is our intent that students from all diverse backgrounds and perspectives be well served by this course, and that students' learning needs be addressed both in and out of class. We recognize the immense value of the diversity in identities, perspectives, and contributions that students bring, and the benefit it has on our educational environment. Your suggestions are encouraged and appreciated. Please let us know ways to improve the effectiveness of the course for you personally or for other students or student groups. In particular:

- We will gladly honour your request to address you by an alternate/preferred name or gender pronoun. Please advise us of this preference early in the semester so we may make appropriate changes to our records.
- We will honour your religious holidays and celebrations. Please inform of us these at the start of the course.
- We will follow AccessAbility Services guidelines and protocols on how to best support students with different learning needs.