Syllabus Analysis II spring 2023.

In the spring semester, Palle Jorgensen will be teaching the Analysis II graduate course. Details: MATH:6210:0001 (fyi: old course number 22M:211:001) Analysis II

Course Title and Details:

Analysis II

**MATH:6210:0001 Prerequisites:** MATH:6200 3 s.h. Delivery Mode: Open

Start and end times: 2:30P - 3:20P MWF 105 MLH

Instructors: Palle Jorgensen (Primary Instructor)

Jorgensen’s Office hours MWF 1:00-2:00 pm MLH 25B ph 3350782 email palle-jorgensen@uiowa.edu

Palle Jorgensen, palle-jorgensen@uiowa.edu Office Hour: 1:00-2:00 pm, MWF, or by appointment, office MLH 25b, ph 319 3350782.

DEO Contact Information:
Professor Ryan Kinser, 14 MLH, Kinser, Ryan D ryan-kinser@uiowa.edu

General Catalog [https://catalog.registrar.uiowa.edu/liberal-arts-sciences/mathematics/](https://catalog.registrar.uiowa.edu/liberal-arts-sciences/mathematics/)

From the catalogue: Note the catalogue details serve as starting points, but the material covered will be tailored to the students who register.

**Catalogue:** “Hilbert space, Banach space techniques; Hahn-Banach theorem, open mapping theorem, principle of uniform boundedness; reflexivity, H-p spaces, Paley-Wiener theorem, space of functions that are analytic on the open unit disk. Riemann surfaces, conformal geometry, spaces of analytic functions and their applications.”

**Topics and aim.** I stress that this course can be tailored to the needs of students registered in the class.
The course covers central and core topics in analysis, concentrating on complex analysis, but also a variety of related topics. See also the TOC below.
This includes the key tools in **complex analysis** (analytic functions in one and in several variables), and with an emphasis on applications, both to related areas within math such as harmonic analysis, complex geometry, and complex dynamics (e.g., Julia set algorithms), and PDE; as well areas of engineering, e.g., filters and algorithms used in signal/image processing, and in systems theory.

**The level** will be adjusted to the students who register.

If you have questions or suggestions, email me: palle-jorgensen@uiowa.edu
In class, will begin with a review (even though the fundamentals of analytic function theory are covered in a 5000 course), and I adjust topic-selection to students who are signed up; so flexible about prerequisites.

Course Text: The primary book for the course will be the second half of W. Rudin, Real and Complex Analysis, 3rd ed, chapters 10 through 20. Chs 1-9 were covered last semester. (But for Analysis II, you need not be already familiar with chs 1-10.) Title, author, publisher, ISBN:

Real and Complex Analysis (Higher Mathematics Series) 3rd Edition
Fyi.: The third edition of the book includes new chapters. Proofs of theorems presented in the book are concise and complete and many challenging exercises appear at the end of each chapter. The book is arranged so that each chapter builds upon the other, giving students a gradual understanding of the subject.

This text is part of the Walter Rudin Student Series in Advanced Mathematics.

In addition to the book by Rudin, we will supplement with current research texts; tailored to specific student needs. And with topics suggested by students in class.
Indeed, in this course, I also supplement with topics from other books, and topics of interest to students in the class. As you know, the 6000 level courses are extremely helpful when you think about plans for your PhD-thesis research.
The list of key course topics includes: One and several complex variables, contour integrals, conformal maps, Riemann surfaces, complex manifolds, conformal geometry, harmonic analysis (especially H^p spaces), functional and harmonic analysis, Hilbert spaces arising from analytic continuation of Fourier transforms (many important applications, e.g., signals and frequency bands), approximation by polynomials and by rational functions. Also covered will be connections to neighboring areas, e.g., to PDEs, to geometry, numerical analysis, functional analysis, and operator theory. An exciting new direction: complex dynamics, see e.g., L. Carleson and J. Milnor: https://www.amazon.com/Complex-Dynamics-Universitext-Lennart-Carleson/dp/0387979425 and https://www.amazon.com/Dynamics-One-Complex-Variable-AM-160/dp/0691124884/ref=sr_1_3?crid=16J60HG5SSZB4&dchild=1&keywords=john+milnor&qid=1608314326&s=books&sprefix=john+milnor%2Cstripbooks%2C150&sr=1-3

PS: Even though the course is called Analysis II, the topics from Analysis I are not prerequisites, and the extent to which stuff from Analysis I will be needed, I will supply the necessary review.

Fyi about the course, in more detail. The course will be about central topics in analysis, concentrating on complex analysis, and related.
The level will be adjusted to the students in the class. Even though the fundamentals of analytic function theory are covered in an analysis 5000 course, I will begin with a review, and will be able to adjust the selection of topics to students who are signed up. I am flexible about prerequisites. Even though the course is called Analysis II, the topics from Analysis I are not prerequisites, and the extent to which stuff from Analysis I will be needed, I will supply the necessary review.

Grading policy: participation 25%, homework 30%, midterms 25%, final 20%.

Homework is assigned weekly, and due every Wednesday. You may hand in in class, or via ICON uploads, like in Analysis I we will also work out student class presentations in place of other assignments and exams. One Midterm, and one Final.

Primary Text: Rudin: The primary book for the course will be the second half of W. Rudin, Real and Complex Analysis, 3rd ed, chapters 10 through 20. (You need not be already familiar with chs 1-10.) But we will also have supplements. But I expect to also supplement with several other books and topics of interest to students in the class. Both theories, research papers, and diverse applications. The 6000 level courses are typically designed to be helpful to students who think about their PhD research.


Fyi./time table: TOC Rudin’s book, chapters, sections, and page numbers. Roughly one week per chapter. But key-results in the first 3 chapters will be familiar to most students from the 5000 level Complex class. So we move fast through chs 10-12.

Chapter 10 Elementary Properties of Holomorphic Functions 196
Complex differentiation 196
Integration over paths 200
The local Cauchy theorem 204
The power series representation 208
The open mapping theorem 214
The global Cauchy theorem 217
The calculus of residues 224.

Chapter 11 Harmonic Functions 231
The Cauchy-Riemann equations 231
The Poisson integral 233
The mean value property 237
Boundary behavior of Poisson integrals 239
Representation theorems 245.

Chapter 12 The Maximum Modulus Principle 253
Introduction 253
The Schwarz lemma 254
The Phragmen-LindelOf method 256
An interpolation theorem 260
A converse of the maximum modulus theorem 262.

**Chapter 13 Approximation by Rational Functions** 266
Preparation 266
Runge's theorem 270
The Mittag-Lerner theorem 273
Simply connected regions 274.

**Chapter 14 Conformal Mapping** 278
Preservation of angles 278
Linear fractional transformations 279
Normal families 281
The Riemann mapping theorem 282
The class \( \mathcal{H} \) 285
Continuity at the boundary 289
Conformal mapping of an annulus 291.

**Chapter 15 Zeros of Holomorphic Functions** 298
Infinite products 298
The Weierstrass factorization theorem 301
An interpolation problem 304
Jensen's formula 307
Blaschke products 310
The Miintz-Szasz theorem 312.

**Chapter 16 Analytic Continuation** 319
Regular points and singular points 319
Continuation along curves 323
The monodromy theorem 326
Construction of a modular function 328
The Picard theorem 331.

**Chapter 17 HP-Spaces** 335
Subharmonic functions 335
The spaces \( \mathcal{H}^p \) and \( \mathcal{N} \) 337
The theorem of F. and M. Riesz 341
Factorization "theorems 342
The shift operator 346
Conjugate functions 350.

**Chapter 18 Elementary Theory of Banach Algebras** 356
Introduction 356
The invertible elements 357
Ideals and homomorphisms, Gelfand theory 362
Applications 365.

**Chapter 19 Holomorphic Fourier Transforms** 371
Introduction 371
Two theorems of Paley and Wiener 372
Quasi-analytic classes 377
The Denjoy-Carleman theorem 380.

**Chapter 20 Uniform Approximation by Polynomials** 386
Introduction 386
Some lemmas 387
Mergelyan's theorem 390.

The combined list of course-topics is flexible, as per student requests, and it includes: One and several complex variables, contour integrals, conformal maps, Cauchy’s theorems, conformal geometry, Riemann mapping, Riemann surfaces, complex manifolds, harmonic analysis (especially $H^p$ spaces), analytic continuation of the Fourier transform, Hilbert spaces arising from analytic continuation of Fourier transforms (many important applications), Reproducing Kernel Hilbert Spaces (RKHS) of analytic functions, and their applications, approximation by polynomials and by rational functions. Also covered will be connections to neighboring areas, e.g., to PDEs, to geometry, operator theory, spectral theory, numerical analysis, functional analysis. New directions include: complex dynamics, see e.g.,
https://www.amazon.com/Complex-Dynamics-Universitext-Lennart-Carleson/dp/0387979425

Dates for midterms and the final exam will be announced in class and in ICON. Weekly homework due on Wednesdays. Palle Jorgensen, palle-jorgensen@uiowa.edu .

Academic Calendar sp 2023.

January 16       Martin Luther King Jr. Convocation, all classes suspended, offices closed
January 17       Opening of classes
March 12-19      Spring break
March 20         Classes resume
May 5           Close of classes
May 8-12        Final examination week.

From the University: Academics and the Classroom Experience

- Classes for the spring 2023 semester will be offered in similar formats as the fall 2020 semester, with a blended format that includes online and face-to-face instruction.
- Unless otherwise indicated, applicable face masks (cloth mask, disposable mask, or face shield with mask) must be worn in classrooms.
- Where social distancing is not possible due to permanently located equipment (e.g., lecture podiums, pottery wheels) or specific course requirements (e.g., lab-based courses, clinical simulations), physical barriers such as plexiglass panels between students (and between students and instructors) should be utilized.
- The university will utilize the grading system that was in effect prior to the pandemic.

For the list of CLAS policies for grad courses, see below.

Supplementary Graduate seminars, fyi. Open to all, but not required.
Often graduate students in our Analysis 6000 sequence also attend weekly seminars. The Math Dept website maintains and updates a website with all the seminars that run during the semester.
Relevant to students in Analysis II, we have two standing seminars with analysis topics, they take place on Tuesdays every semester, spring or fall.

If we manage to go hybrid, I will update you. The classroom we have used for a long time is in the physics building, VAN 309.
The seminars are timed as follows, Tuesdays 1:30 Operator Theory, and 2:30 Mathematical Physics.

The title of the seminars, OT (Operator theory), and MP (Math physics), are to be understood in the broad sense, and we always have a lot of analysis topics. In fact, a diverse areas of math, of physics, and their interconnections.

What is even better is that graduate students are encouraged to suggest topics, and also to present, in the seminars. The organizational meeting for the combined pair of seminars will be Tuesday 1/26 at 1:30 pm. If you might be interested in presenting, just send me an email. More fyi to follow. From ICON:

Main Site - MATH:7290:0231 Spr21 Seminar: Operator Theory

Organization. we will the seminars every Tuesday in person in VAN 309 (VAN is the physics building), and also make the zoom link be available for anyone who is interested in our seminars. For example, we want to make sure that this access is not restricted to folks who are registered in the ICON system.

We welcome everyone to our seminars. The idea is that we offer students choices, for example, to take one or both of our seminars as a grad course, or alternatively just attend seminars as part of your thesis research. Also an opportunity for you to expand your research horizons. If you go to one or more seminars, you may also select to go to some but not all talks.

Recommendation.

Resources and tips for accessing the journal literature: Get used to MathSciNet.

https://mathscinet.ams.org/mathscinet/ log in with your university ID.

MathSciNet - The University of Iowa http://purl.lib.uiowa.edu › mathscinet

Also useful: Zentralblatt: http://journalseek.net/cgi-bin/journalseek/journalsearch.cgi?field=issn&query=0044-4103
ATTENDANCE AND CLASSROOM EXPECTATIONS.
Students are responsible for attending class and for knowing an instructor’s attendance policies, which vary by course and content area. All students are expected to attend class and to contribute to its learning environment in part by complying with University-policies and directives regarding appropriate classroom behavior or other matters.

ABSENCES.
Students are responsible for communicating with instructors as soon they know that an absence might occur or as soon as possible in the case of an illness. Delays in communication could result in a forfeit of what otherwise might be an excused absence.

ABSENCES: ILLNESS, UNAVOIDABLE CIRCUMSTANCES, AND UNIVERSITY SPONSORED ACTIVITIES.
Students who are ill, in an unavoidable circumstance affecting academic work, or who miss class because of a University-sponsored activity are allowed by UI policy to make up a missed exam. Documentation is required by the instructor except in the case of a brief illness. Students are responsible for communicating with instructors as soon as the absence is known (https://opsmanual.uiowa.edu/students/absences-class#8.1).

ABSENCES: HOLY DAYS.
The University is prepared to make reasonable accommodations for students whose religious holy days coincide with their classroom assignments, test schedules, and classroom attendance expectations. Students must notify their instructors in writing of any such Religious Holy Day conflicts or absences within the first few days of the semester or session, and no later than the third week of the semester. If the conflict or absence will occur within the first three weeks of the semester, the student should notify the instructor as soon as possible. See Operations Manual 8.2 Absences for Religious Holy Days for additional information.

ABSENCES: MILITARY SERVICE OBLIGATIONS.
Students absent from class due to U.S. veteran or U.S. military service obligations (including military service-related medical appointments, military orders, and National Guard Service obligations) must be excused without penalty. Instructors must make reasonable accommodations to allow students to make-up exams or other work. Students must communicate with their instructors about the expected possibility of missing class as soon as possible. (For more information, see https://opsmanual.uiowa.edu/iv-8-absences-class%C2%A0%A0-0).

ACADEMIC MISCONDUCT.
Plagiarism and the process for addressing academic misconduct of graduate students are defined in Section IV, Article F “Plagiarism by Graduate Students” of the UI Graduate College Manual of Rules and Regulations. Please contact the CLAS Associate Dean for Graduate Education for any necessary assistance in navigating the process mandated by the Graduate College.

ACADEMIC ACCOMMODATIONS.
The University is committed to providing an educational experience that is accessible to all students. If a student has a diagnosed disability or other disabling condition that may impact the student’s ability to complete the course requirements as stated in the syllabus, the student may seek accommodations through Student Disability Services (SDS). SDS is responsible for making Letters of Accommodation (LOA) available to the student. The student must provide a LOA to the instructor as early in the semester as possible, but requests not made at least two weeks prior to the scheduled activity for which an accommodation is sought may not be accommodated. The LOA will specify what reasonable course accommodations the student is eligible for and those the instructor should provide. Additional information can be found on the SDS website. Note that accommodations are not granted retroactively but from the time of the student’s request to the instructor onward. Graduate students serving as Teaching Assistants, Research Assistants, or Fellows must contact Faculty and Staff Disability Services (https://hr.uiowa.edu/support/faculty-and-staff-disability-services) for assistance with accommodations.

CLASS RECORDINGS: PRIVACY AND SHARING. Course lectures and discussions are sometimes recorded or live-streamed. These are only available to students registered for the course and the intellectual property of the faculty member. These materials may not be shared or reproduced without the explicit written consent of the instructors. Students may not share these recordings with those who are not enrolled in the course; likewise, students may not upload recordings to any other online environment. Doing so is a breach of the Code of Student Conduct and could be a violation of the Federal Education Rights and Privacy Act (FERPA); also see https://dos.uiowa.edu/policies/code-of-student-life/.

COMMUNICATION: UI EMAIL Students are responsible for all official correspondences sent to their UI email address (uiowa.edu) and must use this address for any communication with instructors or staff in the UI community (Operations Manual, III.15.2). Emails should be respectful and brief, with complex matters addressed during the instructor’s drop-in hours, for example. Faculty are not expected to answer email after business hours or during the weekends.

FREE SPEECH AND EXPRESSION. The University of Iowa supports and upholds the First Amendment protection of freedom of speech and the principles of academic and artistic freedom. We are committed to open inquiry, vigorous debate, and creative expression inside and outside of the classroom. Visit Free Speech at Iowa for more information on the University’s policies on free speech and academic freedom: https://freespeech.uiowa.edu/.

COMPLAINTS ABOUT ACADEMIC MATTERS. Students with a complaint about a grade or a related academic matter should first visit with the instructor and then with the course supervisor (if applicable), and finally with the director of the school, department, or program offering the course. If a graduate student has not been able to resolve the issue through the director of the school, department, or program, they should contact the associate dean for graduate education in the College of
Final Exam Policies.
The final exam schedule is published during the fifth week of the fall and spring semesters or on the first day of summer classes; students are responsible for knowing the date, time, and place of their final exams. Students should not make travel plans until knowing this information. A student with exams scheduled on the same day and time or who have more than two final exams on the same day should visit this page for how to resolve these problems by the given deadline (https://registrar.uiowa.edu/makeup-final-examination-policies).

No exams are allowed the week before finals, but with some exceptions made for labs, language courses, and off-cycle courses (https://registrar.uiowa.edu/final-examination-scheduling-policies).

Home of the Course.
The College of Liberal Arts and Sciences (CLAS) is the home of this course, and CLAS governs the policies and procedures for its courses. Graduate students, however, must adhere to the academic deadlines set by the Graduate College. See https://grad.uiowa.edu/academics/deadlines.

Mental Health.
Students are encouraged to be mindful of their mental health and seek help as a preventive measure or if feeling overwhelmed and/or struggling to meet course expectations. Students are encouraged to talk to their instructor for assistance with specific class-related concerns. For additional support and counseling, students are encouraged to contact University Counseling Service (UCS). Information about UCS, including resources and how to schedule an appointment, can be found at counseling.uiowa.edu. Find out more about UI mental health services at: mentalhealth.uiowa.edu. Student Health can also address related concerns (https://studenthealth.uiowa.edu/).

These visits are free to students. After hours, students are encouraged to call the Johnson County Community Crisis Line at (319) 351-0140 or dial 911 in an emergency.

Non-Discrimination Statement.
The University of Iowa prohibits discrimination in employment, educational programs, and activities on the basis of race, creed, color, religion, national origin, age, sex, pregnancy, disability, genetic information, status as a U.S. veteran, service in the U.S. military, sexual orientation, gender identity, associational preferences, or any other classification that deprives the person of consideration as an individual. The university also affirms its commitment to providing equal opportunities and equal access to university facilities. For additional information on nondiscrimination policies, contact the Director, Office of Institutional Equity, the University of Iowa, 202 Jessup Hall, Iowa City, IA 52242-1316, 319-335-0705, oie-ui@uiowa.edu. Students may share their pronouns and chosen/preferred names in MyUI, which is accessible to instructors and advisors.

Sexual Harassment.
The University of Iowa prohibits all forms of sexual harassment, sexual misconduct, and related retaliation. The Policy on Sexual Harassment and Sexual Misconduct governs actions by students, faculty, staff and visitors. Incidents of sexual harassment or sexual misconduct can be
reported to the Title IX and Gender Equity Office or to the Department of Public Safety. Students impacted by sexual harassment or sexual misconduct may be eligible for academic supportive measures and can learn more by contacting the Title IX and Gender Equity Office. Information about confidential resources can be found here. Watch the video for an explanation of these resources.

Fyi; the UI College of Liberal Arts and Sciences (CLAS), from the Dean.

You can get a COVID-19 vaccination at a variety of locations including health clinics, grocery stores, and pharmacies. Find a location near you at vaccines.gov or get your booster or flu shot at Student Health.

free COVID-19 tests for pick-up or mail delivery through Test Iowa.

**Mask recommendation:** The university strongly encourages face coverings in all indoor spaces regardless of your vaccination status. Level 1 medical grade masks are available in all campus buildings.

An essential part of having a healthy community is the responsibility we have to each other, so we’re asking you to do your part. We will get through this together with everyone’s help. We can’t wait to welcome you back this semester and thank you for all you are doing to ensure a healthy Hawkeye community.

**Dean Sara Sanders, PhD, MSW, College of Liberal Arts and Sciences.**

https://coronavirus.uiowa.edu/vaccine-information

**From the Dean: Communication to faculty and students:** You are encouraged to use the statement below in communications to your students, on your ICON course site, and/or in your syllabus. Please note that any published statement may need to be updated as new guidance is released.

“*The University of Iowa strongly encourages students, faculty, and staff to be vaccinated and boosted against COVID-19. The university also encourages students, faculty, and staff to wear a face mask while on campus, and strongly encourages the use of face masks in all classroom settings and during in-person office hours. However, face mask usage is not required except on CAMBUS and in specified research and healthcare settings.*”

PS.
COVID issues, from the University: the correct links:

- **Form**: COVID-19 Self-reporting
- **Form**: Instructor modality change request

University: Information on required syllabi elements may be found in the Operations Manual Sections 15.2.k and l. Specific language regarding free speech and expression, accommodations for students with disabilities, and class absences for religious holy days is provided below.