# Math 421-001

*Complex Analysis*

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## Course Information

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|---|---|---|---|
| Course Time: | M, W, F: 1:25 - 2:15 pm | Office Hours: | W, F (9 - 11 am), Th (1 - 3 pm) |
| Course Location: | Nick 171 | Office Location: | Benson 87 |

## Textbooks and Software

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|---|---|
| A First Course in Complex Analysis: | https://matthbeck.github.io/papers/complexorth.pdf |
| MATLAB | |

## Course Format

As Paul Halmos noted, "The only way to learn mathematics is to do mathematics." Hence, we will spend the majority of our in-person class time doing mathematics. In particular, there will be a short quiz at the beginning of each class, which usually covers important definitions, theorems, or problem solving techniques. The remaining class time is a mixture of lecture and class exercises.

## Learning Outcomes

Upon successful completion of the course, students will be able to

○ Complex Numbers
  - Explain with examples the basic algebraic and geometric properties of the complex field.
  - Perform operations associated with the algebraic manipulation of complex numbers.
○ Differentiation
  - Explain with examples the definition of differentiability for complex functions.
  - Define holomorphic and entire functions.
  - Apply the Cauchy-Riemann equation and the real-differentiable concept to give necessary and sufficient conditions on the complex differentiability of a function.
  - Apply the Cauchy-Riemann equation to harmonic functions.
○ Visual Complex Functions
  - Explain with examples the phase portrait of a complex function.
  - Define Möbius transformations, stereographic projections, and work with the Riemann Sphere.
  - Visualize the complex logarithm, exponential, and trigonometric functions.
○ Integration
  - Explain with examples the definition of integration for complex functions.
  - Prove the Cauchy-Goursat theorem and use it to prove Cauchy's integral formula.
  - Apply Cauchy's integral formula to computing antiderivatives of complex functions.
○ Series
  - Explain with examples power series and Laurent series.
  - Identify power series representations of functions and region of convergence.
  - Explain with examples the relationship between power series, analytic functions, and holomorphic functions.
○ Residue Theorem
  - Classify singularities.
  - Prove the Residue theorem and describe the argument principle and its uses.
  - Apply residue theorem to Rouchés theorem and discrete applications (infinite sums, binomial coefficients, Fibonacci numbers, the 'coin-exchange problem', and Dedekind sums.

# ▬▬▬ Covid Related Issues

## Masking

Masking is no longer required in most areas on campus, with some exceptions. In addition to these areas, which will be marked with signage, and masking when sick or after testing positive for COVID-19, the university encourages anyone who wishes to wear a mask on campus to feel free to do so.

## Student Absences due to illness

Student absences due to illness, be it Covid-19 or another illness, will be treated as before the pandemic. Penn State is no longer communicating students' isolation status to instructors. If a long term absence extends to a large portion of the semester, we recommend the student contact Student Affairs about the possibility of a withdrawal for the semester.

# ▬▬▬ Grading Policy

Your final grade is broken up as follows.

| Category | Percentage |
| --- | --- |
| Office Hours | 5% |
| Daily Quizzes | 10% |
| Homework Assignments | 30% |
| Exams (10% each) | 30% |
| Final Project | 25% |

Your final letter grade is based on the following scale.

| Grade | Percentage Interval | Grade | Percentage Interval |
| --- | --- | --- | --- |
| A | $[93, 100]$ | C+ | $[77, 80)$ |
| A- | $[90, 93)$ | C | $[70, 77)$ |
| B+ | $[87, 90)$ | D | $[60, 70)$ |
| B | $[83, 87)$ | F | $[0, 60)$ |
| B- | $[80, 83)$ | | |

# ▬▬▬ Assignment Descriptions

## Office Hours

Each student must attend at least 3 office hour sessions, or an alternative meeting time, by the end of the semester. Credit will be given only if questions/discussions are had regarding course material.

## Quizzes

Daily quizzes are assigned during the first 5 minutes of each class period. These short quizzes cover pertinent definitions, theorems, and problem solving methods. In addition, these quizzes serve as an attendance marker.

## Homeworks

To help develop a mastery of the material, students will be given several homework assignments which cover the material in greater depth. The students are expected to write out their answers with an appropriate amount of work shown. If the student has an excused absence, they will be given additional time to complete the assignment. However, the student must communicate with the instructor prior to the assignment deadline.

## Exams

We will have 3 exams throughout the semester. These exams are intended to test your general understanding of the concepts covered up to that point, with a heavy emphasis on the main definitions, theorems, and problem solving methods. These exams will be administered in class; only those with an excused absence will be given additional time to complete the exam. Again, the student must communicate with the instructor prior to the exam date.

## Final Project

During the last two weeks of class, students will explore topics from the course and their applications in further detail. In the last week, students will present their findings to the class.

## Academic Integrity

Academic integrity is a basic guiding principle for all academic activity at the University, and all members of the community are expected to adhere to this principle. Specifically, academic integrity is the pursuit of scholarly activity in an open, honest, and responsible manner. It includes a commitment not to engage in or tolerate acts of falsification, misrepresentation, or deception. Such acts violate the fundamental ethical principles of the University community and undermine the efforts of others.

Violations of academic integrity are not tolerated at Penn State Behrend. Violators will receive academic sanctions and may receive disciplinary sanctions, including the awarding of an XF grade. In cases such as these, an XF grade is recorded on the transcript and states that failure of the course was due to an act of academic dishonesty. All acts of academic dishonesty are recorded so those repeat offenders can be sanctioned accordingly. For more information:

> http://behrend.psu.edu/for-faculty-staff/faculty-resources/academic-integrity

## Extra Help

Dot not hesitate to come to my office during office hours or by appointment to discuss a homework problem or any aspect of the course. You also may want to consider the Math Lab (located on the second floor of Roche Hall) or the Learning Resource Center (located in the library). Hours can be found here:

> http://psbehrend.psu.edu/Academics/academic-services/lrc.

See a schedule for all options on TutorTrac at https://tutorapp.bd.psu.edu

## Disabilities and Learning Differences

Penn State is strongly committed to providing full access to its programs and services for all individuals. The University encourages academically qualified students with disabilities to take advantage of the educational programs and accommodations offered at Penn State Behrend. For more information:

> http://behrend.psu.edu/student-life/educational-equity-and-diversity/
> student-resources/students-with-disabilities-and-learning-differences

## Educational Equity Concerns

Penn State takes great pride to foster a diverse and inclusive environment for students, faculty, and staff. Acts of intolerance, discrimination, harassment, and/or incivility due to age, ancestry, color, disability, gender, national origin, race, religious belief, sexual orientation, or veteran status are not tolerated and can be reported through Educational Equity at the Report Bias site:

> https://equity.psu.edu/reportbias

## Counseling and Psychological Services

Students with academic concerns related to this course should contact the instructor in person or via email. Students also may occasionally have personal issues that arise in the course of pursuing higher education that may interfere with their academic performance. If you find yourself facing problems affecting your coursework, you are encouraged to talk with an instructor and to seek confidential assistance at the Penn State Behrend Personal Counseling Services at (814) 898-6504. For more information:

> http://psbehrend.psu.edu/student-life/student-services/personal-counseling

## Copyright of Class Materials

You may not share any information from this course (including notes and assignments) with others who are not currently registered for the course, nor post such information electronically without the permission of the instructor–this includes online note-taking/note-sharing services (See Penn State Administrative Policy AD-40). Also prohibited in the policy is the posting of audio, video, or photographs posted to social media sites or other publicly accessible resources. Unless you have my permission, you risk disciplinary sanctions.

## ▬▬ Title IX

Penn State is committed to fostering an environment free from sexual or gender-based harassment or misconduct. The Office of Sexual Misconduct Prevention and Response ensures compliance with Title IX, a federal law that prohibits discrimination based on the sex or gender of employees and students. Behaviors including sexual harassment, sexual misconduct, dating violence, domestic violence, and stalking, as well as retaliation for reporting any of these acts violate Title IX and are not tolerated. The University is also committed to providing support to those who may have been impacted by incidents of sexual or gender-based harassment or misconduct and may provide various resources and support services to individuals who have experienced one of these incidents. For more information:

https://universityethics.psu.edu/our-expertise/title-ix

or

https://universityethics.psu.edu/our-expertise/title-ix/t9-resources/campus-resources/behrend

## ▬▬ Important Dates

Classes Begin ......................................................................... January 13
Regular Drop Deadline ...................................................... 11:59 pm January 18
Regular Add Deadline ....................................................... 11:59 pm January 19
MLK ................................................................................ January 20
Exam 1 ............................................................................ February 14
Final Exam Conflict Filing Period .............................. February 17 – March 9
Exam 2 ................................................................................ March 7
Spring Break ................................................................... March 9 – 15
Late Drop Deadline ............................................................... April 11
Exam 3 ................................................................................ April 18
Classes End ............................................................................. May 2
Final Exams ................................................................... May 5 – May 9

## ▬▬ Disclaimer:

I reserve the right to diverge from this syllabus in the best interest of my students learning and achievement. Any changes made will be announced in advance.