

MATH-455: INTRO. NUMERICAL ANALYSIS I
Fall 2021

Numerical precision is the very soul of science.

Sir D'Arcy Wentworth Thompson, 1942

Professor:	Thomas R. Cameron	Time:	M W F 9:05 – 9:55 am
Email:	trc5475@psu.edu	Place:	Nick 156
Office:	Prischak P18		

Course Page: https://www.thomasrcameron.com/courses/Math-455/math_455.html

Canvas Page: <https://psu.instructure.com/courses/2126443>

Office Hours: M W F 10:00 - 11:00 am, T Th 3:00 - 4:00 pm

Textbook: None required, a generous amount of resources, such as class notes, will be provided

Programming Language: Python (<https://www.python.org>)

Programming IDE: Replit (<https://replit.com>)

Prerequisite: (CMPSC 201 or CMPSC 202 or CMPSC 121 or CMPSC 131) and MATH 220 and (MATH 230 or MATH 231)

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 and concepts related to the current material. The quiz is turned in during the first 5 minutes of class. Afterwards, I will give a short lecture and students will break into groups to work on the daily exercises, which are not turned in for credit. At the end of class, solutions to the exercises are discussed.

Masking: Penn State University requires everyone to wear a face mask in all university buildings, including classrooms, regardless of vaccination status. ALL STUDENTS MUST wear a mask appropriately (i.e., covering both your mouth and nose) while you are indoors on campus. This is to protect your health and safety as well as the health and safety of your classmates, instructor, and the university community. Anyone attending class without a mask will be asked to put one on or leave. Instructors may end class if anyone present refuses to appropriately wear a mask for the duration of class. Students who refuse to wear masks appropriately may face disciplinary action for Code of Conduct violations. If you feel you cannot wear a mask during class, please speak with your adviser immediately about your options for altering your schedule.

Course Description: An introduction to floating point arithmetic, numerical rootfinding, interpolation, numerical quadrature, and direct methods for solving linear systems. Students may take only one course for credit from MATH 451 and MATH 455.

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

- Describe how floating point numbers are represented in a computer and determine consequences for absolute and relative round-off error.
- Manipulate arbitrary Taylor polynomial expressions to derive numerical approximations, for example for derivative values and Newton’s method.
- Form interpolating polynomials through arbitrary points and use them to derive numerical methods, for example in integration.

- Compare advantages and disadvantages of alternative numerical methods to solve problems in certain areas, e.g., non-linear equations and integration.
- Write Python implementations for the basic algorithms discussed.
- Decide which curve-fitting tool (least-squares, interpolation, splines, etc.) is more appropriate for specific applications.
- Use error bounds and condition numbers to compare accuracy for methods and for specific problems.

Grading Policy:

Your final grade is broken up as follows.

Category	Percentage
Daily Quizzes	10%
Lab Assignments	25%
Homework Assignments	25%
Exams (10% each)	30%
Final Project	10%

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)		

Daily Quizzes: Daily quizzes are assigned during the first 5 minutes of each class period. These short quizzes cover pertinent definitions and theorems that students should know in order to effectively work on the class exercises. In addition, these quizzes serve as an attendance marker. To help alleviate students' concern with missing quizzes due to absence, the three lowest quiz scores will be dropped. Under certain cases, students may be eligible for makeup assignments.

Lab Assignments: It is best to interact with the theory in numerical analysis by writing programs to see that the concepts do in fact work. The Python programming language is easy to learn and very common in scientific computation. Therefore, we will have several lab assignments where the students will implement the

course concepts in Python. To help alleviate students' concern with missing quizzes due to absence, the three lowest quiz scores will be dropped. Under certain cases, students may be eligible for makeup assignments.

Homework Assignments: To help develop a mastery of the material, students will be given several homework assignments which cover the material in greater depth. Not only are these problems more challenging, but the students are held to a higher expectation with regards to the clarity and precision of their solution. If the student has an excused absence, they will be given additional time to complete the assignment. Regarding this matter, 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 algorithms covered. The questions will be theory based, i.e., no programming will be required. These exams will be administered in class and are designed to be finished within 30 minutes, leaving enough time for everyone to complete. If the student has an excused absence, they will be given additional time to complete the assignment. Regarding this matter, the student must communicate with the instructor prior to the assignment deadline.

Final Project: No course can cover all aspects of numerical analysis. Therefore, students will be given an opportunity to research their own numerical analysis topics during the last two weeks of class. A list of potential topics will be provided, but students are encouraged to come up with their own topics. Depending on the class size, the projects may be done individually or in small groups. Presentations will be given during the last two class periods.

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: Do 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: <http://titleix.psu.edu/> or

<http://titleix.psu.edu/resources-penn-state-erie-the-behrend-college/>

Important Dates:

Classes Begin	August 23
Regular Drop Deadline	11:59 pm August 28
Regular Add Deadline	11:59 pm August 29
Labor Day (No Class)	September 6
Exam 1	September 24
Final Exam Conflict Filing Period	September 27 – October 17
Exam 2	October 29
Late Drop Deadline	November 12
Exam 3	November 19
Thanksgiving	November 21 – 28
Final Project Work Days	November 29 – December 6
Final Project Presentations	December 8 – 10
Classes End	December 10
Final Exams	December 13 – 17

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.