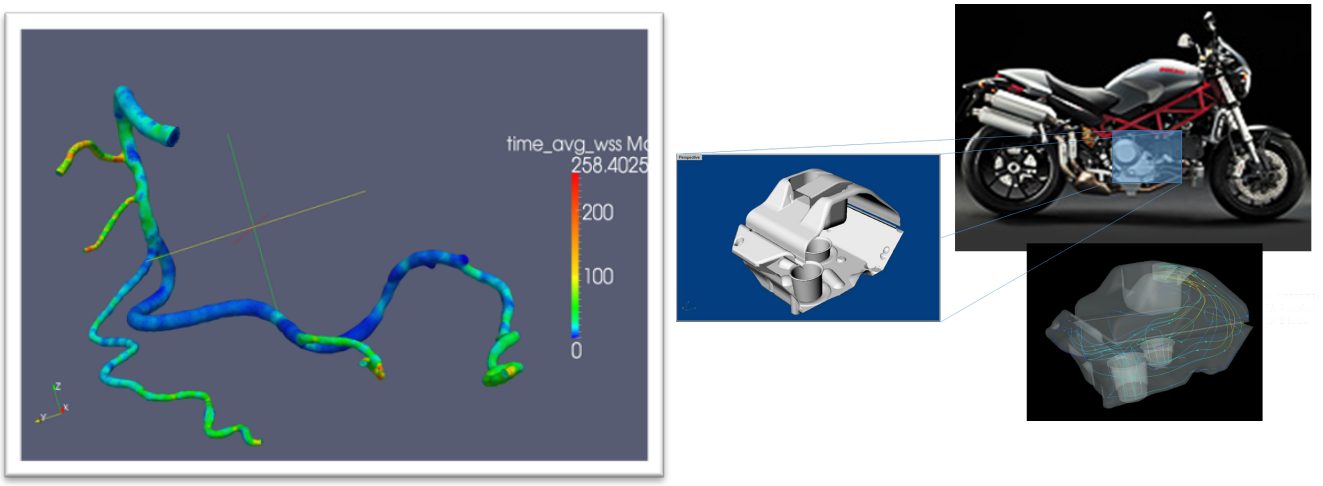
Math 315, Fall 2023 – Course Syllabus
Numerical Analysis

Section 1 - A.Veneziani

Do you want to know how your blood flows in the arteries? Do you want to design a new motorcycle? *Do you love to connect mathematical concepts to real problems?* This course is for you.

Not all mathematical problems can be practically solved by hand. Try to solve by hand a generic linear system of 100x100 equations! (Consider that for state-of-art simulations, we need to solve 10^6 x10^6 systems). Or find the root of a complicated nonlinear equation of interest when a graph shows that a root exists. On the other hand, sometimes we have limited information on a problem; for instance, we have data only in some time instants, and we would like to know what happens in between. In all these cases, we can design methods that can find a quantitative solution with the help of a computer. The more powerful the computer, the harder the problems we can solve. Numerical Analysis is all about the design of these methods, the assessment of their performance, and the understanding of how they work. We will combine theoretical concepts and hands-on sessions to connect theory and practice. You will discover that the theory behind the design of these algorithms is your first and most precious friend to understand if your code is correct. After completing this course, you will be able to analyze numerical methods for the solution of large linear systems, root-finding of nonlinear problems, and other important problems in applied science, as well as to write and test codes that implement those methods.



Course Information

Instructors

	Course Instructor	**Teaching Assistant**
Name	Alessandro Veneziani	Katherine Keegan

Email	avenez2@emory.edu	katherine.emiri.keegan@emory.edu

Weekly Schedule

Note: all times are given based on Atlanta, GA (ET)

	Time	**In-Person Location**	**Remote Location**
Lectures	TT 11:30 am – 12:45 pm	MSC W303	Upon request
Lab Sessions	F 11:30 am – 12:20 pm	MSC W303	Upon request
Office Hours	F 9:30-11 am		

- Office hours are designed to answer your questions. This is your time – use it! You are always welcome to email the instructor directly to ask questions or to request an appointment.
- Instructor's office just moved to **White Hall 307** (on the other side of Dowman Dr. with respect to Math & Science) should be completed. Old documents may have out-of-date information.

Prerequisites

(MATH 221 or MATH_OX 221 or MATH 275 or MATH 321) and (CS 170 or CS_OX 170) or equivalent transfer credit as a prerequisite

Textbook

Introduction to Scientific Computing using Matlab, by I. Gladwell, J. G. Nagy and W. E. Ferguson, Jr.

The textbook will be available through Canvas.
Additional resources I will use:

- Johansson R, Johansson R, John S. Numerical python. New York: Apress; 2019.
- Quarteroni, Alfio, Riccardo Sacco, and Fausto Saleri. *Numerical mathematics*. Vol. 37. Springer Science & Business Media, 2010.
- Quarteroni, Alfio, Fausto Saleri, and Paola Gervasio. *Scientific computing with MATLAB and Octave*. Vol. 3. Berlin: Springer, 2006.

The excerpts of these books you need will also be posted on Canvas.

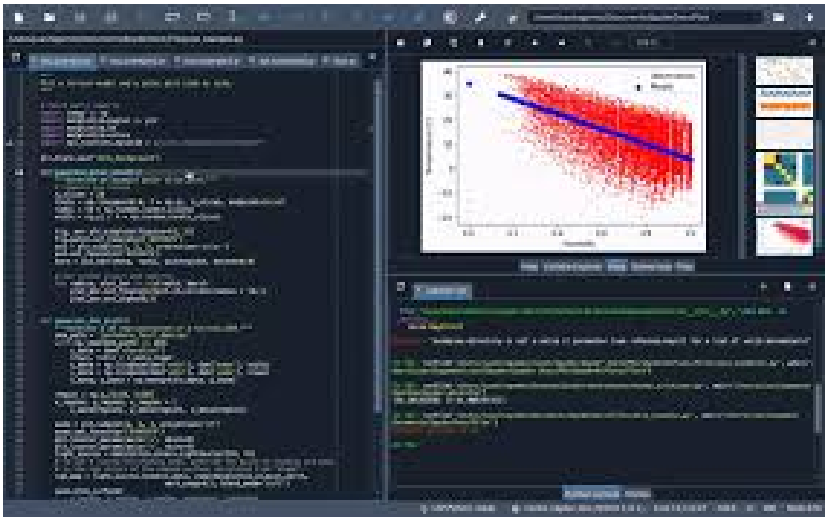
Software

ATTENTION: **The topics covered in this Section of MATH315 are basically the same covered in the other Section offered by Dr. Newman. The concepts you will learn are the same. However, the big difference is in the coding environment. This class will be based on Python and Jupyter - NOT MATLAB**. All the labs and assignments will be carried out in Jupyter Notebooks. You have two options.

1. Run your codes in COLAB, a Google Cloud Computing System running the Jupyter notebooks. In this case, you do not need to install software on your computer. You just need to have a Google account. You need to save your files on your computer (or Google Drive) at the end of

each session to avoid the loss of files (don't leave them on the Colab file system) - see https://colab.research.google.com/#scrollTo=GJBs_flRovLc

2. Have a local Python interpreter. In this case, in particular if you are already familiar with Matlab, I recommend Spyder https://www.spyder-ide.org/, with a layout similar to Matlab. Be sure also to have the plug-in for the interpretation of Jupyter Notebooks. Instructions will be given during the first week of the class.



Material covered

We will cover material sequentially, starting in Chapter 1 and ending with Chapter 8. A tentative schedule of what we will cover is provided at the end of this syllabus.

Diversity and Inclusion

As stated on the Emory Diversity webpage:

The Emory community is open to all who have a commitment to the highest ideals of intellectual engagement, critical inquiry, and integrity. We welcome a diversity of gender identities, sexual orientations, abilities, disabilities, ethnic, cultural, socioeconomic, religious, national, and international backgrounds, believing that the academic and social energy that results from such diversity is essential to advancing knowledge, addressing society's most pressing issues, and attending to the full spectrum of human needs in service to the common good.

In this course, all are welcome. We will ensure that the material is approachable and accessible to all. We will work to establish openness in the class so you can share your needs and ensure that we all have a positive experience learning a challenging but exciting subject!

Expectations

You are expected to learn from attending lectures, lab sessions, and independent work, in particular, reading the textbook and running the codes in individual sessions that may help you assess your level of understanding. Consider that it is impossible to cover everything in detail in class.

In-Person Classroom Policies

- **The use of Laptops, Tablets, and Chromebooks is encouraged during the class for taking notes and testing the codes in real-time.**
- To ensure we all feel safe and stay healthy, the class rules are as follows:
    1. You don't have to **wear your mask** the entire time you are in the classroom.
    2. These rules apply to **lectures and lab sessions**.
    3. **If you are feeling sick or test positive for COVID, do not attend class in-person.** Take care of yourself - that is the highest priority.
    4. Instructors must comply with these rules as well.
- Stay up to date on Emory's COVID policies throughout the semester using Emory Forward.

Grading Information

Grading Scheme Overview

Assignment Type	**Percentage of Final Grade**	**Details**
Problem Sets	25%	~10 assignments, lowest grade dropped
Lab Work	15%	~10 assignments, 2 lowest grades dropped, no makeup assignments
Midterms	30%	2 exams, equally-weighted
Final Exam	30%	cumulative
Pre-requisite quiz (Bonus)	+ 2%	First week

Problem Sets (25%)

- Problem Sets will be assigned each week (not in the first one) and will generally include a mix of numerical analysis and implementation in Python.
- You should develop your submission in the form of a Jupyter Notebook, including solutions to math problems, code, results from experiments, plots, etc.
- Homework will be graded for completion, accuracy, and clarity of presentation.
- There will be ~10 homework assignments (due every week, excluding the first week and exam weeks).

- There will be **no makeup opportunities** for homework assignments, but your **lowest score will be dropped** when computing your final grade.

Lab Work (15%)

- You are expected to attend your particular lab session each week. Labs will be used to clarify material from the week and to extend your knowledge.
- You will work on your Jupyter Notebook, which will be submitted after 30 minutes of the Lab.
- **There are no makeup lab assignments.** Instead, the **lowest two grades on lab assignments will be dropped.** This policy is meant to accommodate extreme situations when you cannot attend lab sessions. However, you are expected to attend.

Exams (30% + 30%)

- There will be two midterm exams and a final exam.
- The final exam will be cumulative with more emphasis on later material.
- All exams are timed and closed-book: no notes, books, or unnecessary electronic devices can be used.
- Currently, the exams are scheduled to be in-person. If exams must be given remotely, more details will be provided.
- Makeup midterms and final exams will be given only in extreme situations. You must notify the instructor at least two weeks before the midterm if you have a conflict, or have a valid excuse verified by the Office of Undergraduate Education (OUE).

Pre-Requisite Quiz (Optional: Bonus 2%)

An optional quiz to assess if you have to refresh some topics from previous classes can be taken at the end of the first week.

Required Technology

Contact the instructor if you have any questions or concerns about these requirements.

Canvas

All course content will be hosted on Canvas. This includes videos, homework assignments, exams, discussions, and more. All announcements will be made through Canvas. In addition, uploading work and grading will be done through Canvas. For information, visit https://canvas-support.emory.edu/

Python

We will primarily code in Python in this course. The coding will be carried out in Jupyter Notebooks to allow in-line comments and explanations (with Latex syntax). If you opt for COLAB, you need a Google account. If you opt for a stand-alone interpreter, feel free to choose the one you prefer.

Zoom

Lectures, lab sessions, and office hours will be held on Zoom UPON REQUEST. Information about meeting rooms and passwords will be provided soon. For information, visit https://it.emory.edu/office365/ZOOM.html

Recorded Lectures

For Weeks 4 and 10, Lectures will be recorded and posted online (Canvas) as the instructor will be engaged in Conferences. The Lab sessions will run regularly.

Web Camera

For office hours and remote learning, please have a web camera available for face-to-face interactions.

Emory University Academic Rules and Support

Honor Code

Whether in-person or remote, **all students must adhere to the Emory Honor Code.**

Netiquette

When using online tools for this course, please be courteous of other students and the instructors.

Technology Services

For assistance, please visit https://it.emory.edu/catalog/index.html

Office of Undergraduate Education (OUE)

The Office of Undergraduate Education (OUE) provides a wide range of academic support for students, including academic advising, peer tutoring, and absentee policies (e.g., if you miss an exam).

Department of Accessibility Services (DAS)

If you have a documented disability and have anticipated barriers related to the format or requirements of this course, or presume having a disability (e.g. mental health, attention, learning, vision, hearing, physical or systemic), and are in need of accommodations for this semester, we encourage you to contact the Department of Accessibility Services (DAS) to learn more about the registration process and steps for requesting accommodations. If you are a student who is currently registered with DAS and have not received a copy of your accommodation notification letter within the first week of class, please notify DAS immediately. Students who have accommodations in place are encouraged to coordinate sometime with your professor, during the first week of the semester, to communicate your specific needs for the course as it relates to your approved accommodations. All discussions with DAS and faculty concerning the nature of your disability remain confidential.

Academic and Religious Holiday Calendar

Please review the Academic Calendar for important dates about schedule changes and final exams. Please also review the Religious Holidays Calendar and communicate schedule conflicts with this course as soon as possible.

EPASS

The course moves quickly and lab/online learning can add additional challenges. Emory has an excellent peer-tutoring program that can be extremely helpful. For information, visit Learning and Peer Assistant Tutoring.

Tentative Schedule

	Dates	Sections	Content
Week 1	Aug. 23 - Aug. 25	—	**Lectures:** Introduction to Numerical Analysis **Lab:** Introduction to Python, Jupyter, Spyder
Week 2	Aug. 28 - Sept. 1	2.1.1-4, 2.2, 2.3.1-3	**Lectures:** Floating Point Numbers **Lab:** TBD **Homework:** Problem Set 1
Week 3	Sept. 4 - Sept. 8	3.1, 3.2, 3.6.1-3, 3.7.1-2	**Lectures:** Solution of Linear Systems **Lab:** TBD **Homework:** Problem Set 2
Week 4	Sept. 11 - Sept. 15	3.3, 3.4, 3.7.3	**Lectures:** Solution of Linear Systems **Lab:** TBD **Homework:** Problem Set 3
Week 5	Sept. 18 - Sept. 22	3.5, 3.6.4, 3.7.4	**Lectures:** Solution of Linear Systems **Lab:** TBD **Homework:** Problem Set 4
Week 6	Sept. 25 - Sept. 29	Review	**Midterm 1:** Covers Weeks 1 through 5
Week 7	Oct. 2 - Oct. 6	4.1, 4.2, 4.6.1, 4.6.2	**Lectures:** Curve Fitting **Lab:** TBD **Homework:** Problem Set 5
Week 8	Oct. 9 - Oct. 13 *No Class Tuesday (Fall Break)*	4.3, 4.4	**Lectures:** Curve Fitting **Lab:** TBD **Homework:** Break
Week 9	Oct. 16 - Oct. 20	4.5, 4.6.3-5, 5.1	**Lectures:** Differentiation and Integration **Lab:** TBD **Homework:** Problem Set 6
Week 10	Oct. 23 - Oct. 27	5.1, 5.3.1	**Lectures:** Differentiation and Integration **Lab:** TBD **Homework:** Problem Set 7
Week 11	Oct. 30 - Nov. 3	Review	**Midterm 2:** Covers Weeks 7 through 10
Week 12	Nov. 6 - Nov. 10	5.2.1, 5.2.2, 5.3.2	**Lectures:** Root Finding **Lab:** TBD **Homework:** Problem Set 8
Week 13	Nov. 13 - Nov. 16	6.1, 6.2, 6.6.1	**Lectures:** Root Finding **Lab:** TBD **Homework:** Problem Set 9
Week 14	Nov. 20 - Nov. 24 *No Class Wed. (Thanksgiving)*	TBD	**Lectures:** Univariate Minimization **Lab:** TBD **Homework:** Break

Week 15	Nov. 27 - Apr. 1	7.1-4	**Lectures:** Univariate Minimization **Lab:** TBD **Homework:** Problem Set 10
Week 16	Dec. 4	Review	
Final Exam **Monday, December 12, 11:30 am – 2:00 pm** **Cumulative**			