

MATH 331

Numerical Analysis

Professor:

Dr. Joanna Bieri

joanna_bieri@redlands.edu

Class:

Fall 2020

M,W,F 2:30 - 3:50 pm

On Microsoft Teams

Office Hours:

In Class Wednesday
or by appointment.

Welcome to Numerical Analysis

My goal is to help each and every student achieve their personal learning goals for numerical analysis. I value a diversity of opinions, learning approaches, cultural backgrounds, abilities, and ideas in my class. Classes, lectures, and group interactions should be a safe learning space where each member of the community feels valued, listened to, and respected. It is the responsibility of each of us to ensure that we are lifting up our peers, breaking free from old biases, reaching across cultural or socioeconomic boundaries, and supporting each other. If at any time in the class you feel that there is something that could be done to improve your learning or your experience please let me know. I am here to lift you up and help you learn!

About This Course

This course is an introduction to Numerical Analysis. All lectures and homework will be posted online. We will be learning asynchronously which means you will watch lectures outside of class time and then use class time to work on problems with help from your group and your professor. Here is what a typical week might look like:

- Saturday/Sunday: Prepare for Monday class by watching lectures, doing research, and starting the homework.
- Monday: Post to your group room and attend class where you will work on concepts you learned over the weekend and get help.
- Tuesday: Prepare your weekly checking, do some self-reflection of your progress from the previous week.
- Wednesday: Post to your group room attend "office hours" class to get questions answered before you finish your weekly check in (DUE: 11:59pm)
- Thursday: Prepare for Friday class by watching lectures, doing research, and starting the homework.
- Friday: Attend class where you will work on concepts you learned Wednesday/Thursday and get help.

Attendance is expected at all class meetings unless you have notified me ahead of time. Please turn on your camera occasionally so I can see your beautiful faces.

You must have completed MATH 235 - Differential Equations or MATH 241 Linear Algebra - before taking this course. Some experience in programming is very helpful.

Course Learning Objectives

By the end of the semester your work must reflect your ability to:

1. Understand how we use computers to solve difficult mathematical problems.
2. Be able to clearly define the different types of computational error and discuss the error in various numerical schemes.
3. Write computer programs to find roots to functions, interpolate polynomials, integrate and differentiate functions, solve systems of linear equations, and solve differential equations.
4. Select appropriate numerical techniques for a given problem.
5. Discuss error and convergence of methods and explain why you think your solutions are making sense.
6. Have some fun telling computers to do the hard work for you!

What are your goals for the class?

Technology

You absolutely need access to a computer that can run Anaconda Python and Jupyter Notebooks. Please let me know if this is a problem and I can help make sure you have access to a working computer. Homework and announcements will be posted on the class website and classes will take place on Microsoft Teams so make sure you have internet access and check daily for updates.

Required Texts

- Elementary Numerical Analysis, 3rd Edition – Atkinson and Han (ISBN 0-471-43337-3)
- Other texts and articles made available via our course website and Moodle.

Classwork

Consistent participation and engagement are crucial to your success in the class. Please read the following carefully:

- Pre-Class Preparation:** Lectures will be posted every Tuesday and Thursday on our class website along with a homework assignment that is intended to help you understand the material. It is your job to watch the lectures, take notes, attempt all parts of the homework, and formulate some questions before class begins. You might also do some research to enhance your understanding of the material. Your goal is to prepare for the class period where you will work with your group to get your questions answered and finish the homework assignment. Please post resources you find, code you write, and your questions to your group Teams page.
- In-Class Participation:** Classes will take place on Monday, Wednesday, and Friday on Microsoft Teams. New content will be explored on Monday and Friday, Wednesday will be a free day to get questions answered and prepare your weekly check-in. You are expected to come to class ready

to participate fully and to improve the learning of your group. Each class you will begin by meeting on your group channel. You will collaborate on creating a list of questions that your group plans to answer and goals for the class time. Joanna will start to check in with each group after the first 15 minutes of class. You should use this time to work together on the homework. If you want to collaborate on CoCalc you can do that and then copy and paste the code into your own HW notebook. In the code comments you should give credit for who participated in the discussion or programming that led to your solution.

- Weekly Check In:** Each Wednesday you will submit a Jupyter Notebook that demonstrates your work and your gained knowledge for the week. Due by 11:59pm. You can choose which content to include in your check-in, but I would like you to respond to each of the following:

- What is one piece of Numerical Analysis knowledge that you are proud of gaining this week? Show some working, commented python code that demonstrates your ability to apply the knowledge to a new problem. Eg. Apply your method to a function that you did not see in the homework or show the limitations of the method (aka where it breaks).
- What is one piece of Numerical Analysis knowledge that you struggled with most this week? Show some python code (working or not) and discuss your struggle. This can be a homework problem that you didn't get working or something interesting that you attempted. If your code does not work yet, how do you plan to improve it. If you did not struggle, what is one area where you are reaching beyond the class comment to continue to challenge yourself?

- In what specific ways have you contributed to your group during class periods? Did you miss any class meetings?
- What goals do you have for yourself in the next week of class?

- Final Reflection:** The final exam will be a combination of a self-reflection and the presentation of an interesting numerical analysis problem (assigned on November 25th). Final reflection Jupyter Notebooks and recorded presentations are due on Wednesday December 2nd at 11:59pm.

Evaluation Procedures

There are four elements of the course which contribute to your overall grade, as follows:

Pre-Class Preparation	20%
In-Class Participation	20%
Weekly Check-In	40%
Final Reflection	20%

How to Succeed in this Class

All work for the course will be graded according following criteria.

- Students can demonstrate pre-class preparation by contributing work to your group before class for the topic has begun. This might include: posting questions to your group discussion, saving your daily homework code on Teams for your group to use, sharing your class notes on Teams for your group to look at, submitting links to the course website that point to helpful resources, or giving mini video lectures for your group on things you have learned.
- Students can demonstrate in-class participation by attending every online class and being actively involved in the group discussion during class time. For some this will be active speaking, for others it will be posting in the chat, for others it will be managing the collaborative jupyter notebook. There are lots of ways to participate, let me know how you best like to contribute!
- Each weekly check-in will be submitted on moodle and graded for 10 points:
 - 2 points for clear communication, proof-reading, and clarity. You should submit a focused report of your achievements and struggles. Don't report every little thing you did, pick the highlights!
 - 2 points for submitting the homework on time, keeping up with the class work, and focusing on goals for your learning.
 - 2 points for demonstrating a true mathematical and programming achievement. In other words, you should present one of the harder concepts or problems along with working example code.

- 2 points for a self reflective summary of where you are still struggling along with some example code or if you are not struggling some ways that you are going beyond the call of the class.
- 2 points for well commented, working code with appropriate citations. The code should run OR if you know it does not run, explain what might be going wrong in the comments.
- The final summary is your chance to show mastery of the concepts for the class. This will be similar to the weekly check-ins, but the goal will be to tackle a more expansive numerical analysis problem with a more in depth analysis and discussion. You will also do a video presentation walking through your logic and explaining your solution to the problem.

Grading Scales:

4.0	95-100%
3.7	90-94%
3.3	87-89%
3.0	83-86%
2.7	80-82%
2.3	77-79%
2.0	73-76%
1.7	70-72%
1.3	67-69%
1.0	63-66%
0.7	60-62%

Please note: According to the University Course Catalog (p. 13) 3.7 and 4.0 are reserved for “outstanding” work; 3.3 and 3.0 are both defined as “excellent,” not mediocre.

Course Policies

Academic Honesty

This syllabus assumes that all students have read and are familiar with the University of Redlands' policies on “Academic Honesty,” as is written in the

2016-2018 Catalog. Any case of academic dishonesty will be processed through the official procedures.

Other

The most reliable way to reach me is by email. Please note that my normal working hours are 9 a.m. to 5 p.m., Monday to Friday. I do not respond to emails after 5 p.m. or on weekends, except in an emergency.

Accommodations

If a student has a disability that qualified for accommodations under the Americans with Disabilities Act and Section 504 of the Rehabilitation Act, he/she/they should contact Academic Success & Disability Services (ASDS). ASDS is located on the ground floor of the Armacost Library across from Human Resources and down the hall from the Jones Computer Center. The primary contact person is:

Amy Wilms

Assistant Dean of Academics and Student Life:

Phone: (909) 748-8069

amy_wilmsredlands.edu.

Discrimination, Harassment, Sexual Misconduct and Retaliation

These policy statements support the University's commitments to equality of opportunity and maintaining an academic environment and workplace that is free from unlawful discrimination, harassment, sexual misconduct, and retaliation. Each person to whom this policy applies shares a responsibility for upholding and enforcing this policy.

- A. No Discrimination. The University prohibits and will not tolerate unlawful discrimination on the basis of age, color, race, ethnicity, national origin, ancestry, sex, marital status, pregnancy, status as a complaining party of domestic violence, sexual orientation, gender, gender identity or expression, physical or mental disability, genetic information, religion/creed, citizenship status (except to comply with legal requirements for employment),

military/veteran status, or any other characteristic protected by law.

- B. No Harassment. The University prohibits and will not tolerate unlawful harassment on the basis of the characteristics identified above.
- C. No Sexual Misconduct. The University prohibits and will not tolerate sexual misconduct. Redlands is committed to fostering a safe, productive learning environment. Title IX and our school policy prohibit discrimination on the basis of sex, which regards sexual misconduct — including harassment, domestic and dating violence, sexual assault, and stalking. We understand that sexual violence can undermine students' academic success and we encourage students who have experienced some form of sexual misconduct to talk to someone about their experience, so they can get the support they need. Confidential support may be obtained from the Chaplain's Office and Counsel-

ing Center. Reporting should be done through the Title IX Office – contact listed below.

- D. No Retaliation. The University prohibits and will not tolerate any retaliation against any person who, in good faith, complains about discrimination, harassment, or sexual misconduct. Similarly, the University prohibits and will not tolerate any retaliation against any person who, in good faith, demonstrates opposition to, or participates in an investigation of, alleged discrimination, harassment, or sexual misconduct.

The person to contact with Title IX Concerns or any concerns about experiences of discrimination:

Erica Moorer, Deputy Title IX Coordinator
Title IX Office, Hunsaker Center 220
Phone: (909) 748-8916
erica_moorerredlands.edu

Course Schedule

Schedule is subject to change as we progress through the semester. You will be notified of any changes in class.

Numerical - CLASS SCHEDULE - Fall 2020

			Before Class			During Class		After Class
DATE	WEEK	DAY	Watch Online	Read	HW	In Class Topic	Assigned	Due
08/26/20	1	Wednesday			HW1	Welcome - Intro	Install Anaconda and get Jupyter Notebooks running	
08/28/20	1	Friday	Intro to Python - Jupyter Notebooks		HW2	Programming in Python - Jupyter		
08/31/20	2	Monday	Taylor Series	1.1	HW3	Taylor Series	Check in 1	
09/02/20	2	Wednesday				Office Hours		CHECK IN 1 - Jupyter Notebook Due
09/04/20	2	Friday	Error in Taylor Series	1.2	HW4	Error in Taylor Series		
09/07/20	3	Monday	Intro to Computational Error	Chapter 2	HW5	Computational Error	Check in 2	
09/09/20	3	Wednesday				Office Hours		CHECK IN 2 - Jupyter Notebook Due
09/11/20	3	Friday	Root Finding: Bisection	3.1	HW6	Bisection method		
09/14/20	4	Monday	Root Finding: Newton	3.2	HW7	Newton's Method	Check in 3	
09/16/20	4	Wednesday				Office Hours		CHECK IN 3 - Jupyter Notebook Due
09/18/20	4	Friday	Fixed Point Iteration - Contraction Mapping	3.4	HW8	Fixed Point Iteration		
09/21/20	5	Monday	More on Contraction Mapping		HW9	Contraction Mapping	Check in 4	

09/23/20	5	Wednesday				Office Hours		CHECK IN 4 - Jupyter Notebook Due
09/25/20	5	Friday	Stability of Iterations	3.5	HW10	Stability of Iterations		
09/28/20	6	Monday	Interpolation	4.1	HW11	Interpolation	Check in 5	
09/30/20	6	Wednesday				Office Hours		CHECK IN 5 - Jupyter Notebook Due
10/02/20	6	Friday	Error in Interpolation	4.2	HW12	Error in Interpolation		
10/05/20	7	Monday	Spline Interpolation	4.3	HW13	Spline Interpolation	Check in 6	
10/07/20	7	Wednesday				Office Hours		CHECK IN 6 - Jupyter Notebook Due
10/09/20	7	Friday	Image Interpolation (2-D)		HW14	Image Interpolation		
10/12/20	8	Monday	Numerical Integration	5.1	HW15	Numerical Integration	Check in 7	
10/14/20	8	Wednesday				Office Hours		CHECK IN 7 - Jupyter Notebook Due
10/16/20	8	Friday	Numerical Integration	5.2	HW16	Numerical Integration		
10/19/20	9	Monday	Numerical Differentiation	5.4	HW17	Numerical Differentiation	Check in 8	
10/21/20	9	Wednesday				Office Hours		CHECK IN 8 - Jupyter Notebook Due
10/23/20	9	Friday	Differentiation Error	5.4	HW18	Differentiation Error		
10/26/20	10	Monday	Differential Equations	8.1	HW19	Differential Equations	Check in 9	
10/28/20	10	Wednesday				Office Hours		CHECK IN 9 - Jupyter Notebook Due
10/30/20	10	Friday	Euler's Method	8.2	HW20	Euler's Method		

11/02/20	11	Monday	Richardson's Method	8.3 and 8.4	HW21	Richardson's Method	Check in 10	
11/04/20	11	Wednesday				Office Hours		CHECK IN 10 - Jupyter Notebook Due
11/06/20	11	Friday	Taylor Methods/Runge Kutta	8.5	HW22	Taylor Methods and Runge Kutta		
11/09/20	12	Monday	Multi-Step Methods	8.6	HW23	Multi-Step Methods	Check in 11	
11/11/20	12	Wednesday				Office Hours		CHECK IN 11 - Jupyter Notebook Due
11/13/20	12	Friday	Review of Linear Systems	6.1 and 6.2	HW24	Review of Linear Systems		
11/16/20	13	Monday	Gaussian Elimination	6.3	HW25	Gaussian Elimination	Check in 12	
11/18/20	13	Wednesday				Office Hours		CHECK IN 12 - Jupyter Notebook Due
11/20/20	13	Friday	Jacobi Iteration	6.6	HW26	Jacobi Iteration		
11/23/20	14	Monday	Least Squares Data Fitting	7.1		Least Squares	Check in 13	
11/25/20	14	Wednesday	Thanksgiving			Thanksgiving	Final Reflections Assigned	CHECK IN 13 - Jupyter Notebook Due
11/27/20	14	Friday	Thanksgiving			Thanksgiving		
11/30/20	15	Monday				LAST DAY CHECK IN		
12/02/20	15	Wednesday						FINAL REFLECTIONS DUE