

SYLLABUS MATH 6371: NUMERICAL ANALYSIS

The information contained in this course syllabus is subject to change.
Students will be informed of possible changes during the course.

Course and Contact Details:

Course Number: 6371-01 (11157)
Term: Spring 2024
Course Name: Numerical Analysis
Instructor: Dr. Loic Cappanera
Email: lmcappan@central.uh.edu
Office: PGH 602

Lecture times: Tuesday and Thursday 10:00am-11:30am in room S 102

Remark: First lecture of Tuesday January 16th will be held online asynchronously, meaning that a video of a lecture will be uploaded on MS Teams.

Online Materials: Some materials (lecture notes, syllabus, assignments, exams sample, Matlab codes) will be shared with students on Microsoft Teams. Please do not try to contact the instructor via Canvas or MS Teams. Only email communications will be answered.

Office hours (PGH 602 or online):

Thursday 3:00pm-4:00pm (in PGH 602)
or by appointment (send an email to instructor to confirm availability).

Required Textbook:

"Numerical Mathematics" by Alfio Quarteroni, Riccardo Sacco & Fausto Saleri, Springer, Second Edition (ISBN-10: 3642071015, ISBN-13: 978-3642071010)

The Matlab scripts for the examples in the second edition of the book are available on the MS Teams' course.

Learning Objectives and Lectures Topics: The following topics will be covered in class. Please keep in mind that this is only a tentative schedule. Adjustments can be made as we proceed.

Polynomial interpolation and approximation theory

- Week 1 (Jan. 15-19): Lagrange interpolation, interpolation error, and stability of polynomial interpolation. Newton form of interpolating polynomials, divided differences.
- Week 2 (Jan. 22-26): Piecewise Lagrange interpolation. Hermitian interpolation.
- Week 3 (Jan. 29-Feb. 2): Approximation by splines.
- Week 4 (Feb. 5-9): Chebyshev polynomials and their properties, Chebyshev interpolation.
- Week 5 (Feb. 12-16): Approximation of a function in the least-squares sense.
- Week 6 (Feb. 19-23): The polynomial of best approximation

EXAM I

Discrete transformations and numerical integration

- Week 7 (Feb. 26 - Mar. 1): Discrete Fourier Transform, Gibbs Phenomenon and FFT. Quadrature formulae and interpolatory quadratures.
- Week 8 (Mar. 4-8): Orthogonal polynomials and Gaussian quadratures.
- Week 9 (Mar. 18-22): Richardson extrapolation and automatic integration. Singular integrals, multidimensional integrals.
- Week 10-11 (Mar. 25-29 + Apr. 1-5): Reviews of some assignments + exams I-II. Review some materials for Prelims in May 2024.

EXAM II (around week 10)

Finite differences and numerical solution of ODE

- Week 12 (Apr. 8-12): The Cauchy problem and one-step numerical methods. Multistep methods and stability analysis for the Cauchy problem. Regions of stability. Stiff systems of ODE.

ODE and two-point boundary value problems.

- Week 13 (Apr. 15-19): Finite difference approximation for two-point b.v.p., stability, convergence. Stability analysis and maximum principle.
- Week 14 (Apr. 22-26): Galerkin method for two-point b.v.p. Finite element method and error estimate.
- (if time permits) Solving Navier-Stokes equations: some numerical methods and applications with FreeFEM++.

FINAL (Thursday 25 April, 10:00am-11:30am, S 102).

Objectives: This course is part of a two-course series meant to introduce Ph.D. students in mathematics to the fundamentals of numerical mathematics. The two-course provides the foundation of numerical methods, the analyze of their basic properties

(stability, accuracy, and computational complexity), and demonstrates their performances on examples.

Prerequisites: Graduate standing or consent of instructor. Students should have had a course in Linear Algebra and an introductory course in analysis. Familiarity with Matlab or experience with compiled languages (e.g., Fortran, C, C++) is also required.

Assessment: Your final grade will be based on:

- (25) 25 points for homeworks. **A random selection of homework problems will be graded from among those assigned.**
- (50) 75 points for three exams (25 points per exams). The final is scheduled on Thursday 25 April, 10:00am-11:30am, in S 102.

Remarks on assignments:

- There will be around 5-7 assignments.
- The assignments and their due dates will be posted on Canvas and sent by email.
- Assignment should be submitted via Canvas as one pdf file.
- No email submissions will be accepted. There are no unjustified extensions.

Remarks on Exams:

All three Exams will be 80 minutes long, and will be open-book, open-note. Students with a valid excuse for missing up to one exam must provide written documentation to that effect, e.g. a medical certificate.

Additional information which is not course specific

Mental Health and Wellness Resources: The University of Houston has a number of resources to support students' mental health and overall wellness, including CoogsCARE and the UH Go App. UH Counseling and Psychological Services (CAPS) offers 24/7 mental health support for all students, addressing various concerns like stress, college adjustment and sadness. CAPS provides individual and couples counseling, group therapy, workshops and connections to other support services on and off-campus. For assistance visit uh.edu/caps, call 713-743-5454, or visit a Let's Talk location in-person or virtually. Let's Talk are daily, informal confidential consultations with CAPS therapists where no appointment or paperwork is needed. The Student Health Center offers a Psychiatry Clinic for enrolled UH students. Call 713-743-5149 during clinic hours, Monday through Friday 8 a.m. - 4:30 p.m. to schedule an appointment. The A.D. Bruce Religion Center offers spiritual support and a variety of programs centered on well-being.

Need Support Now?

If you or someone you know is struggling or in crisis, help is available. Call CAPS crisis support 24/7 at 713-743-5454, or the National Suicide and Crisis Lifeline: call or text 988, or chat 988lifeline.org.

Academic Honesty Policy. High ethical standards are critical to the integrity of any institution, and bear directly on the ultimate value of conferred degrees. All UH community members are expected to contribute to an atmosphere of the highest possible ethical standards. Maintaining such an atmosphere requires that any instances of academic dishonesty be recognized and addressed. The UH Academic Honesty Policy is designed to handle those instances with fairness to all parties involved: the students, the instructors, and the University itself. All students and faculty of the University of Houston are responsible for being familiar with this policy.

Title IX/Sexual Misconduct. Per the UHS Sexual Misconduct Policy, your instructor is a "responsible employee" for reporting purposes under Title IX regulations and state law and must report incidents of sexual misconduct (sexual harassment, non-consensual sexual contact, sexual assault, sexual exploitation, sexual intimidation, intimate partner violence, or stalking) about which they become aware to the Title IX office. Please know there are places on campus where you can make a report in confidence. You can find more information about resources on the Title IX website at <https://uh.edu/equal-opportunity/title-ix-sexual-misconduct/resources/>.

Reasonable Academic Adjustments/Auxiliary Aids. The University of Houston is committed to providing an academic environment and educational programs that are accessible for its students. Any student with a disability who is experiencing barriers to learning, assessment or participation is encouraged to contact the Justin Dart, Jr. Student Accessibility Center (Dart Center) to learn more about academic accommodations and support that may be available to them. Students seeking academic accommodations will need to register with the Dart Center as soon as possible to ensure timely implementation of approved accommodations. Please contact the Dart Center by visiting the website: <https://uh.edu/accessibility/> calling (713) 743-5400, or emailing jdcenter@Central.UH.EDU.

Excused Absence Policy. Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston Undergraduate Excused Absence Policy and Graduate Excused Absence Policy for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Under these policies, students with excused absences will be provided with an opportunity to make up any quiz, exam or other work that contributes to the course grade or a satisfactory alternative. Please read the full policy for details regarding reasons for excused absences, the approval process, and extended absences. Additional policies address absences related to military service, religious holy days, pregnancy and related conditions, and disability.

Recording of Class. Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the Justin Dart, Jr. Student Accessibility Center. If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor's recordings for their own studying and note-taking. Instructor's recordings are not authorized to be shared with anyone without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Resources for Online Learning. The University of Houston is committed to student success, and provides information to optimize the online learning experience

through our Power-On website. Please visit this website for a comprehensive set of resources, tools, and tips including: obtaining access to the internet, AccessUH, Blackboard, and Canvas; using your smartphone as a webcam; and downloading Microsoft Office 365 at no cost. For questions or assistance contact UHOnline@uh.edu.

UH Email. Please check and use your CougarNet email for communications related to this course. Faculty use the CougarNet email to respond to course-related inquiries such as grade queries or progress reports for reasons of FERPA. To access your CougarNet email, login to your Microsoft 365 account with your CougarNet credentials. Visit University Information Technology (UIT) for instructions on how to connect your CougarNet e-mail on a mobile device.

Security Escorts and Cougar Ride. UHPD continually works with the University community to make the campus a safe place to learn, work, and live. The security escort service is designed for the community members who have safety concerns and would like to have a Security Officer walk with them, for their safety, as they make their way across campus. Based on availability either a UHPD Security Officer or Police Officer will escort students, faculty, and staff to locations beginning and ending on campus. If you feel that you need a Security Officer to walk with you for your safety, please call 713-743-3333. Arrangements may be made for special needs.

Parking and Transportation Services also offers a late-night, on-demand shuttle service called “Cougar Ride” that provides rides to and from all on-campus shuttle stops, as well as the MD Anderson Library, Cougar Village/Moody Towers and the UH Technology Bridge. Rides can be requested through the UH Go app. Days and hours of operation can be found at <https://uh.edu/af-university-services/parking/cougar-ride/>.

Syllabus Changes. Please note that the instructor may need to make modifications to the course syllabus. Notice of such changes will be announced as quickly as possible during class and via email.