



Course Title

Numerical Analysis

Course Number: MATH-UA 9252

Instruction Mode: Blended

Fall 2022

If you are enrolled in this course 100% remotely and are not a Go Local/Study Away student for NYU Paris, please make sure that you've completed the online academic orientation via Brightspace so you are aware of site specific support structure, policies and procedures. Please contact nyu.paris.academics@nyu.edu if you have trouble accessing the Brightspace site.

Syllabus last updated on: 03 Aug 2022

Lecturer Contact Information

Urbain VAES
urbain.vaes@nyu.edu
Office hours: Tuesday at 15:00

Prerequisites

The course assumes a basic knowledge of linear algebra and calculus. Prior programming experience in Julia, Python or a similar language is desirable but not required.

Units earned

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Course Details

All the course details are available on the [course website](#).

Course Description

This course is aimed at giving a first introduction to classical topics in numerical analysis, including floating point arithmetics and round-off errors, interpolation and approximation of functions, numerical quadrature, the numerical solution of linear and nonlinear equations, and iterative methods for eigenvalue problems. A more detailed description of the content is

given below. If time permits, we will also cover numerical methods for solving ordinary differential equations.

Course Objective

After the course, the students will be familiar with the key concepts of stability, convergence and computational complexity in the context of numerical algorithms. They will have gained a broad understanding of the classical numerical methods available for performing fundamental computational tasks, and be able to produce efficient computer implementations of these methods.

Assessment Components

You are expected to attend class in person or remote synchronously. Failure to submit or fulfill any required component may result in failure of the class, regardless of grades achieved in other assignments.

Required Text(s) Detailed Content

Self-contained lecture notes will be provided on the course website.

Detailed Content

Six topics will be covered in this course.

- **Floating point arithmetic.** In Chapter 1, we discuss how real numbers are represented, manipulated and stored on a computer. There is an uncountable infinity of real numbers, but only a finite subset of these can be represented exactly on a machine. This subset is specified in the IEEE754 standard, which is widely accepted today and employed in most programming languages.
- **Interpolation and extrapolation of functions.** In Chapter 2, we focus on the topics of interpolation and approximation. *Interpolation* is concerned with the construction of a function within a given set, for example that of polynomials, that takes given values when evaluated at a discrete set of points. The aim of *approximation*, on the other hand, is usually to determine, within a class of simple functions, which one is closest to a given function. Depending on the metric employed to measure closeness, this may or may not be a well-defined problem.
- **Numerical integration.** In Chapter 3, we study numerical methods for computing definite integrals. This chapter is strongly related to the previous one, as numerical approximations of the integral of a function are often obtained by first approximating the function, say by a polynomial, and then integrating this approximation exactly.
- **Solution of linear systems.** In Chapter 4, we study the standard numerical methods for solving linear systems. Linear systems are ubiquitous in science, often arising from the discretization of linear elliptic partial differential equations, which themselves govern a large number of physical phenomena including heat propagation, electromagnetism, gravitation and the deformation of solids.
- **Solution of nonlinear equations.** In Chapter 5, we present widely used methods for solving nonlinear equations. Like linear equations, nonlinear equations are

omnipresent in science, a prime example being the Navier—Stokes equation describing the motion of fluid flows. Nonlinear equations are usually much more difficult to solve and require dedicated techniques.

- **Solution of eigenvalue problems.** In Chapter 6, we present and study the standard iterative methods for calculating the eigenfunctions and eigenvalues of a matrix. Eigenvalue problems have a large number of applications, for instance in quantum physics and vibration analysis. They are also at the root of the PageRank algorithm for ranking web pages, which played a key role in the early success of Google search.

Classroom Etiquette

Please make you sur read and acknowledge the information regarding this section on the **NYU Paris Resources** site on Brightspace.

Your Lecturer

U. Vaes is a researcher at Inria, a French research institution in applied mathematics and computer science. His research focuses on the study and development of systematic methods to sample probability measures in high dimension, particularly for applications related to computational statistical physics and Bayesian inference.

Academic Policies

Grade Conversion

Your lecturer may use one of the following scales of numerical equivalents to letter grades:

US Letter Grade	US numerical	French numerical	
A	94-100 or 4.0	15-20	Excellent
A-	90-93 or 3.7	14	Very Good
B+	87-89 or 3.3	13	Good
B	84-86 or 2.7	12	Good
B-	80-83 or 2.7	11	Satisfactory
C+	77-79 or 2.3	10	Sufficient

C	74-76 or 2.0	9	Sufficient
C-	70-73 or 1.7	8	Sufficient
D	65-66 or 1.0	5-7	Poor
F	below 65 or 0	1-4	Fail

Attendance Policy

Studying at Global Academic Centers is an academically intensive and immersive experience, in which students from a wide range of backgrounds exchange ideas in discussion-based seminars. Learning in such an environment depends on the active participation of all students. And since classes typically meet once or twice a week, even a single absence can cause a student to miss a significant portion of a course. To ensure the integrity of this academic experience, class attendance at the centers, or online through NYU Brightspaces if the course is remote synchronous/blended, is expected promptly when class begins. Attendance will be checked at each class meeting. If you have scheduled a remote course immediately preceding/following an in-person class, you may want to write to nyu.paris.academics@nyu.edu to see if you can take your remote class at the Academic Center.

As soon as it becomes clear that you cannot attend a class, you must inform your professor and/or the Academics team by e-mail immediately (i.e. before the start of your class). Absences are only excused if they are due to illness, Moses Center accommodations, religious observance or emergencies. Your professor or site staff may ask you to present a doctor's note or an exceptional permission from an NYU Staff member as proof. Emergencies or other exceptional circumstances that you wish to be treated confidentially must be presented to staff. Doctor's notes must be submitted in person or by e-mail to the Academics team, who will inform your professors.

Unexcused absences may be penalized with a two percent deduction from the student's final course grade for every week's worth of classes missed, and may negatively affect your class participation grade. Four unexcused absences in one course may lead to a Fail in that course. Being more than 15 minutes late counts as an unexcused absence. Your professor is entitled to deduct points if you frequently join the class late.

Exams, tests and quizzes, deadlines, and oral presentations that are missed due to illness always require a doctor's note as documentation. It is the student's responsibility to produce this doctor's note and submit it to site staff; until this doctor's note is produced the missed assessment is graded with an F and no make-up assessment is scheduled. In content classes, an F in one assignment may lead to failure of the entire class.

Regardless of whether an absence is excused or not, it is the student's responsibility to catch up with the work that was missed.

Final exams

Final exams must be taken at their designated times. Should there be a conflict between your final exams, please bring this to the attention of the Academics team. Final exams may not be taken early, and students should not plan to leave the site before the end of the finals period.

Late Submission of Work

- (1) Work submitted late receives a penalty of 2 points on the 100 point scale for each day it is late (including weekends and public holidays), unless an extension has been approved (with a doctor's note or by approval of NYU SITE Staff), in which case the 2 points per day deductions start counting from the day the extended deadline has passed.
- (2) Without an approved extension, written work submitted more than 5 days (including weekends and public holidays) following the submission date receives an F.
- (3) Assignments due during finals week that are submitted more than 3 days late (including weekends and public holidays) without previously arranged extensions will not be accepted and will receive a zero. Any exceptions or extensions for work during finals week must be approved by Academic Affairs (nyu.paris.academics@nyu.edu).
- (4) Students who are late for a written exam have no automatic right to take extra time or to write the exam on another day.
- (5) Please remember that university computers do not keep your essays - you must save them elsewhere. Having lost parts of your essay on the university computer is no excuse for a late submission.

Academic Honesty/Plagiarism

As the University's policy on "[Academic Integrity for Students at NYU](#)" states: "At NYU, a commitment to excellence, fairness, honesty, and respect within and outside the classroom is essential to maintaining the integrity of our community. By accepting membership in this community, students take responsibility for demonstrating these values in their own conduct and for recognizing and supporting these values in others." Students at Global Academic Centers must follow the University and school policies.

NYU takes plagiarism very seriously; penalties follow and may exceed those set out by your home school. Your lecturer may ask you to sign a declaration of authorship form, and may check your assignments by using TurnItIn or another software designed to detect offences against academic integrity.

The presentation of another person's words, ideas, judgment, images, or data as though they were your own, whether intentionally or unintentionally, constitutes an act of plagiarism. It is also an offense to submit work for assignments from two different courses that is substantially the same (be it oral presentations or written work). If there is an overlap of the subject of your assignment with one that you produced for another course (either in the current or any previous semester), you **MUST** inform your professor.

For guidelines on academic honesty, clarification of the definition of plagiarism,

examples of procedures and sanctions, and resources to support proper citation, please see:

[NYU Academic Integrity Policies and Guidelines](#)

[NYU Library Guides](#)

Inclusivity Policies and Priorities

NYU's Office of Global Programs and NYU's global sites are committed to equity, diversity, and inclusion. In order to nurture a more inclusive global university, NYU affirms the value of sharing differing perspectives and encourages open dialogue through a variety of pedagogical approaches. Our goal is to make all students feel included and welcome in all aspects of academic life, including our syllabi, classrooms, and educational activities/spaces.

Attendance Rules on Religious Holidays

Members of any religious group may, without penalty, excuse themselves from classes when required in compliance with their religious obligations. Students who anticipate being absent due to religious observance should notify their lecturer AND NYU SITE's Academics Office in writing via e-mail one week in advance. If examinations or assignment deadlines are scheduled on the day the student will be absent, the Academics Office will schedule a make-up examination or extend the deadline for assignments. Please note that an absence is only excused for the holiday but not for any days of travel that may come before and/or after the holiday. See also [University Calendar Policy on Religious Holidays](#)

Pronouns and Name Pronunciation (Albert and Zoom)

Students, staff, and faculty have the opportunity to add their pronouns, as well as the pronunciation of their names, into Albert. Students can have this information displayed to faculty, advisors, and administrators in Albert, Brightspace, the NYU Home internal directory, as well as other NYU systems. Students can also opt out of having their pronouns viewed by their instructors, in case they feel more comfortable sharing their pronouns outside of the classroom. For more information on how to change this information for your Albert account, please see the [Pronouns and Name Pronunciation website](#).

Students, staff, and faculty are also encouraged, though not required, to list their pronouns, and update their names in the name display for Zoom. For more information on how to make this change, please see the [Personalizing Zoom Display Names website](#).

Moses Accommodations Statement

Academic accommodations are available for students with documented and registered disabilities. Please contact the Moses Center for Student Accessibility (+1 212-998-4980 or mosescsd@nyu.edu) for further information. Students who are requesting academic accommodations are advised to reach out to the Moses Center as early as possible in the semester for assistance. Accommodations for this course are managed through NYU Paris.

Bias Response

The New York University Bias Response Line provides a mechanism through which members of our community can share or report experiences and concerns of bias, discrimination, or harassing behavior that may occur within our community.

Experienced administrators in the Office of Equal Opportunity (OEO) receive and assess reports, and then help facilitate responses, which may include referral to another University school or unit, or investigation if warranted according to the University's existing Non-Discrimination and Anti-Harassment Policy.

The Bias Response Line is designed to enable the University to provide an open forum that helps to ensure that our community is equitable and inclusive.

To report an incident, please contact one of the following:

- Online using the [Web Form \(link\)](#)
- Email: bias.response@nyu.edu
- Phone (NY): +1 (212) 998-2277
- Office of the Director, NYU Paris: +33 1 53 92 50 80