Mathematical Sciences Syllabi   NJIT Syllabi

Spring 2024

MATH 453-002: High-Performance Numerical Computing

M. Siegel

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MATH 453: High-Performance Numerical Computing
Spring 2024 Course Syllabus

NJIT Academic Integrity Code: All Students should be aware that the Department of Mathematical Sciences takes the University Code on Academic Integrity at NJIT very seriously and enforces it strictly. This means that there must not be any forms of plagiarism, i.e., copying of homework, class projects, or lab assignments, or any form of cheating in quizzes and exams. Under the University Code on Academic Integrity, students are obligated to report any such activities to the Instructor.

COURSE INFORMATION

Course Description: This course covers state-of-the-art numerical algorithms for solving large scale problems accurately and efficiently. Topics include iterative methods for linear systems and eigenvalue computations, introduction to parallel programs and parallel numerical algorithms, and spectral methods. An instructor selected advanced topics will be included in the course.

Number of Credits: 3

Prerequisites: MATH 340 with a grade of C or better and MATH 391 with a grade of C or better.

Course-Section and Instructors:

Course-Section	Instructor
Math 453	Professor M. Siegel

Office Hours for All Math Instructors: Spring 2024 Office Hours and Emails

Required Textbook:

Title	*Introduction to High Performance Scientific Computing*
Author	David L. Chopp
Edition	First Edition, 2019
Publisher	SIAM
ISBN #	978-1-611975-63-5

Additional Text: Introduction to Parallel Computing, Second Edition, 2003 by Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, ISBN: 0-201-64865-2 (freely available online)

University-wide Withdrawal Date: The last day to withdraw with a **W** is Monday, April 1, 2024. It will be strictly enforced.

POLICIES

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy: The final grade in this course will be determined as follows:

Homework	50%
Midterm	20%
Final Project	30%

Attendance Policy: Attendance at all classes will be recorded and is **mandatory**. Please make sure you read and fully understand the Math Department's Attendance Policy. This policy will be strictly enforced.

Exams: Final project presentation will be during the final exam week:

Final Exam Period	May 3 - May 9, 2024

Makeup Exam Policy: There will be NO MAKE-UP QUIZZES OR EXAMS during the semester. In the event an exam is not taken under rare circumstances where the student has a legitimate reason for missing the exam, the student should contact the Dean of Students office and present written verifiable proof of the reason for missing the exam, e.g., a doctor's note, police report, court notice, etc. clearly stating the date AND time of the mitigating problem. The student must also notify the Math Department Office/Instructor that the exam will be missed.

Cellular Phones: All cellular phones and other electronic devices must be switched off during all class times.

ADDITIONAL RESOURCES

Math Tutoring Center: Located in the Central King Building, Lower Level, Rm. G11 (See: Spring 2024 Hours)

Further Assistance: For further questions, students should contact their instructor. All instructors have regular office hours during the week. These office hours are listed on the Math Department's webpage for Instructor Office Hours and Emails.

Accommodation of Disabilities: The Office of Accessibility Resources and Services (OARS) offers long term and temporary accommodations for undergraduate, graduate and visiting students at NJIT.

If you are in need of accommodations due to a disability please If you need an accommodation due to a disability please contact the Office of Accessibility Resources and Services at oars@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Office of Accessibility Resources and Services office authorizing your accommodations will be required.

For further information regarding self identification, the submission of medical documentation and additional support services provided please visit the Office of Accessibility Resources and Services (OARS)

website at:

https://www.njit.edu/accessibility/

Important Dates (See: Spring 2024 Academic Calendar, Registrar)

Date	Day	Event
January 16, 2024	Tuesday	First Day of Classes
January 22, 2024	Monday	Last Day to Add/Drop Classes
March 10, 2024	Sunday	Spring Recess Begins
March 16, 2024	Saturday	Spring Recess Ends
March 29, 2024	Friday	Good Friday - No Classes
April 1, 2024	Monday	Last Day to Withdraw
April 30, 2024	Tuesday	Friday Classes Meet
April 30, 2024	Tuesday	Last Day of Classes
May 1, 2024	Wednesday	Reading Day 1
May 2, 2024	Thursday	Reading Day 2
May 3 - May 9, 2024	Friday to Thursday	Final Exam Period

Course Outline

Week #	Subject Topic
Week 1 - 2	*Finite difference numerical methods; Iterative methods, Jacobi, Gauss-Seidel, SOR*
Week 3	*Introduction to parallel computing.*
Week 4	*Introduction to OpenMP; Parallel matrix and vector operations.*
Week 5	*OpenMP; Parallelizing iterative methods with OpenMP.*
Week 6	*OpenMP; Performance metrics.*
Week 7 - 8	*Fast numerical methods - eg. Fast Poisson equation Solver; FMM.*
Week 9 - 10	*High performance linear algebra: Conjugate Gradient method, GMRES.*
Week 11	*Introduction to Fast Fourier Transform.*
Week 12 - 13	*Spectral methods.*
Week 14	*Introduction to Machine Learning, Stochastic Gradient Descent*