NJIT New Jersey's Science & Technology University

THE COLLEGE OF SCIENCE AND LIBERAL ARTS

THE DEPARTMENT OF MATHEMATICAL SCIENCES

MATH 707-002: ST: Applications of Parallel Computing
Spring 2020 Graduate 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 special topic course is designed to teach students how to program parallel computers to efficiently solve challenging problems in science and engineering, where very fast computers are required either to perform complex simulations or to analyze enormous datasets. The course will provide an introduction to a variety of topics, tools, and techniques for high performance numerical computing, such OpenMP, MPI and computational machine leaning.

Number of Credits: 3

Prerequisites: The course is intended for students from many departments and with different backgrounds, although we will assume reasonable programming skills in a conventional (non-parallel) language, as well as enough mathematical skills to understand the problems and algorithmic solutions presented.

Course-Section and Instructors

Course-Section	Instructor
Math 707-002	Professor S. Afkhami

Office Hours for All Math Instructors: Spring 2020 Office Hours and Emails

Course Materials: All course materials are on: https://moodle.xsede.org

University-wide Withdrawal Date: The last day to withdraw with a **W** is **Monday, April 6, 2020**. 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 and Quizzes	50%
Final Project	50%

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.

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

ADDITIONAL RESOURCES

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

Accommodation of Disabilities: Disability Support Services (DSS) 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 contact Chantonette Lyles, Associate Director of Disability Support Services at 973-596-5417 or via email at lyles@njit.edu. The office is located in Kupfrian Hall, Room 201. A Letter of Accommodation Eligibility from the Disability Support 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 Disability Support Services (DSS) website at:

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

Important Dates (See: Spring 2020 Academic Calendar, Registrar)

Date	Day	Event
January 21, 2020	T	First Day of Classes
January 31, 2020	F	Last Day to Add/Drop Classes
March 15 - 22, 2020	Su-Su	Spring Recess: No Classes/ University Open
April 6, 2020	M	Last Day to Withdraw
April 10, 2020	F	Good Friday - University Closed
May 5, 2020	T	Friday Classes Meet - Last Day of Classes
May 6 & 7, 2020	W & R	Reading Days
May 8 - 14, 2020	F - R	Final Exam Period

COURSE OUTLINE

- Homework 0 - Describing a Parallel Application
- Lecture 1 - Introduction
- Lecture 2 - Single Processor Machines
- Lecture 3 - Optimizing Matrix Multiply
- Programming Homework 1 - Tuning Matrix Multiply
- Lecture 4 - Shared-Memory Programming
- Lecture 5 - Roofline and Performance Modeling
- Lecture 6 - Source of Parallelism and Locality
- Lecture 7 - Sources of Parallelism in Simulation
- Lecture 8 - An Introduction to GPGPU Programming
- Lecture 9: Distributed Memory Machines and Programming
- Lecture 10 - Advanced MPI and Collective Communication
- Programming Homework 2 - Parallelizing a Particle
- Lecture 11 - PGAS and UPC++
- Lecture 12 - Cloud Computing and Big Data Processing
- Programming Homework 3 - Parallelize Graph Algorithms
- Lecture 13 - Parallel Matrix Multiply
- Lecture 14 - Dense Linear Algebra
- Lecture 15 - Sparse Matrix-Vector Multiplication
- Lecture 16 - Structured Grids
- Lecture 17: Machine Learning - Part 1 (Supervised Learning)
- Lecture 18 - Machine Learning - Part 2 (Unsupervised Learning)
- Lecture 19 - Parallel Graph Algorithms
- Lecture 20 - Fast Fourier Transform
- Lecture 21 - Climate Modeling
- Lecture 22: Sorting and Searching
- Lecture 23 - Dynamic Load Balancing
- Lecture 24 - Hierarchical Methods for the N-Body Problem
- Lecture 25 - Computational Biology
- Lecture 26 - Big Bang, Big Data, and Big Iron
- Lecture 27 - Supercomputers and SuperIntelligence
- Lecture 28 - Quantum Computing
- Final Project