# DS642: Parallel Computing

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## DS 642: Applications of Parallel Computing

Monday: 6pm - 8:50pm
NJIT@JerseyCity (101 Hudson St.)
**CRN**: 12247
**Instructor**: Distinguished Professor David A. Bader (https://t.e2ma.net/click/2rb85v/elurcjac/aeu3u6)

**Course Description**

This course will teach students how to design, analyze, and implement, parallel programs for high performance computational science and engineering applications. The course focuses on advanced computer architectures, parallel algorithms, parallel languages, and performance-oriented computing. Students will develop knowledge and skills 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.

**Prerequisites**: Proficiency in (non-parallel) programming in a high level procedural language.

Topics include:

- Introduction to Single Processor Machines and Parallel Computing
- Optimizing/Tuning Matrix Multiplication
- Shared-Memory Programming, Memory Hierarchies, Multicore and Many core
- An Introduction to GPGPU Programming with CUDA
- Distributed Memory Machines and Programming, Advanced MPI and Collective Communication
- Parallel Matrix Multiply, Dense Linear Algebra, Sparse Matrix-Vector Multiplication
- Fast Fourier Transform
- Parallel Graph Algorithms
- Partitioning Applications for Heterogeneous Resources, Dynamic Load Balancing
- Machine Learning, Cloud Computing and Big Data Processing
- Measuring Performance, Identifying Bottlenecks
- Advanced Topics in Parallel Programming
- Project Presentations

**Teaching Assistant**

- **TBD**, xxx@njit.edu
  Office Hours: TBD
  Webex: TBD

**Evaluation**

Grading components:

| | |
|---|---|
| Participation | 5% |
| Homework | 20% |
| Midterm | 25% |
| Final Project | 50% |

**Late Policy**

Students are expected to complete work on schedule. Late work is not accepted unless prior arrangements are made with the instructor.

**Academic Integrity and Student Conduct:**

**"Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf (https://t.e2ma.net/click/7xcjqfb/7td9novf/vc0hkjx) .**

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. **Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university.** If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at **dos@njit.edu (mailto:dos@njit.edu)** "

**Proctoring of midterm and final exams**

*NJIT policy requires that all midterm and final exams must be proctored, regardless of delivery mode, in order to increase academic integrity.* In this course you will be required to use an online proctoring module to ensure academic integrity for exams.

# Course Summary:

| Date | Details | Due |
|---|---|---|
| Mon Jan 27, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106928&include_contexts=course_43787) | 6pm to 8:50pm |
| Tue Jan 28, 2025 | Academic Engagement: Spring 2025 (https://njit.instructure.com/courses/43787/assignments/510816) | due by 11:59pm |

| Date | Details | Due |
| --- | --- | --- |
| Fri Jan 31, 2025 | Get Started with ACCESS (https://njit.instructure.com/courses/43787/assignments/523922) | due by 11:59pm |
| Mon Feb 3, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106926&include_contexts=course_43787) | 6pm to 8:50pm |
| | A View of the Parallel Computing Landscape (https://njit.instructure.com/courses/43787/assignments/523917) | due by 6pm |
| Mon Feb 10, 2025 | Lecture: Solving Global Grand Challenges with High Performance Data Analytics (https://njit.instructure.com/calendar?event_id=106921&include_contexts=course_43787) | 5pm to 6pm |
| | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106915&include_contexts=course_43787) | 6pm to 8:50pm |
| | Using Bridges-2 (HW1) (https://njit.instructure.com/courses/43787/assignments/523931) | due by 6:59pm |
| Mon Feb 17, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106916&include_contexts=course_43787) | 6pm to 8:50pm |
| Thu Feb 20, 2025 | centroid (HW2) (https://njit.instructure.com/courses/43787/assignments/523933) | due by 6pm |
| | matmul (HW2) (https://njit.instructure.com/courses/43787/assignments/523934) | due by 6pm |
| | membench (HW2) (https://njit.instructure.com/courses/43787/assignments/523935) | due by 6pm |
| Mon Feb 24, 2025 | DS 642 Lecture (ONLINE) (https://njit.instructure.com/calendar?event_id=106927&include_contexts=course_43787) | 6pm to 8:50pm |
| Mon Mar 3, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar? | 6pm to 8:50pm |

| Date | Details | Due |
|---|---|---|
| | event_id=106922&include_contexts=course_43787) | |
| | Project proposal (https://njit.instructure.com/courses/43787/assignments/523928) | due by 6pm |
| | Review / Compile / Run OpenMP example code (HW4) (https://njit.instructure.com/courses/43787/assignments/523929) | due by 6pm |
| Mon Mar 10, 2025 | DS 642 Lecture and Midterm Exam (https://njit.instructure.com/calendar?event_id=106919&include_contexts=course_43787) | 6pm to 8:50pm |
| | Midterm Exam (https://njit.instructure.com/courses/43787/assignments/523924) | due by 8:50pm |
| Mon Mar 24, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106924&include_contexts=course_43787) | 6pm to 8:50pm |
| | Matrix multiplication with OpenMP (HW5) (https://njit.instructure.com/courses/43787/assignments/523923) | due by 6pm |
| Mon Mar 31, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106925&include_contexts=course_43787) | 6pm to 8:50pm |
| | Using CUDA (HW6) (https://njit.instructure.com/courses/43787/assignments/523932) | due by 6pm |
| Mon Apr 7, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106929&include_contexts=course_43787) | 6pm to 8:50pm |
| Mon Apr 14, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106917&include_contexts=course_43787) | 6pm to 8:50pm |
| Fri Apr 18, 2025 | 2D Parallel Programming in CUDA (HW7) (https://njit.instructure.com/courses/43787/assignments/523916) | due by 11:59pm |

| Date | Details | Due |
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| Mon Apr 21, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106923&include_contexts=course_43787) | 6pm to 8:50pm |
| | OpenCL Vector Addition (HW8) (https://njit.instructure.com/courses/43787/assignments/523926) | due by 6pm |
| Mon Apr 28, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106918&include_contexts=course_43787) | 6pm to 8:50pm |
| | Data distributions with MPI (HW9) (https://njit.instructure.com/courses/43787/assignments/523919) | due by 6pm |
| Mon May 5, 2025 | DS 642 Lecture (https://njit.instructure.com/calendar?event_id=106914&include_contexts=course_43787) | 6pm to 8:50pm |
| | FFTW (HW11) (https://njit.instructure.com/courses/43787/assignments/523920) | due by 6pm |
| | Final Project (https://njit.instructure.com/courses/43787/assignments/523921) | due by 6pm |
| | Parallelized Matrix Vector Multiplication (HW10) (https://njit.instructure.com/courses/43787/assignments/523927) | due by 6pm |
| Mon May 12, 2025 | DS 642 Final Project (https://njit.instructure.com/calendar?event_id=106920&include_contexts=course_43787) | 6pm to 8:50pm |
| | Class Participation (https://njit.instructure.com/courses/43787/assignments/523918) | |
| | Monte Carlo estimation of Pi in OpenMP (HW3) (https://njit.instructure.com/courses/43787/assignments/523925) | |
| | Roll Call Attendance (https://njit.instructure.com/courses/43787/assignments/523930) | |