CS–5234 (CRN 13534)  
Advanced Parallel Computation  
Spring 2024

Essential information.

Instructor  
Prof. Adrian Sandu  
• Phone 231-2193  
• E-mail sandu@cs.vt.edu  
• Office 2222 KW-II  
• Office hours By appointment, https://virginiatech.zoom.us/my/asandu7

Teaching Assistants  
Amit Subrahmanya  
• E-mail amitns@vt.edu  
• Office https://virginiatech.zoom.us/my/amitns; by appointment in McBryde 106  
• Office hours Mon. 11:15am-12:15p.

Lecture  
Tue–Thu 11am–12:15pm, 277 Whittemore Hall (WHIT 277), 1185 Perry St.  
Web Page http://www.cs.vt.edu/~asandu/Courses/CS5234/CS5234.html  
Prerequisites CS–3204. Graduate standing or permission of the instructor.  
Final Exam Section 11T, May 4, 2024, 1:05pm-3:05am.

Textbook.


Additional References for Parallel Algorithms and Design.


• Prof. Jim Demmel’s CS267 lecture notes: https://sites.google.com/lbl.gov/cs267-spr2023

• Ian Foster, “Designing and Building Parallel Programs”, http://www-unix.mcs.anl.gov/dbpp

Additional Resources for Parallel Programming.

- “The OpenMP Specifications”
- “Introduction to OpenMP”
- “MPICH implementation”, [http://www.mpich.org](http://www.mpich.org)
- “OpenMPI implementation”, [https://www.open-mpi.org](https://www.open-mpi.org)


About the course.

This class discusses fundamental concepts of parallel computing. Topics include a survey of parallel computer architectures, models of parallel computation, and interconnection networks; parallel algorithm development and analysis; programming paradigms and languages for parallel computation; example applications; performance measurement and evaluation. If time permits we will discuss additional topics as well.
Topics.

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<th>Week</th>
<th>Topic</th>
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<tr>
<td>Week 1</td>
<td>Introduction and motivation. Motivating examples: matrix-vector and</td>
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<td>matrix-matrix multiplication. Parallel architectures. Parallel</td>
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<td>programming models.</td>
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<td>Weeks 2–3</td>
<td>Shared memory programming. Race conditions. OpenMP and</td>
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<td>applications.</td>
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<td>Weeks 4–7</td>
<td>Message passing programming. The Message Passing Interface (MPI) and</td>
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<td>applications.</td>
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<td>Weeks 8–9</td>
<td>Principles of parallel algorithm design: tasks, dependency graphs,</td>
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<td>mappings. Decomposition techniques: embarrassingly parallel, data</td>
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<td>decomposition, pipelined computations, etc.</td>
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<td>Week 10</td>
<td>Analytical modeling of parallel programs. Performance metrics and</td>
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<td>parallel performance analysis.</td>
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<td>Week 11</td>
<td>Non-numerical Applications. Graph traversal, sorting.</td>
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<td>Weeks 12–13</td>
<td>Numerical Applications. Matrix-vector and</td>
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<td>matrix-matrix multiplication, solving linear systems.</td>
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<td>Weeks 14–15</td>
<td>Additional topics: programming heterogeneous multi-core</td>
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<td>architectures like graphs processing units (GPUs)</td>
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Grading.

The grade will be based on homework projects and on in-class presentations related to the final project:

30% Final project;

70% Homework projects (theoretical and programming assignments).

Disclaimer.

Some information given to you in class may supersede the information in this syllabus or on the web page.

Student Complaints and Academic Misconduct.

Students are expected to comply to the Honor Code. If you have any problems, the first step is to discuss with me directly.

Disabilities.

Please let me know if you have a disability that requires special arrangements.