THE UNIVERSITY OF WINNIPEG

Applied Computer Science

Course Number: **ACS-7306-002**
Course Name: **Applied Parallel Programming**
Course Webpage: http://courses.acs.uwinnipeg.ca/4306-002/

Instructor Information

Instructor: Dr. Christopher Bidinosti
Email: c.bidinosti@uwinnipeg.ca

Class Room No: 3D03
Class Meeting Time: T/Th 2:30-3:45 pm
Lab Room No: 3D03
Lab Meeting Time: Friday 8:30-9:45 am
Office Hours: TBA

Important Dates

First Class:	January 5
Midterm Test:	February 14
Midterm Reading Week:	February 19 – 25 (no classes)
Withdrawal date w/o academic penalty[2]:	March 1
Last Scheduled Class:	April 4
Final Test (Comprehensive):	April 7, 1:30 pm – 4:30 pm, 3D03 (Tentative) http://www.uwinnipeg.ca/exam-schedules/index.html

[2]A minimum of 20% of the work on which the final grade is based will be evaluated and available to the student before the voluntary withdrawal date.

Additional Course Related Information

1. When it is necessary to cancel a class due to exceptional circumstances, instructors will make every effort to inform you via uwinnipeg email, as well as the departmental assistant and Chair/Dean so that class cancellation forms can be posted outside classrooms.

2. Your uwinnipeg email address will normally be used for course related correspondence.

3. Please note that withdrawing before the VW date does not result in a fee refund.

4. Class make-up days are scheduled at the end of term for courses that conflict with holidays.

Course Objectives/Learning Outcomes

The course focuses on parallel and distributed computing in high-performance scientific application, using the parallel execution model, a generalization of the traditional single threaded paradigm. The course covers multi-core processors, concurrency, parallel execution, latency, communication and coordination among processes, shared-memory models, optimization techniques, parallel algorithms, decomposition strategies, system architecture, and

performance analysis and tuning. Using the language C/C++ and the CUDA platform, students gain hands-on experience writing scalable parallel applications for Graphics Processing Units.

Evaluation Criteria

Midterm Examination (20%)

There will be **one** midterm test.

Assignments (5%)

There will be 12 assignments; take top 10 marks, each consisting of 0.5% of final grade.

Term Project – Research/Teaching Module and Report (35% total)

Students will study, utilize, and present the workings of a parallel algorithm (or other suitable GPU implementation) not covered in class. Examples include linear algebra and matrix manipulation, mathematical functions, data search and sorting, as well as programming GPUs in other languages such as Python. Examples can be found here: https://developer.nvidia.com/gpu-accelerated-libraries

Project Consultation and Proposal (5%)

Students will choose an appropriate algorithm in consultation with the professor. A final written proposal is required.

Guest Lecture and Notes (15%)

Students will teach this algorithm to their classmates. This will involve a formal lecture (~30 minutes) with presentation slides and handout notes summarizing learning objectives, algorithm principles, code structure, and examples of uses.

Final Report and Code Demonstration (15%)

Students will prepare a final detailed report about the algorithm they studied. This will also include a demonstration and analysis of a functioning program that they have written that uses this algorithm.

Final Test (40%)

The final test is comprehensive.

Final Letter Grade Assignment

Historically, numerical percentages have been converted to letter grades using the following scale. However, instructors can deviate from these values based on pedagogical nuances of a particular class, and final grades are subject to approval by the Department Review Committee.

A+	90+ - 100%	B	70 - 74%	F	below 50%
A	85 - 90%	C+	65 - 69%		
A-	80 - 84%	C	60 - 64%		
B+	75 - 79%	D	50 - 59%		

Exam Requirements

- Photo ID is required
- Unless a medical certificate is provided, no accommodation is made for missed exams

- No equipment (*e.g.* calculators, dictionaries, handheld devices) are authorized for use in tests/exams

Student Services and Information

Students with documented disabilities, temporary or chronic medical conditions, requiring academic accommodations for tests/exams (e.g., private space) or during lectures/laboratories (e.g., note-takers) are encouraged to contact Accessibility Services (AS) at 786-9771 or accessibilityservices@uwinnipeg.ca to discuss appropriate options. All information about a student's disability or medical condition remains confidential.
http://www.uwinnipeg.ca/accessibility.

Students facing a charge of academic or non-academic misconduct may choose to contact the University of Winnipeg Students' Association (UWSA) where a student advocate will be available to answer any questions about the process, help with building a case, and ensuring students have access to support. For more information or to schedule an appointment, visit our website at www.theuwsa.ca/academic-advocacy or call 204-786-9780.

We ask that you please be respectful of the needs of classmates and instructors/professors by avoiding the use of unnecessary scented products while attending lectures. Exposure to scented products can trigger serious health reactions in persons with asthma, allergies, migraines or chemical sensitivities. Please consider using unscented necessary products and avoiding unnecessary products that are scented (e.g. perfume).

Required Textbooks

Main texts:

- D. B. Kirk, and W. W. Hwu, *Programming Massively Parallel Processors: A Hands-on Approach, 3rd edition*. Elsevier, 2016, ISBN 978-0-12-811986-0
- H. Nguyen, Ed., *GPU Gems 3*. USA: Addison-Wesley, 2008. [Online]. Available: NVIDIA, https://developer.nvidia.com/content/gpu-gems-3.

Besides the information contained in the main texts, I may also distribute papers, and discuss appropriate material and examples from other sources. Students are responsible for all material covered in the class.

Prerequisite Information (This information can be found in the UW Graduate Calendar)

Consent of the Department Graduate Program Committee Chair or Instructor.

Misuse of Computer Facilities, Plagiarism, and Cheating

Academic dishonesty is a very serious offense and will be dealt with in accordance with the University's discipline bylaw. Be sure that you have read and understood **Student Discipline #9** in the 2016-2017 UW Graduate Course Calendar available at:
http://www.uwinnipeg.ca/academics/graduatecalendar/docs/grad-regandpol.pdf

Course Topics

1. Course Introduction and history of GPU Computing
2. Introduction to Data Parallelism and CUDA C
3. Data-Parallel Execution Model
4. Memory and Data Locality
5. Performance Considerations
6. Numerical Considerations
7. Parallel Patterns:
    a. Convolution
    b. Prefix Sum
    c. Parallel Histogram Computation
    d. Sparse Matrix-Vector Multiplication
8. Dynamic Parallelism
9. Case Studies:
    a. Advanced MRI
    b. Molecular Visualization and Analysis
    c. Machine Learning
10. Parallel Programming and Computational Thinking
11. Heterogeneous Computing Clusters
12. OpenACC
13. Advanced Topics

Note: not all of the above topics may be covered.

Course Readings

Relevant textbook chapters and sections will be given during lectures.

Recommended Study Habits

Students who do well in this class tend to spend an extra 3-5 hours per week doing the following:

- Read the textbook before coming to class
- Attend lectures
- Take notes
- Attempt the problems and exercises at the end of the chapters
- Submit all the exercises and assignments
- Form study groups to study for the midterm and exam
- Regularly ask questions

Advice: Students who fall behind find it very hard to catch up.