THE UNIVERSITY OF WINNIPEG

Applied Computer Science

Course Number: **GACS-7306-001**
Course Name: **Applied Parallel Programming**
Course Webpage: https://nexus.uwinnipeg.ca/d2l/home/47845

Instructor Information

Instructor: Dr. Christopher Henry
Class Room No: 3D03
Office Room No: 3D23
Email: ch.henry@uwinnipeg.ca
Class Meeting Time: T/Th 2:30 - 3:45 pm
Office Hours: Fridays 1:00 – 2:00 pm

Important Dates

First Class:	September 6th, 2022
Midterm Test:	October 6th, 2022
Fall Reading Week:	October 9th – 15th, 2022 **(No classes)**
Remote or Recorded Lecture[0]:	October 25th, 2022
Withdrawal date w/o academic penalty[12]:	November 16th, 2022
Missed Class[3]:	December 1st, 2022
Last (extra) Scheduled Class:	December 8th, 2022
Final Examination (Comprehensive):	TBD
The University is closed on the following dates (No Classes):	
	September 30th, 2022
	October 10th, 2022
	November 11th, 2022
	December 23rd, 2022 – January 2nd, 2023

[0] I will be at conference in Saskatoon so we will have either a remote or recorded lecture on this date.
[1] 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.
[2] Please contact the instructor if you are considering a VW in case there is any help you may need.
[3] I will be away for my brother's wedding. We will make up this class on December 6th.

Note: a permitted or necessary change in mode of delivery may require adjustments to important aspects of course outlines, like class schedule and the number, nature, and weighting of assignments and/or exams.

Course Objectives/Learning Outcomes

The basis of this course is the parallel execution model, which is a generalization of the traditional single threaded paradigm. The focus is parallel and distributed computing for use in

high-performance scientific applications. Students gain considerable knowledge in multi-core processors, concurrency, parallel execution, latency, communication and coordination among processes, message passing, shared-memory models, optimization techniques, parallel algorithms, decomposition strategies, system architecture, and performance analysis and tuning. Using the language C/C++, 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 (20%)

Graduate students are expected to complete the laboratories assigned to undergraduate students. There will be 10 assignments: each consisting of 2% of your final grade. Assignments will be posted on the course website. All work submitted for evaluation must be typed, and code must be commented and formatted. Submissions will be made via Nexus. Late submissions will not be accepted.

Project (20%)

Details will be provided in class.

Final Examination (40%)

The final examination is comprehensive.

Exam Requirements

- Photo ID is required for students writing the examinations
- Unless a medical certificate is provided, no accommodation is made for missed deadlines or examinations
- No equipment (*e.g.* calculators, dictionaries, handheld devices, cell phones, computers) 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 or during lectures/laboratories are encouraged to contact Accessibility Services (AS) at 204.786.9771 or https://www.uwinnipeg.ca/accessibility-services/ to discuss appropriate options. All information about a student's disability or medical condition remains confidential.

All students, faculty and staff have the right to participate, learn, and work in an environment that is free of harassment and discrimination. The UW Respectful Working and Learning Environment Policy may be found at https://www.uwinnipeg.ca/respect/.

Students may choose not to attend classes or write examinations on holy days of their religion, but they must notify their instructors at least two weeks in advance. Instructors will then

provide opportunity for students to make up work or examinations without penalty. A list of religious holidays can be found in the 2022-23 Undergraduate Academic Calendar.

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%		

Required Textbooks

Main texts:

- D. B. Kirk, and W. W. Hwu, *Programming Massively Parallel Processors: A Hands-on Approach*. 3rd Edition, USA: Elsevier, 2016

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 General Calendar)

- Consent of Department Graduate Studies Committee Chair
- Students who have taken ACS-4306 will not be eligible to take ACS-7306 for degree credit.

Regulations, Policies, and Academic Integrity

Academic dishonesty is a very serious offense and will be dealt in accordance with the University's policies.

Avoiding Academic Misconduct and Non-academic Misconduct. Students are encouraged to familiarize themselves with the "Academic Regulations and Policies" found in the University *Academic Calendar* at:
https://uwinnipeg.ca/academics/calendar/docs/regulationsandpolicies.pdf

Particular attention should be given to subsections 8 ("Student Discipline"), 9 ("Senate Appeals") and 10 ("Grade Appeals"). Please note, in particular, the subsection of Student Discipline pertaining to plagiarism and other forms of cheating.

Please note the importance of maintaining academic integrity, and to the potential consequences of engaging in plagiarism, cheating, and other forms of academic misconduct. Even "unintentional" plagiarism, as described in the UW Library video tutorial "Avoiding

Plagiarism" (https://www.youtube.com/watch?v=UvFdxRU9a8g) is a form of academic misconduct.

Detailed information can be found at the following:

- Academic Misconduct Policy and Procedures: https://www.uwinnipeg.ca/institutional-analysis/docs/policies/academic-misconduct-policy.pdf and https://www.uwinnipeg.ca/institutional-analysis/docs/policies/academic-misconduct-procedures.pdf
- Non-Academic Misconduct Policy and Procedures: https://www.uwinnipeg.ca/institutional-analysis/docs/student-non-academic-misconduct-policy.pdf and https://www.uwinnipeg.ca/institutional-analysis/docs/student-non-academic-misconduct-procedures.pdf

Misuse of Filesharing Sites. Uploading essays and other assignments to essay vendor or trader sites (filesharing sites that are known providers of essays for use by others who submit them to instructors as their own work) involves "aiding and abetting" plagiarism. Students who do this can be charged with Academic Misconduct.

Non-academic misconduct. Students are expected to conduct themselves in a respectful manner on campus and in the learning environment irrespective of platform being used. Behaviour, communication, or acts that are inconsistent with a number of UW policies could be considered "non-academic" misconduct.

More detailed information can be found here:

- Respectful Working and Learning Environment Policy https://www.uwinnipeg.ca/respect/respect-policy.html
- Acceptable Use of Information Technology Policy https://www.uwinnipeg.ca/institutional-analysis/docs/policies/acceptable-use-of-information-technology-policy.pdf
- Non-Academic Misconduct Policy and Procedures https://www.uwinnipeg.ca/institutional-analysis/docs/student-non-academic-misconduct-policy.pdf and https://www.uwinnipeg.ca/institutional-analysis/docs/student-non-academic-misconduct-procedures.pdf.

Copyright and Intellectual Property. Course materials are the property of the instructor who developed them. Examples of such materials are course outlines, assignment descriptions, lecture notes, test questions, and presentation slides—irrespective of format. Students who upload these materials to filesharing sites, or in any other way share these materials with others outside the class without prior permission of the instructor/presenter, are in violation of copyright law and University policy. Students must also seek prior permission of the instructor/presenter before, for example, photographing, recording, or taking screenshots of slides, presentations, lectures, and notes on the board. Students found to be in violation of an instructor's intellectual property rights could face serious consequences pursuant to the

Academic Misconduct or Non-Academic Misconduct Policy; such consequences could possibly involve legal sanction under the Copyright Policy
https://copyright.uwinnipeg.ca/docs/copyright_policy_2017.pdf

Privacy

Students have rights in relation of the collecting of personal data the University of Winnipeg:
https://www.uwinnipeg.ca/privacy/admissions-privacy-notice.html

More information:

- Zoom and Privacy: https://www.uwinnipeg.ca/privacy/zoom-privacy-notice.html
- Testing/Proctoring: https://www.uwinnipeg.ca/privacy/zoom-test-and-exam-proctoring.html

Class Cancellation, Correspondence with Students and Withdrawing from Course

When it is necessary to cancel a class due to exceptional circumstances, every effort will be made to inform students via UWinnipeg email (and/or using the preferred form of communication, as designated in this outline).

Students have the responsibility to regularly check their UWinnipeg e-mail addresses to ensure timely receipt of correspondence from the University and/or their course instructors.

Please let course instructor know if you plan on withdrawing from the course. Note that withdrawing before the VW date does not necessarily result in a fee refund.

Course Topics

1. Course Introduction
2. Data Parallel Computing
3. Scalable Parallel Execution
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
    e. Merge Sort
    f. Graph Search
8. CUDA Dynamic Parallelism
9. Case Studies
10. Parallel Programming and Computational Thinking
11. Heterogeneous Computing Clusters
12. Advanced Topics

Note: not all the above topics may be covered.

Course Readings

Relevant textbook chapters and sections will be given during lectures.

Student Wellness

The University of Winnipeg affirms the importance of student mental health and our commitment to providing accessible, culturally appropriate, and effective services for students. Students who are seeking mental health supports are encouraged to reach out to the Wellness Centre at studentwellness@uwinnipeg.ca or 204.988.7611. For community-based mental health resources and supports, students are encouraged to dial 2-1-1. This program of United Way is available 24/7 in 150 languages.

Recommended Study Habits

Students who do well in this class attend lectures, take notes, submit all deliverables, regularly ask questions, and tend to spend an extra 3-5 hours per week doing the following:

- Read course notes and handouts
- Read the textbook before coming to class
- Attempt the problems and exercises at the end of the chapters
- Form study groups to study for the midterm and exam
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Advice: Students who fall behind find it very hard to catch up.