University of Saskatchewan
Department of Computer Science
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Course Syllabus
CMPT 851: Parallel Programming for Scientific Computing (3 c.u.)

Catalogue Description

Parallel programming paradigms and algorithms for shared and distributed memory computer architectures; performance analysis; use of shared infrastructure; applications in scientific computing (e.g., linear systems, differential equations, optimization, quadrature).

Prerequisite(s):	Permission of the instructor (experience in numerical analysis / programming useful)
Class Time and Location:	Tue / Thu 1:00 p.m. – 2:20 p.m., THORV S342
Website:	Blackboard on PAWS

Instructor: Prof. Raymond J. Spiteri

Contact: Email: raymond.spiteri@usask.ca

Phone: 306-966-2909

Office Hours: Location: THORV S425

Times: by appointment

Course Objectives

Despite the extraordinary advances in computing technology, we continue to need ever greater computing power to address important fundamental scientific questions. Because individual compute processors have essentially reached their performance limits, the need for greater computing power can only be met through the use of parallel computers. This course is intended for students who are interested in learning how to take advantage of parallel and distributed computing with the focus of writing parallel code for processor-intensive applications to be run on local clusters, the cloud, or shared infrastructure such as that provided by Compute Canada. The objectives of this course are to give the students an understanding of how they can use parallel computing in their research and enable them to write parallel code for their high-performance computing applications. Extensive use of pertinent and practical examples from scientific computing will be made throughout. The programming languages used will be Matlab, Maple, sage, python, Fortran, or C. Both the shared and distributed paradigms of parallel computing will be covered via the OpenMP and MPI libraries.

Student Evaluation

Grading Scheme

Class contribution	10%
Assignments (4; due every 2–3 weeks)	20%
Course Project	50%
Midterm Exam	20%
Total	100%

Criteria That Must Be Met To Pass

Class Contribution

Students are expected to attend class at the scheduled meeting times. The class contribution grade assigned is necessarily linked to attendance.

The "Class Contribution" portion of your grade will be calculated according to the following guidelines:

- excellent (mid-80s–100): Contributed frequently and insightfully; demonstrated critical understanding of readings/videos; showed awareness of how readings/videos relate to each other and to overarching themes; interacted with other students and built on their comments.
- good (70–low 80s): Contributed regularly; grasped main points of readings/videos; showed awareness of interrelationships between readings/videos and themes or interacted with other students.
- adequate (50s–69): Contributed occasionally; demonstrated partial understanding of readings/videos; some comments unconnected to main subject or restatements of those offered by other students.
- substandard (0–49): Remained silent or contributed minimally; demonstrated little or no understanding of readings/videos; made irrelevant or erroneous comments; absent without excuse.

This course is being run using the "flipped classroom" model. Lectures are pre-recorded and posted on YouTube. Before each class, each student is responsible for watching the appropriate video and printing out and filling in the corresponding guided notes. The guided notes are to be brought to class, where they will be taken up. The remaining classtime will focus on problem-solving or other skills required for the course, e.g., basic software engineering, interactive demonstrations, writing, presentations.

Course Project

An important part of the course is a project on a topic of your choice that is closely related to the course material. Examples of eligible projects include review papers, tutorials, and software (in a relevant programming language or problem-solving environment). Projects are required to have final written reports of at least 20 pages. Use of LaTeX is required.

The breakdown of the grading scheme for the course project is as follows.

Interim presentation	5%
Interim progress report	5%
Final presentation	10%
Final report	30%
Total	50%

Note: All students must be properly registered in order to attend lectures and receive credit for this course.

Textbook Information

Required Text

- Peter S. Pacheco, An Introduction to Parallel Programming, Morgan Kaufmann, 2011.

Lecture Schedule

Topic	Subtopics
Overview of Parallel Computing	• Hardware and software paradigms • Shared infrastructure
Communication Paradigms	• Point-to-point / collective communication • Blocking / non-blocking communication
Designing, Coding, and Debugging	• Foster's methodology • Deadlock; race conditions
Measuring Performance and Profiling	• Performance metrics • Compute-bound vs. memory-bound
Parallel Algorithms and Libraries	• Independent tasks; domain decomposition • Parallel MATLAB, PETSc
Applications	• Linear systems, eigenvalues, quadrature, differential equations, optimization

- There are no formal labs associated with this course.

Learning Outcomes

By the end of the course, students will be expected to be able to correctly solve non-trivial problems involving parallel programming as well as appreciate the issues involved in solving such problems.

Policies

Late Assignments

Late assignments are subject to a penalty of 10% for up to 24 hours late and 20% for up to 48 hours late. Assignments that are more than 48 hours late are not accepted without valid justification.

Missed Examinations

1. "Students who have missed an exam or assignment must contact their instructor as soon as possible. Arrangements to make up the exam may be arranged with the instructor. Missed exams throughout the year aqre left up to the discretion of the instructor if a student may make up the exam or write at a different time. If a student knows prior to the exam that she/he will not be able to attend, they should let the instructor know before the exam."

Incomplete Course Work and Final Grades

When a student has not completed the required course work, which includes any assignment or examination including the final examination, by the time of submission of the final grades, they may be granted an extension to permit completion of an assignment, or granted a deferred examination in the case of absence from a final examination. Extensions for the completion of assignments must be approved by the Department Head, or Dean in non-departmentalized Colleges, and may exceed thirty days only in unusual circumstances. The student must apply to the instructor for such an extension and furnish satisfactory reasons for the deficiency. Deferred final examinations are granted as per College policy.

In the interim, the instructor will submit a computed percentile grade for the course which factors in the incomplete course work as a zero, along with a grade comment of INF (Incomplete Failure) if a failing grade. In the case where the instructor has indicated in the course outline that failure to complete the required course work will result in failure in the course, and the student has a computed passing percentile grade, a final grade of 49% will be submitted along with a grade comment of INF (Incomplete Failure).

If an extension is granted and the required assignment is submitted within the allotted time, or if a deferred examination is granted and written in the case of absence from the final examination, the instructor will submit a revised computed final percentage grade. The grade change will replace the previous grade and any grade comment of INF (Incomplete Failure) will be removed. For provisions governing examinations and grading, students are referred to the University Council Regulations on Examinations subsection of the Calendar.

(2011 University of Saskatchewan Calendar/Academic Courses Policy)

Academic Honesty

The University of Saskatchewan is committed to the highest standards of academic integrity and honesty. Students are expected to be familiar with the standards regarding academic honesty and to uphold them. Students are particularly urged to familiarize themselves with the provisions of the Student Conduct & Appeals subsection of the University Secretary Website and avoid any behaviour that could potentially result in suspicions of cheating, plagiarism, misrepresentation of facts and/or participation in an offence. Academic dishonesty is a serious offence and can result in suspension or expulsion from the University.

All students should read and be familiar with the Regulations on Academic Student Misconduct, http://www.usask.ca/university_secretary/honesty/StudentAcademicMisconduct.pdf, as well as the Standard of Student Conduct in Non-Academic Matters and Procedures for Resolution of Complaints and Appeals, http://www.usask.ca/university_secretary/honesty/StudentNon-AcademicMisconduct2012.pdf.

Academic honesty is also defined and described in the Department of Computer Science Statement on Academic Honesty: http://www.cs.usask.ca/undergrad/honesty.php.

For more information on what academic integrity means for students see the Student Conduct & Appeals subsection of the University Secretary Website at: http://www.usask.ca/university_secretary/pdf/dishonesty_info_sheet.pdf

Examinations with Disability Services for Students (DSS)

Students who have disabilities (learning, medical, physical, or mental health) are strongly encouraged to register with Disability Services for Students (DSS) if they have not already done so. Students who suspect they may have disabilities should contact DSS for advice and referrals. In order to access DSS programs and supports, students must follow DSS policy and procedures. More information is available at http://www.students.usask.ca/disability/, or contact DSS at 306-966-7273 or dss@usask.ca.

Students registered with DSS may request alternative arrangements for mid-term and final examinations. Students must arrange such accommodations through DSS by the stated deadlines. Instructors shall provide the examinations for students who are being accommodated by the deadlines established by DSS.