Course Objectives
The objectives of this course are to introduce students to High-Performance Computing (HPC) and to give students the ability to understand, analyze, design and implement parallel software solutions. Students will develop skills in writing message-passing parallel codes capable of solving large-scale computational problems. Core concepts such as parallel efficiency and load balancing will be covered. The course features detailed analysis of effective techniques for parallel processing of inherently parallel problems and provides a foundation for critically analyzing current and future HPC solutions. Additionally, General Purpose Graphics Processing Units (GPGPUs) will be introduced as parallel co-processors.

Prerequisites
ECE 3760 Digital Systems Design I
COMP 2140 Data Structures and Algorithms

Course Content
The following topics will be covered:
- Basic parallel computer architectures
- Parallel computing using the Message-Passing Interface (MPI)
- Evaluating parallel programs
- Partitioning strategies
- Pipelined computations
- Load balancing
- Algorithms and applications: sorting algorithms, numerical algorithms and image processing.
- A short introduction to GPGPUs

Laboratories
There will be five labs covering the following topics:
1. Point-to-point and collective communication using MPI
2. Embarrassingly parallel computations
3. Divide-and-conquer computations
4. Pipeline computations
5. A short introduction to GPGPU programming

Total Accreditation Units: 46.5
Mathematics: 0%
Natural Science: 0%
Complementary Studies: 0%
Engineering Science: 65%
Engineering Design: 35%

Web Page
https://universityofmanitoba.desire2learn.com/

Textbook
Evaluation Details
The final course grade is determined by the student’s performance on assignments, in laboratories, and on examinations. Students must complete all laboratories and receive a passing grade on the final examination in order to be eligible to receive a passing grade.

Mid-Term
Thursday, October 30, 2014, 6:00-8:00 PM (location TBA)

Instructor
Prof. Ian Jeffrey
Room: E3-546 EITC
Telephone: (204) 474-7476
Email: Ian.Jeffrey@umanitoba.ca

Office Hours
Tuesdays and Thursdays 11:00 am – 12:00 pm or by request. Please include the “ECE 4530” in the subject line of any correspondence.

Teaching Assistants
TBA

Voluntary Withdrawal Date
Wednesday, November 12th, 2014.

Requirements/Regulations
- Attendance at lectures and laboratories is essential for successful completion of this course. Students must satisfy each evaluation component in the course to receive a final grade.
- It is the responsibility of each student to contact the instructor in a timely manner if he or she is uncertain about his or her standing in the course and about his or her potential for receiving a failing grade. Students should also familiarize themselves with Sections 4 and 6 of the Regulations dealing with incomplete term work, deferred examinations, attendance and withdrawal.
- No programmable devices or systems (such as calculators, PDAs, iPods, iPads, cell phones, wireless communication or data storage devices) are allowed in examinations unless approved by the course instructor.

Academic Integrity
Students are expected to conduct themselves in accordance with the highest ethical standards of the Profession of Engineering and evince academic integrity in all their pursuits and activities at the university. As such, in accordance with the General Academic Regulations and Requirements of the University of Manitoba, Section 7.1, students are reminded that plagiarism or any other form of cheating in examinations, assignments, laboratory reports or term tests is subject to serious academic penalty (e.g. suspension or expulsion from the faculty or university). A student found guilty of contributing to cheating in examinations or term assignments is also subject to serious academic penalty.
Learning Outcomes

1. A working knowledge of the Message-Passing Interface (MPI) and its use in parallel software solutions.

2. The ability to analyze a problem and to design and implement parallel strategies for its solution with an emphasis on the trade-offs between time and memory efficiency.

3. Experience with various types of parallelization patterns/algorithms (divide-and-conquer, pipeline, load-balancing) and their application to real-world large-scale engineering computations and software.

4. Familiarity with different parallel hardware architectures (distributed/cluster computing, shared memory systems, and heterogeneous parallel systems) and their influence on parallel software design decisions.

5. The ability to apply parallel programming concepts and skills to emerging and future high-performance computing systems such as GPU and PHI co-processors, among others.

**Expected Competency Level**

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<th>Learning Outcome</th>
<th>Attribute*</th>
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*Attributes:
A1 A knowledge base for engineering
A2 Problem analysis
A3 Investigation
A4 Design
A5 Use of engineering tools
A6 Individual and team work
A7 Communication skills
A8 Professionalism
A9 Impact of engineering on society/environment
A10 Ethics and equity
A11 Economics and project management
A12 Life-long learning

**Competency Levels:**
1 - Knowledge (Able to recall information)
2 - Comprehension (Able to rephrase information)
3 - Application (Able to apply knowledge in a new situation)
4 - Analysis (Able to break problem into its components and establish relationships)
5 - Synthesis (Able to combine separate elements into whole)
6 - Evaluation (Able to judge of the worth of something)

Student Contact Time (Hrs)
- Lectures: 3 hrs lecture/week × 13 weeks/term = 39 hrs
- Laboratories: 3 hrs laboratory × 5 weeks = 15 hrs
- Tutorials: 0 hr tutorial × 0 weeks = 0 hrs

Evaluation

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<tr>
<th>Component</th>
<th>Value (%)</th>
<th>Methods of Feedback</th>
<th>Learning Outcomes Evaluated</th>
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<td>F,S</td>
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* Methods of Feedback: F - formative (written comments and/or oral discussion), S - summative (number grades)