STUDENT INFORMATION SHEET
CPSC 677, PARALLEL PROCESSING, FALL 2025

Course Information

- **Days/Times/Place**:
  CPSC 677 810 MW 5:15 PM – 6:30 PM CAS 134
- **Web page** : *https://timoneilu.github.io/teaching/cs677/*
  Consult the "Info Sheet" link there for content regarding diversity, the ethical use of AI tools, accessibility, Title IX and sexual harassment and violence.
- **Prerequisites**: Admission to the Computer Science Master's Program or permission.

Course Description

Course Rationale :

With advances in technology, parallel computers have become readily available and affordable, making high-performance computing and supercomputing accessible to a much larger segment of the industry. This course explores the specific model of parallel programming using graphics processing units (GPUs) in depth. Along the way, we will discuss practical performance optimization and evaluation techniques for GPU computing.

Learning Objectives :

- To understand
  - The current state-of-the-art in GPU programming environments (i.e. shared-memory architecture, SIMD model), portable software libraries (i.e. CUDA) and parallel program development.
  - The complex interactions between hardware and software in GPU computing and how they affect performance.
- To apply and demonstrate mastery of the presented course concepts by writing a series of programs using the C programming language with CUDA extensions and the Linux and MS Windows operating systems.
- To exhibit the ability to teach and learn from others.

Course Personnel

Instructor : Dr. Tim O'Neil
Contact Info : *Office* : CAS 221A *Phone* : (330) 972 – 6492 E-*mail* : *toneil@uakron.edu*
Office Hours : TBD. I am also available by appointment.

Course Outline

Textbook : Kirk and Hwu, *Programming Massively Parallel Processors: A Hands-On Approach* (3rd Ed., Elsevier, 2017).
Topics : Parallel Programming using GPUs and CUDA

- CUDA Programming Model, Threads and Memories
- Floating-Point and Performance Considerations
  - Review Topics: Caching, Performance Metrics
  - Fundamental issues: data locality and dependencies, fine-grained parallelism
  - Improvement techniques, e.g. loop transformations

Course Grading

Items : Five, 20% each:

- Midterm (Monday October 13 in-class) and Final (Wednesday December 10, 5:15 PM) Exams
- Final Project
- Programming Projects
- Homework, Quizzes, and Class Participation

Approximate Scale :
A 88 – 100, B 75 – 87, C 62 – 74, D 49 – 61. Plus/minus grades assigned at my discretion.

Other Class Policies, Fall Semester 2025

Registration/Drop/Withdrawal

- Students whose names do not appear on the university's official class list by **Sunday August 31** will not be permitted to participate (attend class, take exams or receive credit).
- Students may drop a course online (without my signature) through **Sunday September 7**. Courses dropped by this date will not appear on a student's transcript.
- Students may withdraw from a course online (without my signature) through **Sunday October 12**. A "WD" will appear on the student's transcript.

Scholastic Honesty and Professional Integrity

- All work turned in for grade is to be exclusively the work of the student(s) whose name(s) appear(s) on the work. Incidents of academic dishonesty (such as cheating or plagiarism) will be handled in accordance with university policy by the Office of Student Conduct. In particular, the use of sources other than the textbook without citation, including other books, AI tools like ChatGPT and the World Wide Web, will be viewed as plagiarism. (If you're unsure of what constitutes plagiarism, consult the links on my home page.)
- Some of the materials in this course are possibly copyrighted. They are intended for use only by students registered and enrolled in this course and only for instructional activities associated with and for the duration of this course. They may not be retained in another medium or disseminated further. They are provided in compliance with the provisions of the TEACH Act (2002).

In-Class Conduct During Lectures

- Students are expected to attend all class meetings prepared (i.e. carrying the textbook, note paper, writing instruments, etc.) and participate. You may be dropped from this course and receive an "F" on your transcript for repeated absences (BOT Rule 3359-20-05D, effective 2/14/2013).
- All cell phones, etc., are to be turned off or switched to manner mode during class. Portable computers will be permitted until this privilege is abused.

In-Class Quizzes and Exams

- Written resources (i.e. textbook and printed notes) may be used during in-class quizzes; *electronic ones may not*. In-class quizzes may not be made up if absent, late or unprepared.
- On the other hand, the use of electronic devices is forbidden during in-class exams. Food and drink are also banned.
- Students who leave the room during an exam, or who use electronic devices during an exam, may not continue working on that exam.
- Make-up exams will be given only under extraordinary circumstances. Arrangements should be made prior to the exam and proof furnished.

Homework and Programming Assignments

- There will be no extra credit assignment or do-overs so don't even ask.
- Homework assignments and projects are to be submitted electronically in the manner specified in class. Submissions to my personal e-mail account will be ignored.
- Late assignments will be accepted but penalized according to the following scale: 10% penalty for one calendar day late, 25% for 2, 50% for 3, 75% for 4, and 100% (i.e. no credit) for 5 calendar days (i.e. one week) late. An exception will be made only for medical emergencies.
- All programming assignments must be completed within 10 calendar days of the original due dates to be eligible for a passing grade.
- All programming assignments will be graded according to how well they execute on the computers in CAS 241 or 254. It is your responsibility to check your work on our equipment prior to submission.
- All class assignments must be submitted by 5:00 PM on **Friday December 5**. Nothing will be accepted after this time.
- Students have one week from the return of a graded assignment (quiz, exam, homework or programming assignment) to seek corrections from me regarding grading; after that no changes will be made to scores.

DISCLAIMER: Save for changes that substantially affect implementation of the evaluation (grading) statement, this document is a guide for the course and is subject to change with advance notice.

SCHEDULE, HYBRID CPSC:677, FALL 2025

Day	Date			Agenda	Assignment
1	**Monday**	**8/25/2025**	**Live**	**Administration and Introduction** **Intro to the GPU Programming Model**	
2	Wednesday	8/27/2025	Online	Mathematical Foundations CUDA in Context	Complete HW0
	Monday	**9/1/2025**		**Labor Day, UA Closed**	
3	Wednesday	9/3/2025	Online	Module 1 (85:43): - Intro to GPU Computing (31:58) - Heterogeneous Computing (8:43) - Portability and Scalability (5:17) - CUDA Programming Model (39:45)	Read: Kirk/Hwu Chapter 1
4	**Monday**	**9/8/2025**	**Live**	**Review HW0** **More on the GPU Programming Model**	
5	Wednesday	9/10/2025	Online	Module 2 (78:51): - CUDA Thrust Libraries (12:05) - CUDA Data Allocation API (13:18) - CUDA Parallelism Threads (17:23) - CUDA Toolkit (18:43) - CUDA API (17:22)	Read: Kirk/Hwu Chapter 3 Complete - Online Quiz 1 - Lab 1 (Device Query)
6	**Monday**	**9/15/2025**	**Live**	**The Thrust Template Library** **Intro to Low-Level Image Processing** **Embarrassingly Parallel Examples**	Due: Quiz 1, Lab 1
7	Wednesday	9/17/2025	Online	Module 3 (70:17): - Kernel SPMD Parallelism (21:16) - Kernel Multidimension (17:37) - Color-Greyscale Image Proc. (12:19) - Blur Kernel (6:05) - Transparent Scaling (13:00)	Read: Kirk/Hwu Chapter 4 Complete - Online Quiz 2 - Lab 2 (Vector Addition) - Lab 3 (Image Proc.) - HW1 - Page 60-61, Problem 3.1 - Page 93-94, Problem 4.10
8	**Monday**	**9/22/2025**	**Live**	**Review HW1** **Embarrassingly Parallel Examples (cont)**	Due: Quiz 2
9	Wednesday	9/24/2025	Online	Work day (go to CAS lab finish Lab 3), no class	
10	**Monday**	**9/29/2025**	**Live**	**Performance Considerations Overview**	Due: Labs 2, 3
11	Wednesday	10/1/2025	Online	Module 4A (73:23): - Simple Matrix Multiplication in CUDA (23:15) - CUDA Memory Model (50:08)	
12	**Monday**	**10/6/2025**	**Live**	**Performance Considerations Overview (cont.)** **Catch-up and Midterm Exam Review**	
13	Wednesday	10/8/2025	Online	Work/study day	
14	**Monday**	**10/13/2025**	**Live**	**Midterm Exam**	
15	Wednesday	10/15/2025	Online	Module 4B (90:07): - CUDA Memories (26:44) - Tiled Algorithms (12:08) - Tiled Matrix Multiplication (12:23) - Tiled Matrix Multiplication Kernel (20:50) - Tiled Boundary Conditions (18:02)	Complete - Online Quiz 3 - Lab 4 (Matrix Mult.) - HW2 - P. 119, Probs. 5.1, 5.3, 5.4

Day	Date			Agenda	Assignment
16	**Monday**	**10/20/2025**	**Live**	**Monte Carlo Methods**	Due: Lab 4, Quiz 3
17	Wednesday	10/22/2025	Online	Module 4C (20:34) - Additional CUDA API Features (12:01) - Useful Information on CUDA Tools Properties (8:33) Module 5 (73:03) - Warps and SIMD Hardware (13:52) - Performance Impact of Control Divergence (13:22) - Memory Hardware (45:49)	Read: Kirk/Hwu Chapter 6 Complete - Online Quiz 4 - HW3 - Pg. 147-148, Probs. 6.1-6.4, 6.11, 6.13
18	**Monday**	**10/27/2025**	**Live**	**Review Midterm Exam, HW2 and HW3**	Due: Quiz 4, Project proposal
19	Wednesday	10/29/2025	Online	Module 6 (96:45) - DRAM Bandwidth (21:11) - Memory Coalescing in CUDA (17:09) - Memory Bank Conflicts (58:25)	Complete Online Quiz 5
20	**Monday**	**11/3/2025**	**Live**	**Fundamental GPU Algorithms**	Due: Quiz 5
21	Wednesday	11/5/2025	Online	Module 7 (63:19) - Histogramming (10:48) - Intro to Data Races (11:56) - Atomic Operations in CUDA (9:09) - Atomic Operation Performance (7:27) - Privatization Technique for Improved Throughput (10:27) - Convolution (13:32)	Complete - Online Quiz 6 - Lab 5
22	**Monday**	**11/10/2025**	**Live**	**Fundamental GPU Algorithms (cont.)** **Parallel Reduction Case Study** **More Examples**	Due: Quiz 6
23	**Wednesday**	**11/12/2025**	**Live**	**More Examples (cont.)**	
24	Monday	11/17/2025	Online	Module 11 (51:45) - Prefix Sum (15:21) - A Work-Inefficient Scan Kernel (11:53) - A Work-Efficient Parallel Scan Kernel (11:37) - Parallel Computation Patterns (Scan) (12:54)	Complete - Online Quiz 7 - Lab 6
25	**Wednesday**	**11/19/2025**	**Live**	**MPI and CUDA** **Conclusions and review**	
26	Monday	11/24/2025	Online	Work/study day	Due: Lab 5, Lab 6, Quiz 7
	Wednesday	**11/26/2025**		**Thanksgiving recess, no class**	
27	**Monday**	**12/1/2025**	**Live**	**Student talks**	
28	**Wednesday**	**12/3/2025**	**Live**	**Student talks**	**Due: Project report**
29	**Wednesday**	**12/10/2025**	**Live**	**Final exam, 5:15 – 7:15 PM**	