COSC 407 – Introduction to Parallel Computing
Winter 2024/2025 – Term 2

Instructor A K M Amanat Ullah [amanat.ullah@ubc.ca] (I prefer reaching out to me through canvas, if you email you must include course code COSC 407 and your student ID in email)

Attendance is not mandatory except for Midterm and Final exams.

Zoom (for Lectures and office hour):
https://ubc.zoom.us/j/7390310305?pwd=YWJkZnlNN3JlaE83czFPTUIrbEFLUT09

Meeting ID: 739 031 0305
Passcode: 153296

In person Office hours	FIP309/FIP310	Wed 1:30PM-2:30
Zoom Office hours	Same zoom link	Thurs 1:30PM-2:30

Lectures	LIB-317	Tues and Thurs 6:30pm to 8pm
Labs	As registered on workday	As registered on workday

Permission of Generative AI

Students are permitted to use artificial intelligence tools, including generative AI, to gather information, review concepts or to help produce assignments. However, students are ultimately accountable for the work they submit, and any content generated or supported by an artificial intelligence tool must be cited appropriately. Use of AI tools is not permitted during in person exams (such as in person midterm exams and final exams) in this course.

Course Description

Academic Calendar Entry: Academic Calendar Entry: Design and implementation of parallel programs including theoretical computer models, parallel architectures (distributed, multicore, GPU), and standard parallel libraries. Credit will be granted for only one of COSC 407 or COSC 507. [3-2-0]

More details: The course will provide 3rd and 4th year students with an introduction to parallel computing. Upon completion of the course students will be able to understand parallel computing architectures and their limitations, create and implement parallel programs using various standard libraries, explain the limitation of

the IEEE 754 floating point model, determine whether an undesirable output is due to floating point errors, and write parallel code.

Prerequisites: **COSC 111** or **APSC 177**
Students who lack the prerequisites should not be registered for this course and will receive a failing grade if they remain in it. Any exceptions must be brought to the attention of the instructor immediately.

Course URL: https://canvas.ubc.ca

Assessment

- Online MCQs on Canvas 10 % (canvas)
- Lab Assignments 20 %
- Exams
  - Two Midterm exams 10 - 30% (75 minutes each, **IN-PERSON**, on paper)
    - Final Exam 40 - 60 % (cumulative, **IN-PERSON**, on paper)

Midterms are used to improve your mark, not to penalize. There is **70%** of the course grade for all exams. The exams mark is calculated based on the **best** of the following options:

	Option 1	Option 2	Option 3	Option 4
Midterm 1	15 %	15 %	5 %	5 %
Midterm 2	15 %	5 %	15 %	5 %
Final	40 %	50 %	50 %	60 %

Final grades will be based on the evaluations listed above and the final grade will be assigned according to the standardized grading system outlined in the UBC Okanagan Calendar.

Passing criteria**:** to pass the course, a student must receive: an overall course grade of at least 50%**.** Students will not be able to receive a passing grade if they are not registered to the required lab section.

Final grades will be based on the evaluations listed above, and the final grade will be assigned according to the standardized grading system outlined in the UBC Okanagan Calendar.

Final Examinations: The examination period for this term will be announced at https://students.ok.ubc.ca/coursesmoney-enrolment/exams. Students will be permitted to apply for out-of-time final examinations only if they are representing the University, the province, or the country in a competition or performance; serving in the Canadian military; observing a religious rite; working to support themselves or their family; or caring for a family member. Unforeseen events include (but may not be limited to) the following: ill health or other personal challenges that arise during a term and changes in the requirements of an ongoing job. An examination hardship is defined as the occurrence of an examination candidate being faced with three (3) or more formal examinations scheduled within a 27-hour (inclusive) period.
Further information on Academic Concession can be found under Policies and Regulation in the Okanagan Academic Calendar: http://www.calendar.ubc.ca/okanagan/index.cfm?tree=3,48,0,0

Grading Practices: Faculties, departments, and schools reserve the right to scale grades in order to maintain equity among sections and conformity to university, faculty, department, or school norms. Students should therefore note that an unofficial grade given by an instructor might be changed by the faculty, department, or school. Grades are not official until they appear on a student's academic record.

Grievances and Complaints: A student who has a complaint related to this course should follow this procedure: The student should attempt to resolve the matter with the instructor first. Students may talk first to someone other than the instructor if they do not feel, for whatever reason, that they can directly approach the instructor. If the complaint is not resolved to the student's satisfaction, the student should e-mail the Associate Head of Subject or the Department Head.

Textbook and Reference Materials

- Course website and discussion forum on Canvas, Lecture Notes (available electronically).
- ***Recommended Textbooks*:**
  - Pacheco, P. S. An introduction to Parallel Programming, 2nd Ed., Morgan Kaufmann., 2022 (1st Ed is fine too)
  - Kirk, D. B. & Hwu, W.-m. W. Programming Massively Parallel Processors: A Hands-on Approach, 3rd Ed., Morgan Kaufmann Publishers Inc., 2016 (*earlier editions are ok*)
  - Sanders, J. & Kandrot, E. CUDA by Example: An Introduction to General-Purpose GPU Programming, Addison-Wesley Professional, 2010, ISBN: 0131387685.
- ***More references*:**
  - Rauber, T. & Rünger, G., Parallel Programming: for Multicore and Cluster Systems, Springer Publishing Company Inc. , 2015, ISBN: 3642438067
  - Cheng, J, Grossman, M, &McKercher, T, Professional CUDA C Programming, Wrox, 2014.
  - Eijkhout, V., Intro to High-Performance Scientific Computing, 2015, ISBN: 9781257992546.

Expectations

It is my best day when all my students pass the course, receive good grades, and feel the course was useful. For that to happen, help me by putting enough effort for the course. I expect that you will attend **all classes** and participate in class discussions, read the lecture notes **before** the lecture, attend **all labs**, finish all your assignments on time, and practice on the course materials. I also expect that you will spend (in average) **at least 7 hours per week** in out-of-class relevant activities (homework, preparation, practicing).

Course Format

Lectures*:* This course uses a blended form of learning. There are **two lectures every week** (*see the course schedule*):

1) Regular, in-person lecture (Tuesdays and Thursdays)

Labs .

- A student **must be registered in one lab** for his/her assignments to be accepted.

Exams

- ***Platform*:** Exams will be held **in-person:** Midterms in the same classroom used for the lectures, during the scheduled lecture times. Location for final exam will be announced later.
- ***Format*:** The examinations in this course are all *closed-book*, so you are NOT permitted to access any of the course materials, including your notes, during the exam. You are also NOT to communicate with anyone about the exam during the scheduled write time or after the examination – you are to work independently. Communication with other students (written, text, verbal, etc.) is not permitted and will constitute Academic Misconduct.

Tentative Course Schedule and Required Readings

The course schedule contains the most up-to-date information and important dates for main events such as assignments due dates and tests. These dates and topics are subject to change. Any change will be announced to students. **The due dates of each assignment is one *or* two weeks after the lab (as indicated below) at 11:59 pm.** All assignments should be done on **INDIVIDUAL** basis (NO GROUP WORK).

W	L	Date	Topics	Labs
1	L1	Tue 7 / 1	Introduction to the course	No lab in the first week
	L2	Thu 9 / 1	Intro to C (basics, arrays, functions)	
2	L3	Tue 14 / 1	Intro to C (pointers, struct, directives)	**A1:** Intro to C
	L4	Thu 16 / 1	Basic Concepts of Parallelism OpenMP (A): Intro	
3	L5	Tue 21 / 1	OpenMP (B, C): Mutual Exclusion, Reduction, Sync	**A2:** C-pointers, OpenMP(A)
	L6	Thu 23 / 1	OpenMP (D): Work Sharing 1	
4	L7	Tue 28 / 1	OpenMP (E): Work Sharing 2	**A3:** OpenMP (B,C,D)
	L8	Thu 30 / 1	OpenMP (F,G): Example Applications, Misc.	
5	L9	Tue 4 / 2	Speed/Efficiency	**A4:** OpenMP (E,F)
	L10	Thu 6 / 2	Midterm Overview OpenMP(I): Exercises (with iClicker questions)	
6	L11	Tue 11/2	**Midterm 1** (during lecture time, L1 to L8 + L10)	***Review*** *Students in Monday labs are welcome to join other lab sessions*.
	L12	Thu 13/2	Midterm discussion CUDA (A) : Introduction	
7		Tue 18/2	**NO Classes – Mid term Break**	**No Labs during this week**
		Thu 20/2		
8	L13	Tue 25/2	CUDA (B): Programming model	***Midterm 1 discussion with the TA*** **A5:** CUDA (A,B)
	L14	Thu 27/2	CUDA (C): Threads Organization	
9	L15	Tue 4 / 3	CUDA (C): Threads Organization, cont'd	**A6:** CUDA (C), **A7:** CUDA(D,E,F)

	L16	Thu 6 / 3	CUDA (D,E): Thread Sched, Mem and Performance	
10	L17	Tue 11 / 3	CUDA (E): Mem and Performance, cont'd CUDA (F): Thread Sync CUDA (G): Best Practices	
	L18	Thu 13 /3		
11	L19	Tue 18/3	CUDA (H): Practice Questions	**A8:** CUDA (E,F,G)
	L20	Thu 20/3	Distributed Memory Concurrency (part A)	
12	Lx1	Tue 25/3	Midterm Revision (with iClicker questions)	*Q/A session with your TA*
	L21	Thu 27/3	**Midterm 2** (in-class, L9 + L12 to L19)	
13	L22	Tue 1/4	Midterm discussion Distributed Memory Concurrency (part B)	***Midterm 2 discussion with the TA***
	L23	Thu 3 /4	Distributed Memory Concurrency (part C)	
14		Tues 8/4	COSC507 project presentations – Attendance not required; but feel free to attend if interested)	No lab this week

The letter "W" in the header refers to the week number, and "L" to lecture number.

Missed Graded Work

Students who, because of unforeseen events, are absent during the term and are unable to complete tests or other graded work should generally discuss with their instructors how they can make up for missed work, according to written guidelines given to them at the start of the course (see Grading Practices). Instructors are not required to make allowance for missed tests or incomplete work not satisfactorily accounted for. If ill-health is an issue, students are encouraged to seek attention from a health professional. Campus Health and Counselling will usually provide the documentation only to students who have been seen previously at these offices for treatment or counselling specific to conditions associated with their academic difficulties. There will be no make-up midterm exams. If the absence is satisfactory, the student's final exam will be worth more than the final grade.

Generally speaking, if a student misses an exam without an acceptable excuse according to the UBC Okanagan's policy on excused absences from examinations, the mark received will be zero. If an acceptable excuse is provided to the instructor, then for:

- Midterm Examinations: the grade will be combined with the marks of the final exam so that the exams are still worth **70%** of the total grade.
- Final Examination: all requests for changes to final exams must be sent to the office of the Associate Dean of Students (fos.students.ubco@ubc.ca).

Late Assignments/project

Except for extreme situations (e.g., illness, childbirth, or bereavement supported by a written proof such as a doctor's note), the following policy is applied to late assignments or project:

- 0 to 24 hours late: 25%-mark deduction (e.g., if an assignment is worth 20 marks, then 5 marks will be deducted from the assignment mark; no negative marks will be given.).
- 24 to 48 hours late: 50%-mark deduction

- More than 48 hours: no mark.

One-time Extension Policy

- Everyone can get a one-time extension for **3 days** for any assignment of their choice. Use this extension wisely as I will give no additional extensions unless in very extreme situations (e.g. admission to hospital, death in family). If you used this extension then asked for another one due to having too many exams/assignments, travelling, etc. you will not get a second extension.

- This policy only applies to assignments A1, A2, etc., and it **does *not* apply to the last assignment or the Project.**

- **You do not have to ask for permission to use the 3-day extension**. Just inform your TA directly (no need to email the professor, but you must inform your TA)

Academic Integrity

The academic enterprise is founded on honesty, civility, and integrity. As members of this enterprise, all students are expected to know, understand, and follow the codes of conduct regarding academic integrity. At the most basic level, this means submitting only original work done by you and acknowledging all sources of information or ideas and attributing them to others as required. This also means you should not cheat, copy, or mislead others about what is your work. Violations of academic integrity (i.e., misconduct) lead to the breakdown of the academic enterprise, and therefore serious consequences arise, and harsh sanctions are imposed. For example, incidences of plagiarism or cheating may result in a mark of zero on the assignment or exam and more serious consequences may apply if the matter is referred to the President's Advisory Committee on Student Discipline. Careful records are kept in order to monitor and prevent recurrences.

Cooperation vs. Cheating

Working with others on assignments is a good way to learn the material and we encourage it. However, there are limits to the degree of cooperation that we will permit. Any level of cooperation beyond what is permitted is considered cheating.

When working on programming assignments, you must work only with others whose understanding of the material is approximately equal to yours. In this situation, working together to find a good approach for solving a programming problem is cooperation; listening while someone dictates a solution is cheating. You must limit collaboration to a high-level discussion of solution strategies and stop short of writing down a group answer. Anything that you hand in, whether it is a written problem or a computer program, must be written by you, from scratch, in your own words. If you base your solution on any other written solution, you are cheating. If you provide your solution for others to use, you are also cheating.

Copyright Disclaimer

Diagrams and figures included in lecture presentations adhere to Copyright Guidelines for UBC Faculty, Staff and Students http://copyright.ubc.ca/requirements/copyright-guidelines/ and UBC Fair Dealing Requirements for Faculty and Staff http://copyright.ubc.ca/requirements/fair-dealing/. Some of these figures and images are subject to copyright and will not be posted to ***Canvas.*** All material uploaded to ***Canvas*** that contain diagrams and figures are used with permission of the publisher; are in the public domain; are licensed by Creative Commons; meet the permitted terms of use of UBC's library license agreements for electronic items; and/or adhere to the UBC Fair Dealing Requirements for Faculty and Staff. Access to the ***Canvas*** course site is limited to students currently registered in this course. Under no circumstance are students permitted to provide any other person with means to access this material. Anyone violating these restrictions may be subject to legal action. Permission to electronically record any course materials must be granted by the instructor. Distribution of this material to a third party is forbidden.

Student Service Resources

Disability Resource Centre: The Disability Resource Centre ensures educational equity for students with disabilities and chronic medical conditions. If you are disabled, have an injury or illness and require academic accommodations to meet the course objectives, please contact Earllene Roberts, the Diversity Advisor for the Disability Resource Centre located in the University Centre building (UNC 215).

UNC 215 250.807.9263
email: earllene.roberts@ubc.ca Web:
www.students.ok.ubc.ca/drc

Equity and Inclusion Office: Through leadership, vision, and collaborative action, the Equity & Inclusion Office (EIO) develops action strategies in support of efforts to embed equity and inclusion in the daily operations across the campus. The EIO provides education and training from cultivating respectful, inclusive spaces and communities to understanding unconscious/implicit bias and its operation within in campus environments. UBC Policy 3 prohibits discrimination and harassment on the basis of BC's Human Rights Code. If you require assistance related to an issue of equity, educational programs, discrimination or harassment please contact the EIO.

UNC 325H 250.807.9291
email: equity.ubco@ubc.ca
Web: www.equity.ok.ubc.ca

Office of the Ombudsperson for Students: The Office of the Ombudsperson for Students is an independent, confidential and impartial resource to ensure students are treated fairly. The Ombuds Office helps students navigate campus-related fairness concerns. They work with UBC community members individually and at the systemic level to ensure students are treated fairly and can learn, work and live in a fair, equitable and respectful environment. Ombuds helps students gain clarity on UBC policies and procedures, explore options, identify next steps, recommend resources, plan strategies and receive objective feedback to promote constructive problem solving. If you require assistance, please feel free to reach out for more information or to arrange an appointment.

UNC 328 250.807.9818 email:
ombuds.office.ok@ubc.ca Web:
www.ombudsoffice.ubc.ca

Sexual Violence Prevention and Response Office (SVPRO): A safe and confidential place for UBC students, staff and faculty who have experienced sexual violence regardless of when or where it took place. Just want to talk? We are here to listen and help you explore your options. We can help you find a safe place to stay, explain your reporting options (UBC or police), accompany you to the hospital, or support you with academic accommodations. You have the right to choose what happens next. We support your decision, whatever you decide. Visit svpro.ok.ubc.ca or call us at 250-807-9640.

Independent Investigations Office (IIO): If you or someone you know has experienced sexual assault or some other form of sexual misconduct by a UBC community member and you want the Independent Investigations Office (IIO) at UBC to investigate, please contact the **IIO**. Investigations are conducted in a trauma informed, confidential and respectful manner in accordance with the principles of procedural fairness. You can report your experience directly to the **IIO by** calling 604-827-2060.

Web: https://investigationsoffice.ubc.ca/
E-mail: director.of.investigations@ubc.ca

Student Learning Hub: The Student Learning Hub (LIB 237) is your go-to resource for free math, science, writing, and language learning support. The Hub welcomes undergraduate students from all disciplines and year levels to access a range of supports that include **tutoring in math, sciences, languages, and writing, as well as help with study skills and**

learning strategies. For more information, please visit the Hub's website (https://students.ok.ubc.ca/student-learning-hub/) or call 250-807-9185.

Student Wellness: At UBC Okanagan health services to students are provided by Student Wellness. Nurses, physicians and counsellors provide health care and counselling related to physical health, emotional/mental health and sexual/reproductive health concerns. As well, health promotion, education and research activities are provided to the campus community. If you require assistance with your health, please contact Student Wellness for more information or to book an appointment.

UNC **337** 250.807.9270
email: healthwellness.okanagan@ubc.ca Web:
www.students.ok.ubc.ca/health-wellness

SAFEWALK

Don't want to walk alone at night? Not too sure how to get somewhere on campus? Call Safewalk at ***250-807-8076.***

For more information, see: www.security.ok.ubc.ca