University of Oklahoma

Gallogly College of Engineering
School of Computer Science

CS4473/CS5473: Parallel, Distributed and Network Programming

Fall 2021

Instructor: Dr. Richard Veras

Course Format: In person full contact time

Time: 9:00AM – 10:15AM Tuesday and Thursday

Location: Carson Engineering Center RM 0117

Office Hours: Wednesday 4:00PM-5:00PM

Office Hours Location: TBD

Learning Management System/website: canvas.ou.edu

Course Prerequisite: CS 3113 Operating Systems, CS 4413 Algorithm Analysis

Course Description:

Parallel and distributed computer architectures, algorithms, and programming paradigms. Topics include distributed and shared memory systems, network programming, GPU architectures, load balancing, SIMD/SPMD/MIMD, message passing interface (MPI), multithreaded programming, and distributed systems programming. Students will learn to program using MPI, OpenMP, and CUDA. No student may earn credit for both 4473 and 5473.

Course Goals:
This course is meant to provide an experience for the students to view programming as a goal-oriented process driven by metrics. A major component of this course will be learning from one another through team assignments. Here students will be challenged to think creatively to synthesize potential solutions, devise testing strategies and integrate these solution into their implementations. Teams will compete against each other to provide the best implementation with respect to certain target metrics. Students will be encouraged to reverse engineer each other's implementations and continuously refine their own solutions, thus learning in the process.

Learning Outcomes:

At the completion of the course, students will be able to:

- o Identify the relevant performance metrics in parallel and distributed applications.
- o Analyze and measure the performance of parallel algorithms.
- o Explain parallel hardware, parallel software, and computer network.
- o Explain the TCP/IP layered protocol, Socket Programming, and other network protocols.
- o Develop parallel programs with MPI in distributed memory systems.
- o Develop multi-threading programs with OpenMP in shared memory systems.
- o Develop programs using general-purpose graphics processing unit (GPGPU).
- o Develop distributed applications using modern tools.

Texts and Materials:
There are no required textbooks, however, here are few recommended textbooks that the material in the course is loosely based on. Use https://www.bookfinder.com/ to find reasonable second hand prices for these texts.

- o *An introduction to parallel programming, Peter S. Pacheco, 2011, Morgan Kaufmann, ISBN-13: 978-0123742605*
- o *CUDA by Example: An Introduction to General Purpose GPU Programming, Jason Sanders, Edward Kandrot, Nivida, Addison-Wesley, 2010.*
- o *Computer Networking: A Top Down Approach. Jim Kurose, Keith Ross. Any recent edition.*

Teaching Philosophy & Inclusion Statement:

This course revolves heavily around group assignments to encourage peer learning. Your peers will continue to be your peers beyond graduation. It is my goal to create an inclusive classroom that encourages the strengthening of the bonds between you and your peers.

Learning Activities, Assignments, and Assessment:
The work in this course will be divided into several components including: homework assignments, group programming assignments, exams, and participation activities.

Homeworks will consist of regular written assignments covering the material in class. The group programming assignments will include a warmup component that involves working through examples for the given topic, followed by a competition component where teams will optimize an operation with respect to a given metric and compete against other teams. Team members will be randomized for each programming assignment and will be graded on mastery of material and team effort. A midterm and a final exam will cover the material in the lectures and lab assignments to assess your understanding of the content. Participation will include activities such as engaging in class discussion, being a designated note taker for a lecture, creating tool tutorials, and being a weekly grader assistant.

Graduate students taking this course as CS5473 will have additional assignments (beyond those required for CS4473).

Assigning Grades:

- o Homework: 20%
- o Participation: 10%
- o Projects: 30%
- o Midterm: 20%
- o Final: 20%

Grading Scale:

The letter grade thresholds will be no higher than the following; they may be lower at the discretion of the instructors.

Grade	Points
A	>90
B	80-89
C	70-79
D	60-69
F	<60

Tentative Schedule (Subject to change)

Week	Topics, Readings, or Activities	Assignments and Exams Due
1	Introduction and Preliminaries	
2	Distributed Memory Systems and MPI	HW 1
3	Distributed Memory Systems and MPI	Lab 1: Benchmarking
4	Distributed Memory Systems and MPI	HW 2
5	Shared Memory Systems and OpenMP	Lab 2: MPI 1
6	Shared Memory Systems and OpenMP	HW 3
7	Shared Memory Systems and OpenMP	Lab 3: MPI 2
8	GPGPUs and Cuda	Midterm Due
9	GPGPUs and Cuda	Lab 4: OpenMP
10	GPGPUs and Cuda	HW 4
11	Networks and Network Programming	Lab 5: GPGPUs
12	Networks and Network Programming	HW 5
13	Distributed Systems	Lab 6: Networking
14	Distributed Systems	HW 6

15	Distributed Systems	Lab 7: Distributed
* 12/13		Final Due

Course Policies

<u>**Absences**</u>

You are expected to attend class and actively participate in the exercises and discussions. In cases of sickness, and quarantine alert you instructor before the class period (email) and we will discuss alternative arrangements.

<u>**Late Assignments**</u>

Except in the cases of sickness or provost approved activities, late work will not be accepted.

University Masking Guidelines: The university encourages masking indoors. The university strongly encourages masking for all individuals in high-density settings, such as classrooms and at special events.

Land Acknowledgement Statement Provided by OU's Tribal Liaison office:
Long before the University of Oklahoma was established, the land on which the University now resides was the traditional home of the "Hasinais" Caddo Nation and "<u>Kirikirʔi:s</u>" Wichita & Affiliated Tribes.

We acknowledge this territory once also served as a hunting ground, trade exchange point, and migration route for the Apache, Comanche, Kiowa and Osage nations. Today, 39 tribal nations dwell in the state of Oklahoma as a result of settler and colonial policies that were designed to assimilate Native people. The University of Oklahoma recognizes the historical connection our university has with its indigenous community. We acknowledge, honor and respect the diverse Indigenous peoples connected to this land. We fully recognize, support and advocate for the sovereign rights of all of Oklahoma's 39 tribal nations. This acknowledgement is aligned with our university's core value of creating a diverse and inclusive community. It is an institutional responsibility to recognize and acknowledge the people, culture and history that make up our entire OU Community.

Expectations for Academic Integrity:

Cheating is prohibited at the University of Oklahoma, because it devalues the degree you are working hard to get. As a member of the OU community, it is your responsibility to protect your educational investment by knowing and following the rules. For specific definitions on what constitutes cheating, review the Student's Guide to Academic Integrity at: http://integrity.ou.edu/students_guide.html

To be successful in this class, all work on exams, quizzes and homework must be yours and yours alone. You may not receive outside help. Be aware that it is my professional obligation to report academic misconduct, which I will not hesitate to do. Sanctions for academic misconduct can include expulsion from the University and an F in this course, so do not cheat. It is simply not worth it.

University Policies

Copyright Syllabus Statement:

Sessions of this course may be recorded or live-streamed. These recordings are the intellectual property of the individual faculty member and may not be shared or reproduced without the explicit, written consent of the faculty member. In addition, privacy rights of others such as students, guest lecturers, and providers of copyrighted material displayed in the recording may be of concern. Students may not share any course recordings with individuals not enrolled in the class or upload them to any other online environment.

Religious Observance

It is the policy of the University to excuse the absences of students that result from religious observances and to reschedule examinations and additional required classwork that may fall on religious holidays, without penalty.

Reasonable Accommodation Policy

Students requiring academic accommodation should contact the Accessibility and Disability Resource Center for assistance at (405) 325-3852 or TDD: (405) 325-4173. For more information please visit http://www.ou.edu/drc/home.html. Any student in this course who has a disability that may prevent them from fully demonstrating his or her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.

Title IX Resources and Reporting Requirement

For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the University offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at 405/325-2215 (8 to 5, M-F) or smo@ou.edu. Incidents can also be reported confidentially to OU Advocates at 405/615-0013 (phones are answered 24 hours a day, 7 days a week). Also, please be advised that a professor/GA/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office. Inquiries regarding non-discrimination policies can be directed to University Equal Opportunity Officer and Title IX Coordinator at 405/325-3546 or smo@ou.edu . For more information, visit http://www.ou.edu/eoo.html.

Adjustments for Pregnancy/Childbirth Related Issues

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact your professor or the Disability Resource Center at 405/325-3852 as soon as possible. Also, see http://www.ou.edu/eoo/faqs/pregnancy-faqs.html for answers to commonly asked questions.

Emergency Protocol

During an emergency, there are official university procedures that will maximize your safety.

Severe Weather: If you receive an OU Alert to seek refuge or hear a tornado siren that signals severe weather *1. LOOK* for severe weather refuge location maps located inside most OU buildings near the entrances *2. SEEK* refuge inside a building. Do not leave one building to seek

shelter in another building that you deem safer. If outside, get into the nearest building. *3. GO* to the building's severe weather refuge location. If you do not know where that is, go to the lowest level possible and seek refuge in an innermost room. Avoid outside doors and windows. *4.* GET IN, GET DOWN, COVER UP. 5. *WAIT* for official notice to resume normal activities.

Link to Severe Weather Refuge Areas , *Severe Weather Preparedness - Video*

Armed Subject/Campus Intruder:

If you receive an OU Alert to shelter-in-place due to an active shooter or armed intruder situation or you hear what you perceive to be gunshots:

1. GET OUT: If you believe you can get out of the area WITHOUT encountering the armed individual, move quickly towards the nearest building exit, move away from the building, and call 911. *2. HIDE OUT*: If you cannot flee, move to an area that can be locked or barricaded, turn off lights, silence devices, spread out, and formulate a plan of attack if the shooter enters the room. *3. TAKE OUT*: As a last resort fight to defend yourself.

For more information, visit http://www.ou.edu/emergencypreparedness.html

Shots Fired on Campus Procedure - Video

Fire Alarm/General Emergency:

If you receive an OU Alert that there is danger inside or near the building, or the fire alarm inside the building activates: *1. LEAVE* the building. Do not use the elevators. *2. KNOW* at least two building exits *3. ASSIST* those that may need help *4. PROCEED* to the emergency assembly area *5 ONCE safely outside, NOTIFY first responders of anyone that may still be inside building due to mobility issues. 6. WAIT* for official notice before attempting to re-enter the building.

OU Fire Safety on Campus

Mental Health Support Services:

If you are experiencing any mental health issues that are impacting your academic performance, counseling is available at the University Counseling Center (UCC). The Center is located on the second floor of the Goddard Health Center, at 620 Elm Rm. 201, Norman, OK 73019. To schedule an appointment call (405) 325-2911. For more information please visit http://www.ou.edu/ucc.