University of Oklahoma

Gallogly College of Engineering
School of Computer Science

CS4473/CS5473: Parallel, Distributed and Network Programming

Fall 2025

Instructor: Dr. Richard Veras

Course Format: In Person

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

Exam: 12/15/2024 8-10AM

Location: Dale Hall Room 206

Office Hours: Monday 10AM-11AM

Office Hours Location: DEH 210-C (Send an email when you get to the outer door)

Teaching Assistants: Spencer Smith (Spencer.Smith-1@ou.edu) and Dylan Zemlin (dylan.zemlin@ou.edu)

TA Office Hours: TBD

TA Office Hours Location: DEH 210

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. A major component of this course will be learning from one another through challenging open-ended team assignments. Here students will be challenged to think creatively to synthesize potential solutions, devise testing strategies and integrate these solution into their implementations.

Learning Outcomes:

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

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

ABET Student Outcomes: By the end of the semester, the students will have:

- An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- An ability to communicate effectively with a range of audiences.
- An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Texts and Materials:
The required texts are:

"Multicore and GPU Programming: An Integrated Approach." Gerassimos Barlas. 2nd Edition. 978-0128141205.

The C Programming Language. Brian Kernighan and Dennis Ritchie. 2nd edition.

A 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.

- CUDA by Example: An Introduction to General Purpose GPU Programming, Jason Sanders, Edward Kandrot, Nivida, Addison-Wesley, 2010.
- *"Programming Massively Parallel Processors: A Hands-on Approach." 4th Edition. Wen-mei W. Hwu, David B. Kirk, Izzat El Hajj. 978-0323912310.*
- 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 environment 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, programming assignments, labs, 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:

Category	**CS 4473**	**CS 5473**
Programming Assignments	30	20
Reading Assignments	15	10
Participation	10	10
Projects/Labs	40	40
Graduate Project	0	15
Final	5	5
Total	***100***	***100***

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 (P)
A	P>=90
B	80>=P>90
C	70>=P>80
D	60>=P>70
F	P<60

Schedule of Topics (Subject to change)

Module	Topic
1	Introduction and Preliminaries
2	Parallel Hardware
3	Memory Level Parallelism
4	Shared Memory: Regular Data
5	Instruction Level Parallelism
6	SIMD (Short Vector)
7	Shared Memory
8	Distributed Memory
9	Accelerators (GPGPUs)
10	Distributed Computing
11	Network Programming

Full tentative schedule appended to the end.

Course Policies

Academic Integrity and Plagiarism

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.

Absences

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 via email, in case we need to discuss alternative arrangements. Additionally, you will be required to submit an absence form on canvas for each absence. These forms will be reviewed before the end of the semester. You will be allowed two (2) free absences throughout the semester. Absences beyond that may count against your participation score or your lab grade during lab days.

Late Assignments

Each assignment may contain a grading scale for late submissions. Beyond that, except cases of sickness or provost approved activities, late work will not be accepted. These cases must be documented ahead of time in an absence form.

Grading

Submissions will be scored against a rubric and not against other submissions. We can only grade what is submitted. The resulting grade reflects the quality of the submission, not the individual. If you believe there is an issue with a score to your assignment, with respect to the instructions, rubric, or syllabus, then you may submit a regrade request. If the request is approved, then a regrade of the assignment will occur before final grades are due. The instructor will decide if either part of the assignment will be re-graded, or the entirety. If uncaught mistakes are found, they will be scored as such. If uncaught evidence of academic dishonesty is found, those will be reported as such. Other than professionalism points, there will be no additional extra credit.

Professionalism Points

In certain assignments there will be opportunities to earn additional points. These will be explicitly enumerated in the assignments and aim to highlight professional behavior in the field. These points may be invalidated through unprofessional behavior at the assignment level or the course level. Professionalism points are designed to reward effort, thus behaviors that bypass effort will not receive that reward.

Generative AI

Unless an activity explicitly allows it, you are not allowed to use Generative AI tools on your assignments. This includes code assistants like copilot.

Dead Week Presentation

In this course you and your team will present your final lab at a departmental poster session. This will occur during the Thursday or Friday of dead week. Your team will be responsible for being present during the session.

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 "Kirikir?i:s" 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

Mental Health Support Services

Support is available for any student experiencing mental health issues that are impacting their academic success. Students can either been seen at the University Counseling Center (UCC) located on the second floor of Goddard Health Center or receive 24/7/365 crisis support from a licensed mental health provider through TELUS Health. To schedule an appointment or receive more information about mental health resources at OU please call the UCC at 405-325-2911 or visit University Counseling Center. The UCC is located at 620 Elm Ave., Room 201, Norman, OK 73019.

Title IX Resources and Reporting Requirement

The University of Oklahoma faculty are committed to creating a safe learning environment for all members of our community, free from gender and sex-based discrimination, including sexual harassment, domestic and dating violence, sexual assault, and stalking, in accordance with Title IX. There are resources available to those impacted, including: speaking with someone confidentially about your options, medical attention, counseling, reporting, academic support, and safety plans. If you have (or someone you know has) experienced any form of sex or gender-based discrimination or violence and wish to speak with someone confidentially, please contact OU Advocates (available 24/7 at 405-615-0013) or University Counseling Center (M-F 8 a.m. to 5 p.m. at 405-325-2911).

Because the University of Oklahoma is committed to the safety of you and other students, and because of our Title IX obligations, I, as well as other faculty, Graduate Assistants, and Teaching Assistants, are mandatory reporters. This means that we are obligated to report gender-based violence that has been disclosed to us to the Institutional Equity Office. This means that we are obligated to report gender-based violence that has been disclosed to us to the Institutional Equity Office. This includes disclosures that occur in: class discussion, writing assignments, discussion boards, emails and during Student/Office Hours. You may also choose to report directly to the Institutional Equity Office. After a report is filed, the Title IX Coordinator will reach out to provide resources, support, and information and the reported information will remain private. For more information regarding the University's Title IX Grievance procedures, reporting, or support measures, please visit Institutional Equity Office at 405-325-3546.

Reasonable Accommodation Policy

The University of Oklahoma (OU) is committed to the goal of achieving equal educational opportunity and full educational participation for students with disabilities. If you have already established reasonable accommodations with the Accessibility and Disability Resource Center (ADRC), please submit your semester accommodation request through the ADRC as soon as possible and contact me privately, so that we have adequate time to arrange your approved academic accommodations.

If you have not yet established services through ADRC, but have a documented disability and require accommodations, please complete ADRC's pre-registration form to begin the registration process. ADRC facilitates the interactive process that establishes reasonable accommodations for students at OU. For more information on ADRC registration procedures, please review their Register with the ADRC web page. You may also contact them at (405)325-3852 or adrc@ou.edu, or visit www.ou.edu/adrc for more information.

Note: disabilities may include, but are not limited to, mental health, chronic health, physical, vision, hearing, learning and attention disabilities, pregnancy-related. ADRC can also support students experiencing temporary medical conditions.

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. [See Faculty Handbook 3.15.2]

Adjustments for Pregnancy and Related Issues

Should you need modifications or adjustments to your course requirements because of pregnancy or a pregnancy-related condition, please request modifications via the Institutional Equity Office website or call the Institutional Equity Office at 405/325-3546 as soon as possible. Also, see the Institutional Equity Office FAQ on Pregnant and Parenting Students' Rights for answers to commonly asked questions.

Final Exam Preparation Period

Pre-finals week will be defined as the seven calendar days before the first day of finals. Faculty may cover new course material throughout this week. For specific provisions of the policy please refer to OU's Final Exam Preparation Period policy.

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.

Additional Weather Safety Information is available through the Department of Campus Safety.

The University of Oklahoma Active Threat Guidance

The University of Oklahoma embraces a Run, Hide, Fight strategy for active threats on campus. This strategy is well known, widely accepted, and proven to save lives. To receive emergency campus alerts, be sure to update your contact information and preferences in the account settings section at one.ou.edu.

RUN: Running away from the threat is usually the best option. If it is safe to run, run as far away from the threat as possible. Call 911 when you are in a safe location and let them know from which OU campus you're calling from and location of active threat.

HIDE: If running is not practical, the next best option is to hide. Lock and barricade all doors; turn of all lights; turn down your phone's volume; search for improvised weapons; hide behind solid objects and walls; and hide yourself completely and stay quiet. Remain in place until law enforcement arrives. Be patient and remain hidden.

FIGHT: If you are unable to run or hide, the last best option is to fight. Have one or more improvised weapons with you and be prepared to attack. Attack them when they are least expecting it and hit them where it hurts most: the face (specifically eyes, nose, and ears), the throat, the diaphragm (solar plexus), and the groin.

Please save OUPD's contact information in your phone.

NORMAN campus: *For non-emergencies call (405) 325-1717. For emergencies call (405) 325-1911 or dial 911.*

TULSA campus: *For non-emergencies call (918) 660-3900. For emergencies call (918) 660-3333 or dial 911.*

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

Wk	Date	Day	Homework	Programming	Lab	5473 Milestones	Notes
1	8/24/2025	Su					
1	8/25/2025	M					
1	8/26/2025	T					
1	8/27/2025	W					
1	8/28/2025	Th					
1	8/29/2025	F					
1	8/30/2025	Sa					FIrst Game
2	8/31/2025	Su					
2	9/1/2025	M		Due: PG 0			Labor Day
2	9/2/2025	T			Out: Lab 0		
2	9/3/2025	W					
2	9/4/2025	Th					
2	9/5/2025	F					
2	9/6/2025	Sa	Due: HW 0				
3	9/7/2025	Su					
3	9/8/2025	M					No record of drop
3	9/9/2025	T		Due: PG 1			
3	9/10/2025	W					
3	9/11/2025	Th				Due: Checkpoint 0	
3	9/12/2025	F	Due: HW 1				
3	9/13/2025	Sa					
4	9/14/2025	Su					
4	9/15/2025	M		Due: PG 2			
4	9/16/2025	T					
4	9/17/2025	W					
4	9/18/2025	Th					
4	9/19/2025	F	Due: HW 2				
4	9/20/2025	Sa					
5	9/21/2025	Su					
5	9/22/2025	M		Due: PG 3			

5	9/23/2025	T				
5	9/24/2025	W			Due: Lab 0	
5	9/25/2025	Th			Out: Lab 1	Due: Checkpoint 1
5	9/26/2025	F	Due: HW 3			
5	9/27/2025	Sa				
6	9/28/2025	Su				
6	9/29/2025	M		Due: PG 4		
6	9/30/2025	T				
6	10/1/2025	W				
6	10/2/2025	Th				
6	10/3/2025	F	Due: HW 4			
6	10/4/2025	Sa				
7	10/5/2025	Su				
7	10/6/2025	M		Due: PG 5		
7	10/7/2025	T				
7	10/8/2025	W				
7	10/9/2025	Th				Due: Checkpoint 2
7	10/10/2025	F	Due: HW 5			
7	10/11/2025	Sa				
8	10/12/2025	Su				
8	10/13/2025	M		Due: PG 6		
8	10/14/2025	T				
8	10/15/2025	W			Due: Lab 1	
8	10/16/2025	Th	Due: HW 6		Out: Lab 2	
8	10/17/2025	F				
8	10/18/2025	Sa				
9	10/19/2025	Su				
9	10/20/2025	M		Due: PG 7		
9	10/21/2025	T				
9	10/22/2025	W				
9	10/23/2025	Th				Due: Checkpoint 3
9	10/24/2025	F	Due: HW 7			
9	10/25/2025	Sa				
10	10/26/2025	Su				

10	10/27/2025	M		Due: PG 8		
10	10/28/2025	T				
10	10/29/2025	W				
10	10/30/2025	Th				
10	10/31/2025	F	Due: HW 8			
10	11/1/2025	Sa				
11	11/2/2025	Su				
11	11/3/2025	M		Due: PG 9		
11	11/4/2025	T				
11	11/5/2025	W			Due: Lab 2	
11	11/6/2025	Th			Out: Lab 3	Due: Checkpoint 4
11	11/7/2025	F	Due: HW 9			
11	11/8/2025	Sa				
12	11/9/2025	Su				
12	11/10/2025	M		Due: PG 10		
12	11/11/2025	T				
12	11/12/2025	W				
12	11/13/2025	Th				
12	11/14/2025	F	Due: HW 10			
12	11/15/2025	Sa				
13	11/16/2025	Su				
13	11/17/2025	M		Due: PG 11		
13	11/18/2025	T				
13	11/19/2025	W				
13	11/20/2025	Th				Due: Checkpoint 5
13	11/21/2025	F	Due: HW 11			
13	11/22/2025	Sa				
14	11/23/2025	Su				
14	11/24/2025	M		Due: PG 12		
14	11/25/2025	T	Due: HW 12			
14	11/26/2025	W			Due: Lab 3	
14	11/27/2025	Th			Out: Lab 4	
14	11/28/2025	F				
14	11/29/2025	Sa				

15	11/30/2025	Su					
15	12/1/2025	M		Due: PG 13			
15	12/2/2025	T				Due: Checkpoint 6	
15	12/3/2025	W					
15	12/4/2025	Th					
15	12/5/2025	F					
15	12/6/2025	Sa					
16	12/7/2025	Su					
16	12/8/2025	M	Due: HW 13	Due: PG 14			
16	12/9/2025	T					
16	12/10/2025	W			Due: Lab 4		
16	12/11/2025	Th				Poster Session	
16	12/12/2025	F				Poster Session	
16	12/13/2025	Sa					
17	12/14/2025	Su					
17	12/15/2025	M					Final Exam