COVID-19 and Wichita State University

Wichita State will follow federal, state, and county public health recommendations and mandates related to university operations. The COVID-19 pandemic is a complex, challenging, and fluid situation, which continues to evolve rapidly. Students consistently should review https://www.wichita.edu/about/COVID-19/index.php for the Wichita State COVID-19 Response for information throughout the semester.

ECE 694, High Performance Computer Systems, Spring, 2022

(HPC Systems for Data Science)

- Instructor: Abu Asaduzzaman (DRZ)
- Department: Electrical and Computer Engineering (ECE)
- Office Location: 303 Wallace Hall (WH) building
- Telephone: +1-316-978-5261
- Email: Abu.Asaduzzaman@wichita.edu

- Preferred Method of Contact: Via email or zoom/phone during office hours
- Student/Office Hours: Tue/Thu 3:15-4:00 PM and 5:30-6:30 PM
- Classroom, Day/Time: 261JB, Tuesday and Thursday 2:00-3:15 PM
- Prerequisites: ECE 394 or instructor's consent
- Teaching Assistant (TA): To be determined (TBD)
- TA Contacts: tbd@shochers.wichita.edu

How to use this syllabus

This syllabus provides you with information specific to this course, and it also provides information about important university policies. This document should be viewed as a course overview; it is not a contract and is subject to change as the semester evolves. Any changes should be shared via lecture and/or Blackboard.

University Policies and Procedures

The Wichita State University Policies and Procedures Manual can be found at: https://www.wichita.edu/about/policy/.

Academic Integrity

Students at Wichita State University are expected to uphold high academic standards. WSU will not tolerate a lack of academic integrity. Students are responsible for knowing and following the Student Code of Conduct (see

https://www.wichita.edu/about/policy/ch_08/ch8_05.php) and the Student Academic Honesty policy (see https://www.wichita.edu/about/policy/ch_02/ch2_17.php). When the faculty member determines sanctions are warranted for violations of academic integrity, regardless of severity, the faculty member must report the infraction to the Office of Student Conduct and Community Standards. If you need more information about the process or wish to appeal a decision, please visit https://www.wichita.edu/about/student_conduct/AcademicDishonesty.php.

All homework (HW) assignments in this course are individual assignments (unless otherwise stated). Students can discuss with others, but they should not write the solution together; one's submission (wording/coding) should be substantially different from others' submissions. "Collaboration is good, cheating is not!" There will be severe consequences for academic dishonesty. Cheating (such as copying word-for-word from other sources) in any test will automatically result in an F grade for the course; this applies to all the parties involved (including the ones who help/show).

Course Description

Introduces high performance computer systems that are built using multicore central processing unit (CPU) and many-core graphics processing unit (GPU). Special attention is given to parallel architectures and memory hierarchies of CPU/GPU suitable for multithreaded programming. Projects focus on contemporary scholarly activities and help students develop teamwork skills.

Definition of a Credit Hour

One credit hour is one unit of credit. Success in this 3 credit-hour course is based on the expectation that students will spend, for each unit of credit, a minimum of 45 hours over the length of the course (normally 3 hours per unit per week with 1 of the hours used for lecture) for instruction and preparation/studying or course related activities for a total of 135 hours.

Measurable Student Learning Outcomes

Measurable Student Learning Outcomes: Undergraduate (UG) Level

After passing this course, undergraduate students will be able to:

- (SO: EAC 1) an ability to identify, formulate, and solve computer system problems by applying principles of engineering, science, and mathematics
- (SO: EAC 2) an ability to apply high performance computer design to produce solutions that meet specified needs with consideration of public welfare, as well as global, social, and economic factors

Measurable Student Learning Outcomes: Graduate (GR) Level

After passing this course, graduate students will be able to:

- (SO: EAC 6) an ability to develop appropriate experimentation, analyze data, and use engineering judgment to make useful decisions
- (SO: EAC 7) an ability to acquire and apply new computer knowledge as needed, using appropriate learning strategies

Required Texts/Readings Textbook

Please talk to the instructor before buying books for this course.

Textbook: "COMPUTER ARCHITECTURE: A Quantitative Approach," John L. Hennessy and David A. Patterson, Morgan Kaufmann, 6th edition, 2017.

Reference Book: "Structured Computer Organization," Andrew S. Tanenbaum and Todd Austin, Pearson, sixth edition, 2016.

Other Readings

Class notes and handouts will be made available via WSU Blackboard.

Other Equipment/Materials

Students will be provided accounts to the BeoShock HPC Cluster at WSU (and/or the 'wh-312-cuda' in CAPPLab) and service supports so that they can perform multithreaded programming for homework assignments and/or projects. (CAPPLab stands for Computer Architecture and Parallel Programming Laboratory.) More information will be made available in class as/if needed.

Class Protocol

There are points on class performance. It is expected that students join the instructor and/or TA before classes start. Students are always encouraged to ask questions, especially if they find ambiguity in assignments and materials covered.

Contact Policy

Email communication is preferred. Feel free to email me any questions or concerns following these guidelines:

- **Always** email me from your WSU email address. Email sent from personal email servers like Gmail, Yahoo, etc., have a tendency to end up in my spam folder, and I never see them. You may also email me through Blackboard via the Email My Instructor tab. I also offer a Discussion Forum on Blackboard which allows common questions to be seen and responded to publicly.
- Always use the course name in the subject line of the email.
- Remember to sign your name.
- If you have a problem with accessing or uploading assignments, you should let me know as soon as possible before the assignment is due. You will also have to accompany this notification with the file in question, so I can verify that it is completed by the due date/time.

- You **should NOT** contact me for tech support.
    - Any technical problems involving your computer, or issues regarding file uploading or sharing, should go through the OneStop. You can contact them at 316-978-3909. You can also fill out a request for help form at their website: https://wichita.edusupportcenter.com/sims/helpcenter/common/layout/SelfHelpHome.seam?inst_name=wichita

Response Time

To Email and Discussion Forum Questions:

As soon as possible within 24 hours. If you do not receive reply to your email within 24 hours, please re-send me the email, probably the email did not arrive to my Inbox.

Feedback on Assignments:

As soon as possible after the due date including the late submission date/time. Answer key will be discussed in lecture sessions and/or shared via Blackboard.

Grading Scale

WSU uses a +/- grading scale for final grades and to calculate grade point averages. In this class, usually grades are assigned according to the following chart. However, the grading scale may change as/if needed. (Other classes might assign grades differently: Be sure to understand the different grading scales in all of your classes.)

Points/Percentage	Letter Grade	Grade Points	Interpretation
93 and up	A	4.00	A range denotes excellent performance
90 – less than 93	A-	3.70	
87 – less than 90	B+	3.30	
83 – less than 87	B	3.00	B range denotes good performance
80 – less than 83	B-	2.70	
77 – less than 80	C+	2.30	
73 – less than 76	C	2.00	C range denotes satisfactory performance

Points/Percentage	Letter Grade	Grade Points	Interpretation
70 – less than 73	C-	1.70	
67 – less than 70	D+	1.30	
63 – less than 67	D	1.00	D range denotes unsatisfactory performance
60 – less than 63	D-	0.70	
0 – less than 60	F	0.00	

Assignments

List of grading assignments/components and values toward final grades are shown below. For exams and projects, different grading scales will be used for undergraduate and graduate students. Graduate students will have additional activities in the project assignments that have higher weightage. Homework assignments and their due dates will be announced in class and/or made available via Blackboard. Similarly, the due dates for Quiz, Exam, and Project will be announced in class / Blackboard.

Grading Assignments/Components	Undergraduate	Graduate
Class Performance (random check)	3%	3%
Homework (five of six, take home)	15%	15%
Quiz (two of three, 30-minute, class-time)	10%	10%
Exam-1 (~ Week 5, 65-minute, class-time)	16%	14%
Exam-2 (~ Week 10, 65-minute, class-time)	18%	16%
Exam-3 (cumulative, 65-minute, class-time)	20%	18%
Project (Proposal, Presentation, and Report)	18% (2+8+8)	24% (4+10+10)

Extra Credit

Extra credits are possible as/if needed. Depending on class performance after Week 10, if required, extra credit assignments and their due dates will be determined.

Late Assignments

On time submission is highly encouraged. Exceptions (to on time submission) include documented emergency situations and/or prior consents. For homework assignments, late submissions will not be accepted after five days from the original due date/time. Up to 50% points may be subtracted for each late submission.

No late submission for quiz, exam, and project reports.

Missed Tests

Makeup for missed (quiz and exam) tests will be given only when there is a genuine reason, with clear proof. It is students' responsibility to provide the proof; if the reason for missing a test is illness, a doctor's note will be required. Students should contact the instructor before any makeup test.

Teaching Assistants

Grading TA:

TBD, tbd@shockers.wichita.edu

Office Hours/Room: TBD

The Grading TA is not allowed to solve problems. The TA should grade test papers and provide feedback to students for any missing points. If students have any questions regarding assignments, they should immediately contact the course instructor.

Syllabus Policies and Student Resources available at www.wichita.edu/syllabuspolicies

Information on:

- Important Academic Dates
- Academic Integrity
- Definition of a credit hour
- Video and Audio recording
- Shocker Alert System
- Intellectual Property
- CARE Team
- Counseling and Prevention Services
- Student Health Services
- Heskett Center and Campus Recreation
- Inclusive Excellence
- First Generation Students
- Names and Pronouns
- Disability Services
- Title IX
- Concealed Carry Policy

Laboratory Information

No laboratory is assigned to this course. However, students are welcome to use the Computer Architecture and Parallel Programming Laboratory (CAPPLab) for class project. CAPPLab is physically located in room 312 Wallace Hall (you may visit online at https://www.wichita.edu/academics/engineering/CAPPLab/Lab.php). CAPPLab is used for teaching/research in computer architecture, high performance computing, embedded systems, and related fields.

Brief List of Topics to Cover

Introduction and Motivation (includes Chap. 1 of textbook)

- Introduction: Computer Systems
- Motivation: Computer Performance

High Performance Computer Systems

- Parallelism (hardware/software): ILP, PLP, TLP, SMT
- Parallel Architectures: Multicore, SMT Capable Multicore with GPU
- Cache Memory Subsystems (dynamic behavior and power-hungry)

Memory Hierarchy (includes Chap. 2 of textbook)

- Memory Technology and Optimizations
- Optimizations of Cache Performance
- The Design of Memory Hierarchies

Instruction-Level Parallelism (includes Chap. 3 of textbook)

- ILP: Concepts and Challenges

Data-Level Parallelism (includes Chap. 4 of textbook)

- DLP in Vector, SIMD, and GPU Architectures

Thread-Level Parallelism (includes Chap. 5 of textbook)

- TLP: Shared-Memory Architectures, Multicore Processors

Selected Research/Project Articles

- (UG) Understanding and applying HPC systems
- (GR) Design, develop, and/or analyze HPC systems

Tentative Schedule for 16-week class

Week	Note	Important topics/readings, assignments, due dates, and reminders are listed here so that you can organize your time and academic work.
1 01/17		ECE 694: High Performance Computer Systems; Syllabus; K-probe; Project: Components, Grading; HW-1 discussion;
2 01/24	HW-1	Introduction and Motivation (includes Chap. 1 of textbook) HW-1 (due Thu); Project: Groups, Topics, Proposal Week-6;
3 01/31	HW-2	High Performance Computer (HPC) Systems; HW-2 (due Thu); Quiz-1 discussion;
4 02/07	Quiz-1	HPC Parallelism: ILP, PLP, TLP, SMT; Quiz-1 (Thu, 30-min, 30-pts, closed book); Exam-1 discussion;
5 02/14	Exam-1	Parallel Architectures: SMT Capable Multicore with GPU Exam-1 (65 minutes, 65 points, closed book);
6 02/21	Update	Project: Technical reading, writing, and presentation; Project: Teamwork, Proposal (due); Secure Coprocessors;
7 02/28	HW-3	Memory Hierarchy (includes Chap. 2 of textbook) HW-3 (due Thu); Project: Proposal (feedback);
8 03/07	Mid-Pt HW-4	Memory Hierarchy (includes Chap. 2 of textbook) HW-4 (due Thu); Quiz-2 discussion;
9 03/14	Spr Brk	No Class!
10	Quiz-2	Memory Hierarchy (includes Chap. 2 of textbook)

Week	Note	Important topics/readings, assignments, due dates, and reminders are listed here so that you can organize your time and academic work.
03/21		Quiz-2 (Thu, 30-min, 30-pts, closed book); Exam-2 discussion;
11 03/28	Exam-2	Instruction-Level Parallelism (includes Chap. 3 of textbook) Exam-2 (Thu, 65 minutes, 65 points, closed book);
12 04/04	Update	Data-Level Parallelism (includes Chap. 4 of textbook) Team-Project: Presentation, Report;
13 04/11	HW-5	Thread-Level Parallelism (includes Chap. 5 of textbook) HW-5 (due Thu); Shared-Memory Arch, Multicore Processors;
14 04/18	HW-6 Quiz-3	Team-Project: Presentation, Report; Selected Topics; HW-6 (due Thu) & Quiz-3 (Thu, 30-min, 30-pts, closed book);
15 04/25	Project	Project Presentation: One per group, Teamwork, PPT slides; Project Report: One per group via Blackboard on Study day;
16 05/02	Exam-3	Selected Topics; Exam-3 discussion; Exam-3 (Thu, 65 minutes, 65 points, closed book);
Finals	N/A	None

[_v0) Updated on Jan. 5, 2022; from spring 2020; DRZ]