CS 697AP, Applied Parallel Computing, Spring, 2019

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Preferred Method of Contact:	In person during office hours or e-mail
Office Hours:	TR 11:00AM—12:30PM
Classroom, Days/Time:	310WH, TR 5:35—6:50PM;
Prerequisite(s):	CS 394
Course Website at WSU:	http://webs.wichita.edu/aasaduzzaman/html/cs697ap.html
Course Website at XSEDE:	https://moodle.xsede.org/login/index.php
Teaching Assistant (TA):	TBD

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.

General University Policies

Some general university policies pertaining to all syllabi can be found at:
https://webs.wichita.edu/?u=ofdss&p=/students/syllabusinformation/

Academic Honesty

Students are responsible for knowing and following the Student Code of Conduct, can be found at http://webs.wichita.edu/inaudit/ch8_05.htm and the Student Academic Honesty policy, can be found at http://webs.wichita.edu/inaudit/ch2_17.htm.

All homework assignments in this course are individual assignments (unless otherwise stated). You can discuss with others, but you cannot write the solution together; your submission (wording/coding) should be substantially different from others'. "Collaboration is good, cheating is not!" There will be severe consequences for academic dishonesty. This includes copying homework assignments and cheating during tests (including quizzes and exams). Cheating 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). Be aware that I/we do NOT have to catch you (or even notice) cheating during the test; I/we could catch you later, based on any unusual similarities in your answers.

Course Description

This course is to teach how to program parallel computers to efficiently analyze challenging problems with enormous datasets. Two distinct approaches will be introduced which can be used to solve problems in all manner of domains including data analytics and machine learning. The first approach to be studied will be embarrassingly parallel in nature while the second approach will leverage fine-grain parallelism.

Special Notes

Applications of Parallel Computing, an interdisciplinary course, is developed at the University of California at Berkley with supports from Extreme Science and Engineering Discovery Environment (a National Science Foundation organization). You may take a satellite of this course at WSU.

Definition of a Credit Hour

Success in this three (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: Undergraduate Level

After passing this course, students will be able to:
1) Understand the concepts of parallel computer architectures, parallel computing, and performance analysis.
2) Develop parallel applications to efficiently analyze challenging problems with enormous datasets.

Measurable Student Learning Outcomes: Graduate Level

1) Understand the concepts of parallel computer architectures, parallel computing, and performance analysis.
2) Develop parallel applications to efficiently analyze challenging problems with enormous datasets.
3) Engage in life-long learning of parallel applications and big data analytics for professional success.

Required Texts/Readings Textbook

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

• *Textbook: Multicore and GPU Programming: An Integrated Approach, Gerassimos Barlas, Morgan Kaufmann, 1st edition, 2014.*
• *Reference Book: Structured Computer Organization, Andrew S. Tanenbaum, Pearson India, 6th edition, 2016.*

Topics Include (Summary from UCB Syllabus)

- Introduction and Motivation
  - Single-Core Architecture; Memory Hierarchy
  - Parallel Computers; Matrix Multiply and Data Parallelism
- Shared Memory Programming: OpenMP
- Performance Analysis
- Parallelism and Locality
- GPGPU Programming with CUDA
- Distributed Memory Programming
- MPI and Communication Algorithms
- Partitioned Global Address Space Languages
- Cloud Computing and Big Data Processing
- Parallel Matrix Multiplication
- Dense Linear Algebra: Parallel Gaussian Elimination
- Sparse-Matrix-Vector-Multiplication (SpMV)
- Applications of Parallel Computers: Structured Grids
- Parallel Machine Learning and Deep Neural Networks
- Graph: Partitioning and Parallel Algorithms
- First Fourier Transform (FFT) and FFT Applications
- Modeling and Predicting Climate Change
- Searching and Sorting
- Applications of Parallel Computers: Dynamic Load Balancing
- Applications of Parallel Computers: N-Body Problem
- Computational Biology
- Big Data HPC for Cosmology
- Supercomputers and Superintelligence
- Quantum Computing: The Ultimate HPC Accelerator?

Grading Policy/Scale

The final/letter grade will be based on the grading components listed below. For quiz, exam, and project, different grading scales will be used for undergraduate and graduate students. For homework, the same grading scale will be used for all students.

Grading Components	Undergraduate	Graduate
Homework (four):	10%	10%
Quiz (three of four):	30%	24%
Exam (cumulative, before semester ends):	30%	26%
Project (Proposal, Presentation, and Report):	30% (4+8+18)	40% (5+10+25)

The letter/final grade will be approximately based on the following scale:

A	A-	B+	B	B-	C+	C	C-	D+	D	D-	F
93	90	87	83	80	77	73	70	67	63	60	0

Important Notes

- **Homework Submission:** No e-mail submission. (Repeat) No e-mail submission. Everyone must turn in his/her own assignment, unless special permission is given.
- **Late Submission:** No late submission for assignments after five days from the actual due date/time. Up to 50% points should be subtracted for any late submission.
- **Project Report:** One printed report should be submitted by each group. (In addition, I may ask for an editable softcopy of the report.) NO late submission for project report.
- **Communication via E-mail:** You must use your WSU e-mail account for e-mail communication.
- **Professionalism** (e.g., proper manners) is highly expected.
- All **academic dishonesty** cases will be handled following the University Code of Academic Conduct. You may check the University Catalog for further information.

Assignments

Homework assignments and their due dates will be announced in class. Late submissions will not be accepted after five days from the original due date/time. Exceptions include documented emergency situations and prior consents.

Missed Tests

Makeup for missed tests will be given only when there is a genuine reason, with clear proof. It is your responsibility to provide the proof; if the reason for missing a test is illness, a doctor's note will be required. It is YOUR RESPONSIBILITY to contact me BEFORE the makeup test.

Additional Information

If you think your assignments or tests are graded unfairly, you must send me an e-mail explicitly articulating your rationale for additional points. Then you must bring the assignment/test to my office and I will render a decision. Do NOT expect to discuss it with me in my office without any prior arrangement.

Class notes should be available on course webpage (via WSU Blackboard) as they are covered so that students get an opportunity to focus on lectures. The class notes should be considered as supplements to the textbook materials, not replacements of those. It is expected that before coming to class, students should read the relevant materials with the previous class notes. This should improve students' understanding of the materials and clarify any unclear concepts after reading the book materials and/or the notes.

Important Academic Dates

For spring 2019 semester, classes begin Jan 22, 2019, and end May 9, 2019. The last date to drop a class and receive a W (withdrawn) instead of F (failed) is Apr 5, 2019. The final exams period is May 11-16, 2019.

Tentative Schedule

CS 697AP * Spring 2019 * WSU EECS Dept. *

Tentative Course Plan

Date ranges for each week of the semester	Remark	All of the topics, readings, assignments and reminders are located here so that you can organize your time and academic work. Please ask me any questions at any time (via e-mail) regarding this course.
Week 1 1/22, 1/24 Lectures 1, 2	—	Introduction and Motivation: Single-Core Architecture; Memory Hierarchy
Week 2 (1/29, 31) Lectures 3, 4	—	Introduction and Motivation: Parallel Computers; Matrix Multiply and Data Parallelism
Week 3 (2/5, 2/7) Lectures 5, 6	— **HW-0**	Shared Memory Programming: OpenMP HW: Due on Thu, hardcopy submission
Week 4 2/12, 2/14 Lectures 7, 8	— Quiz-1	Performance Analysis; Parallelism and Locality Quiz: On Thu, 30+5 min, closed book
Week 5 (Eval-1) Lectures 9, 10	— **HW-1**	GPGPU Programming with CUDA HW: Due on Thu, hardcopy submission
Week 6 (2/26, 28) Lectures 11, 12		Distributed Memory Programming HW: Due on Thu, hardcopy submission
Week 7 (3/5, 3/7) Lectures 13, 14		Cloud Computing and Big Data Processing HW: Due on Thu, hardcopy submission
3/11 - 3/17	—	—
Week 8 (3/19, 21) ***Mid-term point*** Lectures 15, 16	Mid Pt, **Project** Proposal	Parallel Matrix Multiplication Proposal: Due on Thu, hardcopy submission
Week 9 (3/26, 28) Lectures 17, 18	— Quiz-2	Dense Linear Algebra: Parallel Gaussian Elimination Quiz: On Thu, 30+5 min, closed book
Week 10 (4/2, 4/4) Lectures 19, 20	— **HW-2(1)**	Applications of Parallel Computers: Structured Grids
Week 11 (4/9, 11) Lectures 21, 22	— Quiz-3	Parallel Machine Learning and Deep Neural Networks Quiz: On Thu, 30+5 min, closed book
Week 12 (4/16, 18) Lectures 23, 24	— **HW-2(2)**	Graph: Partitioning and Parallel Algorithms
Week 13 Lectures 25, 26	— Quiz-4	First Fourier Transform (FFT) and FFT Applications Quiz: On Thu, 30+5 min, closed book
Week 14 (Eval-2) Lectures 27, 28	— Exam	Searching and Sorting Exam: On Thu, 60+10 min, closed book
Week 15 5/7, 5/9 Lectures 29, 30	**Project:** Pre&Rpt **HW-3**	**Presentation:** Teamwork; PowerPoint Slides; Time TBD (for UG/GR); **Report:** Due on Study day (Friday); Hardcopy; Page count (per policy); **Template and Information:** Be available on Blackboard;
Final Exams 5/11—5/16		**None!** Office Hours / Discussion

NOTE:
The topics may not be covered in the order they are listed here. It'll depend on how we make progress one class to the next class and the class performance.

Disabilities
If you have a physical, psychiatric/emotional, or learning disability that may impact on your ability to carry out assigned course work, I encourage you to contact the Office of Disability Services (DS).

Counseling and Testing
The WSU Counseling and Testing Center provides professional counseling services to students, faculty and staff; administers tests and offers test preparation workshops; and presents programs on topics promoting personal and professional growth.

Diversity and Inclusive
Wichita State is committed to being an inclusive campus that reflects the evolving diversity of society. To further this goal, WSU does not discriminate in its programs and activities on the basis of race, religion, color, national origin, gender, age, sexual orientation, gender identity, gender expression, marital status, political affiliation, status as a veteran, genetic information or disability. The Executive Director of WSU Office of Equal Opportunity has been designated to handle inquiries regarding nondiscrimination policies.

Intellectual Property
Wichita State University students are subject to Board of Regents and University policies (see http://webs.wichita.edu/inaudit/ch9_10.htm) regarding intellectual property rights. Any questions regarding these rights and any disputes that arise under these policies will be resolved by the President of the University, or the President's designee, and such decision will constitute the final decision.

Shocker Alert System
Get the emergency information you need instantly and effortlessly! With the Shocker Alert System, we will contact you by email the moment there is an emergency or weather alert that affects the campus. Sign up at www.wichita.edu/alert.

Title IX
Title IX of the Educational Amendments of 1972 prohibits discrimination based on sex in any educational institution that receives federal funding. Wichita State University does not tolerate sex discrimination of any kind including: sexual misconduct; sexual harassment; relationship/sexual violence and stalking. These incidents may limit an individual's ability to benefit from the University's educational activities. Students are asked to immediately report incidents to the University Police Department or the Title IX Coordinator. For more information about Title IX, go to: http://www.wichita.edu/thisis/home/?u=titleixf

Video and Audio Recording
Video and audio recording of lectures and review sessions without the consent of the instructor is prohibited. Unless explicit permission is obtained from the instructor, recordings of lectures may not be modified and must not be transferred or transmitted to any other person, whether or not that individual is enrolled in the course.

Student Health Services
WSU's Student Health clinic is located in Ahlberg Hall. The telephone number is (316) 978-3620. For more information see www.wichita.edu/studenthealth.

Concealed Carry Policy
The Kansas Legislature has legalized concealed carry on public university campuses. Guns must be out of view, concealed either on the body of the carrier, or backpack, purse or bag that remains under the immediate control of the carrier. Gun owners must familiarize themselves with WSU's Concealed Carry Policy at http://webs.wichita.edu/?u=wsunews&p=/weapons_policy_documents and the Kansas Board of Regent's policy at http://www.kansasregents.org/about/policies-by-laws-missions/board_policy_manual_2/chapter_ii_governance_state_universities_2/chapter_ii_full_text#weapons. If you believe that there has been a violation of this policy, please contact the University Police Department at 316 978-3450.

Blackboard/Online

Selected instructional materials (such as lecture notes, reading materials, homework assignments, solution keys, and project related information) and important announcements for this course will be made available via WSU Blackboard (URL: http://blackboard.wichita.edu).

Prerequisite Information

CS 394 (Introduction to Computer Architecture) is the prerequisite for this course. Note that CS 211 (Introduction to Programming) is the prerequisite for CS 394 course. By continued enrollment in this class, you are certifying that you have met the pre-requisite requirements for this course.

Teaching/Computing Resources

Students enrolled in this course at WSU will gain access to the teaching/computing resources from UCB and XSEDE (such as UCB materials/professors and XSEDE supercomputers). Please create your XSEDE portal account (at https://portal.xsede.org/) and provide your XSEDE portal ID/Username information to the course instructor. The instructor will request XSEDE Course Manager(s) to give you access to the teaching resource (via moodle.xsede.org) and computing resources/supercomputers (such as Pittsburgh Supercomputing Center's bridges and San Diego Supercomputer Center's comet).

Laboratory Information

Students enrolled in this course at WSU will gain remote access to XSEDE supercomputers (such as PSC's bridges and SDSC's comet).

Moreover, you are expected to use EECS Computer Science Lab in 205-206 Jabara Hall as you may need. You can access WSU CUDA servers in Computer Architecture and Parallel Programming Laboratory (CAPPLab) only via EECS Linux servers. CAPPLab is in room JB 256 (URL: http://www.cs.wichita.edu/~capplab/). Objectives of CAPPLab includes: (1) lead research in advanced-level computer architecture, high-performance computing, embedded systems, and related fields. And, (2) educate computer architecture, embedded systems, and parallel programming. Currently CAPPLab has the following resources: multicore PCs/Workstations, Linux/Windows OSs, SPEC, VisualSim, OpenMP, Open MPI, CUDA/GPGPU, and supercomputer access.

Graduate Teaching Assistant (GTA)

WSU students, who enrolled in this course, will gain access to the Student Assistants at UC Berkley via XSEDE course website. WSU students are advised to contact the local instructor for each issue related to this course.