Lecture: Three 50 minute lecture sessions per week; one two hour lab per week.

Course description: Computer architecture and programming; memory hierarchies, memory management and cache organization, parallel processing, graphics processing units for general purpose computing.

Prerequisite: ECE 3210, (ECE4220)

Instructor: Dr. Michela Becchi: becchim@missouri.edu – EBW335

Lab TAs:
- Hancheng (Henry) Wu: hwn38@mail.missouri.edu – EBW 352
- Marziyeh Nourian: mndk3@mail.missouri.edu – Lafferre Hall C2222

Grader: Ruidong Gu: rgxc@mail.missouri.edu – EBW 352

Lecture: 11:00AM – 11:50AM (MWF); Lecture location: Lafferre Hall E3508
Lab location: Lafferre Hall C1246


Required texts:

Suggested references on POSIX threads, OpenMP and CUDA:
- POSIX threads tutorial: [https://computing.llnl.gov/tutorials/pthreads/](https://computing.llnl.gov/tutorials/pthreads/)
- OpenMP tutorial: [https://computing.llnl.gov/tutorials/openMP](https://computing.llnl.gov/tutorials/openMP)

Course Topics:
1. Quantitative Computer Architecture
2. Instruction Set Architecture
3. Instruction, Thread, and Data Level Parallelism
4. Pipelining and Advanced Pipelining
5. Dynamic Scheduling and Superscalar Architectures
6. Branch Prediction
7. Compiler Techniques for ILP: Loop Unrolling, Software Pipelining, Trace Scheduling
8. Memory Management & Virtual Memory
Assignments, Labs and Projects:
There will be 4 types of assignments:
1. Readings: Students will read a major portion of the textbook, and documentation on POSIX threads, OpenMP, and GPU programming using CUDA.
2. Homework: There will be several homework assignments designed to deepen and evaluate students’ understanding. Students will perform homework assignments individually or in teams of two, depending on instructions on the specific assignment. The solutions to all homework assignments will be provided in class, but not uploaded on the course website: students are required to take notes. The homework assignments will be graded, and the grade may be modified depending on the ability of the student to answer questions during the in-class homework correction.
3. Labs: Four-to-five lab sessions will cover multithreaded programming using POSIX threads and OpenMP; the remaining will focus on GPU programming. During lab sessions, students will work in teams of two and perform small projects to demonstrate their practical understanding of different aspects of parallel programming. Lab teams MUST be made of the same “class” of students. That is, grad students can only team up with other grad students.
4. Project: Graduate students will perform a more substantial project using GPUs. At the end of the course, they will write a technical report including an experimental evaluation section.

Late homework policy: 2-day delay allowed on both homework and lab assignments (with 10% grade deduction for each day of delay).

Grading:
• Passing grades (A/B/C) ≥ 65%
• +/- grades (A+, A-, B+, B-, C+, C-) are also admitted for graduate students
• Why two values in midterm and final exam? Exams will globally account for 60% of the grade for undergraduate and 55% of the grade for graduate students. For each student, the instructor will consider the best grade obtained by weighing midterm/final either 25%/35% or 20%/40% for undergraduate, and either 25%/30% or 20%/35% for graduate students.

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<td>Midterm Exam</td>
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<td>Final Exam</td>
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ABET Course Learning Objectives:
1. Demonstrate an understanding of modern computer architecture: pipelined CPU, superscalar processor organization, dynamic instruction scheduling, etc.
2. Demonstrate an understanding of memory management, Cache Memory, Virtual Memory, Paging, Distributed and Shared Memory, etc.
3. Design modern computers using x86 (including Core2), ARM processors, RISC, etc.
4. Analyze and compare the performance of architectures based on Multithreading, multi-cores, clusters.
5. Demonstrate the ability to identify single, parallel, and distributed architectures, SISD, SIMD, MISD, and MIMD.
6. Demonstrate the ability to develop parallel programs using generic Graphics Processor Units (GPUs).

Team Work: The laboratory projects are assigned to a lab team (two people per team). Team work and planning are an important part of the engineering profession. Therefore, dividing the problem into parts and assigning parts to team members is not only proper, but advised. However, each member of the team is responsible for understanding everything about the laboratory project.

Academic Dishonesty: Academic integrity is fundamental to the activities and principles of a university. All members of the academic community must be confident that each person's work has been responsibly and honorably acquired, developed, and presented. Any effort to gain an advantage not given to all students is dishonest whether or not the effort is successful. The academic community regards breaches of the academic integrity rules as extremely serious matters. Sanctions for such a breach may include academic sanctions from the instructor, including failing the course for any violation, to disciplinary sanctions ranging from probation to expulsion. When in doubt about plagiarism, paraphrasing, quoting, collaboration, or any other form of cheating, consult the course instructor. Any student found to have cheated during an exam will be given a 0 grade for that exam and the evidence will be sent to the Provost's Office. Students submitting the same or similar solutions to homework or programming assignments will be given a 0 for the assignment and the evidence will be sent to the Provost's Office for determination of possible disciplinary action. Students not being able to explain the solution of a homework or a project that they have provided will be given a 0 for the assignment/project and the evidence will be sent to the Provost's Office for determination of possible disciplinary action. Unless an assignment is specifically structured as a group project, duplicate homework written in collaboration with others is not acceptable. Although it is permissible to discuss the homework with others, these discussions should be of a general nature. All work at a detailed level must be done on your own. Students submitting the same or similar solutions to the homework will be considered as having cheated. No statements or actions made by anyone can alter this policy.

ADA statement: If you need accommodations because of a disability, if you have emergency medical information to share with me, or if you need special arrangements in case the building must be evacuated, please inform me immediately. Please see me privately after class, or at my office. To request academic accommodations (for example, a notetaker), students must also register with the Office of Disability Services, (http://disabilityservices.missouri.edu), S5 Memorial Union, 882-4696. It is the campus office responsible for reviewing documentation provided by students requesting academic accommodations, and for accommodations planning in cooperation with students and instructors, as needed and consistent with course requirements. For other MU resources for students with disabilities, click on "Disability Resources" on the MU homepage.

Intellectual Pluralism: The University community welcomes intellectual diversity and respects student rights. Students who have questions or concerns regarding the atmosphere in this class (including respect for diverse opinions) may contact the Departmental Chair or Divisional Director; the Director of the Office of Students Rights and Responsibilities (http://osrr.missouri.edu/) or the MU Equity Office (equity@missouri.edu; http://equity.missouri.edu/) All students will have the opportunity to submit an anonymous evaluation of the instructor(s) at the end of the course.