IUPUI CS590-HPC: High Performance Computing
Tuesday Thursday 4:30 - 5:45 PM, Room: ES 2127

Professor: Dr. Fengguang Song, Office: SL 275, Phone: 317-274-7265, Email: fgsong@iupui.edu
Office Hours: Wednesday 4:00-5:00 PM, or by appointment.

Note from the instructor: This selected introduction book is intended to help you learn basic parallel programming techniques if you are brand new to computer science. However, the lectures will cover more topics than the book can offer. Also, the instructor will try to follow the same order of the book. This way you are able to read the book and the lecture slides at the same time. The book may provide details/examples and complement the lectures.

Prerequisites: Students should ideally have some programming experience in C or a similar language.

Course Description
The graduate-level HPC course teaches students from the schools of Science, Engineering, and Informatics how to use high performance computing (HPC) systems efficiently. Parallel computers are critical and essentially everywhere from your smart phones, laptops to high-end computers. This course covers important topics of designing parallel algorithms, writing efficient programs, developing large-scale distributed applications, and conducting performance analysis and optimization. This course includes lectures, labs, quizzes, paper-related tutorials, and a course project.

Course Objective
In this course, you will learn advanced computer architectures, parallel algorithms, various parallel programming languages and tools (such as MPI, pthreads, OpenMP, CUDA, OpenCL), and performance modeling and optimizations. This course will prepare you for solving large-scale scientific and engineering problems on the new and emerging high performance computing systems.

Tentative Course Topics
-HPC introduction, parallel computer architectures ................................. January
-Dense linear algebra, sparse matrix problems, MPI ............................... February
-Pthreads, OpenMP, CUDA ............................................................. March
-OpenCL, Cloud computing, paper tutorials/discussions .......................... April

HPC systems to use in the course: Big Red II and Katrast
Please go to https://kb.iu.edu/d/aczn#research to request a new account.

**Requirement and Grading**
The course grade will be determined as follows:

- Labs (40%, four or five, each with a formal 2- or 3-page technical report)
- Quizzes (10%, there will be no exam)
- Paper presentation (10%)
- An individual course project (40%, with a formal 10-page technical report)

**Rationale:** Labs are designed for you to gain hands-on experience in parallel computing. Paper tutorials are designed to learn the latest HPC research that is not taught by any textbooks. Quizzes will be used to evaluate how well you understand the papers as well as the lectures. Course project gives you an opportunity to integrate HPC with your own research project or research for which it will ideally lead to a conference or workshop publication.

**Due Dates, Times, and Policies**
Lab submissions are due at 11:59PM on the due date.
You will submit your labs through the Canvas system.
No late lab will be accepted unless you notify me in advance about your extreme situation.

**Lab Grading (40 points)**
What to submit: 1) source code with generous comments, 2) makefile, 3) readme to explain how to run it, and 4) a formal technical report in PDF.
A suggested format for your technical report (e.g., 3 pages):

1. Abstract
2. Introduction
3. The Algorithm
4. Software Design and Implementation
5. Experimental Results
6. Discussion
7. Conclusion

*Note:* Each student will make a demo of his or her program in class. The algorithm, software implementation, and experimental results should be presented in a set of slides.

**Presentation Grading (10 points)**
You should give a tutorial about one technical paper for 60 minutes. Note that this is more like a lecture (instead of a conference talk). So make sure you slow down and give good examples.

After the 60-minutes tutorial, you should give a 2-question quiz to the class. The quiz is to test how the audience comprehend the material.
Quizzes (10 points)
In addition to the speakers’ quizzes (one quiz per paper), the instructor may also give quizzes (you will be informed in advance). Each quiz may have a couple of questions and should take only 15 minutes.

Course Project (40 points)
Each student will propose a topic for his or her own course project in early March, and complete the project by the end of April. The proposal of the chosen project requires a short 10-minute introduction.

Academic Misconduct: As an IUPUI student, you have agreed to abide by the Code of Students Rights, Responsibilities, and Conducts. You must uphold and maintain academic and professional honesty and integrity. The following link defines what activity is deemed an Academic Misconduct:
http://www.iu.edu/~code/code/responsibilities/academic (there are 6 cases, please check them out).

Cooperation and Cheating (Important): Students can help each other to understand the course materials and understand the lab requirements. However, copying other people’s code or exams is definitely a cheating. We will file an Academic Misconduct report to the university.

CS Department’s Policy against Academic Cheating
The policy against violations of academic integrity will be enforced at our departmental level across multiple courses: (1) If a student does not abide by this policy then for the first violation, he/she will receive zero point for that component of the course and will be reported to the Department Chair; (2) For the second violation of academic integrity (even in a different course), the student will receive a FAIL grade for the course and, in addition, an official reporting process will be initiated as per IUPUI’s Student Conduct Policies that can be found here: http://www.indiana.edu/~code/code/responsibilities/academic.

University Attendance Policy (http://registrar.iupui.edu/withdrawal-policy.html): A basic requirement of this course is that you will participate in all class meetings and conscientiously complete all required course activities and/or assignments. You are expected to attend classes regularly. A student who incurs an excessive number of absences may be withdrawn from a class at the discretion of the professor.

Keep in touch with me if you are unable to attend, participate, or complete an assignment on time. If you miss more than four classes in the first four weeks, you may be administratively withdrawn from this course. Administrative withdrawal may have academic, financial, and financial aid implications. Administrative withdrawal will take place after the full refund period, and if you are administratively withdrawn from the course you will not be eligible for a tuition refund. If you have questions about the administrative withdrawal policy at any point during the semester, please contact me.

Adaptive Educational Services (AES) Policy (http://aes.iupui.edu): Students needing accommodations because of disability will need to register with Adaptive Educational Services and complete the appropriate forms issued by AES before accommodations will be given. The
AES office is located in Taylor Hall, UC 100. You can also reach the office by calling 274-3241.

Important Dates:

First Class ......................................................... Jan 10
Last Class ......................................................... Apr 27
Drop Deadline ................................................... Jan 15
Project: Choose a Topic .......................... early February
Project Proposal: Make a Proposal .................. early March
Project Presentations .............................. Apr 25 and 27