EECS 739: Parallel Scientific Computing
Spring 2019

Course Description
This course is concerned with the application of parallel processing to real-world problems in engineering and the sciences. State-of-the-art serial and parallel numerical computing algorithms are studied along with contemporary applications. The course takes an algorithmic design, analysis, and implementation approach and covers an introduction to scientific and parallel computing, parallel computing platforms, design principles of parallel algorithms, analytical modeling of parallel algorithms, MPI programming, direct and iterative linear solvers, numerical PDEs and meshes, numerical optimization, GPU computing, and applications of parallel scientific computing.

Course Meetings
MWF, 3-3:50pm, 3150 Learned Hall

Instructor
Dr. Suzanne Shontz
3016 Eaton Hall
Dept. of Electrical Engineering and Computer Science
Office Phone: (785) 864-8816
E-mail: shontz@ku.edu

Office Hours: MWF from 1:30-2:30pm or send e-mail to schedule an appointment in advance. (Note that I have a second office which is 238 Nichols Hall. You may be asked to come to Nichols Hall to meet with me if you request a meeting with me outside of office hours on certain days of the week.)

Teaching Assistant
None

Texts
Introduction to Parallel Computing, Second Edition, by Ananth Grama, George Karypis, Vipin Kumar, and Anshul Gupta, Pearson-Education, 2003. Required. (On reserve at Spahr Library.)

Parallel Scientific Computing in C++ and MPI: A Seamless Approach to Parallel Algorithms and Their Implementation, by George Karniadakis and Robert M. Kirby, II, Cambridge University Press, 2003. Required. (On reserve at Spahr Library.)

References
The following books have also been placed on reserve at Spahr Library.

Parallel Programming with MPI, by Peter S. Pacheco, Morgan Kaufmann Publishers, 1997.
Parallel Programming in C with MPI and OpenMP, by Michael J. Quinn, McGraw-Hill Publishers, 2004.

Multicore and GPU Programming: An Integrated Approach by Gerassimos Barlas, Morgan Kauffman Publishers, 2015.

Prerequisites
Math 122 or Math 126; Math 290; experience programming in C, C++, or Fortran; EECS 639 (or equivalent). Highly recommended: Math 127 or Math 223.

Course Requirements
Lecture attendance is required, although attendance will not be recorded. The course requirements for EECS 739 include class participation, three homework assignments, one midterm exam, and a final project. The homework assignments and final project will require a combination of algorithmic design, problem solving, mathematical analysis, and computer programming (using C/C++, MPI, and CUDA) (not all on every assignment). *Prior knowledge of C/C++, MPI, and CUDA programming is not a prerequisite for the course.*

Homework assignments will be due approximately 14 days after they are assigned. Due dates for homework assignments will be announced in class. **There will be a late penalty of 15% per day for homework handed in up to 48 hours late. No homework assignments will be accepted which are either (i) more than 48 hours late or (ii) are not submitted by 11:59pm the day before Stop Day.**

There will be one midterm exam scheduled for Friday, March 8. Please reserve this date on your calendar. The midterm exam will be closed-book. It will cover topics drawn from the lectures and homework, and from the underlying algorithms and mathematics. A make-up midterm exam will be given to any student who is absent from the midterm exam for a compelling reason and gets permission from the instructor.

There will be a final project in lieu of a final exam. Each student will design their own individual project (subject to instructor approval) involving several of the following components: algorithmic design, problem solving, mathematical analysis, and computer programming. The project will involve both a written report and a presentation. **Final projects will be due on Wednesday, May 15. Presentations on the final project will take place during the final examination period for EECS 739 on May 15.** Please reserve this date on your calendar. A make-up final project presentation will be given to any student who is absent from the final project presentation for a compelling reason and gets permission from the instructor.

If you have a mandated religious observance with conflicts with the midterm examination, please contact me privately at the beginning of the semester so that a make-up examination can be scheduled at a mutually acceptable time. (The university policy which applies to religious observances in conflict with examinations does not apply to the final examination period since instructors do not schedule final exams.)

Grading
Class participation will count for 5% of the final grade. The homework assignments will count for 30% of the final grade. The midterm exam will count for 30% of the final grade, and the final project will count for 35%.

Your final grade in the class will then be computed by using the weighted average given above and the following scale:

Grade	**Percentage**
A	[90%-100%]
A-	[88%-90%)
B+	[86%-88%)
B	[78-86%)
B-	[76%-78%)

Fractional Grading Policy. This grading policy is in accordance with the fractional grading policy which was adopted by the School of Engineering. In particular, plus/minus (+/–) grades may be used in the School of Engineering at the instructor's discretion. The plus or minus sign describes intermediate levels of performance between a maximum of A and a minimum of F in a course. Courses in the School of Engineering will not issue plus or minus grades below a D. Intermediate grades are calculated in a student's GPA as 0.3 units above or below the corresponding letter grade (1 grade point of A = 4 pts, 1 grade point of A- = 3.7 pts, 1 grade point of B+ = 3.3 pts, and so on). This course, i.e., EECS 739, will utilize +/- grading in Spring 2019 as indicated above.

Class Schedule

The course calendar shows a week-by-week syllabus. The dates and order of topics are subject to change by the instructor. Any significant changes will be announced in class.

Course Website and E-mail

By the end of the week, there will be a course website available at the following URL:

http://people.eecs.ku.edu/~s906s230/eecs_739_spring_2019.html .

E-mail will be used for announcements not given in class.

Computing Facilities

Students will have access to a high performance computing cluster in the Information and Telecommunication Technology Center at Nichols Hall in order to run your C/C++ and MPI codes. Students will have access to the cycle servers in Eaton Hall in order to run your CUDA codes on GPUs.

Academic Integrity Policy

Cheating in the course will not be tolerated. Students are allowed to collaborate on the homework assignments with at most one other student of the class. The collaboration should involve no more than the formulation of ideas as a pair. Each student is expected to write up the homework assignment by himself or herself. Students must not hand in homework that represents somebody else's ideas entirely. Students should do the C/C++ and MPI coding and the CUDA coding on assignments by themselves--no program code should be shared. No collaboration of any kind is allowed on the midterm exam. Similarly, no collaboration of any kind is allowed on the final project.

Students are permitted to consult outside published material for the homework and final project, although the homework will be fully based on lecture notes, course handouts, and the textbooks. If a student consults a source other than the lecture notes and textbooks, he or she must cite the source--failure to cite the source will be considered cheating.

If you are uncertain as to whether or not a particular behavior is considered cheating, you are encouraged to discuss it with the instructor before engaging in such behavior.

Anyone found cheating will receive a 0 on that work (homework assignment) or an F in the class (midterm exam or final project). A second incident will result in an F grade for the course. These penalties will be received by all parties involved, following a hearing with the instructor. In all cases, reports of academic misconduct will also be made to the dean's office where further disciplinary action may be taken in accordance with School of Engineering and University of Kansas guidelines. This may result in much more serious sanctions.

Academic Achievement and Access

Any student in this course who has a disability that may prevent him/her from fully demonstrating his/her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate the educational opportunity.

The Academic Achievement & Access Center (AAAC) coordinates accommodations and services for all KU students who are eligible. If you have a disability for which you wish to request accommodations and have not contacted the AAAC, please do so as soon as possible. Their office is located in 22 Strong Hall; their phone number is (785) 864-4064 (V/TTY). Information about their services can be found at http://www.achievement.ku.edu/ . Please contact me privately in regard to your needs in this course.

Concealed Carry Policy

Individuals who choose to carry concealed handguns **are solely responsible to do so in a safe and secure manner in strict conformity with state and federal laws** (http://concealedcarry.ku.edu/information) and **KU weapons policy** (http://policy.ku.edu/university-kansas-policy-weapons-including-firearms-effective-july-1-2017).

Safety measures outlined in the KU weapons policy specify that a concealed handgun:

- Must be under the constant control of the carrier.
- Must be out of view, concealed either on the body of the carrier, or backpack, purse, or bag that remains under the carrier's custody and control.
- Must be in a holster that covers the trigger area and secures any external hammer in an un-cocked position.
- Must have the safety on, and have no round in the chamber.

Suzanne M. Shontz, Associate Professor, Department of Electrical Engineering and Computer Science, University of Kansas, shontz@ku.edu

EECS 739: Parallel Scientific Computing
Week-by-Week Syllabus

Week	Lecture Topics	Notes
1	**Jan. 23 and 25:** Introduction to Parallel Scientific Computing	
2	**Jan. 28 and 30, Feb. 1:** Design Principles of Parallel Algorithms	
3	**Feb. 4, 6, and 8:** Direct Linear Solvers	
4	**Feb. 11, 13, and 15:** Direct Linear Solvers/MPI Programming	
5	**Feb. 18, 20, and 22:** MPI Programming	
6	**Feb. 25 and 27, March 1:** Analytical Modeling of Parallel Algorithms	**No class on Feb. 25 (Engineering Expo)**
7	**Mar. 4, 6, and 8:** Iterative Linear Solvers/**Midterm Exam**	**Midterm Exam on March 8**
BREAK	**Mar. 11, 13, and 15: Spring Break**	**No class this week**
8	**Mar. 18, 20, and 22:** Iterative Linear Solvers	
9	**Mar. 25, 27,and 29:** Numerical PDEs and Meshes	
10	**Apr. 1, 3, and 5:** Numerical PDEs and Meshes	
11	**Apr. 8, 10, and 12:** Numerical Optimization	
12	**Apr. 15, 17, and 19:** Numerical Optimization	
13	**Apr. 22, 24, and 26:** Parallel Computing Architectures/GPUs	
14	**Apr. 29, May 1 and 3:** GPUs	
15	**May 6 and 8:** GPUs	
FINAL	**May 15: Final Project Presentations**	**Final project presentations on May 15 from 1:30-4pm**