ECE 699  Heterogeneous Architectures and Green Computing
Spring 2015

Class info: Tuesdays, 4:30pm-7:10 pm, Nguyen Engineering Building 3208
Instructor: Prof. Houman Homayoun
Web: http://cseweb.ucsd.edu/~hhomayoun/
Course website: Materials will post on Blackboard
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Office hours: TBA
Prerequisite: ECE 611 or 511, or equivalent.

Course Description
Future computing platforms will need to be flexible, scalable, and power-conservative, while saving size, weight, energy, etc. Heterogeneous and green architecture can address these challenges by allowing each application to run on an architecture that matches resource needs of applications more closely than a one-size-fits-all core.

Parallel computing is now ubiquitous across all domains, from portable device data centers. Challenges such as Dark Silicon has led computer architect to design computing systems that are heterogeneous to handle specific types of computation more efficiently (e.g., integrating CPU with GPUs). Parallel computing and heterogeneous architecture shown to improve performance at the cost of programmability and generality. The main question that these new platforms arise is how to strike the right balance between efficiency, generality, and ease of programmability?

ECE-699 will help you understand, use, and design the emerging parallel, heterogeneous, and green computing systems. This course will cover both hardware and software aspects, ranging from computer architecture to programming models and provides a strong foundation for understanding modern computer system architecture and for designing future systems to address these challenges.

Course Content (This is tentative and will change as we progress in the class)
  o Introduction and Course Overview (Week 1)
  o Dark Silicon and Heterogeneous Architectures (Week 2)
  o Research Paper Review on Dark Silicon (Week 3)
  o Research Paper Review on Heterogeneous Multicore (Week 4)
  o Parallel Architectures: GPU, FPGA (Week 5)
  o Research Paper Review on FPGA acceleration (Week 6)
  o Research Paper Review on CPU+GPU Design (Week 7)
  o Communication Models: Shared Memory and Message Passing (Week 8)
  o Research Paper Review on Message Passing and Shared Memory (Week 9)
  o Power, Temperature and Reliability Challenges (Week 10)
  o Research Paper Review on Power, Temperature, and Reliability (Week 11)
  o Project Presentation (Week 12)
  o Challenges with Large Scale Systems: Data Centers (Week 13)
Literature
- NO TEXTBOOK REQUIRED
- Reading material will be selected from leading conferences, journals, and magazines including ISCA, MICRO, HPCA, DAC, DATE conferences as well as active research projects. All required material will be made available on the course web page.

Grading Policy
- **Midterm**: (20%)
- **Project**: (50%)
  - Project proposal and 1-page initial progress report (Week 6): 5%
  - Final project report and results: 20%
- **Paper Presentation (20%)**
  - Project proposal and 1-page initial progress report (Week 6): 5%
- **Project Presentation (10%)**

Project
This is probably the most important part of the course. You will be required to conduct “research” in parallel, green and heterogeneous computing:

- Several possible ideas will be given
- Also you may come up with your own

Since this is a class project negative results are OK, i.e. you do not need to prove something is working! If you proof some idea is not working it could also be good!

The project can be done individually or in a group. Students can form their own group (up to 2 students per group). The project involve learning and using simulation tools for measuring performance, estimating power and temperature, and evaluating reliability of the state of the art architectures.

Reading List
Each student needs to present 2 papers from the reading list. (the reading list includes key papers in computer architecture, so you will most likely find slides for these papers online. If not, you can contact the authors, and they will forward you the slides, if they have).

Project Tools:
In this class you will learn how to use these architecture simulator tools:

- Hotspot (temperature simulation)
- CACTI (memory simulator)
- Sniper (heterogeneous architecture simulator)
- McPAT (Power simulator)