Meeting Time & Location

TuTh 1:15PM – 2:30PM CIEMAS 1441

Faculty:

Professor Benjamin Lee Office: 210 Hudson Hall Office Hours: TBD benjamin.c.lee@duke.edu Phone: 660-5043

Webpage:

http://www.duke.edu/~BCL15/class_ece299fall10.html

Synopsis:

This course covers advanced topics in energy-efficient computing with an emphasis on computer architecture and systems. This course surveys recent advances in diverse platforms, ranging from high-performance, enterprise domains to low-power, mobile domains. Discussion-oriented classes focus on in-depth analysis of readings. Students will learn to reason about energy efficiency across the hardware/software interface and across a range of system components. Students will complete a collaborative research project.

After completing this course, students should be able to

- Understand energy efficiency across the hardware/software interface
- Read architecture and systems papers critically.
- Write constructive paper reviews
- Identify open research problems in energy efficient architecture
- Design a research project to address an open research problem
- Execute a research project, presenting results both orally and in writing

Final project and paper required. Appropriate for graduate students, as well as advanced undergraduate students.

Prerequisites:

ECE 152 / Compsci104 or equivalent required.

Grading:

Participation/Discussion: 25% Response Papers: 25% Project/Paper: 50%

Academic Policy:

University policy will be strictly enforced. Zero tolerance for cheating and/or plagiarism.

Participation/Discussion:

This course uses a seminar, not a lecture, format. Each class covers particular topics from assigned papers. Students are expected to read the assigned papers and to prepare for course discussions. A student will be assigned to lead the discussion for each paper.

Response Papers:

The students should prepare an insightful critique of the assigned papers due at the beginning of class. These response papers should take the form of a constructive paper review, including (1) summary, (2) strengths, (3) weaknesses, (4) directions for future work. These response papers should be no longer than one page per class. Papers will be evaluated for brevity and depth of insight.

Email response papers to <u>benjamin.c.lee@duke.edu</u>. Please use the following subject line format to ensure your response does not get lost in the email shuffle.

Format:	ECE299_ <dd><mm><yy>_<lastname><firstname></firstname></lastname></yy></mm></dd>
Example:	ECE299_020910_LeeBenjamin For a response paper due 2 September 2010.

Project/Paper:

The course ends with a research project. Intermediate deliverables include a research statement, research plan, extended abstract, final paper, and oral presentation. At each stage of the process, students will receive detailed feedback and suggestions. The course concludes with a mock program committee in which students review their peers' research papers.

Introduction	Mudge. "Power: A first-class architectural design constraint," IEEE Computer, 2001. Barroso et al., "The case for energy-proportional computing," IEEE Computer, 2007.
Technology I	G. Moore. "Cramming more components onto integrated circuits." Electronics 1965.
	R. Dennard, F. Gaensslen, V. Rideout, E. Bassous, A LeBlanc. "Design of ion-implanted MOSFET's with very small physical dimensions. <i>IEEE Journal of Solid-State Circuits</i> , October 1974.
Technology II	Horowitz et al., "Scaling, power, and the future of CMOS," International Electron Devices Meeting (IEDM), 2005.
	Ho et al., "The future of wires," Proceedings of the IEEE, vol. 89, no. 4, 2001.
Power Modeling	Brooks et al., "Wattch: A framework for architectural-level power analysis and optimizations," 27th International Symposium on Computer Architecture (ISCA), 2000.
	Lee et al., "Accurate and efficient regression modeling for microarchitectural performance and power prediction," 12th International Conference on Architectural Support for Programming Languages and Operating Systems (ASPLOS), 2006.

Drogossor	Hrishikosh at al "The optimal useful logic depth por pipeline stage
Pipelining	is 6 to 8 EQ4 inverter delays " anth International Symposium on
Tipenning	Computer Architecture (ISCA) 2002
	Computer Architecture (ISCA), 2002.
	Srinivasan at al "Ontimizing pipelines for newer and
	performance" arth International Symposium on
	Microsprehitesture (MICRO), 2000
	Microarchitecture (MICRO), 2002.
Drogoggor	Vuman at al "Single ISA hataraganagua multi gana anghitagtunga
Hotomogonoity	The potential for processor power reduction " of the International
field ogeneity	Sumposium on Microarchitecture (MICPO), 2000
	Symposium on Microarchitecture (MiCRO), 2003.
	Lee et al "Illustrative design snace studies with microarchitectural
	regression models." 19th International Symposium on High-
	Performance Computer Architecture (HPCA) 2007
	renormance computer Arcintecture (III CA), 2007.
Processor	Lin et al., "SODA: A low-power architecture for software radio."
Specialization	33rd International Symposium on Computer Architecture (ISCA).
~ P • • • • • • • • • • • • • • •	2006.
	Hameed et al., "Understanding sources of inefficiency in general-
	purpose chips," 37th International Symposium on Computer
	Architecture (ISCA) 2010.
Power	Wu et al., "A dynamic compilation framework for controlling
Measurement and	microprocessor energy and performance," 38th International
Control	Symposium on Microarchitecture (MICRO), 2005.
	Reddi et al., "Voltage emergency prediction: Using signatures to
	reduce operating margins," 15th International Symposium on
	High-Performance Computer Architecture (HPCA), 2009.
Memory	Udipi et al., "Rethinking DRAM design and organization for
	energy-constrained multi-cores," 37 th International Symposium on
	Computer Architecture (ISCA) 2010.
	Les et al "Anabitacting phase shange memory of a scalable DDAM
	Lee et al., Architecting phase change memory as a scalable DRAM
	Auchitecture, 36th International Symposium on Computer
	Architecture (ISCA), 2009.
Storago	Curumurthi "Architecting storage for the cloud computing ore"
Storage	IFFF Micro 2000
	TEEE MICIO, 2009.
	Gurumurthi et al "DRPM: Dynamic speed control for power
	management in server class disks " 20th International Symposium
	on Computer Architecture (ISCA) 2002
	Caulfield et al., "Gordon: Using Flash memory to build fast, power-
	efficient clusters for data-intensive applications." 14th
	International Conference on Architectural Support for
	Programming Languages and Operating Systems (ASPLOS). 2009.

Network	Heller et al., "Elastic Tree: Saving energy in data center networks," 7th Symposium on Networked System Design and Implementation (NSDI), 2010.
	Abts et al., "Energy proportional datacenter networks," 37th International Symposium on Computer Architecture (ISCA) 2010.
Data Center Components	Lim et al., "Understanding and designing new server architectures for emerging warehouse-computing environments," 35th International Symposium on Computer Architecture (ISCA), 2008. Reddi et al., "Web search using mobile cores: Quantifying and mitigating the price of efficiency," 37th International Symposium on Computer Architecture (ISCA), 2010.
Data Center Management	 Ranganathan et al., "Ensemble-level power management for dense blade servers," 33rd International Symposium on Computer Architecture (ISCA), 2006. Fan et al., "Power provisioning for a warehouse-sized computer," 34th International Symposium on Computer Architecture (ISCA), 2007.
Utility Computing	Chase et al., "Managing energy and server resources in hosting centers," 18th Symposium on Operating Systems Principles (SOSP), 2001. Doyle et al., "Model-based resource provisioning in a web service utility," 4th Symposium on Internet Technologies and Systems (USITS), 2003.
Applications	 Baek et al., "Green: A framework for supporting energy-conscious programming using controlled approximation," Conference on Programming Language Design and Implementation (PLDI), 2010. Wehner et al., "Towards ultra-high resolution models of climate and weather," International Journal on High Performance Computing Applications (IJHPC), 2008.