What is Computer Architecture?

- $CA = ISA + O + H$
  - ISA – Instruction Set Architecture
  - O – Organization
  - H - Hardware

- Computer architect designs a computer
  - to meet functional requirements AND
  - to meet price, performance and availability goals
Course Goals

1. To understand fundamentals of instruction set design, processor design to exploit parallelism (ILP, TLP, DLP), memory-hierarchy design, storage system design.

2. To understand the current trends in CA
   - shift from single processor (core) chips to multiprocessor on chips (multi-core) to optimize performance/watts,
   - increasing focus on dependability – to address more hard/soft errors at smaller feature sizes < 65nm.
Course Goals - Indirect

- To enrich with new ideas
- To train you in systems oriented thinking
- To prepare you for research in computer architecture – but more generally – in computer systems (CA+Compiler+OS+Application)
More Pictorially .....

Architecture?
Architecture of a Computing Machine?
How Computer Architectures evolved?


[Image: Alan Turing](http://en.wikipedia.org/wiki/Alan_Turing)
What is the architecture of Intel ATOM and Why it is used in Notebooks?

Source: http://en.wikipedia.org/wiki/Intel_Atom
Why PS3 Uses Cell Processors?


Source: http://en.wikipedia.org/wiki/PlayStation_3
Why Multicore Architectures?

An AMD Athlon X2 6400+ dual-core processor

Source: http://en.wikipedia.org/wiki/Multi-core_processor

Why companies are very secretive about their Datacenter’s Architecture? And Why (Mega) Datacenters are situated near large electricity power plants?
Processor Virtualization

Intel® Virtualization Technology

Without Virtualization:
- App
- App
- App
- OS
- Platform Hardware

With Virtualization:
- Virtual Machine Monitor
- Intel® Virtualization Technology
- Platform Hardware
- OS (x3)

VMM = Layer of system software
Enabled multiple OS's to share hardware
Vanderpool Technology can allow OS & Apps to run without modifications

Virtualization Technology-enhanced hardware capabilities to facilitate virtualization
And Much More…

- Dynamic Scheduling: Tumasulo’s Algorithm
- Virtual Memory
- Protection and Synchronization Mechanisms
- Shared memory architectures
- Storage Architectures: RAID
That is …

- CSE230 Goal 1 “To provide an exposure to the organization and implementation of a computer system at the hardware level.”
  - The student can identify the five major components of a computer system and describe how the components interact and the effect on the system as a whole.
  - The student can describe data representation, the instruction set, addressing modes, and register organization.
  - The student can describe the execution of instructions, and the hardware components used in each step.
  - The student can identify several approaches to processor implementations: Single cycle, Multi-cycle, Pipelined, Superscalar
  - The students can describe various memory organizations including virtual memory and cache organization structures
  - The student can describe what busses are and describe their role in connecting the major system components.
  - The student can describe how processor identifies different sources of interrupts and exceptions and invokes the corresponding handler to deal with the interrupt or exception.
That is … (Cont.)

- CSE230 Goal 2 “To develop an introductory understanding of assembly language and the relationship between computer hardware and machine code/assembly code.”
  - The student can develop assembly language programs that include flow control constructs (sequential, conditional and iterative).
  - The student can develop assembly language programs, including subroutines employing modularity, readability and reliability principles.
  - The student can develop assembly-language programs that use the stack to save register contents, pass parameters to subroutines, and create stack frames for local variables.
  - The student can develop a basic interrupt handler routine
  - The student can develop a basic IO handler routine
That is … (Cont.)

- CSE 230 Goal 3: “To develop the tools necessary to analyze the performance of computer architecture and organization.”
  - The student can identify various metrics to evaluate the performance of computer systems.
  - The student can evaluate memory cache performance
  - The student can identify several I/O performance measures.
Course Pre-req

- CSE 230 (new) – Computer Organization and Assembly Language Programming
  http://cse.asu.edu/courses/descriptions/230.php
- CSE 330 (old) – Computer Organization, CSE 225 – Assembly Language programming
- Knowledge of C and Assembly Language Programming
Course Info

Instructor
Georgios Varsamopoulos
BY 514
Mon, Tue, Wed 3:30pm – 4:30pm

Teaching Assistant
Wei Wu
BYENG 531AB
Tue, Thu 3pm – 4pm

- Use of webpage
  http://impact.asu.edu/cse430sp11.html for material,
- Use of Blackboard as a dropbox (SafeAssign)
- Take Notes! Most testing methods are open-note.
About the instructor

- **Name:** Georgios Varsamopoulos
- **Title:** Research Assistant Professor
- **Joined ASU:** 2007 as a post-doctorate researcher
- **Research Lab**
  - Impact Lab: [http://impact.asu.edu/](http://impact.asu.edu/)
- **Research Projects** *(REU positions available)*
  - Thermal-aware and sustainable management of computing systems
  - BlueTool: Research Infrastructure for sustainable data centers
- **Interests**
  - resource allocation and management, computer networks, sustainable computing, performance optimization, cyber-physical models
Concerns

- Your Concerns
  - Amount of work
  - Difficulty of programming
  - Required background
  - Usefulness of the course

- My concerns
  - Here-for-grade or here-for-degree mentality
  - Starting homework a couple of days before it is due
  - Not using knowledge from previous experience
  - Not participating and not challenging the information given
  - Plagiarism and other forms of cheating
  - Seeing students give up and fail
Course Workload

- Pop quizzes roughly on a biweekly basis
- About 6 homework assignments
- One Prerequisite exam
  - Mid February
- Two midterms
  - Early March
  - Early April
- A project
  - Groups preferred
  - Start mid March
  - May replace final exam

Grading distribution:
- 20% homework assignments
- 10% quizzes
- 25% project/exam
- 20% each midterm
- 5% active attendance (in-class participation)

Grading Rubric:
- Ability to solve problem
- Understanding of background
- Creativity
- Clarity
My biggest concern

• Technical writing skill
  – In four words: **brief, exact, complete, clear**

• Research resources
  – The quality and authenticity of your sources is a defining factor of your work's quality
    • The web and wikipedia is ok as a start.
    • Did you know of Google Scholar (scholar.google.com)?
    • Have you ever used the ACM and IEEE online libraries?

• Please pay particular attention to your technical writing and your written expression skills.
PreReq: Fallacies and Pitfalls

• **Fallacy**: “Pre-req don’t matter, I am smart enough to pick it up during semester.”

• **Fallacy**: “Instructor doesn’t care about Pre-req.”

• **Pitfall**: Attempting to do assignments and exams without getting sound grasp on pre-req material
Course Books

• Computer Architecture: A Quantitative Approach (Fourth Edition) by John L. Hennessy and David A. Patterson

• Computer Organization and Design: The Hardware Software Interface, Patterson and Hennessy
Course Mechanics

- **Assignments**: 20%
  - involves solving problems and programming in C/Java/Assembly
- **Quizzes & in-class Participation**: 10%
- **Projects/Term Paper**: 30%
  - Progress report 5%, Presentation/Poster 10%, Final Paper 15%
- **Exams**: 30%
  - One prereq exam, two midterms and one final
A Note about “RAQ” Hazard

- RAQ = “Read After Quiz”
- Quizzes can be unannounced
- Meant to make sure you are in SYNC with the class
- Reduce some pressure for Exam preparation
- Read the material (book, slides, paper etc.) before coming to class
“No Distraction” Policy

• No Laptops/Netbooks/Cell Phone/News Papers etc.
• Laptops/Netbooks may be permitted – only with instructor’s permission
Cheating/Plagiarism Policy

- Strictly prohibited
- See University policy
- My policy
  - First offense: zero grade for the entire assignment & personal appointment
  - Repeat offense: reporting action as per the University policy
Grad. Student Work++

• Graduate students are expected to demonstrate a deeper understanding of the subject material.
• At times, graduate students will be assigned more challenging assignments and exam problems
  - Paper reading and presentation
  - Solving more difficult problem
  - Short (team) projects
Class Format

- Quiz (10 min)
- Quiz review + Recap (5 min)
- Lecture (45 to 55 (when no Q) min)
  - Take Notes!
  - (If used) Slides will be posted after the class
- Discussion (10)
  - Take Notes!
- Assignment Qs/Next Class (5 min)
  - Take Notes!
- You can use your notes in most forms of examination except otherwise stated.
Class Cyberpresence

- [http://impact.asu.edu/cse420sp11.html](http://impact.asu.edu/cse420sp11.html)
  - class assignments
  - Solutions
  - Slides
  - reference material
- Visit regularly for latest information
- Blackboard: Dropbox (SafeAssign) and other supplementary material.
What can you expect from this course?

• Lots of in-class interaction
• Interesting and challenging assignments and exam questions
• Help/Tutorials on difficult material
• And lot more!
NSF REU positions available

- Contact me if you are interested in working with my graduate students on NSF projects on **Green Computing**, **Pervasive Health monitoring**, **Mobile Computing**, **Wireless Sensor Networks**, **Information Security/Privacy**, and **Energy-Efficient Computing**.
What’s Next?

- Next Class: Fundamentals of Computer Design – CH1 CA-QA
- Start reading Chapter 1
- Plan for next few lectures: Fundamentals of Computer Design (Ch1) Review of ISA (Appendix B), Memory Hierarchy (Appendix C) and Pipelining (Appendix A)