ECE4100 Course Syllabus

ECE4100

Advanced Computer Architecture (3-0-0-3)

CMPE Degree

This course is Elective for the CMPE degree.

EE Degree

This course is Elective for the EE degree.

Lab Hours

0 supervised lab hours and 0 unsupervised lab hours

Course Coordinator

Qureshi,Moinuddin K

Prerequisites

ECE 3057

Corequisites

None

Catalog Description

Comprehensive coverage of the architecture and system issues that confront the design of high performance workstation/PC computer architectures with emphasis on quantitative evaluation. Credit is not allowed for both ECE 4100 and any of the following courses: ECE 6100, CS 4290, CS 6290.

Textbook(s)

Hennessey & Patterson, *Computer Architecture: A Quantitative Approach* (6th edition), Morgan Kaufmann, 2017. ISBN 9780128119051 (required)

Course Outcomes

Upon successful completion of this course, students should be able to:

1. Perform quantiative evalution of in-order and out-of-order processors.
2. Analyze modern memory systems.
3. Perform power and energy trade-offs in modern computer systems.

Student Outcomes

In the parentheses for each Student Outcome:
"P" for primary indicates the outcome is a major focus of the entire course.
“M” for moderate indicates the outcome is the focus of at least one component of the course, but not majority of course material.
“LN” for “little to none” indicates that the course does not contribute significantly to this outcome.

1. (P) An ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics

2. (M) An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. (LN) An ability to communicate effectively with a range of audiences
4. (LN) An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts
5. (LN) An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. (M) An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions
7. (LN) An ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

Topical Outline

- Performance Evaluation
  - Metrics for performance (MIPS, IPC, Execution time)
  - Different means and when it is right to use them
  - Benchmarks
  - Amdahl?s law
- Pipelines
  - Review basic principles, hazards, dependencies
  - Data hazards, scoreboards, Tomasulo algorithm
  - Control hazards, advanced branch prediction techniques
  - Multiple instruction issue
  - Precise exception and in-order-retirement
  - Reorder buffer
- Memory systems
  - Review of caches principles
  - Techniques to reduce miss rate, hit time, miss time (multi-le
  - DRAM memory: basic organization and operation (row hit/miss)
  - Prefetching and simple prefetch algorithms (stream/stride)
  - Virtual memory
- Parallel Computers
  - Taxonomy of parallel architectures, parallel applications
  - Shared memory and message passing computers
  - Multi-core processors: shared cache and private cache
  - Multi-threading: Coarse-grained, fine-grained, and SMT
  - Vectors and SIMD
  - GPU basic organization and operation
  - Coherence protocols: bus based and directory based
  - Memory consistency models, relaxed consistency models
  - Synchronization, locks and barriers
  - Interconnection networks, bi-section bandwidth, topologies
- Power and Energy Issues
  - Basics of energy dissipation: dynamic and static
  - Clock gating and power gating
  - Dynamic voltage and frequency scaling
  - Turbo-boost
  - Microarchitecture power models
- Storage Systems

Reliability: RAID, RAID-1 to RAID-5
Parity and error-correction code