

# ***CS-480/585: Computer Architecture, Summer 2002 Semester***

## **Course Syllabus**

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### **Summary Course Description:**

This course builds upon the basics of Computer Organization that were previously covered in the course of that name, and delves in considerably greater depth into issues of Computer Architecture. Computer Architecture is first defined and distinguished from Computer Organization. The principles of digital logic are reviewed in depth, in conjunction with the principal axioms and theorems of Boolean Algebra. Sum-of-Products and Product-of-Sums forms for the implementation of Boolean Functions are discussed, also Latches and Flip-Flops, Registers, and Counters.

The representation of data in digital computers is covered in several aspects: Integer or Fixed-Point Representation is covered in several variants, including Ones'-Complement, Two's-Complement, Signed-Magnitude, Nines'-Complement and Ten's-Complement as used in Binary-Coded Decimal Arithmetic, and Biased or Excess Representation. Floating-Point Representation is discussed with emphasis on the issue of precision. Arithmetic is discussed in several of the representation schemes including addition, subtraction, multiplication, and division. The classical Ripple-Carry Adder is discussed, along with the Carry-Look-Ahead Adder.

Instruction-Set Architecture, Big-Endian vs. Little-Endian representation, the Fetch-Execute Cycle, and the datapath are discussed both from the theoretical standpoint and from the standpoint of a simplified version of the well-known SPARC architecture. Assembly, compilation, subroutine linkage, loading, and use of a stack are covered. Microprogramming is contrasted with Hardwired control.

Memory hierarchy is discussed in depth, including the organization of "Random Access Memory (RAM)", different types of Cache Memory, and Virtual Memory, including both paging and segmentation. Several bus architectures are covered, and several types of input devices and mass storage devices. Some modern streams in Computer Architecture are discussed, including pipelining, superscalar machines, some unique machine architectures, and the difference in design philosophies between CISC and RISC: use of the chip real estate for complex logic circuitry vs. larger numbers of registers.

## Required Textbooks and Materials:

For both CS-480 and CS-585:

MURDOCCA, MILES J.; & HEURING, VINCENT P. (2000). *Principles of Computer Architecture*. Upper Saddle River, NJ: Prentice-Hall, Inc. QA76.9.A73 M86 2000; 004.2'2—dc21; 99-046113; ISBN 0-201-43664-7.

CS-585 only:

HILL, MARK D.; JOUPPI, NORMAN P.; & SOHI, GURINDAR S., editors (2000). *Readings in Computer Architecture*. San Francisco, CA: Morgan Kaufmann Publishers. QA76.9.A73H55 2000; 004.2'2—dc21; 99-44480; ISBN 1-55860-539-8.

## Additional Possibly Helpful Reference Materials:

GORDON, KAREN ELIZABETH (1993). *The Deluxe Transitive Vampire: The Ultimate Handbook of Grammar for the Innocent, the Eager, and the Doomed*. New York, NY: Pantheon Books. ISBN 0679418601.

This book is a concise, wittily written tutorial on the fine points of grammar and punctuation. It can serve as a guide for preparation of the term paper.

DUPRE, LYN (1998). *Bugs in Writing Revised. A Guide to Debugging Your Prose*. Reading, MA: Addison-Wesley. ISBN 0-201 37921-X.

The author specifically addresses the needs of computer professionals and other technical people to write clearly.

## Learning Objectives:

By the end of this course, the student should be able to:

- (1) Describe the difference between Computer Organization and Computer Architecture;

- (2) Describe, differentiate between, and make use of the principal axioms and theorems of Boolean Algebra;
- (3) Inter-relate the textual definition of a Boolean Function, the Truth Table for the function, an algebraic expression for the function expressed in “Sum of Products” form, an algebraic expression for the function expressed in “Product of Sums” form, and logical diagrams of the circuit in both NAND-NAND and NOR-NOR circuitry;
- (4) Differentiate between the different types of latches and flip-flops;
- (5) Describe how a digital computer carries out addition, subtraction, multiplication, and division of numbers in both fixed-point and floating-point representations using a variety of specific fixed-point and floating-point representations;
- (6) Describe the operation of a Carry-Look-Ahead adder and the benefits of this type of adder over those of the Ripple-Carry Adder;
- (7) Define the term “Instruction-Set Architecture”;
- (8) Recognize the difference between Big-Endian and Little-Endian data representation;
- (9) Describe the Fetch-Execute Cycle;
- (10) Explain what happens in the processes of Assembly, Compilation, Subroutine Linkage, Loading, and use of a stack;
- (11) Distinguish between Microprogrammed and Hardwired processor control, and describe the benefits of each approach;
- (12) Describe the organization of RAM;
- (13) Distinguish between Directly-Mapped Cache, Associative Cache, and Set-Associative Cache, and describe the principal issues related to cache memory organization;
- (14) Describe the importance of the hit ratio to the effectiveness of the cache memory;
- (15) Distinguish between virtual memory schemes based upon segmentation and based upon paging;
- (16) Describe the differences between asynchronous and synchronous buses, as well as the importance of bus arbitration schemes to the effective operation of the bus;

(17) Explain the relative advantages of such concepts of computer architecture as CISC, RISC, pipelining, superscalar design, and Very Long Instruction Word processors.

## **Instructor:**

[Dr. Charles Abzug](#)

**[Course Practices.](#)**

**[Grading Policy.](#)**

**[Homework.](#)**

**[Philosophy Regarding Classes Missed by Students.](#)**

## **Class Meetings:**

Classes meet during the Summer 2002 semester on Monday, Tuesday, Wednesday, and Thursday afternoons from 1300 to 1445 hrs in ISAT/CS Room 243.