EE 3755—Computer Organization

Call Number 1711 (Spring 2002)

URL: http://www.ece.lsu.edu/ee3755

Offered by:
David M. Koppelman
349 EE Building
578-5482, koppel@ece.lsu.edu, http://www.ece.lsu.edu/koppel/koppel.html
Tentative office hours: Mon 15:00-16:00; Wed 9:30-10:30; Tue & Thr 14:00-15:30.

Should already know...
... how to design with logic.

Will learn...
... how to design a rudimentary computer.

Prerequisites

Prerequisite by Course
EE 2730 (Digital Logic II) or equivalent.

Prerequisite by Topic
Logic design.
Binary number representation and arithmetic.
Programming of some kind.

Texts

“Verilog HDL,” Samir Palnitkar (Optional).
Additional Verilog reference material on course Web page.

Graded Material

40% Midterm Exam
40% Final Exam
20% Homework (Roughly six assignments.)
Lowest homework grade dropped.
Short Course Outline

Hardware Description using Verilog
- A commonly used language for designing digital hardware.

Computer Arithmetic
- How computers add, subtract, multiply, and divide.
- Integer and floating-point.
- Will use Verilog to design circuits.

RISC Microprocessor Programming
- The basics of programming an easy-to-program processor, MIPS.

Computer Organization
- Design hardware to execute MIPS programs.
- This material will be continued in EE 4720.

Detailed Course Outline

Digital Design Hardware Description Languages (HDLs)
- Designs for digital parts captured in a **HDL description**.

Popular HDLs: Verilog, VHDL.
- An HDL description is fed to:
  - A *simulator*, to see what the design does.
    - Whether it does what it’s supposed to do.
  - A *synthesis program*, to prepare the design for fabrication or downloading.
    - Chips may be fabricated using the synthesized description.
    - The synthesized description might be downloaded to a special chip (FPGA).

HDL Material
- Language used: Verilog
- Subset of the language covered.
  - Enough to implement processor arithmetic units and other datapath elements.

HDL Topics Covered
- Writing structural descriptions of hardware.
- Writing simple behavioral descriptions of hardware.
- Relationship between descriptions and synthesized hardware.

HDL Topics Not Covered
- Less-common structural elements and delay specifiers.
- Much event- and delay-related behavioral code.
- Will not know enough to write a good *testbench*.

Thorough HDL treatment may be given in other courses.
HDL Software Used
Host System
   ECE Sun systems.
Simulator
   Model Technology (Mentor Graphics) ModelSim SE Plus
Synthesis
   Exemplar (Mentor Graphics) Leonardo Spectrum

Computer Arithmetic Topics
Integer arithmetic algorithms. (Mostly review).
Integer adder implementations.
ALU implementation.
Basic integer multiplication and division implementations.
High-speed integer multiplier implementation.
Floating-point representations.
Floating-point arithmetic algorithms.
Floating-point adder implementation.

RISC Microprocessor Topics
RISC Processor
   A type of processor that became popular in 80's.
   RISCs simple to program and to implement (design hardware for).
   Simplicity allows high-speed implementation.
   Starting in 80's all new major processors were RISCs . . .
   . . . until now with Intel’s IA-64.
   (IA-64 covered in EE 4720.)

RISC Families:
   MIPS: Ownership: Independent, then Silicon Graphics, now ??.
   SPARC: Ownership: Sun Microsystems / SPARC International.
   POWER, PowerPC: Ownership: IBM, Apple/IBM/Motorola.
   Alpha: Ownership: DEC, Compaq.
   MIPS used in Patterson & Hennessy text (and so used in class).
   SPARC used in ECE computers.
Covered for the MIPS processor.

MIPS Processor organization:
  What machine-language programs can access.
  What machine-language instructions can do.

MIPS Programming
  Subset of instructions covered.

Processors Covered in Other Courses
  EE 3750 /3751: IA-32 (Intel 80x86, Pentium)
  EE 4720: DLX, SPARC, some IA-64 and other architectures.

Building a “Toy” MIPS Processors
Use Verilog.
Topics
  Functional Simulator: Simple Design, Inefficient Hardware
  Multicycle Hardwired Control
  Multicycle Microprogrammed Control

Material continued in EE 4720.