Software Eng. 2DA4 - Digital System Principles and Logic Co-design for Software Engineering
Sept 2011

INSTRUCTOR:
Dr. Ryan Leduc
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Office Hours: Fridays 14:30-15:20.
Term: 1

LECTURES:

- Location: JHE/326H.
- Time: Monday, Wednesday, and Thursday 13:30-14:20.

Note: Information will sometimes be sent to your mcmaster.ca e-mail accounts. It's your responsibility to check this account regularly.

LABS:

- Location: ITB/235.
- Time: Tuesday and Wednesday 14:30-17:20. Start of the labs will be announced in class.

MIDTERM: TBA.

TEACHING ASSISTANTS: The TA names and contact information will be posted on the course website.

MISSION:

This course teaches the design (logical, not physical) of computers and other digital circuits. While students learn about the basic physical limitations on the implementation of logical functions (e.g. heat dissipation, propagation delay, power requirements), the course stresses the use of the gate/flip-flop abstractions and teaches the organisation of synchronous and asynchronous circuits that perform complex functions. We will also discuss software/hardware codesign.

OBJECTIVES:

The students will learn systematic design procedures; Combinatorial circuit design, design of sequential machines, redundancy, number representations, organisation of large logic circuits. Use of logic simulators. Knowledge of software/hardware codesign issues.

GRADING SCHEME:

- Assignments/Labs/Project 5%/5%/10%
- Midterm 30%
- Final Exam 50%

(The instructor reserves the right to conduct deferred examinations orally. All work on assignments is to be done individually.)

TEXT:

1. . Brown and Z. Vranesic, *Fundamentals of Digital Logic with Verilog Design, 2nd Ed.*, McGraw-Hill Higher Education, 2008.

2. Custom courseware for SE 2DA4: Readings from Embedded System Design.

REFERENCES:

Frank Vahid and Tony Givargis, *Embedded Systems Design: A Unified Hardware/Software Introduction*, John Wiley & Sons, Inc., 2002.

DETAILED COURSE OUTLINE:

Introduction to Combinational Logic :

- motivation
- switches and logic gates
- logic functions, truth tables and variables
- boolean axioms and laws, sum of products, product of sums
- simple algebraic minimization - making things cheaper

Technology & Practical Considerations :

- logic voltage levels
- transistors as a switch
- NMOS and CMOS logic gates
- real propagation delay, and timing diagrams
- fanout and fanin constraints
- fanout dependent delay
- TTL Logic, Programmable Logic Devices: PLAs, PALs, CPLDs
- introduction to Verilog and CAD tools

Combinational Logic & Optimization :

- minimization goals - speed and cost
- Karnaugh Maps
- Don't Cares
- multi-level logic optimization
- multiplexors & tristate gates
- multiplexors as logic; decoders

Numbers and Arithmetic :

- number representations: binary, ones & twos complement representation of negative numbers, floating-point, overflow
- basic adder/subtracter
- carry lookahead fast adder

Sequential Logic :

- distinction between combinatorial and sequential logic (gates and flip-flops)
- cross-coupled NOR gates as storage element
- clocked D latch
- Master-Slave D flip-flop
- shift registers
- counters
- Read Only Memory & Random Access Memory

Synchronous Sequential Circuits :

- Finite State Machines:
  - how logic is controlled
  - Mealy/Moore state machines
  - state diagrams & state tables
  - state machine synthesis
  - state encoding and optimization
  - state machines in Verilog

Asynchronous Sequential Circuits :

- comparison of synchronous/asynchronous circuits
- dealing with asynchronous inputs
- asynchronous hazards

Software/Hardware Co-design :

- implementing software as a single purpose processor
- digital camera example

NOTES:

Calculators

Calculators are not needed for this course and their use will not be permitted during tests.

Academic Dishonesty

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: Grade of F assigned for academic dishonesty), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at http://www.mcmaster.ca/academicintegrity. The following illustrates only a few forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not ones own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.
4. Giving a copy of old assignments, midterms, or solutions to other students.
5. Allowing another student to look at or copy your assignment.
6. Using assignment solutions from previous years, other courses, from the internet or the textbook solution manual.
7. Using midterm or exam solutions from previous years that are not given to you by the current instructor.
8. Discussing specifics of how to solve an assignment question with people other than the instructor or the TAs.