CARLETON UNIVERSITY
Department of Systems and Computer Engineering
SYSC 4507 Computer Systems Architecture Winter 2011
Course Handout

Instructors:

Professor T.W. Pearce, P.Eng., room 3215VS, e-mail pearce@sce.carleton.ca (Please send from your connect account and include "SYSC 4507" in the subject line to ensure a response.)

Professor R.A. Goubran, P.Eng., email Goubran@sce.carleton.ca

Office hours: By appointment. See course web site for additional hours.

Instructional Hours per Week:

- 3 lecture hours: Tuesdays & Thursdays 8:35-9:55am in 3275 ME
- One problem analysis hour: Fridays 11:35am-12:25pm in 180 UC

Prerequisites:

(ELEC2607) **AND** (SYSC2001 **OR** SYSC3006)

Students who have not satisfied the prerequisites for this course must either: **a)** withdraw from the course, **b)** submit a prerequisite waiver online at http://www.sce.carleton.ca/ughelp, or **c)** may be deregistered from the course after the last day to register for courses in the Winter 2012 term.

Textbook: (recommended)

"Computer Architecture and Organization", John P. Hayes, McGraw-Hill, Third Edition, ISBN 0-07-027355-3, 2002

Web Page:

The course web page can be located at www.sce.carleton.ca/courses/sysc-4507/. Students are required to check this page often for course updates. Supplementary lecture notes will be posted there for student use. Note that reading the supplementary lecture notes only is **NOT ENOUGH** to pass this course! The single best predictor of student performance is attendance at lectures and labs.

Other References: (more recent editions may be available and are also suitable)

- "Computer Organization and Architecture: Designing for Performance", William Stallings, 8th edition, Prentice Hall, ISBN-13: 978-0-13-607373-4, 2010
- "Modern Processor Design: Fundamentals of Superscalar Processors", John P. Shen, Mikko Lipatsi, McGraw-Hill, ISBN 0-07-057064-7, 2005
- "Computer Organization: A Quantitative Approach", J. Hennessy and D. Patterson, Morgan Kaufmann, Third Edition, ISBN 1-55860-724-2, 2003
- "Computer Organization", C. Hamacher, Z. Vranesic and S. Zaky, McGraw Hill, Fifth Edition, ISBN 0-07-232086-9, 2002
- Additional materials may be made available on the course website.

Grading Scheme:

Problem Assignments:	2 X 5 %	.....	= 10 %
In-Class Tests:	2 X 15 %	.....	= 30 %
Final Exam (scheduled 3 hours, closed-book):	60 %	.....	= 60 %

Important Notes:

1) **Students must pass the Final Examination Paper** (50% or higher) in order to pass the course. (i.e. Failing to pass the Final Examination results in an F grade for the course). The final examination is for evaluation purposes only and will not be returned to the students.

2) **Students are expected to attend all lectures and labs.** If a student is absent from a lecture, it is up to the student to obtain missed lecture material from colleagues in the course.

3) **Students who miss a test** due to illness must provide a valid medical certificate to the instructor not later than 48Hrs after returning to campus. The certificate **must clearly state** the name of the doctor with contact information, the date & time that you were seen, the time of onset, the degree of incapacitation, and the expected recovery date. Once the certificate has been verified, the test weight will be added to the final examination weight.

4) **Academic Accommodation.** You may need special arrangements to meet your academic obligations during the term because of disability, pregnancy or religious obligations. Please review the course outline promptly and write to me with any requests for academic accommodation during the first two weeks of class, or as soon as possible after the need for accommodation is known to exist.

Students with disabilities requiring academic accommodations in this course are encouraged to contact a coordinator at the Paul Menton Centre for Students with Disabilities to complete the necessary letters of accommodation. After registering with the PMC, make an appointment to meet and discuss your needs with me at least two weeks prior to the final exam. This is necessary in order to ensure sufficient time to make the necessary arrangements. Please note the following deadlines for submitting completed forms to the Paul Menton Centre: ***March 7, 2012*** for the Winter Term.

5) **Plagiarism** (e.g. copying and/or handing in for credit someone else's work) is a serious instructional offence that will not be tolerated. Please refer to the section on instructional offences in the Undergraduate Calendar for additional information.

6) **Deferred Exams.** Students who miss the final exam may be granted permission to write a deferred examination (see the Undergraduate Calendar for regulations on deferred exams). To be considered for a deferred exam, *satisfactory performance during the term* **includes** submitting all tests and assignments and achieving an overall average of at least 50%.

7) Accreditation of our Engineering programs requires that classes and laboratories, tutorials, or problem analysis sessions continue to run through the review period of the winter term.

Health and Safety:

Every student should have a copy of our Health and Safety Manual. An electronic version of the manual can be found at:

http://www.sce.carleton.ca/courses/health-and-safety.pdf

Outline of Topics:

0 Evolution of Computers (2 lectures)

- The Mechanical Era (Pascal, Babbage's Difference & Analytical Engines)
- First & Second Generations (Vacuum tubes; Discrete transistors)
- The Harvard Architecture
- The Von-Neumann Architecture
- Third & Fourth Generations (Integrated circuits; VLSI)
- Performance improvements
- Multicore

1 Performance (1 lecture)

- Limitations of Computers
- Measuring Performance
- Benchmarks

2 Central Processing Unit (CPU) (1 lecture)

- General Description and Basic Concepts
- Instruction Set Characteristics and Completeness
- Instruction Formats (Fixed and Variable Length)

3 Arithmetic Logic Unit (ALU) (1 lecture)

- Computer Arithmetic and Information Representation
- Arithmetic Logic Unit Design

4 Control Unit Design (2 lectures)

- Control Unit Operation and Instruction Sequencing
- Hardwired Control Units and Design Methods
- Microprogrammed Control Units

5 Memory & I/O Organization (2 lectures)

- Memory Characteristics
- Memory Hierarchy
- Virtual Memories
- High-Speed Memories (Cache, Interleaved, and Associative)
- I/O Organization (Programmable IO, Interrupt, DMA, IO Processors)

6 Performance Improvements: Instruction Level Parallelism (3 lectures)

- Reduced Instruction Set Computer (RISC)
- Pipeline, Data and Control Hazards
- Superscalar
- Branch Prediction, Speculative Execution, Out-Of-Order execution
- Hardware Threads

7 Fault Tolerant Computers (2 lectures)

- Classification of Redundancy (HW, SW, Information, & Time Redundancies)
- Hardware Redundancy: Static (TMR) & Dynamic (Diagnosis and Recovery)
- Reliability, Availability, and Mean Time to Failure (MTTF)
- Error Detection & Correction
- Examples (TANDEM Computers)

8 Parallel Organization (1 lecture)

- Overview of Parallel Processing: Goals, Approaches, and Challenges
- Classification of Parallel Architectures: SISD, SIMD, MISD, and MIMD
- Multiprocessor Systems: Shared Memory and Distributed Memory
- Multicore, Many-Core
- Interconnection Networks
- Performance Limitations of Parallel Processing: Amdahl's Law / Effect

9 Modern Directions (with examples taken from ...) (7 lectures)

- Desktop
- Server
- Graphics
- Mobile
- DSP and Embedded
- Supercomputer
- Emerging and Future Trends: cloud computing, internet of things, dataflow architecture