

**CARLETON UNIVERSITY**  
**Department of Systems and Computer Engineering**

**SYSC 3006****Computer Organization****Summer 2016**

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**Lecturer:** Prof. Yuu Ono, Room CB-6205, 613-520-2600 (ext. 8787), [yuuono@sce.carleton.ca](mailto:yuuono@sce.carleton.ca) (Please send email from your cmail account and include "SYSC 3006" in the subject line to ensure a response.)

**Course Description:** This is a first course on the organization of computer systems at the hardware/software interface. Understanding this interface involves the processor's Instruction Set Architecture (ISA), the system's memory organization, and the system's I/O peripherals. Engineers working with microcontrollers (including mobile devices) must understand computer systems at this level, and these concepts form the foundation on which more powerful computer systems are based (such as desktop systems, servers, multiprocessors, and supercomputers).

The processor's native assembly language is a central software topic in the course. The increasing use of high level languages such as C is reducing the need for assembly language programming proficiency. As a result, the course will focus more on understanding how an assembly language manipulates information at the hardware/software interface and can support a high level language, and will not emphasize developing complete applications in assembly language.

**Calendar Description:** Computer organization: processor, memory, input/output, system bus. Number systems: binary, decimal, hexadecimal. Assembly language programming: representation of data, instruction encoding, execution. Devices: keyboard, programmable timer, parallel interface. Input/output methods: polling, hardware/software interrupts.

**Prerequisites:** (SYSC-2002 or SYSC-2006) and ELEC-2607. This course precludes additional credit for SYSC-2001 and SYSC-2003. This course may not be taken for credit by students in Computer Systems Engineering, Communications Engineering, or Software Engineering.

Students who have not satisfied the prerequisites for this course must either a) withdraw from the course, or b) obtain a prerequisite waiver online at <http://www.carleton.ca/engineering-design/current-students/undergrad-academic-support/>, or c) will be deregistered from the course after the last day to register for courses.

**Website:** The course will use the SYSC3006A (LEC) Summer 2016 website on cuLearn. Course materials will be placed on the website for student personal use, and students are responsible for checking the website frequently.

**Course material copyright:** Student, TA or professor materials created for this course (including presentations and posted notes, labs, case studies, assignments and exams) remain the intellectual property of the author(s). They are intended for personal use and may not be reproduced or redistributed without prior written consent of the author(s).

**Textbooks:** A specific textbook is not recommended in the course. Course notes and supporting material will be supplied via the course webpage for student personal use.

**Attendance:** Students are expected to attend all lectures and labs. The Faculty of Engineering and Design requires its students to have a conflict-free timetable, so requests to accommodate missed exams, assignment due dates, etc., because of conflicts with other courses, jobs or vacation plans will not be considered.

**Laboratory:** There will be 6 graded laboratories that will be posted on the course website. Lab attendance is mandatory, with work to be demonstrated by the end of the lab period. Marks will only be awarded for labs

demonstrated during the student's schedule lab time (according to section registration). During the scheduled lab times, TA assistance will be available. The computer lab is open seven days a week, whenever the building is open. You may use the lab at any time other than those timeslots when the lab is reserved for other courses or for other sections of this course.

**Study Questions:** Study questions will be posted on the course website, but will not be collected and graded.

Students are encouraged to discuss issues when working on labs; however, they are expected to do their own lab work individually. Suspected plagiarism will be investigated and may result in a mark of zero for the lab. As well, alleged instructional offences will be reported to the Associate Dean of Engineering. (Please see the current undergraduate calendar, "Instructional Offences", in the Undergraduate Calendar Supplement).

Students are warned that the labs and study questions form a very important part of this course – doing these (by yourself) is an excellent way for you to learn the material. In this context, it should be noted that copying labs is, even if you are not caught, a self-defeating exercise. Historically, most of the students who resorted to copying did not do particularly well on the mid-term or final exam.

**Midterm Exam:** There will be one closed book, no-calculator, midterm test. Room arrangements will be announced during class and in the course website.

**Final Exam:** A closed book, no-calculator, final exam will be held during the University's formal examination period. The final exam is for evaluation purposes only and will not be returned to students.

Students who miss the final exam **may** be granted permission to write a deferred examination (see the Undergraduate Calendar for regulations on deferred exams).

**Grading Scheme:** To pass the course, a student must (1) pass the final (D- or better) **and** (2) obtain an overall passing average. For students who pass the final exam, the final grade will be calculated as follows:

Labs:	25 %
Mid-term test:	25 %
Final exam:	50 %

**Medical Certificates:** A medical certificate must adhere to the format required by the Registrar. The format is available as a PDF form through the Registrar's website <http://www.carleton.ca/registrar/forms>. All medical certificates must be presented immediately upon return from the illness; they will not be accepted after the fact.

**Lab:** If one lab is missed, with a valid medical certificate, a mark equal to the average of the other labs will be given. Further absences will result in a mark of zero for the missed labs, unless valid documentation of a prolonged illness is provided. There will be no lab make-ups.

**Midterm:** If the midterm is missed, with a valid medical certificate, the midterm weight will be added to the final examination weight.

**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>

### Academic Accommodation

You may need special arrangements to meet your academic obligations during the term. For an accommodation request the processes are as follows:

**Pregnancy obligation:** 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. For more details see the Student Guide

(<http://www2.carleton.ca/equity/ccms/wp-content/ccms-files/Student-Guide-to-Academic-Accommodation.pdf>)

**Religious obligation:** 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. For more details see the Student Guide

**Academic Accommodations for Students with Disabilities:** The Paul Menton Centre for Students with Disabilities (PMC) provides services to students with Learning Disabilities (LD), psychiatric/mental health disabilities, Attention Deficit Hyperactivity Disorder (ADHD), Autism Spectrum Disorders (ASD), chronic medical conditions, and impairments in mobility, hearing, and vision. If you have a disability requiring academic accommodations in this course, please contact PMC at 613-520-6608 or [pmc@carleton.ca](mailto:pmc@carleton.ca) for a formal evaluation. If you are already registered with the PMC, contact your PMC coordinator to send me your Letter of Accommodation at the beginning of the term, and no later than two weeks before the first in-class scheduled test or exam requiring accommodation (if applicable). After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (<http://www.carleton.ca/pmc>) for the deadline to request accommodations for the formally-scheduled exam (if applicable).

**Lecture Content:** The following themes are interwoven in the lectures throughout the course. The number of lectures beside each theme indicates the (approximate) total amount of class time spent on that theme over the term.

#### **Computer system architecture (basics)**

- Computer system components: processor, memory, I/O, interconnection bus
- Information encoding, data representation in binary, hexadecimal
- Number systems, unsigned integers, signed integers, 2's complement
- Computer hardware organization: datapath and control
- Registers, instruction cycle

#### **Hardware/software interface (Instruction Set Architecture)**

- Instructions: data manipulation, data transfer, control flow, instruction encoding
- Computer arithmetic, flags

#### **Microcontroller example**

- Microcontroller concept
- System on Chip, memory model, ISA

#### **Assembly language programming**

- Code snippets, examples
- Assembly process, linker, loader

#### **High-level Language Support**

- Variables, arrays, structures, assignment, looping, conditional statements
- Procedures and functions, parameter passing

#### **Peripheral I/O and Interrupts**

- Register model of peripheral devices: parallel I/O, serial I/O, timers
- Polling
- Hardware interrupts: vectored and prioritized, Nested Vector Interrupt Controller(NVIC)
- Examples: timer, serial
- Software interrupts, O/S calls