CARLETON UNIVERSITY
Department of Systems and Computer Engineering

**SYSC 3006**  **Computer Organization**  **Summer 2019**

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Email: yuuono@sce.carleton.ca, please send email from your email account and include “SYSC 3006” in the subject line to ensure a response.
Office Hours: To be posted on cuLearn.

**Website:** The course will use the SYSC3006A (LEC) Summer 2019 website on cuLearn. Course materials will be placed on the website for student personal use, and students are responsible for checking the website frequently.


**Prerequisites:** SYSC 2006 and ELEC 2607. This course precludes additional credit for SYSC 2001, SYSC 2003, SYSC 2320 and SYSC 3310. 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.

**Course Objectives:** 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.

**Learning Outcomes:** Upon completion of this course, students should be able to:
1. understanding how a computer works at hardware/software interface through the Instruction Set Architecture (ISA);
2. understanding microarchitecture (computer organization) to fetch an instruction from the memory and execute using the datapath;
3. understand hardware circuits necessary to interface input/output modules using polling and interrupt-based techniques;
4. design finite state machines necessary for the implementation of various instructions;
5. design hardware circuits at the core of microprocessors and microcontrollers;
6. develop machine code and corresponding assembly language programs to implement specific programming tasks;

Graduate Attributes (GA's): The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess 12 attributes. Activities related to the learning outcomes listed here are intended to develop students' competence in the following GAs. Data obtained from exam questions related to the learning outcomes will be collected to assess students' progress towards achieving each GA.

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<th>Graduate Attributes</th>
<th>Learning Outcomes</th>
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<tr>
<td>1.10.E Knowledge base: Discipline-specific concept DOE-7: Digital systems and computers</td>
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<tr>
<td>1.5.S Knowledge base: Discipline-specific concept SCE-2: Computer Systems</td>
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<td>4.2 Design: Detailed design specifications and requirements</td>
<td>4-5</td>
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<td>4.5 Design: Design implementation / task(s) definition</td>
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<td>5.2 Use of engineering tools: Document-processing and graphics packages</td>
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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.

Evaluation and 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 %

Breakdown of course requirements

- 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.

  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 midterm or final exam.

- Midterm Exam: There will be one closed book, no-calculator, midterm exam. Midterm attendance is
required. Room arrangements will be announced during class and in the course website. It may be held outside of regular class time if necessary.

- **Final Exam:** A closed book, no-calculator, final exam will be held during the University's formal examination period. The final examination is for evaluation purposes only and will not be returned to students. You will be able to make arrangements with the instructor or with the department office to see your marked final examination after the final grades have been made available.

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

**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](http://www.carleton.ca/registrar/forms)). All medical certificates must be presented no later than three (3) working days after the term work was due or immediately upon return from the illness; they will not be accepted after the fact. 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.

- **Lab demo:** 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.

- **Lab report:** Submission website of lab reports is open for a week. Late submission or medical certificate cannot be accepted unless valid documentation of a prolonged illness is provided.

- **Midterm:** If the midterm is missed, with a valid medical certificate, students are responsible for making alternate arrangements with the instructor.

**Lecture Breakdown:** 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) (3 lectures)**
  - 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) (2 lectures)**
  - Instructions: data manipulation, data transfer, control flow, instruction encoding
  - Computer arithmetic, flags

- **Microcontroller example (1 lecture)**
  - Microcontroller concept
  - System on Chip, memory model, ISA
- **Assembly language programming (3 lectures)**
  - Code snippets, examples
  - Assembly process, linker, loader

- **High-level Language Support (1 lecture)**
  - Variables, arrays, structures, assignment, looping, conditional statements
  - Procedures and functions, parameter passing

- **Peripheral I/O and Interrupts (2 lectures)**
  - 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

**General Regulations**

**Attendance:** Students are expected to attend all lectures and lab periods. The University requires students to have a conflict-free timetable. For more information, see the current Undergraduate Calendar, Academic Regulations of the University, Section 1.2, Course Selection and Registration and Section 1.5, Deregistration.

**Health and Safety:** Every student should have a copy of our Health and Safety Manual. A PDF copy of this manual is available online: [http://sce.carleton.ca/courses/health-and-safety.pdf](http://sce.carleton.ca/courses/health-and-safety.pdf)

**Deferred Term Work:** Students who claim illness, injury or other extraordinary circumstances beyond their control as a reason for missed term work are held responsible for immediately informing the instructor concerned and for making alternate arrangements with the instructor and in all cases this must occur no later than three (3.0) working days after the term work was due. The alternate arrangement must be made before the last day of classes in the term as published in the academic schedule. For more information, see the current Undergraduate Calendar, Academic Regulations of the University, Section 2.6, Deferred Term Work.

**Appeal of Grades:** The processes for dealing with questions or concerns regarding grades assigned during the term and final grades is described in the Undergraduate Calendar, Academic Regulations of the University, Section 2.7, Informal Appeal of Grade and Section 2.8, Formal Appeal of Grade.

**Academic Integrity:** Students should be aware of their obligations with regards to academic integrity. Please review the information about academic integrity at: [https://carleton.ca/registrar/academic-integrity/](https://carleton.ca/registrar/academic-integrity/). This site also contains a link to the complete Academic Integrity Policy that was approved by the University's Senate.

**Plagiarism:** Plagiarism (copying and handing in for credit someone else's work) is a serious instructional offense that will not be tolerated.

**Academic Accommodation:** You may need special arrangements to meet your academic obligations during the term. You can visit the Equity Services website to view the policies and to obtain more
detailed information on academic accommodation at http://www.carleton.ca/equity/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 https://carleton.ca/equity/wp-content/uploads/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 https://carleton.ca/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf

- **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 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 https://carleton.ca PMC/students/dates-and-deadlines/ for the deadline to request accommodations for the formally-scheduled exam (if applicable).

- **Survivors of Sexual Violence**: As a community, Carleton University is committed to maintaining a positive learning, working and living environment where sexual violence will not be tolerated, and where survivors are supported through academic accommodations as per Carleton’s Sexual Violence Policy. For more information about the services available at the university and to obtain information about sexual violence and/or support, visit: https://carleton.ca/sexual-violence-support/.

- **Accommodation for Student Activities**: Carleton University recognizes the substantial benefits, both to the individual student and for the university, that result from a student participating in activities beyond the classroom experience. Reasonable accommodation must be provided to students who compete or perform at the national or international level. Please contact your instructor 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 https://carleton.ca/senate/wp-content/uploads/Accommodation-for-Student-Activities-1.pdf

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