Systems and Computer Engineering (SYSC)

Courses

Note: the Departments of Systems and Computer Engineering and Electronics offer courses in: Biomedical and Electrical Engineering, Communications Engineering, Computer Systems Engineering, Electrical Engineering, Software Engineering and Engineering Physics.

SYSC 1005 [0.5 credit]
Introduction to Software Development
Software development as an engineering discipline, using a modern programming language, Language syntax. Algorithm design. Tracing and visualizing program execution. Testing and debugging. Program style, documentation, reliability. Lab projects are drawn from a variety of application domains: digital image manipulation, computer games, robotics.
Precludes additional credit for ECOR 1606, SYSC 1100(no longer offered), COMP 1005 and COMP 1405.
Lectures three hours a week, laboratory three hours a week.

SYSC 2001 [0.5 credit]
Computer Systems Foundations
Computer architecture and organization: CPU, cache, memory, input/output, bus structures, interrupts; computer arithmetic: integer and floating point; CPU: instruction sets, addressing modes, instruction encoding. Input/output: programmed, interrupt-driven, block-oriented. Examples from several modern processor families.
Precludes additional credit for SYSC 2320, SYSC 3006.
Prerequisite(s): ECOR 1606 or SYSC 1005. Additional recommended background: SYSC 2006.
Lectures three hours a week, laboratory two hours a week.

SYSC 2003 [0.5 credit]
Introductory Real-Time Systems
Precludes additional credit for SYSC 3006 and SYSC 3310.
Prerequisite(s): SYSC 2001 and SYSC 2006.
Lectures three hours a week, laboratory two hours a week.

SYSC 2004 [0.5 credit]
Object-Oriented Software Development
Designing and implementing small-scale programs as communities of collaborating objects, using a dynamically-typed or statically-typed programming language. Fundamental concepts: classes, objects, encapsulation, information hiding, inheritance, polymorphism. Iterative, incremental development and test-driven development.
Precludes additional credit for SYSC 1101, COMP 1006 and COMP 1406.
Prerequisite(s): SYSC 2006 or permission of the department.
Lectures three hours a week, laboratory two hours a week.

SYSC 2006 [0.5 credit]
Foundations of Imperative Programming
Precludes additional credit for SYSC 1102, SYSC 2002 and COMP 2401.
Prerequisite(s): ECOR 1606 or SYSC 1005.
Lectures three hours a week, laboratory two hours a week.

SYSC 2100 [0.5 credit]
Algorithms and Data Structures
Thorough coverage of fundamental abstract collections: stacks, queues, lists, priority queues, dictionaries, sets, graphs. Data structures: review of arrays and linked lists; trees, heaps, hash tables. Specification, design, implementation of collections, complexity analysis of operations. Sorting algorithms.
Precludes additional credit for SYSC 2002 and COMP 2402.
Prerequisite(s): SYSC 2006 and SYSC 2004.
Lectures three hours a week, laboratory two hours a week.

SYSC 2310 [0.5 credit]
Introduction to Digital Systems
Precludes additional credit for ELEC 2607.
Prerequisite(s): SYSC 1005 or ECOR 1606, and enrolment in Computer Systems Engineering, Communications Engineering, or Software engineering.
Lectures three hours a week, laboratory three hours alternate weeks.
SYSC 2320 [0.5 credit]
Introduction to Computer Organization and Architecture

SYSC 2510 [0.5 credit]
Probability, Statistics and Random Processes for Engineers
Discrete and continuous random variables. Joint and conditional probabilities, independence, sums of random variables. Expectation, moments, laws of large numbers. Introduction to statistics. Stochastic processes, stationarity, additive white Gaussian noise, Poisson processes. Markov processes, transition probabilities and rates, birth death processes, introduction to queueing theory. Prerequisite(s): MATH 1004 and MATH 1104. Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 3006 [0.5 credit]
Computer Organization

SYSC 3010 [0.5 credit]
Computer Systems Development Project
Development of expertise in designing, implementing and testing maintainable, reusable software through team projects. Applying modern programming languages, design patterns, frameworks, UML and modern development processes (refactoring, iterative and incremental development, version control techniques) to medium-scale projects; for example, embedded or mobile applications. Precludes additional credit for SYSC 2101, SYSC 3110 and COMP 2404. Prerequisite(s): SYSC 2100, and third-year status in Computer Systems Engineering. Lectures two hours a week, laboratory three hours a week.

SYSC 3020 [0.5 credit]
Introduction to Software Engineering
Introduction to software engineering principles, software development life-cycles. Modelling in software engineering. Current techniques, notations, methods, processes and tools used in software engineering. UML modelling. Introduction to software quality, software verification and validation, software testing. Precludes additional credit for SYSC 3100, SYSC 3120, SYSC 4120 and COMP 3004. Prerequisite(s): SYSC 2004 and (SYSC 2006 or SYSC 2002). Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 3101 [0.5 credit]
Programming Languages
Principles underlying different kinds of programming languages (procedural, functional, logic programming) and their semantics. Overview of machinery needed for language support (compilers, interpreters and run-time systems). Precludes additional credit for COMP 3007. Prerequisite(s): SYSC 2004. Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 3110 [0.5 credit]
Software Development Project
Development of expertise in designing, implementing and testing maintainable, reusable software through team projects. Applying modern programming languages, design patterns, frameworks, UML and modern development processes (detection of olfactible source code defects, refactoring, iterative and incremental development, version control techniques) to medium-scale projects. Precludes additional credit for SYSC 2101, SYSC 3010 and COMP 2404. Prerequisite(s): SYSC 2100, and third-year status in Software Engineering. Lectures two hours a week, laboratory three hours a week.

SYSC 3120 [0.5 credit]
Software Requirements Engineering
Current techniques, notations, methods, processes and tools used in Requirements Engineering. Requirements elicitation, negotiation, modeling requirements, management, validation. Skills needed for Requirements Engineering and the many disciplines on which it draws. Requirements analysis: domain modeling, modeling object interactions; UML modeling. Introduction to software development processes. Precludes additional credit for SYSC 3020 and COMP 3004. Prerequisite(s): SYSC 2100 and third-year status in Software Engineering. Lectures three hours a week, laboratory three hours alternate weeks.
SYSC 3200 [0.5 credit]  
**Industrial Engineering**  
Techniques of operations research for decision-making in complex engineering systems. Linear programming, network models, PERT, integer programming, dynamic programming, queuing systems and inventory models. Problem solving is emphasized.  
Precludes additional credit for BUSI 2300, ECON 4004, or MATH 3801.  
Prerequisite(s): MATH 1004 and MATH 1104 and (ECOR 1606 or SYSC 1005).  
Lectures three hours a week, laboratory/problem analysis one and a half hours per week.

SYSC 3203 [0.5 credit]  
**Bioelectrical Systems**  
Prerequisite(s): MATH 3705 and PHYS 1004 and enrolment in Biomedical and Electrical Engineering or Biomedical and Mechanical Engineering programs.  
Lectures three hours a week, laboratory three hours a week.

SYSC 3303 [0.5 credit]  
**Real-Time Concurrent Systems**  
Principles and practice of a systems engineering approach to the development of software for real-time, concurrent, distributed systems. Designing to achieve concurrency, performance, and robustness, using visual notations. Converting designs into programs. Introduction to hard real-time systems. Team project.  
Prerequisite(s): for students in the Faculty of Engineering and Design: (SYSC 2003 or SYSC 3310) and SYSC 2004. For students in Computer Science: COMP 2401 and COMP 2402.  
Lectures three hours a week, laboratory two hours a week.

SYSC 3310 [0.5 credit]  
**Introduction to Real-Time Systems**  
Precludes additional credit for SYSC 2003, SYSC 3006.  
Prerequisite(s): SYSC 2320.  
Lectures three hours a week, laboratory two hours a week.

SYSC 3320 [0.5 credit]  
**Computer Systems Design**  
System on Chip (SoC)-based computer system design. SoC internal organization. Cache memory. Interfacing: external memory, hardware subsystems. Direct memory access. Floating point units. Introduction to field programmable gate arrays.  
Precludes additional credit for SYSC 3601 and ELEC 4601.  
Prerequisite(s): SYSC 3310 and third year status in Computer Systems Engineering, or permission of the Department.  
Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 3320 [0.5 credit]  
**Computer Systems Design**  
System on Chip (SoC)-based computer system design. SoC internal organization. Cache memory. Interfacing: external memory, hardware subsystems. Direct memory access. Floating point units. Introduction to field programmable gate arrays.  
Precludes additional credit for SYSC 3601 and ELEC 4601.  
Prerequisite(s): SYSC 3310 and third year status in Computer Systems Engineering, or permission of the Department.  
Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 3350 [0.5 credit]  
**Signals and Systems**  
Signals: energy and power signals, discrete-time and continuous. Linear systems and convolution. Fourier Transform; complex Fourier series; signal spectral properties and bandwidth. Laplace transform and transient analysis. Transfer functions, block diagrams. Baseband and passband signals, with applications to communications systems.  
Precludes additional credit for SYSC 3600, SYSC 2500 (no longer offered) and SYSC 3610.  
Prerequisite(s): MATH 2004 and enrolment in Communications Engineering.  
Lectures three hours a week, problem analysis three hours alternate weeks.

SYSC 3350 [0.5 credit]  
**Communication Theory**  
Review of signals, linear systems and Fourier theory; signal bandwidth and spectra; digital waveform coding; introduction to analog and digital modulation systems; synchronization; characterization and effects of noise; link budgets; communications media and circuits; applications to current communications systems.  
Precludes additional credit for SYSC 3503.  
Prerequisite(s): MATH 3705 and (SYSC 3600 or SYSC 3610).  
Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 3350 [0.5 credit]  
**Communication Theory II**  
Precludes additional credit for SYSC 3501 or SYSC 4600.  
Prerequisite(s): SYSC 3500 and (STAT 2605 or SYSC 2510).  
Lectures three hours a week, laboratory three hours alternate weeks.
SYSC 3600 [0.5 credit]
Systems and Simulation
Precludes additional credit for SYSC 2500 (no longer offered), SYSC 3500 or SYSC 3610.
Prerequisite(s): MATH 1005, and (ECOR 1101 or PHYS 1001).
Lectures three hours a week, laboratory three hours a week.

SYSC 3601 [0.5 credit]
Microprocessor Systems
Precludes additional credit for SYSC 3320 or ELEC 4601.
Prerequisite(s): ELEC 2607, and SYSC 2003 or permission of the department.
Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 3610 [0.5 credit]
Biomedical Systems, Modeling, and Control
Precludes additional credit for SYSC 3500 or SYSC 3600.
Prerequisite(s): MATH 3705 and ECOR 1101 and enrolment in Biomedical and Electrical Engineering program or in Biomedical and Mechanical Engineering programs.
Lectures three hours a week, laboratory three hours a week.

SYSC 3999 [0.0 credit]
Co-operative Work Term

SYSC 4001 [0.5 credit]
Operating Systems
Introduction to operating system principles. Processes and threads. CPU scheduling. Managing concurrency: mutual exclusion and synchronization, deadlock and starvation. Managing memory and input/output. Concurrent programming, including interprocess communication in distributed systems.
Precludes additional credit for SYSC 3001 and COMP 3000.
Prerequisite(s): SYSC 2006 and (SYSC 2003 or SYSC 3006 or SYSC 3310).
Lectures three hours a week, laboratory three hours a week.

SYSC 4005 [0.5 credit]
Discrete Simulation/Modeling
Prerequisite(s): (SYSC 2510 or STAT 2605 or STAT 3502) and fourth-year status in Engineering, or permission of the Department.
Also offered at the graduate level, with different requirements, as SYSC 5001, for which additional credit is precluded.
Lectures three hours a week, laboratory one hour a week.

SYSC 4101 [0.5 credit]
Software Validation
Techniques for the systematic testing of software systems. Software validation and verification, software debugging, quality assurance, measurement and prediction of software reliability. Emphasis on the treatment of these topics in the context of real-time and distributed systems.
Precludes additional credit for COMP 4004.
Prerequisite(s): SYSC 3120 or SYSC 3020.
Lectures three hours a week, laboratory/problem analysis three hours alternate weeks.

SYSC 4102 [0.5 credit]
Performance Engineering
Techniques based on measurements and models, for predicting and evaluating the performance of computer systems. Instrumentation. Simple queueing models and approximations. Techniques for modifying software designs to improve performance.
Prerequisite(s): STAT 3502 and SYSC 4001.
Also offered at the graduate level, with different requirements, as SYSC 5101, for which additional credit is precluded.
Lectures three hours a week, laboratory/problem analysis three hours alternate weeks.

SYSC 4105 [0.5 credit]
Engineering Management
Introduction to engineering management: management of new products, management of manufacturing processes, management of the linkages between new products and manufacturing processes. Current theories, concepts and techniques are stressed, using a combination of readings, cases and guest speakers.
Prerequisite(s): fourth-year status in Engineering.
Lectures three hours a week.
SYSC 4106 [0.5 credit]
Software Product Management
Stages of the life cycle of software products and their implications for architecture definition, requirements specification, variety, target market segmentation, adoption, roll-out plans, documentation, maintenance, skills, building prototypes, testing, feature prioritization, quality and tools infrastructures.
Prerequisite(s): SYSC 3020 or SYSC 3120 (may be taken concurrently) or COMP 3004.
Lectures three hours a week.

SYSC 4107 [0.5 credit]
Software Business
Establishing and growing businesses anchored on software design and development. Models for software business; partnerships with suppliers and customers; distribution; raising money; intellectual property protection; evolving core products and sources of competitive advantage; alignment among the business model, infrastructures, and software development.
Prerequisite(s): fourth-year status in Engineering or Computer Science.
Lectures three hours a week.

SYSC 4120 [0.5 credit]
Software Architecture and Design
Introduction and importance of software architectures and software system design in software engineering. Current techniques, modeling notations, method processes and tools used in software architecture and system design. Software architectures, architectural patterns, design patterns, software qualities, software reuse.
Precludes additional credit for SYSC 3020, SYSC 4800 and COMP 3004.
Prerequisite(s): SYSC 3120.
Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 4101 [0.5 credit]
Ethics, Research Methods and Standards for Biomedical Engineering
Ethical theories, ethical decision-making, biomedical research ethics: informed consent, confidentiality, privacy, research ethics boards; research methods: hypothesis formulation, data collection, sampling bias, experimental design, statistical literacy; regulations for design, manufacture, certification of medical devices; impact of technology and research (social, political, financial).
Prerequisite(s): ELEC 3605 or SYSC 3203.
Lectures three hours a week, problem analysis three hours alternate weeks.
SYSC 4310 [0.5 credit]
Computer Systems Architecture
Evolution of computer systems architecture to improve performance. Memory hierarchy, hardware accelerators. Instruction level parallelism, pipelining, vector processing, superscalar, out-of-order execution, speculative execution. Thread level parallelism, multi-core, many-core, heterogeneous systems. Processor-level interconnect bus, non-uniform memory access. Application-oriented architectures. Virtualization. Precludes additional credit for SYSC 4507. Prerequisite(s): SYSC 3320 and fourth year status in Computer Systems Engineering. Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 4320 [0.5 credit]
Case Studies in Computer Systems
Examples of several modern computer systems are presented in a computer systems context: system objectives, software and hardware components, interactions. The case studies present computer systems trends emerging in practice. Prerequisite(s): SYSC 4310 and fourth year status in Computer Systems Engineering. Lectures three hours a week, problem analysis one hour a week.

SYSC 4405 [0.5 credit]
Digital Signal Processing
Discrete time signal and system representation: time domain, z-transform, frequency domain. Sampling theorem. Digital filters: design, response, implementation, computer-aided design. Spectral analysis: the discrete Fourier transform and the FFT. Applications of digital signal processing. Prerequisite(s): SYSC 3500 or SYSC 3600 or SYSC 3610. Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 4502 [0.5 credit]
Communications Software
Communications software architectures, protocols and operating systems. Application layer protocols, APIs and socket programming. P2P algorithms, network virtualization, SDN. Reliable data transfer algorithms, FSM, MSC. Network security. Multimedia applications, RTSP, CDN, DASH, RTP, RTCP. Packet scheduling algorithms, DiffServ, IntServ, RSVP. Traffic classification, cross-layer optimization. Prerequisite(s): SYSC 4602 and SYSC 2004 and third-year status in Engineering. Lectures three hours a week, problem analysis three hours alternate weeks.

SYSC 4504 [0.5 credit]
Fundamentals of Web Development

SYSC 4505 [0.5 credit]
Automatic Control Systems I

SYSC 4507 [0.5 credit]
Computer Systems Architecture
Evolution of computer systems architecture, influences of changing technology, techniques to improve performance, memory hierarchy, hardware accelerators. Instruction level parallelism, pipelining, vector processing, superscalar, out of order execution, speculative execution. Thread level parallelism, multi-core, many-core, heterogeneous systems. Evolution of architectures for specific application domains. Precludes additional credit for SYSC 4310. Prerequisite(s): ELEC 2607 and (SYSC 2001 or SYSC 3006). Lectures three hours a week, laboratory/problem analysis one hour a week.

SYSC 4600 [0.5 credit]
Digital Communications
Review of probability, random variables, signal representation. Baseband data transmission: Nyquist criterion, equalization, optimal receiver, error probability. Digital modulation, performance. Synchronization. Introduction to information theory. Error detection and correction. Spread spectrum. Applications to current digital wired and wireless communications systems. Precludes additional credit for SYSC 3503 and SYSC 4604. Prerequisite(s): SYSC 3501 and STAT 3502. Lectures three hours a week, laboratory three hours alternate weeks.
SYSC 4602 [0.5 credit]
Computer Communications
Layered network architectures, TCP/IP suite, circuit switching, packet switching. Physical media, data transmission, multiplexing. Data link controls, MAC protocols, random access, polling, IEEE 802 standards. Bridges, switched Ethernet, VLANs. Routing algorithms, Internet routing protocols, datagram networks, virtual circuit networks. Transport protocols. Precludes additional credit for COMP 3203. Prerequisite(s): SYSC 2510 or STAT 2605 or STAT 3502 (may be taken concurrently), and third-year status in Biomedical and Electrical, Electrical, Communications, Computer Systems, Software, or Sustainable and Renewable Energy Engineering. Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 4604 [0.5 credit]
Digital Communication Theory
Introduction to information theory, source coding and data compression, Error control coding, Trellis coded modulation, advanced topics of current interest: spread spectrum; digital wireless communications. Precludes additional credit for SYSC 4600. Prerequisite(s): SYSC 3503. Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 4607 [0.5 credit]
Wireless Communications
Wireless radio channel characterization, diversity, equalization; cellular architecture, multiple access principles, spread spectrum systems, radio resource management; examples from modern wireless systems, networks, and standards, including cellular networks, WLANs, ad hoc networks, and satellite systems. Prerequisite(s): SYSC 3501 or SYSC 3503. Lectures three hours a week, laboratory three hours alternate weeks.

SYSC 4700 [0.5 credit]
Telecommunications Engineering
Telecommunications as a national and international infrastructure. Systems view of network architecture: transmission, access, switching, multiplexing, signalling, and teletraffic. Network planning, management, security and control. Role of government, regulation and competition. Current telecommunications network evolution. Prerequisite(s): fourth-year status in Electrical, Computer Systems or Communications Engineering, and SYSC 3501 or SYSC 3503. Lectures three hours a week, laboratory/problem analysis three hours alternate weeks.

SYSC 4701 [0.5 credit]
Communications Systems Lab
Project-oriented level experience in the design of communication systems to meet user requirements. Lectures on queuing theory and teletraffic analysis; system specification and design: requirements analysis, solution alternatives, evaluation of alternative technologies, design, costing, implementation, test. Prerequisite(s): fourth-year status in Communications Engineering. Lectures two hours a week, laboratory four hours a week.

SYSC 4805 [0.5 credit]
Computer Systems Design Lab
Developing professional-level expertise in selected, important areas of the field by applying, honing, integrating, and extending previously acquired knowledge in team projects in the laboratory. Lecture periods are devoted to new knowledge required for the selected areas, to project-related issues, and to student presentations. Prerequisite(s): SYSC 3303 and SYSC 3020 and fourth year status in Computer Systems Engineering. Lectures two hours a week, laboratory four hours a week.

SYSC 4806 [0.5 credit]
Software Engineering Lab
Applying the full spectrum of engineering and programming knowledge acquired in the program through team projects in the laboratory. Practice in doing presentations and reviews. Lectures will discuss software engineering issues as they relate to the projects, from a mature point of view. Prerequisite(s): SYSC 4120 and fourth-year status in Software Engineering. Lectures two hours a week, laboratory four hours a week.

SYSC 4810 [0.5 credit]
Introduction to Network and Software Security
Network security with coverage of computer security in support of networking concepts. Covers various security issues in data networks at different protocol layers. Routing security, worm attacks, and botnets. Security of new mobile networks and emerging networked paradigms such as social networks and cloud computing. Prerequisite(s): fourth-year status in Engineering or permission of the Department. Lectures three hours a week, problem analysis one and a half hours a week.

SYSC 4906 [0.5 credit]
Special Topics
At the discretion of the Department, a course dealing with selected advanced topics of interest to students in Biomedical and Electrical, Communications, Computer Systems, Electrical, Software Engineering, and Engineering Physics may be offered. Prerequisite(s): permission of the Department.
SYSC 4907 [1.0 credit]  
**Engineering Project**  
Student teams develop professional-level experience by applying previously acquired knowledge to a major design project. Lectures discuss project-related issues and student presentations. A project proposal, interim report, oral presentations, and a comprehensive final report are required.  
Prerequisite(s): fourth-year status in Engineering and ECOR 4995 (may be taken concurrently). Certain projects may have additional prerequisites.  
Lecture one hour a week, laboratory seven hours a week.

SYSC 4917 [1.0 credit]  
**Biomedical Engineering Project**  
Student teams develop professional-level experience by applying previously acquired knowledge to a major design project in biomedical engineering. Lectures discuss project-related issues and student presentations. A project proposal, interim report, oral presentations, and a comprehensive final report are required.  
Prerequisite(s): fourth-year standing in Biomedical and Electrical Engineering and ECOR 4995 (may be taken concurrently). Certain projects may have additional prerequisites.  
Lecture one hour a week, laboratory seven hours a week.

SYSC 4927 [1.0 credit]  
**Software Engineering Project**  
Student teams gain professional-level experience by applying and extending previously acquired knowledge in a major design project in software engineering. Lectures discuss project-related issues and student presentations. A project proposal, interim report, oral presentations, and a comprehensive final report are required.  
Prerequisite(s): fourth-year status in Software Engineering and ECOR 4995 (may be taken concurrently). Certain projects may have additional prerequisites.  
Lecture one hour a week, laboratory seven hours a week.

SYSC 4937 [1.0 credit]  
**Communications Engineering Project**  
Student teams gain professional-level experience by applying and extending previously acquired knowledge in a major design project in communications engineering. Lectures discuss project-related issues and student presentations. A project proposal, interim report, oral presentations, and a comprehensive final report are required.  
Prerequisite(s): fourth-year status in Communications Engineering and ECOR 4995 (may be taken concurrently). Certain projects may have additional prerequisites.  
Lecture one hour a week, laboratory seven hours a week.

**Summer session:** some of the courses listed in this Calendar are offered during the summer. Hours and scheduling for summer session courses will differ significantly from those reported in the fall/winter Calendar. To determine the scheduling and hours for summer session classes, consult the class schedule at central.carleton.ca

Not all courses listed are offered in a given year. For an up-to-date statement of course offerings for the current session and to determine the term of offering, consult the class schedule at central.carleton.ca