Carleton University | Department of Systems and Computer Engineering

SYSC 3600
Systems and Simulation

Calendar description

Properties of linear systems. Linear dynamic models of engineering systems. Applications of the Laplace transform. Transfer functions. Block diagrams. Frequency and time response. System simulation with digital computers.

Includes: Experiential Learning Activity.

Lectures three hours a week, laboratory three hours a week.

http://calendar.carleton.ca/undergrad/courses/SYSC/

Prerequisites

MATH 1005 and ((ECOR 1051 and ECOR 1052 and ECOR 1053 and ECOR 1054) or ECOR 1101 or PHYS 1001), and second-year status in Engineering.

Precludes additional credit for SYSC 3500 or SYSC 3610.

Prior knowledge

Students should have knowledge of:

- Engineering dynamics
- Differential equations
- Circuit design and analysis
- Laplace Transforms and elements of frequency response

Course objectives

This course provides an introduction to the techniques of system modeling, analysis and simulation. One will learn how to predict the behaviour of dynamic systems to various inputs. Knowledge gained from previous courses on mechanical and electrical systems and differential equations is integrated to provide an understanding of the dynamic behavior of engineering systems. The topics to be covered include: modeling of dynamic systems, the properties of dynamic systems, the use of Laplace transforms, transfer functions and block diagrams, convolution and time and frequency response.

List of topics

- Models of analogous systems. The time response and use of Operational Amplifiers. State variable models of electrical, mechanical and electromechanical systems.

- State variable modeling continued and examples presented. The drawing of simulation diagrams from the system models.
- Time domain solutions to the first order differential equation. Derivation of the convolution integral. The unit impulse response and the step response of first order systems.
- The use of convolution to compute the system output. Graphical methods and examples.
- The Laplace transform:
  - The Laplace transform of the impulse and step inputs.
  - The Laplace transform of basic functions and important Laplace transform properties.
  - Initial value and final value theorems and Laplace transform examples.
- Laplace transform of linear differential equations. Derivation of the transfer function. Inverse Laplace transform by partial fraction expansion. Residues of real and complex poles. Graphical techniques and examples.
- Dynamics of second order systems. Damping factor, natural frequency and the step response. Dynamics of higher order systems.
- Operations on block diagrams. Derivation of the transfer function using block diagram reduction.
- Steady state frequency response of first order and second order systems. Bode diagrams. Resonance, filter quality, examples.
- Frequency response of higher order systems. Bode diagrams, asymptotes, break frequency, bandwidth and graphical methods.
- Examples of bode diagrams for higher order lumped parameter systems.

Learning outcomes

By the end of this course, students should be able to:

- Model lumped parameter dynamic systems and draw and reduce simulation diagrams.
- Understand the time response of first, second and higher order systems.
- Derive transfer functions in the Laplace domain and understand from the locations of poles and zeros what the dynamic response will be.
- Sketch accurate Bode diagram in the frequency domain and relate the diagrams to physical behavior of the system.

Graduate Attributes (GAs)

The Canadian Engineering Accreditation Board requires graduates of engineering programs to possess 12 attributes at the time of graduation. Activities related to the learning outcomes listed above are measured throughout the course and are part of the department's continual improvement process. Graduate attribute measurements will not be taken into consideration in determining a student's grade in the course. For more information, please visit: https://engineerscanada.ca/.

Graduate Attribute	Learning outcome(s)

1.6.S: Knowledge Base: Developed: Signals and systems	
2.1: Problem Analysis: Developed: Problem definition	
3.5: Investigation: Introduced: Interpretation of data (synthesis) and discussion	
4.4: Design: Introduce: Design solution(s)	
5.1: Use of Engineering Tools: Applied: Diagrams and engineering sketches	
5.3: Use of Engineering Tools: Developed: Tools for design, experimentation, simulation, visualization, and analysis	
7.2: Communication skills: Developed: Professional documents: writing, design, notes, drawings, attributions, and references	

Accreditation Units (AUs)

For more information about Accreditation Units, please visit: https://engineerscanada.ca/.

The course has a total of 55 AUs, divided into:

- Engineering Science: 75%
- Engineering Design: 25%

Instructor and TA contact

Specific to course offering (tbd)

Textbook (or other resources)

Specific to course offering (tbd)

Evaluation and grading scheme

Specific to course offering (tbd)

Breakdown of course requirements

Specific to course offering (tbd)

Tentative week-by-week breakdown

Specific to course offering (tbd)

General regulations

Specific to course offering (tbd)