Instructor:
Prof. Abdullah Kadri, abdullahkadri@cunet.carleton.ca. Office hours are by appointment. Please email me to schedule an appointment.

Calendar Description:
SYSC 3600: Systems and Simulation

Prerequisites: MATH 1005, and (ECOR 1101 or PHYS 1001). Precludes additional credit for SYSC 2500 (no longer offered), SYSC 3500 or SYSC 3610. Students are expected to know engineering dynamics, differential equations, circuit design and analysis, Laplace Transforms and elements of frequency response. Students who have not satisfied the prerequisites for this course must either withdraw from the course or obtain a prerequisite waiver by visiting the Engineering Undergraduate Academic Support Office.

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 behaviour 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.

Learning Outcomes:
1. The students should be able to model lumped parameter dynamic systems and draw and reduce simulation diagrams.
2. The students should understand the time response of first, second and higher order systems.
3. The students should be able to derive transfer functions in the Laplace domain and understand from the locations of poles and zeros what the dynamic response will be.
4. The students should be able to sketch accurate Bode diagram in the frequency domain and relate the diagrams to physical behavior of the system.
5. Students should be able to conduct system simulation and analyze simulation results.
Graduate Attributes:
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 attributes will not be taken into consideration in determining a student’s grade in the course. For more information, please visit: https://engineerscanada.ca/

<table>
<thead>
<tr>
<th>Graduate Attribute</th>
<th>Learning Outcome(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.6.S Knowledge Base: Signals and Systems</td>
<td>1,2</td>
</tr>
<tr>
<td>2.1 Problem definition</td>
<td>1</td>
</tr>
<tr>
<td>3.5 Interpretation of data (synthesis) and discussion</td>
<td>5</td>
</tr>
<tr>
<td>4.4 Design solution(s)</td>
<td>4,5</td>
</tr>
<tr>
<td>5.1 Diagram and engineering sketches</td>
<td>4</td>
</tr>
<tr>
<td>5.3 Tools for design, experimentation, simulation, visualization, and analysis</td>
<td>2,3,4</td>
</tr>
<tr>
<td>7.2 Professional documents: writing, design notes, drawing, attributions, and references</td>
<td>4,5</td>
</tr>
</tbody>
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Course Textbook:

Grading:
Assignments(5): 20%
Laboratories(3): 20%
Final Exam: 60%

Labs:
The labs may be done in groups of two (with only one lab report required per group).

Final Exam: The final examination is for evaluation purposes only and will not be returned to students. Students will be able to make arrangements with the instructor or with the department office to see their marked final examination after the final grades have been made available.
Course Outline:

Week 1 – Models of analogous systems. The time response and use of Operational Amplifiers. State variable models of electrical, mechanical and electromechanical systems.

Week 2 – State variable modeling continued and examples presented. The drawing of simulation diagrams from the system models.

Week 3 – 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.

Week 4 – The use of convolution to compute the system output. Graphical methods and examples.

Week 5 – 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.


Week 7 – Dynamics of second order systems. Damping factor, natural frequency and the step response. Dynamics of higher order systems.

Week 8 - Operations on block diagrams. Derivation of the transfer function using block diagram reduction.


Week 10-11 - Frequency response of higher order systems. Bode diagrams, asymptotes, break frequency, bandwidth and graphical methods.

Week 12 - Examples of bode diagrams for higher order lumped parameter systems.
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 2.1.3, Course Selection and Registration and Section 2.1.7, 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 4.4, 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 3.3.4, Informal Appeal of Grade and Section 3.3.5, 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/](http://www.carleton.ca/equity/) For an accommodation request, the processes are as follows:

- **Pregnancy or Religious obligation:** 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/equity/wp-content/uploads/Student-Guide-to-Academic-Accommodation.pdf](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). Requests made within two weeks will be reviewed on a case-by-case basis. After requesting accommodation from PMC, meet with me to ensure accommodation arrangements are made. Please consult the PMC website (www.carleton.ca/pmc) 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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