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Fall 2021 -- Department of Computer Science, University of Western Ontario

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## CS3331 - Foundations of Computer Science

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### Course description ([course web site](#))

We live during the computer revolution, which is changing fast everything around us. While programming languages change quickly, the fundamental underlying theory does not. This course covers the basic concepts of the theory of computation. To study computation thoroughly, we need models. Ideally, we would like simple models to solve our problems. This is what the theory of computation is about: computational models and their power, with an impressive array of applications. The practical models we study in this course include finite state machines, regular expressions, push-down automata, and context-free grammars. A crucial aspect is studying the limits of computations, which involves investigating all powerful models, such as Turing machines. Some problems are intractable, that is, it takes ages to solve them, others are provably impossible to solve even on an infinitely powerful computer. Computability theory sheds light on these issues of fundamental importance to anyone attempting to understand what computers can do for us.

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### Topics

- Regular Languages
    - Finite State Machines (FSM), Deterministic (DFSM), Nondeterministic (NDFSM), Regular Expressions, Regular Grammars
    - Minimizing DFSM, Conversions between DFSM, NDFSM, Reg. Exp., and Reg. Grammars
    - Proving regularity, Closure properties
    - Proving nonregularity, Pumping theorem, Using closure properties
    - Decision Problems, Membership, Emptiness, Totality, Finiteness, Equivalence, Minimality
  - Context-free Languages
    - Pushdown Automata (PDA), Context-free Grammars (CFG)
    - Conversions, PDA  $\leftrightarrow$  CFG, CFG  $\rightarrow$  Chomsky Normal Form
    - Ambiguity
    - Proving context-freeness, Closure properties
    - Proving noncontext-freeness, Pumping theorem, Using closure properties
    - Decision Problems, Membership, Emptiness, Finiteness
  - Turing Machines and Undecidability
    - Turing Machines (TM), Deterministic TM
    - Decidable languages (D), Semidecidable languages (SD)
    - Multi tape TM, Nondeterministic TM
    - Universal TM, Halting Problem
    - D and SD, Enumeration
    - Reduction, Using reduction to prove undecidability
    - Rice's Theorem, Non-SD languages
    - Unrestricted Grammars
    - Non-TM Problems, Post Correspondence Problem (PCP), Context-free language problems
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## Prerequisites

Computer Science 2214A/B or Mathematics 2155F/G

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## Instructor

- Prof. [Lucian Ilie](#), MC378
    - Office hours: **Zoom**, Wednesdays 10:30 - 12:30
    - Zoom meeting information will be sent to your OWL messages
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## Class time

- Tuesdays, 3:30 - 5:30pm
  - Wednesdays, 1:30 - 2:30pm
  - **Lectures: Zoom: live classes and posted videos**
    - Zoom meeting information for lectures will be sent to your OWL messages
    - Videos will be posted in the Lecture Notes section (see top)
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## Textbook (required)

- Elaine Rich, *Automata, Computability, and Complexity. Theory and Applications*, © Person Prentice Hall (2008), ISBN 978-0-13-228806-4.
    - The textbook is out of print. A [free PDF](#) is available from the author's web site. You can find a hard copy from previous students or from [AbeBooks](#).
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## Tools

- [JFLAP](#) (You are allowed to use JFLAP for assignments.)
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## Evaluation -- Assignments will be available in OWL

- Assignments -- best 3 out of 4 will be considered; these due dates are tentative - the date on the assignment supersedes this:
  - Assignment 1 (10%) -- due Oct. 12
  - Assignment 2 (10%) -- due Oct. 21
  - Assignment 3 (10%) -- due Nov. 30
  - Assignment 4 (10%) -- due Dec. 5
- Exams - written format, closed book, no cheat sheet, no devices
  - Midterm Exam (31%) - **IN PERSON - Tuesday, Oct. 26, 3:30 - 5:30pm, (room TBA)**
    - Material required for midterm: Regular and Context-free Languages -- see Topics above
  - Final Exam (39%) - **IN PERSON (TBA)**
    - Material required for final: everything
    - Final makeup: TBA

**Evaluation rules -- read carefully**

- **Exam passing rule**
    - In order to pass the course you must pass the exams, that is, your weighted average grade for the two exams should be at least 50/100. Otherwise, your final grade for the course will be the weighted average of the exam grades.
  - **Missed homework or exam**
    - There is no midterm makeup. In case of missed midterm, you need approved accommodation from the Dean's office for the weight of the midterm to be moved to the final. All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.
    - I suggest that you complete at least 3 assignments as it is easier to get higher grades on assignments than exams. However, missed assignments automatically (that is, no accommodation needed) get their grade from the exams as follows: assignments 1 and 2 get the grade of the midterm, and assignments 3 and 4 get the grade of the final. A submitted assignment will also get the grade of the corresponding exam, if the latter is higher. This way everyone will have four assignment grades. After that, the best three out of four are considered.
  - **Self-reported absences**
    - To simplify things, I give two-day penalty-free extension on all assignments (as indicated in each assignment). This is the equivalent of everyone having a self-reported absence. Self-reported absences cannot be used to add an additional extension.
    - Self-reported absences cannot be used for midterm or final exam (midterm weight is over 30% and they can never be used for final exams).
  - **Mark inquiries**
    - The goal is to make grading as objective and consistent as possible. The assignments and exams will have detailed evaluation schemes. For consistency, the same question will be graded, whenever possible, by the same grader for all students.
    - Inquiries for marks will be addressed first to the TA who graded the question. In case of disagreement, the complaint will be resolved by the instructor. In case of multiple complaints for one exam from a student, the entire exam of that student will be regraded by the instructor.
    - Mark inquiries can be made only within one week from the day the marks are made available.
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## TAs and office hours

- Hosseini, SeyedMosen (shosse59@uwo.ca) - in charge of the course email: [cs3331@uwo.ca](mailto:cs3331@uwo.ca). All questions are to be sent to this email address.
  - Manka, Marlin (mmanka@uwo.ca) - times TBD
  - Li, Xiaoou (xli889@uwo.ca) - times TBD
  - Bhattejee, Anurag (abhat23@uwo.ca) - times TBD
  - Wong, Anthony (awong655@uwo.ca) - times TBD
  - Office hours
    - Office hours will be on **Zoom**
    - Zoom meeting information will be sent to your OWL messages
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## Assignments

- The assignments will consist of a set of exercises related to the material covered in class. The solutions for the exercises should be neatly written or typed.
- All assignments will be made available in OWL. The availability of assignments will be announced on

class and/or via e-mail. Students are responsible for checking the course OWL site and their e-mail on a regular basis.

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## Appeals of Assignment Marks

- Appeals of assignment marks should be addressed to the T.A. first. If you and the T.A. cannot agree, then the T.A. will discuss the situation with the lecturer.
  - Appeals must occur within 1 week from the first day that the marked assignments were made available to students. After that 1 week period has gone by, no more appeals will be considered.
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## Computing Facilities

Each student will be given an account on the Computer Science Department senior undergraduate computing facility, GAUL. In accepting the GAUL account, a student agrees to abide by the department's; [Rules of Ethical Conduct](#).

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## Student Absences

**Academic Consideration for Student Absences** Students who experience an extenuating circumstance (illness, injury or other extenuating circumstance) sufficiently significant to temporarily render them unable to meet academic requirements may submit a request for academic consideration through the following routes:

- (i) Submitting a Self-Reported Absence (SRA) form provided that the conditions for submission are met. To be eligible for a Self-Reported Absence:
  - an absence must be no more than 48 hours
  - the assessments must be worth no more than 30% of the student's final grade
  - no more than two SRAs may be submitted during the Fall/Winter term
- (ii) For medical absences, submitting a Student Medical Certificate (SMC) signed by a licensed medical or mental health practitioner to the Academic Counselling office of their Faculty of Registration.
- (iii) Submitting appropriate documentation for non-medical absences to the Academic Counselling office in their Faculty of Registration.

Note that in all cases, students are required to contact their instructors within 24 hours of the end of the period covered, unless otherwise instructed in the course outline.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.

For the policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs, see: [https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/accommodation\\_illness.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf) and for the Student Medical Certificate (SMC), see: [http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/medicalform.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf).

**Religious Accommodation** When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic

Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at <https://multiculturalcalendar.com/ecal/index.php?s=c-univwo>".

**Absences from Final Examinations** If you miss the Final Exam, please contact the Academic Counselling office of your Faculty of Registration as soon as you are able to do so. They will assess your eligibility to write the Special Examination (the name given by the University to a makeup Final Exam). You may also be eligible to write the Special Exam if you are in a "Multiple Exam Situation" (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

If a student fails to write a scheduled Special Examination, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See the Academic Calendar for details (under Special Examinations).

## Accommodation and Accessibility

**Accommodation Policies** Students with disabilities work with Accessible Education (formerly SSD), which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at: [https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/Academic Accommodation\\_disabilities.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf).

## Academic Policies

The website for Registrarial Services is <http://www.registrar.uwo.ca>.

In accordance with policy, [https://www.uwo.ca/univsec/pdf/policies\\_procedures/section1/mapp113.pdf](https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf), the centrally administered e-mail account provided to students will be considered the individual's official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at his/her official university address is attended to in a timely manner.

**Scholastic offences** are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: [http://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/scholastic\\_discipline\\_undergrad.pdf](http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf).

## Support Services

Please visit the Science & Basic Medical Sciences Academic Counselling webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: <https://www.uwo.ca/sci/counselling/>.

Please contact the course instructor if you require lecture or printed material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Accessible Education at (519) 661-2147 if you have any questions regarding accommodations.

Students who are in emotional/mental distress should refer to Mental Health@Western (<http://www.health.uwo.ca/mentalhealth>) for a complete list of options about how to obtain help.

Additional student-run support services are offered by the USC, <http://westernusc.ca/services>.

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