Course Outline
Applied Logic for Computer Science[1]
COMPSCI 2209A

1. Course Information

Course Information

- Course Name: Applied Logic for Computer Science
- Academic Term: Fall 2024
- Instructor: Dr. Sajad Sadeghi
- Lectures:
  - Hours: Tuesdays 9:30-11:30 am, and Thursdays 9:30-10:30 am
  - Location: NSC-1

List of Prerequisites

Prerequisite(s): Either 1) Computer Science 1027A/B, Computer Science 1037A/B, the former Computer Science 2101A/B, Computer Science 2121A/B or Digital Humanities 2221A/B in each case with at least 65%, and 1.0 course with at least 60% in each from Applied Mathematics 1201A/B, Numerical and Mathematical Methods 1411A/B, Numerical and Mathematical Methods 1412A/B, Numerical and Mathematical Methods 1414A/B, Calculus 1000A/B, Calculus 1301A/B, Calculus 1500A/B, Calculus 1501A/B, Mathematics 1600A/B, the former Applied Mathematics 1411A/B, the former Applied Mathematics 1412A/B, the former Applied Mathematics 1414A/B, the former Applied Mathematics 1413; or 2) Integrated Science 1001X with at least 60%.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees if you are dropped from a course for failing to have the necessary prerequisites.

2. Instructor Information

- Instructor: Dr. Sajad Sadeghi
- Email: ssadegh3@uwo.ca
- Office: MC 28C

Course Contact Policies

- Students must use their Western (**@uwo.ca**) email addresses when contacting their professor.

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[1] This course outline is subject to change, and any changes will be clearly communicated via the course OWL website.

- Any email sent to the professor MUST say CS 2209A in the subject line; Any email without a proper subject line, and/or sent from an email other than a Western email, may be deleted unread.

Office Hours Information
The office hours are held online in Zoom by appointment on Mondays from 3 PM to 4 PM. To get an appointment please send an email to the instructor.

3. Course Syllabus, Schedule, Delivery Mode

Applied Logic is an introduction to logic with emphasis on methodologies and applications in Computer Science. Topics include propositional and predicate logic, methods for logical reasoning, SAT solvers, and programming languages based on logic.

Course Delivery:
The course will be delivered in person. Lecture notes will be posted online in OWL. Office hours are online in Zoom.

Course-level learning outcomes:
- Define declarative statements in propositional logic and predicate logic.
- Explain the syntax and the semantics of propositional logic and predicate logic.
- Construct formal proofs in propositional logic and predicate logic.
- Explain the main applications of logic in computer science, including database query languages, software verification, programming languages, and digital electronics.
- Explain the expressiveness and limitations of propositional and predicate logic.

Table of contents (tentative):

0**. Week 0**, September 5-September 8:
- What is logic? Logic propositions and connectives.

1. **Week 1**, September 9-September 15:
   - Truth tables, translations between English and propositional logic, propositional logic formulas, review of induction, structural induction, propositional language semantics, and satisfiability
2. **Week 2**, September 16-September 22:
   - Proving argument validity in propositional logic, propositional calculus laws, disjunctive and conjunctive normal forms
3. **Week 3**, September 23-September 29:
   - Adequate set of connectives, Boolean algebra, logic gates, circuit design and minimization, code analysis and simplification
4. **Week 4**, September 30-October 6:
   - Formal deduction for propositional logic, soundness and completeness of formal deduction for propositional logic
5. **Week 5**, October 7-October 13:
   - Automated theorem-proving: resolution, Davis-Putnam procedure, first-order logic (domain, terms, relations, variables, quantifiers),

6. **Week 6**, October 14-October 20: Reading week
7. **Week 7**, October 21-October 27:
    - First–order logic syntax and semantics
    - The **midterm exam** is on October 22, during the lecture time, the location will be announced, and we'll have class on Thursday.
8. **Week 8**, October 28-November 3:
    - Logical consequence in first-order logic, formal deduction in first-order logic,
9. **Week 9**, November 4-November 10:
    - Formal deduction in first-order logic (proof examples), Resolution for first-order logic, Prenex Normal Form, Existential-free PNF, unification and resolution, automated theorem provers/verifiers
10. **Week 10**, November 11-November 17:
    - Computation and logic: Turing machines, undecidability, the halting problem, Turing machine examples, decidability and complexity of some logic problems
11. **Week 11**, November 18-November 24:
    - Peano arithmetic, proving theorems in Peano arithmetic, Godel's incompleteness theorem.
12. **Week 12**, November 25-December 1:
    - Program verification (Hoare triples, partial and total correctness, rules for assignment, implication, and composition), Program verification (conditional statements)
13. **Week 13**, December 2-December 6:
    - Program Verification: (partial-while, program termination, undecidability of partial and total correctness

Contingency plan for an in-person class pivoting to 100% online learning

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, affected course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will **not** change. Any remaining assessments will also be conducted online as determined by the course instructor.

Key Sessional Dates:

- Classes begin: September 5, 2024
- Last day to add or drop: September 13, 2024
- Fall Reading Week: October 12 – 20
- Last day to drop (without academic penalty): November 30, 2024
- Classes end: December 6, 2024
- Exam period: December 9–22, 2024

4. Course Materials

We will use the book *Mathematical Logic for Computer Science*, Second Edition, by Lu Zhongwan mainly for definitions, notation, and the sections on formal deduction, but this book does not cover all the topics we discuss in the course. The notes will be posted on OWL.
The following books are also recommended:
- *Logic in Computer Science: Modeling and Reasoning about Systems*, Second Edition, Michael Huth and Mark Ryan
- *Logic for Computer Science*, Uwe Schoning
- *Introduction to Logic*, Fifteenth Edition, Irving M. Copi, Carl Cohen, Kenneth McMahon
- *The Foundations of Mathematics*, Kenneth Kunen

Learning Management System (OWL Brightspace)

Students are responsible for checking the course OWL site (https://westernu.brightspace.com) on a regular basis for the course content, news and updates. This is the primary method by which information will be disseminated to all students in the class.

All course material will be posted to OWL: https://westernu.brightspace.com. All students are expected to be aware of information and make use of materials, posted on the course website. Important information will be posted on the Announcement tab of the website.

Students must acquaint themselves with OWL Brightspace and configure their settings to receive all notifications for announcements. Upon logging into OWL Brightspace, they can access the "Getting Started (for students)" guide under the Help dropdown menu to undergo the necessary training for navigating this new platform. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

5. Methods of Evaluation

The final course grade will be determined by student performance on the following course components:

- Assignments 20% (four assignments, 5% each)
- Quizzes (online) 15% (five quizzes, 3% each)
- Midterm Test 25%
- Final exam 40%

To pass the course, students must obtain at least a weighted average of 50% between the Midterm Test and the Final Exam.

Tentative list of subjects and dates:

Assignments:

- Assignment 1: From the content of Weeks 0-2 (available: Week 2, deadline: Week 4, October 6, at 11:55 pm)
- Assignment 2: From the content of Weeks 3-5 (available: Week 5, deadline: Week 8, November 3, at 11:55 pm)
- Assignment 3: From the content of Weeks 7-8 (available: Week 8, deadline: Week 10, November 17, at 11:55 pm)
- Assignment 4: From the content of Weeks 9-10 (available: Week 10, deadline: Week 12, December 1, at 11:55 pm)

Assignment Submission

All assignments have to be submitted to Gradescope as PDF files. You can either create these files with software (for example LaTeX), scan a paper copy, or photograph a paper copy and convert the photo to a PDF file. Be certain to submit ONLY ONE file for each assignment. It is the student's responsibility to make sure that the PDF file is uploaded correctly.

Students are expected to submit each of the four assignments by the deadline listed. Should extenuating circumstances arise, students do not need to request Academic Consideration and they are permitted to submit their assignment up to 48, hours past the deadline without a late penalty. Should students submit their assessment beyond 48 hours past the deadline, a late penalty of 20% loss of marks per day (including weekends and holidays). The model answer will be posted after seven days, and no submission will be accepted.

Ethical Conduct

All assignments are individual assignments. You may discuss approaches to problems among yourselves; however, the actual details of the work must be an individual effort. The standard departmental penalty for assignments that are judged to be the result of academic dishonesty is, for the student's first offence, a mark of zero for the assignment, with an additional penalty equal to the weight of the assignment also being applied. You are responsible for reading and respecting the Computer Science Department's policy on Scholastic Offences

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

The University of Western Ontario uses software for plagiarism checking. Students may be required to submit their written work and programs in electronic form for plagiarism checking.

Online Quizzes:
- Quiz 1: From the content of Weeks 0-2 (Week 3, online, deadline: September 29, at 11:55 pm)
- Quiz 2: From the content of Weeks 3-5 (Week 7, online, deadline: October 27, at 11:55 pm)
- Quiz 3: From the content of Weeks 7-8 (Week 9, online, deadline: November 10, at 11:55 pm)
- Quiz 4: From the content of Weeks 9-10 (Week 11, online, deadline: November 24, at 11:55 pm)
- Quiz 5: From the content of Weeks 11-12 (Week 13, online, deadline: December 6, at 11:55 pm)

The online quizzes are available within a five-day window. Once you start, you will have **30 minutes** or until the deadline—whichever is shorter—to complete the quiz. It will be automatically submitted at that time, regardless of whether you have answered all the questions. You can submit each quiz **only once**.

- **Midterm Test**: Weeks 1-5 (date and time: October 22, 9:30 AM-11:30 AM, in class)

- **Final Exam**: Weeks 1-12 (date and time: TBD)

  - See the Absence/Missed Work Policy on the next page.

General information about missed coursework
Students must familiarize themselves with the *University Policy on Academic Consideration – Undergraduate Students in First Entry Programs* posted on the Academic Calendar:
https://www.uwo.ca/univsec/pdf/academic_policies/appeals/academic_consideration_Sep24.pdf,

This policy does not apply to requests for Academic Consideration submitted for **attempted or completed work**, whether online or in person.

The policy also does not apply to students experiencing longer-term impacts on their academic responsibilities. These students should consult Accessible Education.

For procedures on how to submit Academic Consideration requests, please see the information posted on the Office of the Registrar's webpage:
https://registrar.uwo.ca/academics/academic_considerations/
All requests for Academic Consideration must be made within 48 hours after the assessment date or submission deadline.

All Academic Consideration requests must include supporting documentation; however, recognizing that formal documentation may not be available in some extenuating circumstances, the policy allows students to make one Academic Consideration request **without supporting documentation** in this course. However, the **Final Exam** is excluded from this, and therefore **always requires formal supporting documentation**.
When a student *mistakenly* submits their one allowed Academic Consideration request **without supporting documentation** for the Final Exam or those in the **Coursework with Assessment Flexibility** section below, the request cannot be recalled and reapplied. This privilege is forfeited.

If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

Midterm Test:
There is no make-up for the midterm exam. If a student misses the midterm exam, they need to submit an **Academic Consideration request** to the Academic Counseling Office of their Faculty of Registration, and their final will be reweighted to cover the mark for the midterm.

Coursework with Assessment Flexibility

> **Online Quizzes and Assignments:**
> All Academic Consideration requests for Online Quizzes and Assignments will be denied, and the mark for any missed quiz or assignment will be recorded as zero.

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 can 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., 3 or more exams in a 23-hour period, 4 or more 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).

6. Accommodation and Accessibility

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 an 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 the University's list of recognized religious holidays (updated annually) at www.edi.uwo.ca

Accommodation Policies
Students with disabilities are encouraged to contact Accessible Education, 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/AcademicAccommodation_disabilities.pdf

7. Academic Policies

The website for Registrarial Services is https://www.registrar.uwo.ca
In accordance with policy,

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 their official university address is attended to in a timely manner.

No calculators or other electronic devices or any other aids are allowed on the tests and the exam.

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.

Computer-marked multiple-choice tests and exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating.

8. 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/.

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

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at

https://www.uwo.ca/health/student_support/survivor_support/get-help.html.

To connect with a case manager or set up an appointment, please contact support@uwo.ca.

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

http://academicsupport.uwo.ca/accessible_education/index.html

if you have any questions regarding accommodations.

Learning-skills counsellors at the Student Development Centre (https://learning.uwo.ca) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: https://www.uwo.ca/se/digital/.

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