CISC 204: Logic for Computing Science
Syllabus for Fall 2021

Calendar Description:
Elements of mathematical logic with computing applications. Formal proof systems for propositional and predicate logic. Interpretations, validity, and satisfiability. Introduction to soundness, completeness, and decidability.

Book:
Logic in Computer Science: Modelling and Reasoning about Systems by Huth and Ryan, 2004 (ISBN 978-0521543101, Cambridge University Press). We will cover most of chapters 1 and 2. Content from other chapters may appear but will be limited.

Planned Delivery:
Remote asynchronous lectures with three one-hour live lectures covering tutorials, problem sets, interactive class activities, etc. I.e., flipped classroom.

Live Lecture Details:
Biosciences Auditorium 1101 Wed @ 10:30am ● Thurs @ 11:30am ● Fri @ 9:30am

Preface

Whatever this semester looks like, it probably isn't anything like we imagined it. We now find ourselves in extraordinary times that demand extraordinary things of everyone. The entire teaching staff is committed to giving you the best possible experience and being as equitable and inclusive as we can in doing so. What does this mean for you? Well…

1. There will be ample opportunity to let us know how things are going, and we'll be doing our best to be flexible in responding to and acting on this feedback.

2. We have designed the syllabus with a diversity of students in mind – most required elements are asynchronous, and we'll be accommodating everyone in the course as best we can.

3. There is a large element of freedom how you will be assessed. From choosing between more high-stakes quizzes or a self-driven course project on a topic of your choosing, to dropping the lowest grade on both assignments and quizzes.

4. We will have several opportunities for you to connect with your peers, including discussion forums, Teams chat channels, and regularly held office hours at various times of day.

Because the class will represent a diversity of individuals, beliefs, backgrounds, and experiences, every member of this class should show respect for every other member of this class. Thank you for joining us this semester. We sincerely hope you have fun, and we look forward to seeing you!

What we hope you will learn

By the end of this course, you will be able to phrase natural language statements in a logical way and be able to formally reason with them. More concretely, here are the course level outcomes and contents.

Course Level Outcomes

PROGRAM CODE	LEARNING OUTCOME
2.1	Construct syntactic and semantic proofs in propositional and predicate logic
3.1	Express English language and mathematical expressions in logic
	Determine semantic equivalences, satisfiability and validity
2.1	Verify the correctness of computer programs
	Apply model checking for verification

Content

The schedule is subject to change, but currently the plan is to cover the following material.

Propositional Logic: Deduction (2 weeks)

- Intro to formula syntax, sequents, deduction
- Conjunction
- Negation
- Implication
- Disjunction
- Proof by contradiction
- Law of excluded middle

Propositional Logic: Semantics (3 weeks)

- Well formed formulae
- Truth tables
- Semantic entailment
- Soundness & completeness
- Semantic equivalence
- Satisfiability
- De Morgan's Law
- Conjunctive Normal Form
- Tseitin Encoding

Predicate Logic: Deduction (4 weeks)

- Formal language definition
- Quantifier scope
- Substitution
- Universal elimination / introduction
- Existential elimination / introduction
- Distributing universal

Predicate Logic: Semantics (3 weeks)

- Basics of predicate logic semantics
- Equality
- Environments and Interpretations
- Satisfiability
- Consistency
- Validity
- Semantic entailment
- Undecidability

Additional skills

Beyond the actual content listed above, throughout this course you will make use of a variety of technologies including GitHub; key Python packages for logical reasoning; Jape software for proof verification; etc. Some of these skills may prove essential throughout your entire degree.

What it takes to be successful in this course

There are two paths you can take through the course: full assignment/quiz assessment ***or*** partial assignment/quiz assessment with a major project. The latter means one fewer assignment/quiz and no essay requirement. Details on the two options are listed in this section. There are 4 assignments + quizzes common to both options, and these are described below as well.

Option 1

60%	15% x 4	best 4 of 5 quizzes
30%	6% x 5	assignments
10%	---	essay

Option 2

45%	15% x 3	best 3 of 4 quizzes
24%	6% x 4	assignments
31%	---	modelling project

Option 1: No Project

In this first option, students have 5 quizzes and 5 assignments total. There is an additional essay, worth 10% of the grade, due in two installments (mid-way and at the end of the term).

Option 2: Modelling Project

In the second option, the essay and one quiz/assignment pair are replaced with a course project worth 31% of the final grade. There are several checkpoints/deliverables throughout the course, and students will be encouraged to work in small teams to complete this element of the course.

Choosing an Option

The first checkpoint for the modelling project will be the project proposal, and it is tentatively scheduled to be due on October 1st.

Your decision to follow option 1 -vs- option 2 must be made at this checkpoint.

By submitting a project proposal, you are de facto choosing to go with Option 2. By not submitting a proposal, you are de facto choosing to go with Option 1.

Quizzes

There will be 5 scheduled quizzes worth **15% each**. For those in option 1, the best 4 of 5 grades will contribute to your quiz grade (out of **60% total**). For those in option 2, one quiz will not be offered (tentatively the 4th one), and your quiz grade will be based on the best 3 out of 4 (**45% total**).

The following schedule is the tentative timing for each of the 5 quizzes:

Quiz #1	Sep 24	Week 3
Quiz #2	Oct 7	Week 5
Quiz #3	Nov 5	Week 8
Quiz #4[1]	Nov 19	Week 10
Quiz #5	Dec 3	Week 12

The flexibility of dropping your lowest quiz score is to accommodate the twists and turns life throws at you during the semester. It allows for accommodation, when you need it most, with no questions asked.

In order to allow the teaching staff sufficient time to get all of the grades to students, any concerns with a mark should be raised *no later than one week* after receiving your mark.

[1] Only for those in Option 1 (i.e., non-project).

Assignments

There will be a total of 5 small assignments throughout the course. They are scheduled to coincide to each of the 5 quizzes and will serve as an indicator of your ability with the material just prior to the quiz that assess things more fully. For those in Option 2, only four assignments will be assessed.

Assignment #1	Sep 16	Week 2
Assignment #2	Sep 30	Week 4
Assignment #3	Oct 28	Week 7
Assignment #4[2]	Nov 11	Week 9
Assignment #5	Nov 25	Week 11

Deadlines: The due dates are selected so that there is enough time to provide feedback on the material prior to taking the quiz. Late submissions will be accepted without penalty (i.e., no loss of marks) for up to 3 days after the due date – this is to allow for overcoming any technical difficulties you may face.

After this 3-day grace period, submissions will be penalized at 25% / day (maximum of 3 extra days). E.g., for assignment #1 (due Sep 16), if you submit on XX, get a grade of 80%, your grade will be YY:

XX	YY
Sep 16 - 19	80%
Sep 20	80% - (0.25 * 80%) = 60%
Sep 21	80% - (0.50 * 80%) = 40%
Sep 22	80% - (0.75 * 80%) = 20%
Sep 23 - …	80% - (1.00 * 80%) = 0%

Please keep in mind that submitting them late (even within the grace period) may prevent you from knowing what you might focus on while studying for the quiz, as there are no guarantees we will be able to mark it in time.

Modelling Project

For those that choose the project option, in lieu of a quiz + assignment + essay you will have the opportunity to work in a team implementing a logical model of a project topic of your choosing (topic subject to approval). If you are *not* interested in the project option, you may skip this syllabus section.

A key skill you will acquire from this course is the ability to express logic-based settings formally. To explore this possibility, the self-directed group project will teach you to:

1. Articulate a problem
2. Model it in logic using a provided Python interface
3. Explore the solutions it provides
4. Provide feedback on the model of one other team

[2] Only for those in Option 1 (i.e., non-project).

The grading scheme for the project will be provided in a separate document and is worth 31% of your final grade. The project will give you the chance to explore the concepts from the course in a setting that you are familiar with and are interested in.

Deadlines: The final submission will be around week 11 or 12 but has yet to be decided. Suggested checkpoint dates corresponding to each of the steps will be provided to help you make sufficient progress throughout the semester and receive feedback early on.

Teaming: For the project, you will have the option to work in a small team of your peers, and collectively work on a single project. Feedback you provide on another project, however, will be unique to yourself. Your grade for the project will be a combination of the team component plus the individual feedback grade you receive.

Student Feedback (step 4): This component will be graded for the quality of your feedback on another student's project. While the feedback of other students on your own project should be carefully considered in working on your model, *their feedback is not an assessment and will not be used to calculate your grade*. Provide good feedback to your classmates and you should expect the same!

Essay

For those pursuing option 1, there will be a minor essay/report due near the end of the semester worth 10%. Some portion of this will correspond to peer review you provide on essays from others in the course. *This is not peer evaluation, and your review will not influence the grade of other essays.* The idea is to give you a chance to provide & receive feedback before the final submission. More details to come!

Lectures

We will hopefully be in-person for the lectures this semester. Please be aware that we may record the live lectures to accommodate students that cannot be there. In addition, wherever possible, we may stream the lectures live for students to participate remotely. There is no guarantee that either of these will work, and we will regardless make of the core course content available to students through onQ.

The University has taken steps to configure these platforms in a secure manner. Where possible, classes will be recorded with video and audio (and in some cases transcription) and will be made available to students in the course for the duration of the term. The recordings may capture your name, image or voice through the video and audio recordings. By attending these live classes, you are consenting to the collection of this information for the purposes of administering the class and associated coursework. If you are concerned about the collection of your name and other personal information in the class, please contact the course instructor to identify possible alternatives.

To learn more about how your personal information is collected, used and disclosed by Queen's University, please see the Notice of Collection, Use and Disclosure of Personal Information.

Communication

Announcements and course material will be posted on the appropriate onQ page. We will have a dedicated forum on the School of Computing's Discourse found at https://discourse.caslab.queensu.ca/. This is the primary location for communication with your classmates and teaching staff. Questions of a sensitive nature (e.g., problems with a particular assignment question) should be directed either to (1) the TA responsible for the relevant topic; or (2) the head TA. If neither can help with your request, they will direct you to myself.

Why can't I email you directly?
I'd love to chat directly with all the students, but will unfortunately have ~500 students across various classes to accommodate!! This means that your email will likely go unanswered unless you follow the recommendations above. If it's a question that isn't sensitive in nature (e.g., "how do I apply this rule?"), then asking on the Discourse Forum means that (1) I just may pop in to answer; and (2) many of your classmates will also benefit from the question.

Miscellaneous Items

The School of Computing provides a common syllabus component for courses in the department. You should consider it to be a proper extension of this syllabus, and you can find the details here:

https://www.cs.queensu.ca/students/undergraduate/syllabus/year2021-22.php

For information on academic integrity, accommodation requests, copyright, etc., please see "**University and Course Policies**" in the Course OnQ.

Generally, you retain copyright to the materials you submit for the course (e.g., the course project submission). However, we reserve the option to make use of the logic formulae and proofs that you produce during the semester for future iterations of the course. These aspects contain no identifiable information, and we will not associate personally identifiable information with these elements.

Finally, for any considerations beyond the flexibility built into the course, please refer to the process for academic considerations here (the FAQ linked on that page answers many questions):

https://www.queensu.ca/artsci/undergrad-students/academic-consideration-for-students