CISC204: Logic for Computing Science

WINTER 2022

Preface:

It wasn't that long ago when we all thought that CISC204/CMPE204 would be happening in person at Queen's University. 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? In brief:

- There will be ample opportunity to let us know how things are going, and we will be doing our best to be flexible in responding to and acting on this feedback
- We have designed the syllabus with a diversity of students in mind – most learning material can be accessed asynchronously, accommodations for quizzes will be managed by us
- We use a "universal design" approach to academic consideration for tests; here, you can drop the lowest test grade without academic penalty
- We will have multiple 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 online!

What We Want You To Learn:

By the end of this course, you should be able to phrase natural language statements in a logical way and be able to formally reason with these logical statements.

Course Contents: The schedule is subject to change. This is the most recent the plan to cover the course material.

Propositional Logic: Deduction (2 weeks)

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

Propositional Logic: Semantics (3 weeks)

- Well formed formulas
- Truth tables
- Semantic entailment
- Soundness and completeness
- Semantic equivalence
- Satisfiability
- De Morgan's Laws
- 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 Jape software for proof verification and, optionally, key Python packages for logical reasoning. Some of these skills may prove essential throughout your entire degree.

Learning Outcomes, Course Level:

These are the learning outcomes, using the program codes for the School of Computing

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

Textbook:

We will use the text *Logic in Computer Science: Modelling and Reasoning about Systems* by Huth and Ryan, ISBN 9780521543101. We will cover most of chapters 1 and 2. Content from other chapters may appear but will be limited.

We will also use the instructor's notes and other sources that are available through permissions granted to the Queen's University Library.