cse541
LOGIC FOR COMPUTER SCIENCE

Professor Anita Wasilewska
LECTURE 0
GENERAL INFORMATION
Course Text Book

Anita Wasilewska

Logics for Computer Science: Classical and Non-Classical

Springer 2018


You can get the book in Hard cover, or in Electronic form

Springer also has an option of providing you with chapters of your choice

The BOOK Goal

I wrote the Book with students on my mind so that they can read and learn by themselves, even before coming to class. For sure, it is also essential to study after the class.

The Book and hence the course progresses slowly, making sure that the pace is appropriate for somebody without previous knowledge of formal logic.

The Book contains hundreds of examples and problems with detailed solutions to facilitate understanding of material.
Course Goal

The main goal of the course is to teach intuitive and formal understanding of the classical logic and some non-classical logics.

Moreover, the goal of course is also to teach the modern formal logic as a scientific subject.

You will learn Formal Logic basic notions and definitions, Main Theorems, similarities, differences and problems characteristic to different logics; classical and non-classical
Course Web Page
www3.cs.stonybrook.edu/~cse541

The course Webpage contains:

Lecture SLIDES for each chapter of the BOOK

Collection of passed Quizzes and Tests

We will not cover all of the chapters of the BOOK in detail
I made Lectures for all of them accessible for students’ reading and future use
Course Webpage
www3.cs.stonybrook.edu/~cse541

The course **Webpage** contains two kind of Lectures: **Class Lectures** and **VIDEO Lectures**

The **Class Lectures** are very detailed lectures slides
They were developed for each **Chapter** of the Textbook

Usually there are 2 - 5 **Class Lectures** for one **Chapter**
The **Video Lectures** are created especially for the Logic Youtube Channel

The **VIDEO Lectures** correspond, chapter by chapter to the slides used in the Textbook Chapters **VIDEOS**

You can use the **VIDEO Lectures** slides to follow the Chapters **VIDEOS** as they are exactly the same as slides used in the **VIDEOS**
Logic Youtube Channel

LOGIC, Theory of Computation CHANNEL
https://www.youtube.com/channel/UCLZp06JC9yit6M_YW3XuvIw
First 4 VIDEOS are for the Theory of Computation, the LOGIC VIDEOS follow
TESTING

All QUIZZES and TESTS, including the FINAL Examination will be given as a IN CLASS TESTS

I will design them is a way the most profitable for your new way of learning
Workload

There will be two Quizzes, one Midterm, Practice Final, and a Final.

The consistency of your efforts and work is the most important for this course.

None of the grades will be curved.

Records of students points are kept on BLACKBOARD.

Contact only TAs for information about grading, grades changes, etc....
Workload

**TESTS** and Quizzes cover Lectures and Book Chapters only for the *portion* of material that was *covered* before the dates of respective tests.

Consult Weekly STUDY PLAN

**Quizzes (total 50 pts)**
There will be 2 quizzes, 25 points each
Each quiz will consist of 3 - 4 questions
Workload

**Midterm (75pts)**
Midterm will covers material from Q1 and material covered after Q1 in class before Midterm

**Practice Final (15 extra pts)** - it is a take home test

**Final (75pts)**
Final will cover mainly material covered after Midterm including material from Q2 and covered after Q2, and on Practice Final
But there will be 2-4 questions from Q1 and the material covered before Midterm

**Extra Credit** I may give some extra credit problems on Tests.
TESTS SCHEDULE

This is a PRELIMINARY schedule. Changes, if any, will be posted on Blackboard and Webpage.

Q1 - Tuesday **September 27**

**MIDTERM** - Thursday, **October 20**

Q2 - Thursday, **November 17**

**Practice Final** - posted **November 29** - due **December 1**
Workload

Quizzes and Tests problems will be very similar to exercises and problems solved in the Book. They can be very similar to some Homework Assignments located at the end of the chapters of the BOOK. They also can be similar to problems included in the Lectures, previous Quizzes, and Tests as published on the Webpage.

There also will be some challenge problems given as extra credit.
Final grade computation

You can earn up to 200 points + x extra points = 200+x points during the semester

The grade will be determined in the following way:
# of earned points divided by 2 = % grade

The % grade is translated into a letter grade in a standard way as described in the course Syllabus
Final grade computation

The % grade is translated into a letter grade in a standard way i.e.
100 – 95 % is A
94 – 90 is A−
89 – 86% is B+, 85 – 83 % is B, 82 – 80 % is B−
79 – 76 % is C+, 75 – 73 % is C, 72 – 70 % is C−
69 – 60 % is D range and
F is below 60%
General Goals and Tasks of the Book
The General Goal of the Book

The **General Goal** of the book is to make readers understand the need of, and existence of **Logic** as a **scientific** field.

The **book** teaches not only **intuitive** understanding of different logics, but also teaches modern **symbolic logic** as a **scientific** subject.

The **book progresses** relatively **slowly**, making sure that the pace is appropriate for a reader with only **cursory knowledge** of logic.

**Readers** can learn introductory chapters by themselves, and then gradually **progress** to more **advanced** chapters and other, more **advanced books**.
Main Tasks of the Book

First Task when one builds a symbolic logic, or foundations of mathematics, or foundations of computer science, is to define formally a proper symbolic language.

We distinguish and define two kind of languages: propositional and predicate.

They are also called also zero and first order languages, respectively.
Main Tasks of the Book

**Second Task** is to define formally what does it mean that formulas of a symbolic language are considered to be true, and always true i.e. we have to define a notion of a tautology.

It means that we define what is called a semantics for a given language.

The same languages can have different semantics.

For example, the languages for classical and intuitionistic logics can be the same, but their the semantics are different.
Main Tasks of the Book

Third Task is to define a syntactical notion of a proof in a proof system based on a given language. It allows us to find out what can, or cannot be proved if certain axioms and rules of inference are assumed. This part of syntax is also called a proof theory.
Main Tasks of the Book

Fourth Task is to investigate the relationship between a syntactical notion of a proof system based on a given language and a semantics for that language.

It means we establish formal relationship between the syntax and semantics for a given language.

This relationship is established by providing answers to the following two questions.
Main Tasks of the Book

Fourth Task is to pose and answer the following questions

Q1: Is everything one proves in a given proof system tautology under a given semantics?

The positive answer to the question Q1 is called Soundness Theorem for a given proof system and a given semantics proof system

Such proof system is called a sound proof system
Main Tasks of the Book

We write the **Soundness Theorem** symbolically as follows

**Soundness Theorem** (with respect to a semantics $M$)
Let $S$ be a proof system and $A$ any formula of its language, then the following holds

\[
\text{IF } \vdash_S A \text{ THEN } \models_M A
\]
Main Tasks of the Book

Q2: Is it also possible to guarantee a **provability** in a **sound** proof system of everything we know to be a **tautology** under a given semantics?

The positive answer to the question Q2 is called **Completeness Theorem** for a proof system under a given semantics.

Such proof system is called **complete** proof system with respect to the given semantics.
Main Tasks of the Book

We write the Completeness Theorem symbolically as follows

**CompletenessTheorem** (with respect to a semantics $M$)

Let $S$ be a proof system and $A$ any formula of its language, then the following holds

$$\vdash_S A \quad \text{if and only if} \quad \models_M A$$
Main Tasks of the Book

Fifth Task is to develop proof systems in which a process of finding proofs can be carried fully automatically.

These are automated theorem proving systems.

The book presents various Gentzen Type automated theorem proving systems.

It also discusses various methods of proving the Completeness Theorem for them.

The book also provides an introduction to the Resolution based automated theorem proving systems.
Main Goals of the Book

The first set of Main Goals of the book is to formally define and develop the above FIVE TASKS in case of Classical Propositional and Predicate Logic.

The second set of Main Goals is to develop and discuss the FIVE TASKS for some Non-Classical Propositional Logics, namely for some extensional Many Valued logics, for the Intuitionistic logic, and Modal S4, S5 logics.
Main Goals of the Book

The third set of **Main Goals** of the book is to formally define and develop the notion of a **formal theory** based on a given **proof system** for a first order logic.

It discusses notions of a **model** of a theory, its semantical and syntactical **consistency** and **completeness**.

The book presents some **Formal Theories** based on classical predicate logic. In particular presents the **Peano Arithmetic of Natural Numbers PA** and discusses and proves the **Gödel Incompleteness Theorems**.