Mathematical Logic

Theorem 1.2.29: Let p, q, and r be statements. Then the following logical equivalences hold.

(i)   *Commutative laws:* $p \wedge q \equiv q \wedge p$ and $p \vee q \equiv q \vee p$

(ii)   *Associative laws:* $(p \wedge q) \wedge r \equiv p \wedge (q \wedge r)$ and
$$(p \vee q) \vee r \equiv p \vee (q \vee r)$$

(iii)   *Distributive laws:* $p \vee (q \wedge r) \equiv (p \vee q) \wedge (p \vee r)$ and
$$p \wedge (q \vee r) \equiv (p \wedge q) \vee (p \wedge r)$$

(iv)   *Absorption laws*: $p \wedge (p \vee q) \equiv p$ and $p \vee (p \wedge q) \equiv p$

(v)   *Idempotent laws:* $p \wedge p \equiv p$ and $p \vee p \equiv p$

(vi)   *Double negation law:* $\sim\sim p \equiv p$

(vii)   *DeMorgan's laws:* $\sim(p \wedge q) \equiv (\sim p) \vee (\sim q)$ and
$$\sim(p \vee q) \equiv (\sim p) \wedge (\sim q)$$

Mathematical Logic

G. T. Kneebone

Mathematical Logic:

A Concise Introduction to Mathematical Logic Wolfgang Rautenberg,2006-09-28 While there are already several well known textbooks on mathematical logic this book is unique in treating the material in a concise and streamlined fashion This allows many important topics to be covered in a one semester course Although the book is intended for use as a graduate text the first three chapters can be understood by undergraduates interested in mathematical logic The remaining chapters contain material on logic programming for computer scientists model theory recursion theory Godel s Incompleteness Theorems and applications of mathematical logic Philosophical and foundational problems of mathematics are discussed throughout the text **Mathematical Logic for Computer Science** Mordechai Ben-Ari,2012-06-16 Mathematical Logic for Computer Science is a mathematics textbook with theorems and proofs but the choice of topics has been guided by the needs of students of computer science The method of semantic tableaux provides an elegant way to teach logic that is both theoretically sound and easy to understand The uniform use of tableaux based techniques facilitates learning advanced logical systems based on what the student has learned from elementary systems The logical systems presented are propositional logic first order logic resolution and its application to logic programming Hoare logic for the verification of sequential programs and linear temporal logic for the verification of concurrent programs The third edition has been entirely rewritten and includes new chapters on central topics of modern computer science SAT solvers and model checking **Modern Mathematical Logic** Joseph Mileti,2022-09-22 This textbook gives a complete and modern introduction to mathematical logic The author uses contemporary notation conventions and perspectives throughout and emphasizes interactions with the rest of mathematics In addition to covering the basic concepts of mathematical logic and the fundamental material on completeness compactness and incompleteness it devotes significant space to thorough introductions to the pillars of the modern subject model theory set theory and computability Requiring only a modest background of undergraduate mathematics the text can be readily adapted for a variety of one or two semester courses at the upper undergraduate or beginning graduate level Numerous examples reinforce the key ideas and illustrate their applications and a wealth of classroom tested exercises serve to consolidate readers understanding Comprehensive and engaging this book offers a fresh approach to this enduringly fascinating and important subject *Handbook of Mathematical Logic* J. Barwise,1982-03-01 The handbook is divided into four parts model theory set theory recursion theory and proof theory Each of the four parts begins with a short guide to the chapters that follow Each chapter is written for non specialists in the field in question Mathematicians will find that this book provides them with a unique opportunity to apprise themselves of developments in areas other than their own *Introduction to Mathematical Logic* Elliot Mendelsohn,2012-12-06 This is a compact mtroduction to some of the pnncipal tOpICS of mathematical logic In the belief that beginners should be exposed to the most natural and easiest proofs I have used free swinging set theoretic methods The

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   Mathematical Logic George Tourlakis,2011-03-01 A comprehensive and user friendly guide to the use of logic in mathematical reasoning Mathematical Logic presents a comprehensive introduction to formal methods of logic and their use as a reliable tool for deductive reasoning With its user friendly approach this book successfully equips readers with the key concepts and methods for formulating valid mathematical arguments that can be used to uncover truths across diverse areas of study such as mathematics computer science and philosophy The book develops the logical tools for writing proofs by guiding readers through both the established Hilbert style of proof writing as well as the equational style that is emerging in computer science and engineering applications Chapters have been organized into the two topical areas of Boolean logic and predicate logic Techniques situated outside formal logic are applied to illustrate and demonstrate significant facts regarding the power and limitations of logic such as Logic can certify truths and only truths Logic can certify all absolute truths completeness theorems of Post and G del Logic cannot certify all conditional truths such as those that are specific to the Peano arithmetic Therefore logic has some serious limitations as shown through G del s incompleteness theorem Numerous examples and problem sets are provided throughout the text further facilitating readers understanding of the capabilities of logic to discover mathematical truths In addition an extensive appendix introduces Tarski semantics and proceeds with detailed proofs of completeness and first incompleteness theorems while also providing a self contained introduction to the theory of computability With its thorough scope of coverage and accessible style Mathematical Logic is an ideal book for courses in mathematics computer science and philosophy at the upper undergraduate and graduate levels It is also a

valuable reference for researchers and practitioners who wish to learn how to use logic in their everyday work   A Course on Mathematical Logic Shashi Mohan Srivastava,2013-01-16 This is a short modern and motivated introduction to mathematical logic for upper undergraduate and beginning graduate students in mathematics and computer science Any mathematician who is interested in getting acquainted with logic and would like to learn G del s incompleteness theorems should find this book particularly useful The treatment is thoroughly mathematical and prepares students to branch out in several areas of mathematics related to foundations and computability such as logic axiomatic set theory model theory recursion theory and computability In this new edition many small and large changes have been made throughout the text The main purpose of this new edition is to provide a healthy first introduction to model theory which is a very important branch of logic Topics in the new chapter include ultraproduct of models elimination of quantifiers types applications of types to model theory and applications to algebra number theory and geometry Some proofs such as the proof of the very important completeness theorem have been completely rewritten in a more clear and concise manner The new edition also introduces new topics such as the notion of elementary class of structures elementary diagrams partial elementary maps homogeneous structures definability and many more   **Mathematical Logic** Roman Kossak,2018-10-03 This book presented in two parts offers a slow introduction to mathematical logic and several basic concepts of model theory such as first order definability types symmetries and elementary extensions Its first part Logic Sets and Numbers shows how mathematical logic is used to develop the number structures of classical mathematics The exposition does not assume any prerequisites it is rigorous but as informal as possible All necessary concepts are introduced exactly as they would be in a course in mathematical logic but are accompanied by more extensive introductory remarks and examples to motivate formal developments The second part Relations Structures Geometry introduces several basic concepts of model theory such as first order definability types symmetries and elementary extensions and shows how they are used to study and classify mathematical structures Although more advanced this second part is accessible to the reader who is either already familiar with basic mathematical logic or has carefully read the first part of the book Classical developments in model theory including the Compactness Theorem and its uses are discussed Other topics include tameness minimality and order minimality of structures The book can be used as an introduction to model theory but unlike standard texts it does not require familiarity with abstract algebra This book will also be of interest to mathematicians who know the technical aspects of the subject but are not familiar with its history and philosophical background   **A Beginner's Guide to Mathematical Logic** Raymond M. Smullyan,2014-03-19 Combining stories of great writers and philosophers with quotations and riddles this original text for first courses in mathematical logic examines problems related to proofs propositional logic and first order logic undecidability and other topics 2014 edition   **Introduction to Mathematical Logic** Jerome Malitz,2012-12-06 This book is intended as an undergraduate senior level or beginning graduate level text for mathematical

logic There are virtually no prere quisites although a familiarity with notions encountered in a beginning course in abstract algebra such as groups rings and fields will be useful in providing some motivation for the topics in Part III An attempt has been made to develop the beginning of each part slowly and then to gradually quicken the pace and the complexity of the material Each part ends with a brief introduction to selected topics of current interest The text is divided into three parts one dealing with set theory another with computable function theory and the last with model theory Part III relies heavily on the notation concepts and results discussed in Part I and to some extent on Part II Parts I and II are independent of each other and each provides enough material for a one semester course The exercises cover a wide range of difficulty with an emphasis on more routine problems in the earlier sections of each part in order to familiarize the reader with the new notions and methods The more difficult exercises are accompanied by hints In some cases significant theorems are devel oped step by step with hints in the problems Such theorems are not used later in the sequence   **Mathematical Logic** René Cori,Daniel Lascar,2000 Logic forms the basis of mathematics and is hence a fundamental part of any mathematics course It is a major element in theoretical computer science and has undergone a huge revival with the every growing importance of computer science This text is based on a course to undergraduates and provides a clear and accessible introduction to mathematical logic The concept of model provides the underlying theme giving the text a theoretical coherence whilst still covering a wide area of logic The foundations having been laid in Part I this book starts with recursion theory a topic essential for the complete scientist Then follows Godel s incompleteness theorems and axiomatic set theory Chapter 8 provides an introduction to model theory There are examples throughout each section and varied selection of exercises at the end Answers to the exercises are given in the appendix   **Mathematical Logic and the Foundations of Mathematics** G. T. Kneebone,1963   **Mathematical Logic** Ian Chiswell,Wilfrid Hodges,2007-05-17 Assuming no previous study in logic this informal yet rigorous text covers the material of a standard undergraduate first course in mathematical logic using natural deduction and leading up to the completeness theorem for first order logic At each stage of the text the reader is given an intuition based on standard mathematical practice which is subsequently developed with clean formal mathematics Alongside the practical examples readers learn what can and can t becalculated for example the correctness of a derivation proving a given sequent can be tested mechanically but there is no general mechanical test for the existence of a derivation proving the given sequent The undecidability results are proved rigorously in an optional final chapter assumingMatiyasevich s theorem characterising the computably enumerable relations Rigorous proofs of the adequacy and completeness proofs of the relevant logics are provided with careful attention to the languages involved Optional sections discuss the classification of mathematical structures by first order theories the required theory of cardinality is developed from scratch Throughout the book there are notes on historical aspects of the material and connections with linguistics andcomputer science and the discussion of syntax and semantics is influenced by modern linguistic approaches Two basic themes in recent cognitive

science studies of actual human reasoning are also introduced Including extensive exercises and selected solutions this text is ideal for students in Logic Mathematics Philosophy and Computer Science   Mathematical Logic Heinz-Dieter Ebbinghaus,Jörg Flum,Wolfgang Thomas,2021-05-28 This introduction to first order logic clearly works out the role of first order logic in the foundations of mathematics particularly the two basic questions of the range of the axiomatic method and of theorem proving by machines It covers several advanced topics not commonly treated in introductory texts such as Fra ss s characterization of elementary equivalence Lindstr m s theorem on the maximality of first order logic and the fundamentals of logic programming   **Mathematical Logic** H.-D. Ebbinghaus,J. Flum,Wolfgang Thomas,2013-03-14 What is a mathematical proof How can proofs be justified Are there limitations to provability To what extent can machines carry out mathe matical proofs Only in this century has there been success in obtaining substantial and satisfactory answers The present book contains a systematic discussion of these results The investigations are centered around first order logic Our first goal is Godel s completeness theorem which shows that the con sequence relation coincides with formal provability By means of a calcu lus consisting of simple formal inference rules one can obtain all conse quences of a given axiom system and in particular imitate all mathemat ical proofs A short digression into model theory will help us to analyze the expres sive power of the first order language and it will turn out that there are certain deficiencies For example the first order language does not allow the formulation of an adequate axiom system for arithmetic or analysis On the other hand this difficulty can be overcome even in the framework of first order logic by developing mathematics in set theoretic terms We explain the prerequisites from set theory necessary for this purpose and then treat the subtle relation between logic and set theory in a thorough manner   *Mathematical Logic* Joseph R. Shoenfield,2001-02-09 8 3 The consistency proof 8 4 Applications of the consistency proof 8 5 Second order arithmetic Problems Chapter 9 Set Theory 9 1 Axioms for sets 9 2 Development of set theory 9 3 Ordinals 9 4 Cardinals 9 5 Interpretations of set theory 9 6 Constructible sets 9 7 The axiom of constructibility 9 8 Forcing 9 9 The independence proofs 9 10 Large cardinals Problems Appendix The Word Problem Index   **Set Theory And Foundations Of Mathematics: An Introduction To Mathematical Logic - Volume I: Set Theory (Second Edition)** Douglas Cenzer,Christopher Porter,Jindrich Zapletal,2025-01-10 This book presents both axiomatic and descriptive set theory targeting upper level undergraduate and beginning graduate students It aims to equip them for advanced studies in set theory mathematical logic and other mathematical fields including analysis topology and algebra The book is designed as a flexible and accessible text for a one semester introductory in set theory where the existing alternatives may be more demanding or specialized Readers will learn the universally accepted basis of the field with several popular topics added as an option Pointers to more advanced study are scattered through the text This new edition includes additional topics on trees ordinal functions and sets along with numerous new exercises The presentation has been improved and several typographical errors have been corrected   An Introduction to Mathematical Logic and Type Theory Peter B. Andrews,2013-04-17 In case

you are considering to adopt this book for courses with over 50 students please contact ties nijssen springer com for more information This introduction to mathematical logic starts with propositional calculus and first order logic Topics covered include syntax semantics soundness completeness independence normal forms vertical paths through negation normal formulas compactness Smullyan s Unifying Principle natural deduction cut elimination semantic tableaux Skolemization Herbrand s Theorem unification duality interpolation and definability The last three chapters of the book provide an introduction to type theory higher order logic It is shown how various mathematical concepts can be formalized in this very expressive formal language This expressive notation facilitates proofs of the classical incompleteness and undecidability theorems which are very elegant and easy to understand The discussion of semantics makes clear the important distinction between standard and nonstandard models which is so important in understanding puzzling phenomena such as the incompleteness theorems and Skolem s Paradox about countable models of set theory Some of the numerous exercises require giving formal proofs A computer program called ETPS which is available from the web facilitates doing and checking such exercises Audience This volume will be of interest to mathematicians computer scientists and philosophers in universities as well as to computer scientists in industry who wish to use higher order logic for hardware and software specification and verification   *Popular Lectures on Mathematical Logic* Hao Wang,1993-01-01 Noted logician discusses both theoretical underpinnings and practical applications exploring set theory model theory recursion theory and constructivism proof theory logic s relation to computer science and other subjects 1981 edition reissued by Dover in 1993 with a new Postscript by the author

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