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Teacher's Edition for Beginning Algebra, Form B College Algebra Academic Assessment and Intervention The Algebraic and Geometric Theory of Quadratic Forms Lie Groups and Lie Algebras III Tame Algebras and Integral Quadratic Forms Introduction to Quadratic Forms over Fields Geometry, Topology, and Mathematical Physics Representations and Invariants of the Classical Groups Introduction to Finite and Infinite Dimensional Lie (Super)algebras The Scope and History of Commutative and Noncommutative Harmonic Analysis Intermediate Algebra 2e W-symmetry Geometric Methods in the Algebraic Theory of Quadratic Forms Clifford Algebras with Numeric and Symbolic Computations Control Theory and Optimization I Nilpotent Lie Algebras Quadratic and Higher Degree Forms Differential Geometric Structures Classification and Identification of Lie Algebras Logic and Program Semantics Singularities of Differentiable Maps, Volume 1 Lie Algebras, Part 2 Geometry of Nonpositively Curved Manifolds Noncommutative Algebraic Geometry Period Mappings and Period Domains Lie Algebras, Geometry, and Toda-Type Systems Encyclopaedia of Mathematics Lectures on Real Semisimple Lie Algebras and Their Representations Singularities of Differentiable Maps Complex Semisimple Lie Algebras Reveal Algebra 2 Representation of Lie Groups and Special Functions Instructor's Resource Manual [for] Elementary Algebra for College Students [by] Allen R. Angel Lie Algebras Graded by the Root Systems BC$_r$, $r\geq 2$ Symmetry, Representations, and Invariants Lie Theory Quantum Invariants Hypoelliptic Laplacian and Orbital Integrals (AM-177) Dirac Operators in Representation Theory

This Festschrift volume is published in honor of Dexter Kozen on the occasion of his 60th birthday. Dexter Kozen has been a leader in the development of Kleene Algebras (KAs). The contributions in this volume reflect the breadth of his work and influence. The volume includes 19 full papers related to Dexter Kozen's research. They deal with coalgebraic methods, congruence closure; the completeness of various programming logics; decision procedure for logics; alternation; algorithms and complexity; and programming languages and program analysis. The second part of this volume includes laudatios from several collaborators, students and friends, including the members of his current band. ... there is nothing so enthralling, so grandiose, nothing that stuns or captivates the human soul quite so much as a first course in a science. After the first five or six lectures one already holds the brightest hopes, already sees oneself as a seeker after truth. I too have wholeheartedly pursued science passionately, as one would a beloved woman. I was a slave, and sought no other sun in my life. Day and night I crammed myself, bending my back, ruining myself over my books; I wept when I beheld others exploiting science fot personal gain. But I was not long enthralled. The truth is every science has a beginning, but never an end - they go on for ever like periodic fractions. Zoology, for example, has discovered thirty-five thousand forms of life ... A. P. Chekhov. "On the road" In this book a start is made to the "zoology" of the singularities of differentiable maps. This theory is a young branch of analysis which currently occupies a central place in mathematics; it is the crossroads of paths leading from very abstract corners of mathematics (such as algebraic and differential geometry and topology, Lie groups and algebras, complex manifolds, commutative algebra and the like) to the most applied areas (such as differential equations and dynamical systems, optimal control, the theory of bifurcations and catastrophes, short-wave and saddle-point asymptotics and geometrical and wave optics). ?Singularity theory is a far-reaching extension of maxima and minima investigations of differentiable functions, with implications for many different areas of mathematics, engineering (catastrophe theory and the theory of bifurcations), and science. The three parts of this first volume of a two-volume set deal with the stability problem for smooth mappings, critical points of smooth functions, and caustics and wave front singularities. The second volume describes the topological and algebro-geometrical aspects of the theory: monodromy, intersection forms, oscillatory integrals, asymptotics, and mixed Hodge structures of singularities. The first volume has been adapted for the needs of non-mathematicians, presupposing a limited mathematical background and beginning at an elementary level. With this foundation, the book's sophisticated development permits readers to explore more applications than previous books on singularities. In the last decade, the areas of quadratic and higher degree forms have witnessed dramatic advances. This volume is an outgrowth of three seminal conferences on these topics held in 2009, two at the University of Florida and one at the Arizona Winter School. The volume also includes papers from the two focused weeks on quadratic forms and integral lattices at the University of Florida in 2010.Topics discussed include the links between quadratic forms and automorphic forms, representation of integers and forms by quadratic forms, connections between quadratic forms and lattices, and algorithms for quaternion algebras and quadratic forms. The book will be of interest to graduate students and mathematicians wishing to study quadratic and higher degree forms, as well as to established researchers in these areas. Quadratic and Higher Degree Forms contains research and semi-expository papers that stem from the presentations at conferences at the University of Florida as well as survey lectures on quadratic forms based on the instructional workshop for graduate students held at the Arizona Winter School. The survey papers in the volume provide an excellent introduction to various aspects of the theory of quadratic forms starting from the basic concepts and provide a glimpse of some of the exciting questions currently being investigated. The research and expository papers present the latest advances on quadratic and higher degree forms and their connections with various branches of mathematics. This volume is devoted to the theory of nilpotent Lie algebras and their applications. Nilpotent Lie algebras have played an important role over the last years both in the domain of algebra, considering its role in the classification problems of Lie algebras, and in the domain of differential geometry. Among the topics discussed here are the following: cohomology theory of Lie algebras, deformations and contractions, the algebraic variety of the laws of Lie algebras, the variety of nilpotent laws, and characteristically nilpotent Lie algebras in nilmanifolds. Audience: This book is intended for graduate students specialising in algebra, differential geometry and in theoretical physics and for researchers in mathematics and in theoretical physics. Starting from the foundations, the author presents an almost entirely self-contained treatment of differentiable spaces of nonpositive curvature, focusing on the symmetric spaces in which every geodesic lies in a flat Euclidean space of dimension at least two. The book builds to a discussion of the Mostow Rigidity Theorem and its generalizations, and concludes by exploring the relationship in nonpositively curved spaces between geometric and algebraic properties of the fundamental group. This introduction to the geometry of symmetric spaces of non-compact type will serve as an excellent guide for graduate students new to the material, and will also be a useful reference text for mathematicians already familiar with the subject. This is the long awaited follow-up to Lie Algebras, Part I which covered a major part of the theory of Kac-Moody algebras, stressing primarily their mathematical structure. Part II deals mainly with the representations and applications of Lie Algebras and contains many cross references to Part I. The theoretical part largely deals with the representation theory of Lie algebras with a triangular decomposition, of which Kac-Moody algebras and the Virasoro algebra are prime examples. After setting up the general framework of highest weight representations, the book continues to treat topics as the Casimir operator and the Weyl-Kac character formula, which are specific for Kac-Moody algebras. The applications have a wide range. First, the book contains an exposition on the role of finite-dimensional semisimple Lie algebras and their representations in the standard and grand unified models of elementary particle physics. A second application is in the realm of soliton equations and their infinite-dimensional symmetry groups and algebras. The book concludes with a chapter on conformal field theory and the importance of the Virasoro and Kac-Moody algebras therein. * Focuses on two fundamental questions related to semisimple Lie groups: the geometry of Riemannian symmetric spaces and their compactifications, and branching laws for unitary representations * Wide applications of compactification techniques * Concrete examples and relevant exercises engage the reader * Knowledge of basic representation theory of Lie groups, semisimple Lie groups and symmetric spaces is required This book presents a comprehensive treatment of important new ideas on Dirac operators and Dirac cohomology. Using Dirac operators as a unifying theme, the authors demonstrate how some of the most important results in representation theory fit together when viewed from this perspective. The book is an excellent contribution to the mathematical literature of representation theory, and this self-contained exposition offers a systematic examination and panoramic view of the subject. The material will be of interest to researchers and graduate students in representation theory, differential geometry, and physics. "When I was invited to speak at the conference on the history of analysis given at Rice University [in 1977], I decided that it might be interesting to review the history of mathematics and physics in the last three hundred years or so with heavy emphasis on those parts in which harmonic analysis had played a decisive or at least a major role. I was pleased and somewhat astonished to find how much of both subjects could be included under this rubric ... The picture that gradually emerged as the various details fell into place was one that I found very beautiful, and the process of seeing it do so left me in an almost constant state of euphoria. I would like to believe that others can be led to see this picture by reading my paper, and to facilitate this I have included a large number of short expositions of topics which are not widely understood by non-specialists." --from the Preface This volume, containing the paper mentioned above as well as five other reprinted papers by Mackey, presents a sweeping view of the importance, utility, and beauty of harmonic analysis and its connections to other areas of mathematics and science. A seventh paper, written exclusively for this volume, attempts to unify certain themes that emerged after major discoveries in 1967 and 1968 in the areas of Lie algebras, strong interaction physics, statistical mechanics, and nonlinear partial differential equations--discoveries that may at first glance appear to be independent, but which are in fact deeply interrelated. Information for our distributors: Copublished with the London Mathematical Society beginning with volume 4. Members of the LMS may order directly from the AMS at the AMS member price. The LMS is registered with the Charity Commissioners. This ENCYCLOPAEDIA OF MATHEMATICS aims to be a reference work for all parts of mathematics. It is a translation with updates and editorial comments of the Soviet Mathematical En cyclopaedia published by 'Soviet Encyclopaedia Publishing House' in five volumes in 1977 - 1985. The annotated translation consists of ten volumes including a special index volume. There are three kinds of articles in this ENCYCLOPAEDIA. First of all there are survey-type articles dealing with the various main directions in mathematics (where a rather fine subdivision has been used). The main requirement for these articles has been that they should give a reasonably complete up-to-date account of the current state of affairs in these areas and that they should be maximally accessible. On the whole, these articles should be understandable to mathe matics students in their first specialization years, to graduates from other mathematical areas and, depending on the specific subject, to specialists in other domains of science, engineers and teachers of mathematics. These articles treat their material at a fairly general level and aim to give an idea of the kind of problems, techniques and concepts involved in the area in question. They also contain background and motivation rather than precise statements of precise theorems with detailed definitions and technical details on how to carry out proofs and constructions. The second kind of article, of medium length, contains more detailed concrete problems, results and techniques. This book uses the hypoelliptic Laplacian to evaluate semisimple orbital integrals in a formalism that unifies index theory and the trace formula. The hypoelliptic Laplacian is a family of operators that is supposed to interpolate between the ordinary Laplacian and the geodesic flow. It is essentially the weighted sum of a harmonic oscillator along the fiber of the tangent bundle, and of the generator of the geodesic flow. In this book, semisimple orbital integrals associated with the heat kernel of the Casimir operator are shown to be invariant under a suitable hypoelliptic deformation, which is constructed using the Dirac operator of Kostant. Their explicit evaluation is obtained by localization on geodesics in the symmetric space, in a formula closely related to the Atiyah-Bott fixed point formulas. Orbital integrals associated with the wave kernel are also computed. Estimates on the hypoelliptic heat kernel play a key role in the proofs, and are obtained by combining analytic, geometric, and probabilistic techniques. Analytic techniques emphasize the wavelike aspects of the hypoelliptic heat kernel, while geometrical considerations are needed to obtain proper control of the hypoelliptic heat kernel, especially in the localization process near the geodesics. Probabilistic techniques are especially relevant, because underlying the hypoelliptic deformation is a deformation of dynamical systems on the symmetric space, which interpolates between Brownian motion and the geodesic flow. The Malliavin calculus is used at critical stages of the proof. Lie superalgebras are a natural generalization of Lie algebras, having applications in geometry, number theory, gauge field theory, and string theory. Introduction to Finite and Infinite Dimensional Lie Algebras and Superalgebras introduces the theory of Lie superalgebras, their algebras, and their representations. The material covered ranges from basic definitions of Lie groups to the classification of finite-dimensional representations of semi-simple Lie algebras. While discussing all classes of finite and infinite dimensional Lie algebras and Lie superalgebras in terms of their different classes of root systems, the book focuses on Kac-Moody algebras. With numerous exercises and worked examples, it is ideal for graduate courses on Lie groups and Lie algebras. Discusses the fundamental structure and all root relationships of Lie algebras and Lie superalgebras and their finite and infinite dimensional representation theory Closely describes BKM Lie superalgebras, their different classes of imaginary root systems, their complete classifications, root-supermultiplicities, and related combinatorial identities Includes numerous tables of the properties of individual Lie algebras and Lie superalgebras Focuses on Kac-Moody algebras College Algebra provides a comprehensive exploration of algebraic principles and meets scope and sequence requirements for a typical introductory algebra course. The modular approach and richness of content ensure that the book meets the needs of a variety of courses. College Algebra offers a wealth of examples with detailed, conceptual explanations, building a strong foundation in the material before asking students to apply what they've learned. Coverage and Scope In determining the concepts, skills, and topics to cover, we engaged dozens of highly experienced instructors with a range of student audiences. The resulting scope and sequence proceeds logically while allowing for a significant amount of flexibility in instruction. Chapters 1 and 2 provide both a review and foundation for study of Functions that begins in Chapter 3. The authors recognize that while some institutions may find this material a prerequisite, other institutions have told us that they have a cohort that need the prerequisite skills built into the course.

Chapter 1: Prerequisites Chapter 2: Equations and Inequalities Chapters 3-6: The Algebraic Functions Chapter 3: Functions Chapter 4: Linear Functions Chapter 5: Polynomial and Rational Functions Chapter 6: Exponential and Logarithm Functions Chapters 7-9: Further Study in College Algebra Chapter 7: Systems of Equations and Inequalities Chapter 8: Analytic Geometry Chapter 9: Sequences, Probability and Counting Theory Useful for independent study and as a reference work, this introduction to differential geometry features many examples and exercises. It defines geometric structure by specifying the parallel transport in an appropriate fiber bundle, focusing on the simplest cases of linear parallel transport in a vector bundle. The treatment opens with an introductory chapter on fiber bundles that proceeds to examinations of connection theory for vector bundles and Riemannian vector bundles. Additional topics include the role of harmonic theory, geometric vector fields on Riemannian manifolds, Lie groups, symmetric spaces, and symplectic and Hermitian vector bundles. A consideration of other differential geometric structures concludes the text, including surveys of characteristic classes of principal bundles, Cartan connections, and spin structures. This volume contains a selection of papers based on presentations given in 2006-2007 at the S. P. Novikov Seminar at the Steklov Mathematical Institute in Moscow. Novikov's diverse interests are reflected in the topics presented in the book. The articles address topics in geometry, topology, and mathematical physics. The volume is suitable for graduate students and researchers interested in the corresponding areas of mathematics and physics. The book describes integrable Toda type systems and their Lie algebra and differential geometry background. The geometric approach to the algebraic theory of quadratic forms is the study of projective quadrics over arbitrary fields. Function fields of quadrics have been central to the proofs of fundamental results since the 1960's. Recently, more refined geometric tools have been brought to bear on this topic, such as Chow groups and motives, and have produced remarkable advances on a number of outstanding problems. Several aspects of these new methods are addressed in this volume, which includes an introduction to motives of quadrics by A. Vishik, with various applications, notably to the splitting patterns of quadratic forms, papers by O. Izhboldin and N. Karpenko on Chow groups of quadrics and their stable birational equivalence, with application to the construction of fields with u-invariant 9, and a contribution in French by B. Kahn which lays out a general framework for the computation of the unramified cohomology groups of quadrics and other cellular varieties. W-symmetry is an extension of conformal symmetry in two dimensions. Since its introduction in 1985, W-symmetry has become one of the central notions in the study of two-dimensional conformal field theory. The mathematical structures that underlie W-symmetry are so-called W-algebras, which are higher-spin extensions of the Virasoro algebra. This book contains a collection of papers on W-symmetry, covering the period from 1985 through 1993. Its main focus is the construction of W-algebras and their representation theory. A recurrent theme is the intimate connection between W-algebras and affine Lie algebras. Some of the applications, in particular W-gravity, are also covered.The significance of this reprint volume is that there are no textbooks entirely devoted to the subject. These notes are a record of a course given in Algiers from lOth to 21st May, 1965. Their contents are as follows. The first two chapters are a summary, without proofs, of the general properties of nilpotent, solvable, and semisimple Lie algebras. These are well-known results, for which the reader can refer to, for example, Chapter I of Bourbaki or my Harvard notes. The theory of complex semisimple algebras occupies Chapters III and IV. The proofs of the main theorems are essentially complete; however, I have also found it useful to mention some complementary results without proof. These are indicated by an asterisk, and the proofs can be found in Bourbaki, Groupes et Algebres de Lie, Paris, Hermann, 1960-1975, Chapters IV-VIII. A final chapter shows, without proof, how to pass from Lie algebras to Lie groups (complex-and also compact). It is just an introduction, aimed at guiding the reader towards the topology of Lie groups and the theory of algebraic groups. I am happy to thank MM. Pierre Gigord and Daniel Lehmann, who wrote up a first draft of these notes, and also Mlle. Franr,:oise Pecha who was responsible for the typing of the manuscript. A comprehensive and modern account of the structure and classification of Lie groups and finite-dimensional Lie algebras, by internationally known specialists in the field. This Encyclopaedia volume will be immensely useful to graduate students in differential geometry, algebra and theoretical physics. More than half a century has passed since Weyl's 'The Classical Groups' gave a unified picture of invariant theory. This book presents an updated version of this theory together with many of the important recent developments. As a text for those new to the area, this book provides an introduction to the structure and finite-dimensional representation theory of the complex classical groups that requires only an abstract algebra course as a prerequisite. The more advanced reader will find an introduction to the structure and representations of complex reductive algebraic groups and their compact real forms. This book will also serve as a reference for the main results on tensor and polynomial invariants and the finite-dimensional representation theory of the classical groups. It will appeal to researchers in mathematics, statistics, physics and chemistry whose work involves symmetry groups, representation theory, invariant theory and algebraic group theory. High school algebra, grades 9-12. Introduction The $\mathfrak{g}$-module decomposition of a BC_r-graded Lie algebra, $r\ge 3$ (excluding type $\mathrm{D}_3)$ Models for BC_r-graded Lie algebras, $r\ge 3$ (excluding type $\mathrm{D}_3)$ The $\mathfrak{g}$-module decomposition of a BC_r-graded Lie algebra with grading subalgebra of type B_2, C_2, D_2, or D_3 Central extensions, derivations and invariant forms Models of BC_r-graded Lie algebras with grading subalgebra of type B_2, C_2, D_2, or D_3 Appendix: Peirce decompositions in structurable algebras References. This up-to-date introduction to Griffiths' theory of period maps and period domains focusses on algebraic, group-theoretic and differential geometric aspects. Starting with an explanation of Griffiths' basic theory, the authors go on to introduce spectral sequences and Koszul complexes that are used to derive results about cycles on higher-dimensional algebraic varieties such as the Noether–Lefschetz theorem and Nori's theorem. They explain differential geometric methods, leading up to proofs of Arakelov-type theorems, the theorem of the fixed part and the rigidity theorem. They also use Higgs bundles and harmonic maps to prove the striking result that not all compact quotients of period domains are Kähler. This thoroughly revised second edition includes a new third part covering important recent developments, in which the group-theoretic approach to Hodge structures is explained, leading to Mumford–Tate groups and their associated domains, the Mumford–Tate varieties and generalizations of Shimura varieties. This book is a comprehensive study of the algebraic theory of quadratic forms, from classical theory to recent developments, including results and proofs that have never been published. The book is written from the viewpoint of algebraic geometry and includes the theory of quadratic forms over fields of characteristic two, with proofs that are characteristic independent whenever possible. For some results both classical and geometric proofs are given. Part I includes classical algebraic theory of quadratic and bilinear forms and answers many questions that have been raised in the early stages of the development of the theory. Assuming only a basic course in algebraic geometry, Part II presents the necessary additional topics from algebraic geometry including the theory of Chow groups, Chow motives, and Steenrod operations. These topics are used in Part III to develop a modern geometric theory of quadratic forms. This edited survey book consists of 20 chapters showing application of Clifford algebra in quantum mechanics, field theory, spinor calculations, projective geometry, Hypercomplex algebra, function theory and crystallography. Many examples of computations performed with a variety of readily available software programs are presented in detail. This book provides a comprehensive introduction to the interactions between noncommutative algebra and classical algebraic geometry. Serving students with academic deficiencies necessitates communication and collaboration among professionals from several disciplines. Academic Assessment and Intervention brings together divergent approaches in order to demonstrate that scientific evidence, rather than biases or previous practice, must determine assessment practices that are selected and used for particular purposes. Similar to a handbook in its comprehensive topical coverage, this edited collection provides a contextual foundation for academic assessment and intervention; describes both norm-referenced and curriculum-based assessment/measurement in detail; considers the implications of both of these assessments on ethnically diverse populations; provides a clear link between assessment, evidence-based interventions and the RTI model; and considers other important topics related to this area such as teacher behavior. Intended primarily for graduate-level courses in education, school psychology, or child clinical psychology, it will also be of interest to practicing professionals in these fields. This is the last of three major volumes which present a comprehensive treatment of the theory of the main classes of special functions from the point of view of the theory of group representations. This volume deals with q-analogs of special functions, quantum groups and algebras (including Hopf algebras), and (representations of) semi-simple Lie groups. Also treated are special functions of a matrix argument, representations in the Gel'fand-Tsetlin basis, and, finally, modular forms, theta-functions and affine Lie algebras. The volume builds upon results of the previous two volumes, and presents many new results. Subscribers to the complete set of three volumes will be entitled to a discount of 15%. The only monograph on the topic, this book concerns geometric methods in the theory of differential equations with quadratic right-hand sides, closely related to the calculus of variations and optimal control theory. Based on the author's lectures, the book is addressed to undergraduate and graduate students, and scientific researchers. The book begins with a simplified (and somewhat extended and corrected) exposition of the main results of F. Karpelevich's 1955 paper and relates them to the theory of Cartan-Iwahori. It concludes with some tables, where an involution of the Dynkin diagram that allows for finding self-conjugate representations is described and explicit formulas for the index are given. In a short addendum, written by J. V. Silhan, this involution is interpreted in terms of the Satake diagram. Symmetry is a key ingredient in many mathematical, physical, and biological theories. Using representation theory and invariant theory to analyze the symmetries that arise from group actions, and with strong emphasis on the geometry and basic theory of Lie groups and Lie algebras, Symmetry, Representations, and Invariants is a significant reworking of an earlier highly-acclaimed work by the authors. The result is a comprehensive introduction to Lie theory, representation theory, invariant theory, and algebraic groups, in a new presentation that is more accessible to students and includes a broader range of applications. The philosophy of the earlier book is retained, i.e., presenting the principal theorems of representation theory for the classical matrix groups as motivation for the general theory of reductive groups. The wealth of examples and discussion prepares the reader for the complete arguments now given in the general case. Key Features of Symmetry, Representations, and Invariants: (1) Early chapters suitable for honors undergraduate or beginning graduate courses, requiring only linear algebra, basic abstract algebra, and advanced calculus; (2) Applications to geometry (curvature tensors), topology (Jones polynomial via symmetry), and combinatorics (symmetric group and Young tableaux); (3) Self-contained chapters, appendices, comprehensive bibliography; (4) More than 350 exercises (most with detailed hints for solutions) further explore main concepts; (5) Serves as an excellent main text for a one-year course in Lie group theory; (6) Benefits physicists as well as mathematicians as a reference work. A new version of the author's prize-winning Algebraic Theory of Quadratic Forms (Benjamin, 1973), this book gives a modern and self-contained introduction to the theory of quadratic forms over fields of characteristic not two. Starting with few prerequisites besides linear algebra, the author charts an expert course from Witt's classical theory of quadratic forms, quaternion and Clifford algebras, Artin-Schreier theory of formally real fields, and structural theorems on Witt rings, to the theory of Pfister forms, function fields, and field invariants. These main developments are seamlessly interwoven with excursions into Brauer-Wall groups, local and global fields, trace forms, Galois theory, and elementary algebraic K-theory, to create a uniquely original treatment of quadratic form theory over fields. Two new chapters totaling more than 100 pages have been added to the earlier incarnation of this book to take into account some of the newer results and more recent viewpoints in the area. As is characteristic of this author's expository style, the presentation of the main material in this book is interspersed with a copious number of carefully chosen examples to illustrate the general theory. This feature, together with a rich stock of some 280 exercises for the thirteen chapters, greatly enhances the pedagogical value of this book, both as a graduate text and as a reference work for researchers in algebra, number theory, field theory, algebraic geometry, algebraic topology, and geometric topology. The purpose of this book is to serve as a tool for researchers and practitioners who apply Lie algebras and Lie groups to solve problems arising in science and engineering. The authors address the problem of expressing a Lie algebra obtained in some arbitrary basis in a more suitable basis in which all essential features of the Lie algebra are directly visible. This includes algorithms accomplishing decomposition into a direct sum, identification of the radical and the Levi decomposition, and the computation of the nilradical and of the Casimir invariants. Examples are given for each algorithm. For low-dimensional Lie algebras this makes it possible to identify the given Lie algebra completely. The authors provide a representative list of all Lie algebras of dimension less or equal to 6 together with their important properties, including their Casimir invariants. The list is ordered in a way to make identification easy, using only basis independent properties of the Lie algebras. They also describe certain classes of nilpotent and solvable Lie algebras of arbitrary finite dimensions for which complete or partial classification exists and discuss in detail their construction and properties. The book is based on material that was previously dispersed in journal articles, many of them written by one or both of the authors together with their collaborators. The reader of this book should be familiar with Lie algebra theory at an introductory level. This book provides an extensive and self-contained presentation of quantum and related invariants of knots and 3-manifolds. Polynomial invariants of knots, such as the Jones and Alexander polynomials, are constructed as quantum invariants, i.e. invariants derived from representations of quantum groups and from the monodromy of solutions to the Knizhnik-Zamolodchikov equation. With the introduction of the Kontsevich invariant and the theory of Vassiliev invariants, the quantum invariants become well-organized. Quantum and perturbative invariants, the LMO invariant, and finite type invariants of 3-manifolds are discussed. The ChernOCoSimons field theory and the WessOCoZuminoOCoWitten model are described as the physical background of the invariants. Contents: Knots and Polynomial Invariants; Braids and Representations of the Braid Groups; Operator Invariants of Tangles via Sliced Diagrams; Ribbon Hopf Algebras and Invariants of Links; Monodromy Representations of the Braid Groups Derived from the KnizhnikOCoZamolodchikov Equation; The Kontsevich Invariant; Vassiliev Invariants; Quantum Invariants of 3-Manifolds; Perturbative Invariants of Knots and 3-Manifolds; The LMO Invariant; Finite Type Invariants of Integral Homology 3-Spheres. Readership: Researchers, lecturers and graduate students in geometry, topology and mathematical physics."