

Chapter 1

The Category of Graded Rings

1.1 Graded Rings

Unless otherwise stated, all rings are assumed to be associative rings and any ring R has an identity $1 \in R$. If X and Y are nonempty subsets of a ring R then XY denotes the set of all finite sums of elements of the form xy with $x \in X$ and $y \in Y$. The group of multiplication invertible elements of R will be denoted by $U(R)$.

Consider a multiplicatively written group G with identity element $e \in G$. A ring R is **graded of type G** or R is G -graded, if there is a family $\{R_\sigma, \sigma \in G\}$ of additive subgroups R_σ of R such that $R = \oplus_{\sigma \in G} R_\sigma$ and $R_\sigma R_\tau \subset R_{\sigma\tau}$, for every $\sigma, \tau \in G$. For a G -graded ring R such that $R_\sigma R_\tau = R_{\sigma\tau}$ for all $\sigma, \tau \in G$, we say that R is **strongly graded by G** .

The set $h(R) = \cup_{\sigma \in G} R_\sigma$ is the set of **homogeneous elements** of R ; a nonzero element $x \in R_\sigma$ is said to be **homogeneous of degree σ** and we write : $\deg(x) = \sigma$. An element r of R has a unique decomposition as $r = \sum_{\sigma \in G} r_\sigma$ with $r_\sigma \in R_\sigma$ for all $\sigma \in G$, but the sum being a finite sum i.e. almost all r_σ zero. The set $\text{sup}(r) = \{\sigma \in G, r_\sigma \neq 0\}$ is the **support of r in G** . By $\text{sup}(R) = \{\sigma \in G, R_\sigma \neq 0\}$ we denote the **support of the graded ring R** . In case $\text{sup}(R)$ is a finite set we will write $\text{sup}(R) < \infty$ and then R is said to be a **G -graded ring of finite support**.

If X is a nontrivial additive subgroup of R then we write $X_\sigma = X \cap R_\sigma$ for $\sigma \in G$. We say that X is **graded (or homogeneous)** if : $X = \sum_{\sigma \in G} X_\sigma$. In particular, when X is a subring, respectively : a left ideal, a right ideal, an ideal, then we obtain the notions of **graded subring**, respectively : a **graded left ideal**, a **graded right ideal**, **graded ideal**. In case I is a graded ideal of R then the factor ring R/I is a graded ring with gradation defined by : $(R/I)_\sigma = R_\sigma + I/I$, $R/I = \oplus_{\sigma \in G} (R/I)_\sigma$.

Methods Of Graded Rings

**Marek Biskup, Anton Bovier, Frank den
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Toninelli**

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Methods of Homological Algebra Sergei I. Gelfand, Yuri J. Manin, 2013-04-17 Homological algebra first arose as a language for describing topological prospects of geometrical objects As with every successful language it quickly expanded its coverage and semantics and its contemporary applications are many and diverse This modern approach to homological algebra by two leading writers in the field is based on the systematic use of the language and ideas of derived categories and derived functors Relations with standard cohomology theory sheaf cohomology spectral sequences etc are described In most cases complete proofs are given Basic concepts and results of homotopical algebra are also presented The book addresses people who want to learn about a modern approach to homological algebra and to use it in their work

Methods of Graded Rings Constantin Nastasescu, Freddy van Oystaeyen, 2014-01-15

Commutative Algebra Methods for Coding Theory Ștefan Ovidiu I. Tohăneanu, 2024-07-01 This book aims to be a comprehensive treatise on the interactions between Coding Theory and Commutative Algebra With the help of a multitude of examples it expands and systematizes the known and versatile commutative algebraic framework used since the early 90 s to study linear codes The book provides the necessary background for the reader to advance with similar research on coding theory topics from commutative algebraic perspectives

Methods of Algebraic Geometry in Control Theory: Part II Peter Falb, 1990 Control theory represents an attempt to codify in mathematical terms the principles and techniques used in the analysis and design of control systems Algebraic geometry may in an elementary way be viewed as the study of the structure and properties of the solutions of systems of algebraic equations The aim of this book

is to provide access to the methods of algebraic geometry for engineers and applied scientists through the motivated context of control theory The development which culminated with this volume began over twenty five years ago with a series of lectures at the control group of the Lund Institute of Technology in Sweden I have sought throughout to strive for clarity often using constructive methods and giving several proofs of a particular result as well as many examples The first volume dealt with the simplest control systems i e single input single output linear time invariant systems and with the simplest algebraic geometry i e affine algebraic geometry While this is quite satisfactory and natural for scalar systems the study of multi input multi output linear time invariant control systems requires projective algebraic geometry Thus this second volume deals with multi variable linear systems and projective algebraic geometry The results are deeper and less transparent but are also quite essential to an understanding of linear control theory A review of From the Preface to Part 1 viii Preface the scalar theory is included along with a brief summary of affine algebraic geometry Appendix E Differential Geometric Methods in Mathematical Physics Pedro L. Garcia, Antonio Perez-Rendon, 2006-11-15 The focal topic of the 14th International Conference on Differential Geometric Methods was that of mathematical problems in classical field theory and the emphasis of the resulting proceedings volume is on superfield theory and related topics and classical and quantized fields

The Method of Approximate Inverse: Theory and Applications Thomas Schuster, 2007-05-07 Inverse problems arise whenever one tries to calculate a required quantity from given measurements of a second quantity that is associated to the first one Besides medical imaging and non destructive testing inverse problems also play an increasing role in other disciplines such as industrial and financial mathematics Hence there is a need for stable and efficient solvers The book is concerned with the method of approximate inverse which is a regularization technique for stably solving inverse problems in various settings such as L_2 spaces Hilbert spaces or spaces of distributions The performance and functionality of the method is demonstrated on several examples from medical imaging and non destructive testing such as computerized tomography Doppler tomography SONAR X ray diffractometry and thermoacoustic computerized tomography The book addresses graduate students and researchers interested in the numerical analysis of inverse problems and regularization techniques or in efficient solvers for the applications mentioned above **Methods of Contemporary Mathematical Statistical**

Physics Marek Biskup, Anton Bovier, Frank den Hollander, Dima Ioffe, Fabio Martinelli, Karel Netocný, Christina Toninelli, 2009-07-31 This volume presents a collection of courses introducing the reader to the recent progress with attention being paid to laying solid grounds and developing various basic tools It presents new results on phase transitions for gradient lattice models Cohomological Methods in Transformation Groups C. Allday, V. Puppe, 1993-07 This is an account of the theory of certain types of compact transformation groups namely those that are susceptible to study using ordinary cohomology theory and rational homotopy theory which in practice means the torus groups and elementary abelian p groups The efforts of many mathematicians have combined to bring a depth of understanding to this area However to make

it reasonably accessible to a wide audience the authors have streamlined the presentation referring the reader to the literature for purely technical results and working in a simplified setting where possible In this way the reader with a relatively modest background in algebraic topology and homology theory can penetrate rather deeply into the subject whilst the book at the same time makes a useful reference for the more specialised reader

Cohomological Methods in Homotopy Theory Jaume Aguade, Carles Broto, Carles Casacuberta, 2012-12-06 This book contains a collection of articles summarizing the state of knowledge in a large portion of modern homotopy theory A call for articles was made on the occasion of an emphasis semester organized by the Centre de Recerca Matemàtica in Bellaterra Barcelona in 1998 The main topics treated in the book include abstract features of stable and unstable homotopy homotopical localizations p compact groups H spaces classifying spaces for proper actions cohomology of discrete groups K theory and other generalized cohomology theories configuration spaces and Lusternik Schnirelmann category The book is addressed to all mathematicians interested in homotopy theory and in geometric aspects of group theory New research directions in topology are highlighted Moreover this informative and educational book serves as a welcome reference for many new results and recent methods

Functional Analytic Methods for Partial Differential Equations Hiroki Tanabe, 2017-11-22 Combining both classical and current methods of analysis this text presents discussions on the application of functional analytic methods in partial differential equations It furnishes a simplified self contained proof of Agmon Douglis Nirenberg's L_p estimates for boundary value problems using the theory of singular integrals and the Hilbert transform

New Materials, Processes, and Methods Technology Mel Schwartz, 2005-11-04 Materials selection is a crucial factor in determining the cost quality and corrosion protection for every engineering project The variety of increasingly durable materials and their combinations coupled with the rise of new and more critical service requirements and the demand for lower costs have expanded upon trial and error criteria into many

Point Estimation of Root Finding Methods Miodrag Petkovic, 2008-05-29 This book sets out to state computationally verifiable initial conditions for predicting the immediate appearance of the guaranteed and fast convergence of iterative root finding methods Attention is paid to iterative methods for simultaneous determination of polynomial zeros in the spirit of Smale's point estimation theory introduced in 1986 Some basic concepts and Smale's theory for Newton's method together with its modifications and higher order methods are presented in the first two chapters The remaining chapters contain the recent author's results on initial conditions guaranteeing convergence of a wide class of iterative methods for solving algebraic equations These conditions are of practical interest since they depend only on available data the information of a function whose zeros are sought and initial approximations The convergence approach presented can be applied in designing a package for the simultaneous approximation of polynomial zeros

Differential Equations Driven by Rough Paths Terry J. Lyons, Michael J. Caruana, Thierry Lévy, 2007-04-25 Each year young mathematicians congregate in Saint Flour France and listen to extended lecture courses on new topics in Probability Theory

The goal of these notes representing a course given by Terry Lyons in 2004 is to provide a straightforward and self supporting but minimalist account of the key results forming the foundation of the theory of rough paths

Séminaire de Probabilités XLIII Catherine Donati Martin, Antoine Lejay, Alain Rouault, 2010-10-20 This is a new volume of the Séminaire de Probabilités which is now in its 43rd year Following the tradition this volume contains about 20 original research and survey articles on topics related to stochastic analysis It contains an advanced course of J Picard on the representation formulae for fractional Brownian motion The regular chapters cover a wide range of themes such as stochastic calculus and stochastic differential equations stochastic differential geometry filtrations analysis on Wiener space random matrices and free probability as well as mathematical finance Some of the contributions were presented at the Journées de Probabilités held in Poitiers in June 2009

The Analysis of Fractional Differential Equations Kai Diethelm, 2010-09-03 Fractional calculus was first developed by pure mathematicians in the middle of the 19th century Some 100 years later engineers and physicists have found applications for these concepts in their areas However there has traditionally been little interaction between these two communities In particular typical mathematical works provide extensive findings on aspects with comparatively little significance in applications and the engineering literature often lacks mathematical detail and precision This book bridges the gap between the two communities It concentrates on the class of fractional derivatives most important in applications the Caputo operators and provides a self contained thorough and mathematically rigorous study of their properties and of the corresponding differential equations The text is a useful tool for mathematicians and researchers from the applied sciences alike It can also be used as a basis for teaching graduate courses on fractional differential equations

Commutative Algebra and Algebraic Geometry Freddy Van Oystaeyen, 1999-03-31 Contains contributions by over 25 leading international mathematicians in the areas of commutative algebra and algebraic geometry The text presents developments and results based on and inspired by the work of Mario Fiorentini It covers topics ranging from almost numerical invariants of algebraic curves to deformation of projective schemes

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