

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

C. Nastasescu, F. Van Oystaeyen



Methods Of Graded Rings:

Methods of Graded Rings Constantin Nastasescu, Freddy van Oystaeyen, 2004-02-07 The topic of this book graded algebra has developed in the past decade to a vast subject with new applications in noncommutative geometry and physics Classical aspects relating to group actions and gradings have been complemented by new insights stemming from Hopf algebra theory Old and new methods are presented in full detail and in a self contained way Graduate students as well as researchers in algebra geometry will find in this book a useful toolbox Exercises with hints for solution provide a direct link to recent research publications The book is suitable for courses on Master level or textbook for seminars

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Methods of Graded Rings Constantin Năstăsescu, 2004

Methods in Ring Theory Freddy Van Oystaeyen, 2012-12-06 Proceedings of the NATO Advanced Study Institute Antwerp Belgium August 2 12 1983

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

Graded Ring Theory C. Nastasescu, F. Van Oystaeyen, 2011-08-18 This book is aimed to be a technical book on graded rings By technical we mean that the book should supply a kit of tools of quite general applicability enabling the reader to build up his own further study of non commutative rings graded by an arbitrary group The body of the book Chapter A contains categorical properties of graded modules localization of graded rings and modules Jacobson radicals of graded rings the structure theory for simple objects in the graded sense chain conditions Krull dimension of graded modules homogenization homological dimension primary decomposition and more One of the advantages of the generality of Chapter A is that it allows direct applications of these results to the theory of group rings twisted and skew group rings and crossed products With this in mind we have taken care to point out on several occasions how certain techniques may be specified to the case of strongly graded rings We tried to write Chapter A in such a way that it becomes suitable for an advanced course in ring theory or general algebra we strove to make it as selfcontained as possible and we included several problems and exercises Other chapters may be viewed as an attempt to show how the general techniques of Chapter A can be applied in some particular cases e g the case where the gradation is of type $\mathbb{Z}$ In compiling the material for Chapters B and C we have been guided by our own research interests Chapter 6 deals with commutative graded rings of type 2 and we focus on two main topics arithmetically graded domains and secondly local conditions for Noetherian rings In Chapter C we derive some structural results relating to the graded properties of the rings considered The following classes of graded rings

receive special attention fully bounded Noetherian rings birational extensions of commutative rings rings satisfying polynomial identities and Von Neumann regular rings Here the basic idea is to derive results of ungraded nature from graded information Some of these sections lead naturally to the study of sheaves over the projective spectrum $\text{Proj } R$ of a positively graded ring but we did not go into these topics here We refer to [125] for a noncommutative treatment of projective geometry i.e. the geometry of graded PI algebras

Methods of Homological Algebra Sergei I. Gelfand, Yuri I. Manin, 2013-03-09

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 a modern approach to homological algebra and to use it in their work For the second edition the authors have made numerous corrections

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

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

The Enigmatic Realm of **Methods Of Graded Rings**: Unleashing the Language is Inner Magic

In a fast-paced digital era where connections and knowledge intertwine, the enigmatic realm of language reveals its inherent magic. Its capacity to stir emotions, ignite contemplation, and catalyze profound transformations is nothing in short supply of extraordinary. Within the captivating pages of **Methods Of Graded Rings** a literary masterpiece penned by a renowned author, readers embark on a transformative journey, unlocking the secrets and untapped potential embedded within each word. In this evaluation, we shall explore the book's core themes, assess its distinct writing style, and delve into its lasting affect the hearts and minds of those who partake in its reading experience.

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