

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

Gunnar Sjödin



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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 Algebraic Geometry in Control Theory: Part II Peter Falb, 2013-12-01 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

Ring Theory - Proceedings Of The Biennial Ohio State-denison Conference 1992 Surender K Jain, Syed Tariq Rizvi, 1993-09-30 This volume consists of a collection of invited papers on the theory of rings and modules most of which were presented at the biennial Ohio State Denison Conference May 1992 in memory of Hans Zassenhaus The topics of these papers represent many modern trends in Ring Theory The wide variety of methodologies and techniques demonstrated will be valuable in particular to young researchers in the area Covering a broad range this book should appeal to a wide spectrum of researchers in algebra and number theory

Commutative Algebra, Algebraic Geometry, and Computational Methods David Eisenbud, 1999-07 This volume contains papers presented at the International Conference on Commutative Algebra Algebraic geometry and Computational methods held in Hanoi in 1996 as well as papers written subsequently It features both expository articles as well as research papers on a range of currently active areas in commutative algebra algebraic geometry particularly surveys on intersection theory and combinatorics In addition a special feature is a section on the life and work of Wolfgang Vogel who was an organiser of the conference

The Jacobson Radical of Classical Rings Gregory Karpilovsky, 1991 This book aims to provide comprehensive coverage of the structure of the Jacobson radical of classical rings Special attention is drawn to the

discoveries concerning the Jacobson radical of graded rings The main objective has been to present an accessible self contained and detailed coverage of the present state of the subject so that the reader can find in one place all that is needed for a thorough understanding of the main results along with concrete information on how the ideas are applied Relative Invariants of Rings F. Van Oystaeyen, A. Verschoren, 1983

Applications of homological methods in commutative algebra Gunnar Sjödin, 19??

Encyclopaedia of Mathematics Michiel Hazewinkel, 2013-12-01 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 Encyclopaedia 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 mathematics 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

Reviews in Ring Theory, 1980-84 Lance W. Small, 1986

Computational Methods in Commutative Algebra and Algebraic Geometry Wolmer V. Vasconcelos, David Eisenbud, 1998 This ACM volume in computational algebra deals with methods and techniques to tackle problems that can be represented by data structures which are essentially matrices with polynomial entries mediated by the disciplines of commutative algebra and algebraic geometry It relates discoveries by a growing interdisciplinary group of researchers in the past decade It highlights the use of advanced techniques to bring down the cost of computation The book includes concrete algorithms written in MACAULAY It is intended for advanced students and researchers with interests both in algebra and computation Many parts of it can be read by anyone with a basic abstract algebra course

Proceedings of the Royal Society of London Royal Society (Great Britain), 1901

The suggestive handbook of practical school method, by T.A. Cox and R.F. Macdonald Thomas A. Cox, 1896

Journal of the Institution of Electrical Engineers, 1921

Fluctuation Theory for Lévy Processes Ronald A. Doney, 2007-04-19 Lévy processes i.e. processes in continuous time with stationary and independent increments are named after Paul Lévy who made the connection with infinitely divisible distributions and described their structure They form a flexible class of models which have been applied to the study of storage processes

insurance risk queues turbulence laser cooling and of course finance where the feature that they include examples having heavy tails is particularly important Their sample path behaviour poses a variety of difficult and fascinating problems Such problems and also some related distributional problems are addressed in detail in these notes that reflect the content of the course given by R Doney in St Flour in 2005 **Tutorials in Mathematical Biosciences** ,2008

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