1   Chapter 1

1.1   Rings, Ideals, Radicals

1. Exercise 1. Show that if x is nilpotent and u is a unit, $x + u$ is a unit.

   Exercise 1 solution. Suppose $x^m = 0$. First consider $u = 1$. We have $(1 + x)(1 - x + x^2 - \cdots + (-x)^{m-1}) = 1 + (-1)^{m-1}x^m = 1$. Thus $1 + x$ is a unit. Now for arbitrary u, we have $u + x = u(1 + u^{-1}x)$, and since $u^{-1}x$ is clearly nilpotent and the unit group is closed under products, $u + x$ must be a unit as well.

2. Exercise 2. Let $f = a_0 + a_1 x + \cdots + a_n x^n \in A[x]$. Prove that

   (a) f is a unit of $A[x]$ if and only if all the coefficients but the constant term are nilpotents of A and the constant term is a unit of A.

   Exercise 2a solution. One direction is easy: if a_0 is a unit and $a_1, \ldots, a_n$ are nilpotents, then $a_1 x + \cdots + a_n x^n$ is in the nilradical of $A[x]$, and then the previous problem shows that $f = a_0 + (a_1 x + \cdots + a_n x^n)$ is a unit.

   In the other direction, let f be a unit; suppose $fg = 1$. Looking at the constant term, it is clear that a_0 is a unit. Now for the higher-degree terms, it is enough to show a_n is nilpotent, for if it is, then $f' = f - a_n x^n$ is a unit by Exercise 1. Then by the same argument it will be true that a_{n-1}, the lead coefficient of f', is nilpotent, and so on down the line.

   Suppose $g = b_0 + b_1 x + \cdots + b_m x^m$. Then $a_n b_m = 0$. Furthermore, $a_n b_{m-1} + a_{n-1} b_m = 0$; multiplying by a_n, we find $a_n a_{n-1} b_m + a_n^2 b_{m-1} = 0$. But the first term is zero since $a_n b_m$ is zero. So $a_n^2 b_{m-1} = 0$ too. Continuing inductively: the coefficient of the term x^k in the product is $\sum_{i+j=k} a_i b_j$ (where $i, j \geq 0$), and this is zero if $k \geq 1$ because $fg = 1$. If $k \geq n$, writing $k = m + n - r$ (so $r \leq m$), we can rewrite this sum as

$$\sum a_{n-i} b_{m-r+i} = 0$$

   provided we define $a_{n-i+j} = 0$ if $n - r + i < 0$ (which will happen if $r > n$). This equation is true for all r satisfying $r \leq m$, since this implies $n + m - r \geq n > 0$. (There is nothing to prove when $n = 0$.) We have shown $a_n b_m = 0$, and we contend $a_n^{r} b_{m-r} = 0$ for all $r \leq m$. We prove it by induction on r, with the case $r = 0$ the one just handled. (In fact, we handled $r = 1$ as an intimation of the induction step.) Multiply the above equation by a_n^{r}:

$$\sum a_n^{r} a_{n-i} b_{m-r+i} = 0$$

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Multivariable Mathematics Theodore Shifrin,2004-01-26 Multivariable Mathematics combines linear algebra and multivariable calculus in a rigorous approach The material is integrated to emphasize the role of linearity in all of calculus and the recurring theme of implicit versus explicit that persists in linear algebra and analysis In the text the author addresses all of the standard computational material found in the usual linear algebra and multivariable calculus courses and more interweaving the material as effectively as possible and also including complete proofs By emphasizing the theoretical aspects and reviewing the linear algebra material quickly the book can also be used as a text for an advanced calculus or multivariable analysis course culminating in a treatment of manifolds differential forms and the generalized Stokes s Theorem *Scientific and Technical Books in Print* ,1972 *Scientific and Technical Books and Serials in Print* ,1984 Books in Print Supplement ,1994 *Books in Print* ,1994 **Subject Guide to Books in Print** ,1984 *Waves And Rays In Elastic Continua (3rd Edition)* Michael A Slawinski,2014-12-15 The present book which is the third significantly revised edition of the textbook originally published by Elsevier Science emphasizes the interdependence of mathematical formulation and physical meaning in the description of seismic phenomena Herein we use aspects of continuum mechanics wave theory and ray theory to explain phenomena resulting from the propagation of seismic waves The book is divided into three main sections Elastic Continua Waves and Rays and Variational Formulation of Rays There is also a fourth part which consists of appendices In Elastic Continua we use continuum mechanics to describe the material through which seismic waves propagate and to formulate a system of equations to study the behaviour of such a material In Waves and Rays we use these equations to identify the types of body waves propagating in elastic continua as well as to express their velocities and displacements in terms of the properties of these continua To solve the equations of motion in anisotropic inhomogeneous continua we invoke the concept of a ray In Variational Formulation of Rays we show that in elastic continua a ray is tantamount to a trajectory along which a seismic signal propagates in accordance with the variational principle of stationary traveltime Consequently many seismic problems in elastic continua can be conveniently formulated and solved using the calculus of variations In the Appendices we describe two mathematical concepts that are used in the book namely homogeneity of a function and Legendre s transformation This section also contains a list of symbols **Waves And Rays In Elastic Continua (Fourth Edition)** Michael A Slawinski,2020-09-24 Seismology as a branch of mathematical physics is an active subject of both research and development Its reliance on computational and technological advances continuously motivates the developments of its underlying theory The fourth edition of Waves and Rays in Elastic Continua responds to these needs The book is both a research reference and a textbook Its careful and explanatory style which includes numerous exercises with detailed solutions makes it an excellent textbook for the senior undergraduate and graduate courses as well as for an independent study Used in its entirety the book could serve as a sole textbook for a year long course in quantitative

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
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