Abstract Algebra
Chapter 13 - Field Theory
David S. Dummit and Richard M. Foote

Solution Manual by positrón0802

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13   Field Theory

§13.1   Basic Theory and Field Extensions

Exercise 1. Show that $p(x) = x^3 + 9x + 6$ is irreducible in $\mathbb{Q}[x]$. Let θ be a root of $p(x)$. Find the inverse of $1 + \theta \in \mathbb{Q}(\theta)$

Solution: $p(x) = x^3 + 9x + 6$ is irreducible in $\mathbb{Z}[x]$ by Eisenstein Criterion with $p = 3$. By Gauss Lemma, then it is irreducible in $\mathbb{Q}[x]$. To find $(1 + \theta)^{-1}$, we apply the Euclidean algorithm (long division) to $p(x)$ and $1 + x$. We find

$$x^3 + 9x + 6 = (1 + x)(x^2 - x + 10) - 4.$$

Evaluating at θ, we find $(1 + \theta)(\theta^2 - \theta + 10) = 4$. Therefore

$$(1 + \theta)^{-1} = \frac{\theta^2 - \theta + 10}{4}.$$

Exercise 2. Show that $x^3 - 2x - 2$ is irreducible over $\mathbb{Q}$ and let θ be a root. Compute $(1 + \theta)(1 + \theta + \theta^2)$ and $\dfrac{1 + \theta}{1 + \theta + \theta^2}$ in $\mathbb{Q}(\theta)$.

Solution: Let $f(x) = x^3 - 2x - 2$. f is irreducible over $\mathbb{Z}$ by Eisenstein Criterion with $p = 2$, hence over $\mathbb{Q}$ by Gauss Lemma. Now, if θ is a root of f, then $\theta^3 = 2\theta + 2$. Hence

$$(1 + \theta)(1 + \theta + \theta^2) = 1 + 2\theta + 2\theta^2 + \theta^3 = 3 + 4\theta + 2\theta^2.$$

For computing $\dfrac{1 + \theta}{1 + \theta + \theta^2}$, first we compute $(1 + \theta + \theta^2)^{-1}$. Applying the Euclidean algorithm, we obtain

$$x^3 - 2x - 2 = (x^2 + x + 1)(x - 1) - 2x - 1,$$

and

$$x^3 - 2x - 2 = (2x + 1)(\frac{x^2}{2} - \frac{x}{4} - \frac{7}{8}) - \frac{9}{8}.$$

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  Fermat Equation over several fields and other historical mathematical conjectures Mercedes Orús Lacort,2019-03-09 As a teacher of several mathematics subjects at university level and writer of several books that preceded to this one and as a result of my goal to try to explain what seemed difficult as something easy for a few years I began to investigate in several mathematics areas about possible simple proofs to complex mathematical problems This book contains the results of these investigations referring to Fermat s last theorem as well as the existence of solutions for the Fermat equation in other fields such as quadratic integers and Gaussians and conjectures such as Collatz conjecture and Goldbach strong conjecture   **Mastering Algebra** Sachin Nambeesan,2025-02-20 Mastering Algebra is a comprehensive and student friendly exploration of fundamental principles and advanced applications of algebra tailored specifically for undergraduate students We provide a valuable resource for those seeking to deepen their understanding of algebraic theory and its diverse range of applications across various disciplines Our book starts with foundational concepts such as algebraic manipulation equation solving and functions It then progresses to more advanced topics including linear algebra abstract algebra and algebraic geometry offering a seamless transition from basic to advanced algebraic theory What sets this book apart is its emphasis on clarity coherence and practical relevance Each chapter is meticulously crafted to provide clear explanations of complex concepts supported by illustrative examples and thought provoking exercises that encourage active learning and critical thinking Furthermore Mastering Algebra highlights the practical applications of algebra in fields such as physics computer science engineering and economics demonstrating its importance and versatility in solving real world problems Whether you are a mathematics major looking to deepen your understanding of algebraic theory or a student from another discipline seeking to strengthen your quantitative skills this book is your essential companion on the journey to mastering algebra Prepare to embark on an enriching intellectual adventure that will empower you to unlock the full potential of algebraic concepts and their applications   Mathematical Insights for Cutting-Edge Solutions in Theoretical Physics: String Theory, Quantum Gravity, and Cosmology Cheok, Adrian David,Nardelli, Michele,Zhang, Hao,2025-10-24 Continued exploration of theoretical physics presents new questions about the nature of space time and matter At the center lies an evolving integration with advanced mathematics These fields demand new insights and often inspire the development of new mathematical frameworks From the symmetries of string theory to the structures of quantum spacetime and the geometry of cosmology mathematical innovation is essential for navigating the complexities of modern physics Further examination of this convergence of disciplines may reveal cutting edge solutions that redefine our understanding of the universe Mathematical Insights for Cutting Edge Solutions in Theoretical Physics String Theory Quantum Gravity and Cosmology explores modern theoretical physics particularly string theory quantum gravity and cosmology It offers a fresh perspective on how number theory and modular functions could provide new innovative developments in emerging fields This

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