# CONTENTS

*Preface*  
*Notes for the reader*  

## 1. The language of functors

- **1.1** Notation  
- **1.2** Bimodules  
- **1.3** Covariant functors  
- **1.4** Contravariant functors  
- **1.5** Additional structure  
- **1.6** Bifunctors  
- **1.7** Equivalent functors  

*Solutions to the Exercises on Chapter 1*  
*Supplementary Exercises on Chapter 1*

## 2. The Hom functor

- **2.1** Notation  
- **2.2** The Hom functor  
- **2.3** Projective modules  
- **2.4** Injective modules  
- **2.5** Injective \( \mathbb{Z} \)-modules  
- **2.6** Essential extensions and injective envelopes  

*Solutions to the Exercises on Chapter 2*

## 3. A derived functor

- **3.1** Notation  
- **3.2** A basic isomorphism  
- **3.3** Some remarks on diagrams  
- **3.4** The Ker–Coker sequence  
- **3.5** Further properties of \( \text{Ext}^1_{\Lambda} \)  
- **3.6** Consequences of the vanishing of \( \text{Ext}^1_{\Lambda} (A, B) \)  
- **3.7** Projective and injective dimension
CONTENTS

3.8 A-sequences  
3.9 The extension problem  
Solutions to the Exercises on Chapter 3

4. Polynomial rings and matrix rings
4.1 General  
4.2 The polynomial functor  
4.3 Generators of a category  
4.4 Equivalent categories  
4.5 Matrix rings  
Solutions to the Exercises on Chapter 4

5. Duality
5.1 General remarks  
5.2 Noetherian and Artinian conditions  
5.3 Preliminaries concerning duality  
5.4 Annihilators  
5.5 Duality in Noetherian rings  
5.6 Perfect duality and Quasi-Frobenius rings  
5.7 Group rings as Quasi-Frobenius rings  
Solutions to the Exercises on Chapter 5

6. Local homological algebra
6.1 Notation  
6.2 Projective covers  
6.3 Quasi-local and local rings  
6.4 Local Quasi-Frobenius rings  
6.5 Modules over a commutative ring  
6.6 Algebras  
6.7 Semi-commutative local algebras  
Solutions to the Exercises on Chapter 6

References  
Index