

Contents

Preface to the Second Edition	x
How to Read This Book	xiii
Chapter 1 Introduction	
1.1 Simplicial Homology	1
1.2 Categories and Functors	7
1.3 Singular Homology	29
Chapter 2 Hom and Tensor	
2.1 Modules	37
2.2 Tensor Products	69
2.2.1 Adjoint Isomorphisms	91
Chapter 3 Special Modules	
3.1 Projective Modules	98
3.2 Injective Modules	115
3.3 Flat Modules	131
3.3.1 Purity	146
Chapter 4 Specific Rings	
4.1 Semisimple Rings	154
4.2 von Neumann Regular Rings	159
4.3 Hereditary and Dedekind Rings	160

4.4	Semihereditary and Prüfer Rings	169
4.5	Quasi-Frobenius Rings	173
4.6	Semiperfect Rings	179
4.7	Localization	188
4.8	Polynomial Rings	203

Chapter 5 Setting the Stage

5.1	Categorical Constructions	213
5.2	Limits	229
5.3	Adjoint Functor Theorem for Modules	256
5.4	Sheaves	273
5.4.1	Manifolds	288
5.4.2	Sheaf Constructions	294
5.5	Abelian Categories	303
5.5.1	Complexes	317

Chapter 6 Homology

6.1	Homology Functors	323
6.2	Derived Functors	340
6.2.1	Left Derived Functors	343
6.2.2	Axioms	357
6.2.3	Covariant Right Derived Functors	364
6.2.4	Contravariant Right Derived Functors	369
6.3	Sheaf Cohomology	377
6.3.1	Čech Cohomology	384
6.3.2	Riemann–Roch Theorem	392

Chapter 7 Tor and Ext

7.1	Tor	404
7.1.1	Domains	412
7.1.2	Localization	415
7.2	Ext	418
7.2.1	Baer Sum	428
7.3	Cotorsion Groups	438
7.4	Universal Coefficients	448

Chapter 8 Homology and Rings

8.1	Dimensions of Rings	453
8.2	Hilbert’s Syzygy Theorem	467
8.3	Stably Free Modules	476
8.4	Commutative Noetherian Local Rings	484

Chapter 9 Homology and Groups

9.1	Group Extensions	495
9.1.1	Semidirect Products	500
9.1.2	General Extensions and Cohomology	504
9.1.3	Stabilizing Automorphisms	514
9.2	Group Cohomology	519
9.3	Bar Resolutions	525
9.4	Group Homology	535
9.4.1	Schur Multiplier	541
9.5	Change of Groups	559
9.5.1	Restriction and Inflation	564
9.6	Transfer	572
9.7	Tate Groups	580
9.8	Outer Automorphisms of p -Groups	587
9.9	Cohomological Dimension	591
9.10	Division Rings and Brauer Groups	595

Chapter 10 Spectral Sequences

10.1	Bicomplexes	609
10.2	Filtrations and Exact Couples	616
10.3	Convergence	624
10.4	Homology of the Total Complex	628
10.5	Cartan–Eilenberg Resolutions	647
10.6	Grothendieck Spectral Sequences	656
10.7	Groups	660
10.8	Rings	666
10.9	Sheaves	675
10.10	Künneth Theorems	678
References	689	
Special Notation	695	
Index	697	