CONTENTS

INTRODUCTION

1	Set theory 1	
2	General topology 4	
3	Group theory 6	
4	Modules 7	
5	Euclidean spaces 9	
HO	PMOTOPY AND THE FUNDAMENTAL GROUP	
1	Categories 14	
2	Functors 18	
3	Homotopy 22	
4	Retraction and deformation 27	
5	H spaces 33	
6	Suspension 39	
7	The fundamental groupoid 45	
8	The fundamental group 50	
	Exercises 56	

xii	CONTENTS
	 COLILATION

2	CO	OVERING SPACES AND FIBRATIONS	60
	1	Covering projections 62	
	2	The homotopy lifting property 65	
	3	Relations with the fundamental group	70
	4	The lifting problem 74	
	5	The classification of covering projections	79
	6	Covering transformations 85	
	7	Fiber bundles 89	
	8	Fibrations 96	
		Exercises 103	
•			
3	PO	LYHEDRA	106
	1	Simplicial complexes 108	
	2	Linearity in simplicial complexes 114	
	3	Subdivision 121	
	4	Simplicial approximation 126	
	5	Contiguity classes 129	
	6	The edge-path groupoid 134	
	7	Graphs 139	
	8	Examples and applications 143	
		Exercises 149	
4	***	MOLOGY	154
	HR W	MULUUI	194
	1	Chain complexes 156	
	2	Chain homotopy 162	
	3	2110 11011010 69 07	167
	4	Singular homology 173	
	5	Exactness 179	
	6	Mayer-Vietoris sequences 186	
	7	Some applications of homology 193	
	8	Axiomatic characterization of homology	199
		Exercises 205	

CONTENTS	xii

5	IP III	RODUCTS	210
		Homology with coefficients 212	
	I	in the state of th	
	2	The uniteditate coefficient meeting of the grant	
	3	The Künneth formula 227	
	4	Cohomology 236	
	5	The universal-coefficient theorem for cohomology 241	
	6	Cup and cap products 248	
	7	Homology of fiber bundles 255	
	8	The cohomology algebra 263	
	9	The Steenrod squaring operations 269	
		Exercises 276	
O			
U	GE	NERAL COHOMOLOGY THEORY AND DUALITY	284
		The slant product 286	
	1		
	2	2 dailing in representation	
	3		
	4	3	
	5		
	•		
		7 Presheaves 323	
	•		
	•	3 31	
	10	Characteristic classes 346	
		Exercises 356	
7			0.00
	HO	OMOTOPY THEORY	362
	1	Exact sequences of sets of homotopy classes 364	
	2	Higher homotopy groups 371	
	3	Change of base points 379	
	4	The Hurewicz homomorphism 387	
	5	The Hurewicz isomorphism theorem 393	
	6		
	7	CW complexes 400	
		Homotopy functors 406	
	8	Weak homotopy type 412	
		Exercises 418	

	V H	STRUCTION THEORY	422
	1	Eilenberg-MacLane spaces 424	
	2	Principal fibrations 432	
	3	Moore-Postnikov factorizations 437	
	4	Obstruction theory 445	
	5	The suspension map 452	
		Exercises 460	
9	SP	PECTRAL SEQUENCES AND HOMOTOPY	
	GR	ROUPS OF SPHERES	464
	1	Spectral sequences 466	
	2	The spectral sequence of a fibration 473	
	3		
	4	Multiplicative properties of spectral sequences 490	
	5	Applications of the cohomology spectral sequence 498	
	6	Serre classes of abelian groups 504	
	7	Homotopy groups of spheres 512	
		Exercises 518	
	IN	DEX	521