Contents

List of Figures ix

Preface xi

Introduction 1

1 The characterization of homotopy types 9
- 1.1 A review of surgery . . . 9
- 1.2 Executing surgery . . . 27
- 1.3 The π-π theorem and its applications . . . 32
- 1.4 Propagation of group actions . . . 36
- 1.5 Wall Chapter 9 . . . 48
- 1.6 Algebraic surgery theory . . . 50

2 Some calculations of L-groups 55
- 2.1 Calculating $\mathbf{L}_*(\mathbb{Z}[\mathbf{e}])$ . . . 56
- 2.2 Elementary Witt theory . . . 60
- 2.3 L-theory of finite groups . . . 65
- 2.4 Odd L-groups and the Ranicki-Rothenberg sequence . . . 73
- 2.5 Transfer and Dress induction . . . 78
- 2.6 Squares . . . 84
- 2.7 Using splitting theorems . . . 86

3 Classical surgery theory 93
- 3.1 Low dimensions and smoothing theory . . . 93
- 3.2 The homotopy groups of F/PL . . . 95
- 3.3 Some PL and Diff examples . . . 102
- 3.4 The homotopy type of F/PL . . . 106
- 3.5 Finite H-spaces . . . 114
- 3.6 PL tori . . . 122
- 3.7 The Kirby-Siebenmann invariant . . . 133
- 3.8 Nonrigidity of nonuniform arithmetic manifolds . . . 136

4 Topological surgery and surgery spaces 143
- 4.1 Beginning the spacification . . . 143
- 4.2 The surgery problem . . . 149
- 4.3 Blocked surgery . . . 153

4.4 Surgery spectra 157
4.5 Periodicity of structure sets 163
4.6 Smooth structures 170

5 Applications of the assembly map **177**
5.1 The Borel conjecture and related questions 178
5.2 Applications of periodicity and functoriality 189
5.3 Automatic variability of characteristic classes 193

6 Beyond characteristic classes **199**
6.1 A secondary signature invariant 199
6.2 Manifolds with fundamental group $\mathbb{Z}_2$ 203
6.3 General splittability 209
6.4 Connected sums of projective spaces 219
6.5 Lens spaces 224
6.6 The topological space form problem 235
6.7 Oozing problem 250
6.8 Introduction to the Farrell-Jones conjecture 258
6.9 Propagation of group actions on closed manifolds 260

7 Flat and almost flat manifolds **263**
7.1 The α-approximation theorem 264
7.2 Flat manifolds 267
7.3 Almost flat manifolds 277

8 Other surgery theories **285**
8.1 Smooth surgery without usual normal data 286
8.2 Local surgery 288
8.3 Homology surgery 290
8.4 Proper and bounded surgery 299
8.5 Controlled surgery 307
8.6 Homology manifolds 314
8.7 Stratified surgery 323

Appendix A: Some background in algebraic topology **337**
A.1 Obstruction theory 337
A.2 Principal bundles and characteristic classes 341
A.3 Generalized homology theories 349
A.4 Localization 353
A.5 Whitehead torsion 357

Appendix B: Geometric preliminaries **365**
B.1 The smooth category 365
B.2 The PL category 370
B.3 The topological category 373

List of Symbols 381

Bibliography 387

Index 423