

Graduate Texts in Mathematics

David A. Cox
John Little
Donal O'Shea

Using Algebraic Geometry

Second Edition

 Springer

Contents

Preface to the Second Edition	v
Preface to the First Edition	vii
1 Introduction	1
§1 Polynomials and Ideals	1
§2 Monomial Orders and Polynomial Division	6
§3 Gröbner Bases	13
§4 Affine Varieties	19
2 Solving Polynomial Equations	26
§1 Solving Polynomial Systems by Elimination	26
§2 Finite-Dimensional Algebras	37
§3 Gröbner Basis Conversion	49
§4 Solving Equations via Eigenvalues and Eigenvectors	56
§5 Real Root Location and Isolation	69
3 Resultants	77
§1 The Resultant of Two Polynomials	77
§2 Multipolynomial Resultants	84
§3 Properties of Resultants	95
§4 Computing Resultants	102
§5 Solving Equations via Resultants	114
§6 Solving Equations via Eigenvalues and Eigenvectors	128
4 Computation in Local Rings	137
§1 Local Rings	137
§2 Multiplicities and Milnor Numbers	145
§3 Term Orders and Division in Local Rings	158
§4 Standard Bases in Local Rings	174
§5 Applications of Standard Bases	180

5	Modules	189
§1	Modules over Rings	189
§2	Monomial Orders and Gröbner Bases for Modules	207
§3	Computing Syzygies	222
§4	Modules over Local Rings	234
6	Free Resolutions	247
§1	Presentations and Resolutions of Modules	247
§2	Hilbert's Syzygy Theorem	258
§3	Graded Resolutions	266
§4	Hilbert Polynomials and Geometric Applications	280
7	Polytopes, Resultants, and Equations	305
§1	Geometry of Polytopes	305
§2	Sparse Resultants	313
§3	Toric Varieties	322
§4	Minkowski Sums and Mixed Volumes	332
§5	Bernstein's Theorem	342
§6	Computing Resultants and Solving Equations	357
8	Polyhedral Regions and Polynomials	376
§1	Integer Programming	376
§2	Integer Programming and Combinatorics	392
§3	Multivariate Polynomial Splines	405
§4	The Gröbner Fan of an Ideal	426
§5	The Gröbner Walk	436
9	Algebraic Coding Theory	451
§1	Finite Fields	451
§2	Error-Correcting Codes	459
§3	Cyclic Codes	468
§4	Reed-Solomon Decoding Algorithms	480
10	The Berlekamp-Massey-Sakata Decoding Algorithm	494
§1	Codes from Order Domains	494
§2	The Overall Structure of the BMS Algorithm	508
§3	The Details of the BMS Algorithm	522
	References	533
	Index	547