## Table of Contents

Introduction				
1	Con	structive Ideal Theory 7		
	1.1	Ideals and Gröbner Bases 8		
	1.2	Elimination Ideals		
	1.3	Syzygy Modules		
	1.4	Hilbert Series		
	1.5	The Radical Ideal		
	1.6	Normalization		
2	Inva	ariant Theory		
	2.1	Invariant Rings		
	2.2	Reductive Groups		
	2.3	Categorical Quotients		
	2.4	Homogeneous Systems of Parameters		
	2.5	The Cohen-Macaulay Property of Invariant Rings 62		
	2.6	Hilbert Series of Invariant Rings		
3	Invariant Theory of Finite Groups			
	3.1	Homogeneous Components		
	3.2	Molien's Formula		
	3.3	Primary Invariants 80		
	3.4	Cohen-Macaulayness		
	3.5	Secondary Invariants		
	3.6	Minimal Algebra Generators and Syzygies 95		
	3.7	Properties of Invariant Rings		
	3.8	Noether's Degree Bound		
	3.9	Degree Bounds in the Modular Case		
	3.10	Permutation Groups		
	3.11	Ad Hoc Methods		
4	Inva	ariant Theory of Reductive Groups		
	4.1	Computing Invariants of Linearly Reductive Groups 139		
	4.2	Improvements and Generalizations		
	4.3	Invariants of Tori		

	4.4	Invariants of $SL_n$ and $GL_n$	162
	4.5	The Reynolds Operator	
	4.6	Computing Hilbert Series	
	4.7	Degree Bounds for Invariants	
	4.8	Properties of Invariant Rings	
5	App	olications of Invariant Theory	209
	5.1	Cohomology of Finite Groups	
	5.2	Galois Group Computation	
	5.3	Noether's Problem and Generic Polynomials	
	5.4	Systems of Algebraic Equations with Symmetries	
	5.5	Graph Theory	
	5.6	Combinatorics	
	$\frac{5.0}{5.7}$		
	•	Coding Theory	
	5.8	Equivariant Dynamical Systems	
	5.9	Material Science	
	5.10	Computer Vision	231
A	Line	ear Algebraic Groups	237
	A.1	Linear Algebraic Groups	237
	A.2	The Lie Algebra of a Linear Algebraic Group	239
	A.3	Reductive and Semi-simple Groups	243
	A.4	Roots	244
	A.5	$Representation\ Theory\ \dots \dots \dots \dots \dots \dots$	245
Re	feren	ces	247
No	tatio	n	261
Ind	low		263