

## *Contents*

<i>Editor's statement</i>	<i>page</i> viii
<i>Section editor's foreword</i>	ix
<i>Preface to the first edition</i>	x
<i>Preface to the second edition</i>	xii
<b>Introduction</b>	1
Problems	12
Notes	13
<b>Part one: Information theory</b>	
<b>1 Entropy and mutual information</b>	17
1.1 Discrete random variables	17
1.2 Discrete random vectors	33
1.3 Nondiscrete random variables and vectors	37
Problems	44
Notes	49
<b>2 Discrete memoryless channels and their capacity–cost functions</b>	50
2.1 The capacity–cost function	50
2.2 The channel coding theorem	58
Problems	68
Notes	73
<b>3 Discrete memoryless sources and their rate–distortion functions</b>	75
3.1 The rate–distortion function	75
3.2 The source coding theorem	84
Problems	91
Notes	93

vi	<i>Contents</i>	
<b>4</b>	<b>The Gaussian channel and source</b>	95
4.1	The Gaussian channel	95
4.2	The Gaussian source	99
	Problems	105
	Notes	110
<b>5</b>	<b>The source–channel coding theorem</b>	112
	Problems	120
	Notes	122
<b>6</b>	<b>Survey of advanced topics for part one</b>	123
6.1	Introduction	123
6.2	The channel coding theorem	123
6.3	The source coding theorem	131
<b>Part two: Coding theory</b>		
<b>7</b>	<b>Linear codes</b>	139
7.1	Introduction: The generator and parity-check matrices	139
7.2	Syndrome decoding on $q$ -ary symmetric channels	143
7.3	Hamming geometry and code performance	146
7.4	Hamming codes	148
7.5	Syndrome decoding on general $q$ -ary channels	149
7.6	Weight enumerators and the MacWilliams identities	153
	Problems	158
	Notes	165
<b>8</b>	<b>Cyclic codes</b>	167
8.1	Introduction	167
8.2	Shift-register encoders for cyclic codes	181
8.3	Cyclic Hamming codes	195
8.4	Burst-error correction	199
8.5	Decoding burst-error correcting cyclic codes	215
	Problems	220
	Notes	228
<b>9</b>	<b>BCH, Reed–Solomon, and related codes</b>	230
9.1	Introduction	230
9.2	BCH codes as cyclic codes	234
9.3	Decoding BCH codes, Part one: the key equation	236
9.4	Euclid’s algorithm for polynomials	244
9.5	Decoding BCH codes, Part two: the algorithms	249
9.6	Reed–Solomon codes	253
9.7	Decoding when erasures are present	266

	<i>Preface</i>	vii
9.8	The (23,12) Golay code	277
	Problems	282
	Notes	292
<b>10</b>	<b>Convolutional codes</b>	293
	10.1 Introduction	293
	10.2 State diagrams, trellises, and Viterbi decoding	300
	10.3 Path enumerators and error bounds	307
	10.4 Sequential decoding	313
	Problems	322
	Notes	329
<b>11</b>	<b>Variable-length source coding</b>	330
	11.1 Introduction	330
	11.2 Uniquely decodable variable-length codes	331
	11.3 Matching codes to sources	334
	11.4 The construction of optimal UD codes (Huffman's algorithm)	337
	Problems	342
	Notes	345
<b>12</b>	<b>Survey of advanced topics for Part two</b>	347
	12.1 Introduction	347
	12.2 Block codes	347
	12.3 Convolutional codes	357
	12.4 A comparison of block and convolutional codes	359
	12.5 Source codes	363
	<i>Appendices</i>	
	A Probability theory	366
	B Convex functions and Jensen's inequality	370
	C Finite fields	375
	D Path enumeration in directed graphs	380
	<i>References</i>	
	1 General reference textbooks	384
	2 An annotated bibliography of the theory of information and coding	384
	3 Original papers cited in the text	386
	<i>Index of Theorems</i>	388
	<i>Index</i>	390