

Contents

Preface	xi
Chapter 1. Representation of Numbers	1
1.1. Representation of numbers	2
1.1.1. Position numbering	2
1.1.2. The binary system.	3
1.1.3. Octal system and hexadecimal system	6
1.2. Representation of numbers in a machine	8
1.2.1. Machine representation of negative numbers.	8
1.2.2. Representation of rational numbers	12
Chapter 2. Media Representation	17
2.1. Character coding.	17
2.2. Image coding.	23
2.2.1. Representation of digital colors	23
2.2.2. Scanning an image	24
2.2.3. Image quality	24
2.3. Sound coding.	26
2.4. Video coding	28
2.5. Tagging codes	29
2.5.1. Figures	29
2.5.2. Bank cards.	30
2.5.3. Barcodes	32
2.5.4. QR codes	34
Chapter 3. Signals and Systems.	47
3.1. Characteristics and varieties	47
3.1.1. Introduction	47
3.1.2. Periodicity	49

3.1.3. Noise	50
3.2. Fourier analysis	51
3.2.1. Fourier series expansion	51
3.2.2. Examples	52
3.2.3. Special cases.	55
3.2.4. Other development writing.	55
3.2.5. Power	56
3.3. Dirac distribution	58
3.4. Convolution	62
3.4.1. Definition	62
3.4.2. Dirac distribution and convolution	64
Chapter 4. z-transforms, Fourier Transforms and Laplace Transforms . .	67
4.1. z-transform	68
4.1.1. Definitions and main results	68
4.1.2. Application to discrete systems	70
4.2. Fourier transform	73
4.2.1. Periodic signals	73
4.2.2. Non-periodic signals	74
4.2.3. Main properties of Fourier transforms	79
4.2.4. Application to analog signals and systems	82
4.2.5. Transfer function	86
4.2.6. Autocorrelation and intercorrelation of signals.	88
4.3. Discrete Fourier transform and fast Fourier transform	91
4.3.1. Discrete Fourier transform	91
4.3.2. Fast Fourier transform (FFT)	95
4.4. Laplace transform	101
4.4.1. Definition	101
4.4.2. Properties	102
4.4.3. Differential equation	103
4.4.4. Convolution product	104
Chapter 5. Digitizing an Analog Signal	107
5.1. Introduction	107
5.2. Sampling	108
5.3. Quantization	112
5.4. Coding	116
Chapter 6. Modulation	119
6.1. Types of modulation.	119
6.2. Amplitude modulation.	121
6.2.1. Principle	121

6.2.2. Frequency space.	123
6.2.3. Signal strength	124
6.2.4. Overmodulation.	125
6.2.5. Demodulation	126
6.2.6. Single sideband	127
6.2.7. Modulation of a binary signal	127
6.3. Frequency modulation.	130
6.3.1. Principle	130
6.3.2. Case of a sinusoidal signal	132
6.3.3. Spectrum.	133
6.3.4. Signal power	136
6.3.5. FSK modulation.	136
6.4. Phase modulation	139
6.4.1. Principle	139
6.4.2. PSK modulation.	141
Chapter 7. Filtering	145
7.1. Definitions and reminders.	145
7.1.1. Discrete signals	146
7.1.2. Analog signals.	147
7.2. Analog filtering	148
7.2.1. General information	148
7.2.2. Common filters	148
7.2.3. Differential equations and transfer functions	152
7.3. Digital filtering.	160
7.3.1. General information	160
7.3.2. Difference equation.	161
7.3.3. Transfer function	163
7.3.4. Filter stability	166
7.3.5. Frequency behavior.	168
7.3.6. FIR filters	170
7.3.7. IIR filters	173
Chapter 8. The Digital Image	177
8.1. Raster and vector images	177
8.1.1. Raster images	177
8.1.2. Vector images	179
8.2. Notions of colorimetry	179
8.2.1. Grayscale	180
8.2.2. Colors	184
8.2.3. True color and indexed color	188

8.4. Image display modes	190
8.4.1. Matrix coding	190
8.4.2. Vector coding	192
8.4.3. Fractal curves	193
8.5. Compression and compaction.	193
8.6. Image formats	195
8.6.1. Raster image formats	195
8.6.2. Vector image formats.	196
Chapter 9. 2D Computer Graphics	197
9.1. Basic graphics processing.	197
9.1.1. Drawing a segment	197
9.1.2. Drawing a circle.	201
9.1.3. Windowing	202
9.1.4. Filling and coloring.	204
9.2. 2D geometric transformations	205
9.2.1. Homogeneous coordinates	205
9.2.2. Translation.	206
9.2.3. Rotation around the origin	207
9.2.4. Dilation	208
9.2.5. Symmetries	209
9.2.6. Composition of transformations	210
9.2.7. Object representation	211
9.3. 2D parametric curves	212
9.3.1. Using cubic curves	212
9.3.2. Hermite curves	213
9.3.3. Bézier curves	214
9.3.4. B-spline curves	216
Chapter 10. Concepts in Image Processing and Analysis	217
10.1. Image display	218
10.1.1. Simple correspondence	218
10.1.2. Random threshold display	218
10.1.3. Threshold matrix display	220
10.2. Basic image analysis tools.	222
10.2.1. Histogram	222
10.2.2. Profiles	224
10.2.3. Level search	224
10.2.4. Information contained in an image.	224
10.3. Basic processing	226
10.3.1. Histogram transformation.	226
10.3.2. Changing the shape of the histogram: equalization.	230

10.3.3. Image subtraction and averaging	233
10.4. Filtering	233
10.4.1. Filtering in the spatial domain	233
10.4.2. Frequency domain filtering	241
10.5. Binary images	245
10.5.1. Morphological operators	246
10.6. Segmentation	247
10.6.1. Outline extraction	248
10.6.2. Regional segmentation	252
Chapter 11. Basics of Image Compression	257
11.1. General information	258
11.1.1. Coding redundancy	258
11.1.2. Interpixel redundancy	259
11.1.3. Psychovisual redundancy	260
11.1.4. Confidence criteria	261
11.1.5. Modeling image compression	262
11.2. Lossless compression or compaction	263
11.2.1. Variable-length coding	263
11.2.2. Bit-plane coding	266
11.2.3. Predictive coding	268
11.3. Lossy compression	269
11.3.1. Predictive coding	269
11.3.2. Transform coding	270
11.4. An image compression standard: JPEG	272
Chapter 12. Elements of Numerical Analysis	277
12.1. Numerical solution of a linear system	278
12.1.1. Exact solution of a linear Cramerian system	278
12.1.2. Principle of iterative methods	280
12.1.3. Diagonal iteration and Gauss–Seidel iteration	282
12.1.4. Direct methods.	283
12.2. Numerical solution of $\mathbf{f}\mathbf{x} = \mathbf{0}$	287
12.2.1. Introduction	287
12.2.2. General methods.	288
12.2.3. Methods applicable to polynomial equations	294
12.3. Numerical integration	297
12.3.1. Introduction	297
12.3.2. Classic methods	297
12.3.3. Polynomial interpolation	302
12.3.4. Quadrature formulas.	304
12.3.5. Monte Carlo method	307

12.4. Numerical solution of differential equations	310
12.4.1. Introduction	310
12.4.2. Separate-step algorithms	311
12.4.3. Linked-step methods	318
12.5. Numerical solution of partial differential equations	320
12.5.1. Definitions	320
12.5.2. Finite difference method	321
12.5.3. Resolution examples	325
12.6. Appendices	331
12.6.1. Dichotomy method	331
12.6.2. Iterative method	332
12.6.3. Secant method	332
12.6.4. Tangent method	333
12.6.5. Monte Carlo method, Example 12.7	334
12.6.6. Monte Carlo method, Example 12.8	336
References.	339
List of Authors	343
Index.	345