

Contents

1	Sampling of Continuous Time Signals	1
1.1	Sampling Operation for Continuous Time Signals	2
1.1.1	Sampling Frequency	4
1.1.2	Mathematical Characterization of the Sampling Operation	5
1.2	Sampling Operation	6
1.2.1	The Fourier Transform of the Product Signal	7
1.3	How to Draw Fourier Transforms of Product Signal and Digital Signal	11
1.3.1	Drawing the Fourier Transform of Digital Signal	25
1.4	Aliasing (Spectral Overlapping)	30
1.4.1	The Meaning of the Aliasing (Overlapping)	33
1.4.2	Drawing the Frequency Response of Digital Signal in Case of Aliasing (Practical Method)	39
1.5	Reconstruction of an Analog Signal from Its Samples	45
1.5.1	Approximation of the Reconstruction Filter	51
1.6	Discrete Time Processing of Continuous Time Signals	55
1.7	Continuous Time Processing of Digital Signals	61
1.8	Problems	68
2	Multirate Signal Processing	71
2.1	Sampling Rate Reduction by an Integer Factor (Downsampling, Compression)	72
2.1.1	Fourier Transform of the Downsampled Signal	75
2.1.2	How to Draw the Frequency Response of Downsampled Signal	78
2.1.3	Aliasing in Downsampling	80
2.1.4	Interpretation of the Downsampling in Terms of the Sampling Period	83

2.1.5	Drawing the Fourier Transform of Downsampled Signal in Case of Aliasing (Practical Method)	92
2.2	Upsampling: Increasing the Sampling Rate by an Integer Factor	97
2.2.1	Upsampling (Expansion)	97
2.2.2	Mathematical Formulization of Upsampling	98
2.2.3	Frequency Domain Analysis of Upsampling	99
2.2.4	Interpolation	103
2.2.5	Mathematical Analysis of Interpolation	107
2.2.6	Approximation of the Ideal Interpolation Filter	111
2.2.7	Anti-aliasing Filter	126
2.3	Practical Implementations of C/D and D/C Converters	128
2.3.1	C/D Conversion	129
2.3.2	Sample and Hold	130
2.3.3	Quantization and Coding	134
2.3.4	D/C Converter	136
2.4	Problems	139
3	Discrete Fourier Transform	145
3.1	Manipulation of Digital Signals	146
3.1.1	Manipulation of Periodic Digital Signals	149
3.1.2	Shifting of Periodic Digital Signals	149
3.1.3	Some Well Known Digital Signals	156
3.2	Review of Signal Types	158
3.3	Convolution of Periodic Digital Signals	165
3.3.1	Alternative Method to Compute the Periodic Convolution	166
3.4	Sampling of Fourier Transform	170
3.5	Discrete Fourier Transform	172
3.5.1	Aliasing in Time Domain	182
3.5.2	Matrix Representation of DFT and Inverse DFT	184
3.5.3	Properties of the Discrete Fourier Transform	185
3.5.4	Circular Convolution	188
3.6	Practical Calculation of the Linear Convolution	198
3.6.1	Evaluation of Convolution Using Overlap-Add Method	199
3.6.2	Overlap-Save Method	204
3.7	Computation of the Discrete Fourier Transform	207
3.7.1	Fast Fourier Transform (FFT) Algorithms	207
3.7.2	Decimation in Time FFT Algorithm	207
3.7.3	Decimation in Frequency FFT Algorithm	217
3.8	Total Computation Amount of the FFT Algorithm	225
3.9	Problems	230

4 Analog and Digital Filter Design	233
4.1 Review of Systems	233
4.1.1 Z-Transform	236
4.1.2 Laplace Transform	239
4.2 Transformation Between Continuous and Discrete	
Time Systems	240
4.2.1 Conversion of Transfer Functions of LTI Systems	245
4.2.2 Forward Difference Transformation Method	246
4.2.3 Bilinear Transformation	248
4.3 Analogue Filter Design	253
4.3.1 Ideal Filters	254
4.3.2 Practical Analog Filter Design	258
4.3.3 Practical Filter Design Methods	260
4.3.4 Analog Frequency Transformations	272
4.4 Implementation of Analog Filters	273
4.4.1 Low Pass Filter Circuits	273
4.4.2 Analog High-Pass Filter Circuit Design	279
4.4.3 Analog Bandpass Active Filter Circuits	282
4.4.4 Analog Bandstop Active Filter Circuits	282
4.5 Infinite Impulse Response (IIR) Digital Filter Design	
(Low Pass)	283
4.5.1 Generalized Linear Phase Systems	289
4.6 Finite Impulse Response (FIR) Digital Filter Design	290
4.6.1 FIR Filter Design Techniques	291
4.7 Problems	297
Bibliography	299
Index	301



<http://www.springer.com/978-981-10-4961-3>

Understanding Digital Signal Processing

Gazi, O.

2018, IX, 303 p. 334 illus., Hardcover

ISBN: 978-981-10-4961-3