

Contents

Preface	1
A Fourier Analysis in L1	5
Introduction	7
A1 Fourier Transforms of Stable Signals	11
A1.1 Fourier Transform in L^1	11
A1.2 Inversion Formula	20
A2 Fourier Series of Locally Stable Periodic Signals	27
A2.1 Fourier Series in L^1_{loc}	27
A2.2 Inversion Formula	30
A3 Pointwise Convergence of Fourier Series	35
A3.1 Dini's and Jordan's Theorems	35
A3.2 Féjer's Theorem	43
A3.3 The Poisson Formula	48
References	51
B Signal Processing	53
Introduction	55

B1 Filtering	59
B1.1 Impulse Response and Frequency Response	59
B1.2 Band-Pass Signals	71
B2 Sampling	76
B2.1 Reconstruction and Aliasing	76
B2.2 Another Approach to Sampling	82
B2.3 Intersymbol Interference	84
B2.4 The Dirac Formalism	89
B3 Digital Signal Processing	95
B3.1 The DFT and the FFT Algorithm	95
B3.2 Z-Transform	100
B3.3 All-pass and Spectral Factorization	110
B4 Subband Coding	115
B4.1 Band Splitting with Perfect Reconstruction	115
B4.2 FIR Subband Filters	119
References	125
C Fourier Analysis in L²	127
Introduction	129
C1 Hilbert Spaces	133
C1.1 Basic Definitions	133
C1.2 Continuity Properties	136
C1.3 Projection Theorem	139
C2 Complete Orthonormal Systems	146
C2.1 Orthonormal Expansions	146
C2.2 Two Important Hilbert Bases	151
C3 Fourier Transforms of Finite Energy Signals	156
C3.1 Fourier Transform in L^2	156
C3.2 Inversion Formula in L^2	160
C4 Fourier Series of Finite Power Periodic Signals	162
C4.1 Fourier Series in L^2_{loc}	162
C4.2 Orthonormal Systems of Shifted Functions	164
References	169

D Wavelet Analysis	171
Introduction	173
D1 The Windowed Fourier Transform	177
D1·1 Uncertainty Principle	177
D1·2 The WFT and Gabor's Inversion Formula	180
D2 The Wavelet Transform	187
D2·1 Time–Frequency Resolution of Wavelet Transforms	187
D2·2 The Wavelet Inversion Formula	189
D3 Wavelet Orthonormal Expansions	195
D3·1 Mother Wavelet	195
D3·2 Mother Wavelet in the Fourier Domain	201
D3·3 Mallat's Algorithm	209
D4 Construction of a MRA	213
D4·1 MRA from an Orthonormal System	213
D4·2 MRA from a Riesz Basis	216
D4·3 Spline Wavelets	219
D5 Smooth Multiresolution Analysis	224
D5·1 Autoreproducing Property of the Resolution Spaces	224
D5·2 Pointwise Convergence Theorem	226
D5·3 Regularity Properties of Wavelet Bases	229
References	233
Z Appendix	235
The Lebesgue Integral	237
References	261
Glossary of Symbols	262
Index	265