

Table of Contents

Preface	VII
1 Wavelet Bases	1
1.1 Wavelet Bases in $L_2(\Omega)$	1
1.1.1 General Setting	2
1.1.2 Characterization of Sobolev-Spaces	5
1.1.3 Riesz Basis Property in $L_2(\Omega)$	7
1.1.4 Norm Equivalences	8
1.1.5 General Setting Continued.....	9
1.1.6 Further Wavelet Features.....	10
1.1.7 A Program for Constructing Wavelets.....	11
1.2 Wavelets on the Real Line	12
1.2.1 Orthonormal Wavelets	13
1.2.2 Biorthogonal B-Spline Wavelets	14
1.2.3 Interpolatory Wavelets	15
1.3 Wavelets on the Interval.....	17
1.3.1 Boundary Scaling Functions	19
1.3.2 Biorthogonal Scaling Functions.....	20
1.3.3 Biorthogonalization.....	25
1.3.4 Refinement Matrices	30
1.3.5 Biorthogonal Wavelets on $(0, 1)$	33
1.3.6 Quantitative Aspects of the Biorthogonalization	41
1.3.7 Boundary Conditions	44
1.3.8 Other Bases	45
1.4 Tensor Product Wavelets	46
1.5 Wavelets on General Domains	47
1.5.1 Domain Decomposition and Parametric Mappings	51
1.5.2 Multiresolution and Wavelets on the Subdomains	53
1.5.3 Multiresolution on the Global Domain Ω	54
1.5.4 Wavelets on the Global Domain	55
1.5.5 Univariate Matched Wavelets and Other Functions	56
1.5.6 Bivariate Matched Wavelets	62
1.5.7 Trivariate Matched Wavelets	73
1.5.8 Characterization of Sobolev Spaces	78
1.6 Vector Wavelets	81

2 Wavelet Bases for $H(\text{div})$ and $H(\text{curl})$	83
2.1 Differentiation and Integration	84
2.1.1 Differentiation and Integration on the Real Line	84
2.1.2 Differentiation and Integration on $(0, 1)$	85
2.1.3 Assumptions for General Domains	86
2.1.4 Norm Equivalences	89
2.2 The Spaces $H(\text{div})$ and $H(\text{curl})$	90
2.2.1 Stream Function Spaces	91
2.2.2 Flux Spaces	91
2.2.3 Hodge Decompositions	92
2.3 Wavelet Systems for $H(\text{curl})$	92
2.3.1 Wavelets in $\mathbf{H}_0(\mathbf{curl}; \Omega)$	93
2.3.2 Curl-Free Wavelet Bases	95
2.4 Wavelet Bases for $H(\text{div})$	98
2.4.1 Wavelet Bases in $\mathbf{H}(\text{div}; \Omega)$	98
2.4.2 Divergence-Free Wavelet Bases	99
2.5 Helmholtz and Hodge Decompositions	100
2.5.1 A Biorthogonal Helmholtz Decomposition	100
2.5.2 Interrelations and Hodge Decompositions	101
2.6 General Domains	102
2.6.1 Tensor Product Domains	102
2.6.2 Parametric Mappings	103
2.6.3 Fictitious Domain Method	104
2.7 Examples	105
3 Applications	109
3.1 Robust and Optimal Preconditioning	109
3.1.1 Wavelet-Galerkin Discretizations	109
3.1.2 The Lamé Equations for Almost Incompressible Material	112
3.1.3 The Maxwell Equations	116
3.1.4 Preconditioning in $\mathbf{H}(\text{div}; \Omega)$	117
3.2 Analysis and Simulation of Turbulent Flows	118
3.2.1 Numerical Simulation of Turbulence	118
3.2.2 Divergence-Free Wavelet Analysis of Turbulence	119
3.2.3 Proper Orthogonal Decomposition (POD)	120
3.2.4 Numerical Implementation and Validation	122
3.2.5 Numerical Results I: Data Analysis	124
3.2.6 Numerical Results II: Complexity of Turbulent Flows .	128
3.3 Hardening of an Elastoplastic Rod	138
3.3.1 The Physical Problem	138
3.3.2 Numerical Treatment	142
3.3.3 Stress Correction and Wavelet Bases	145
3.3.4 Numerical Results I: Variable Order Discretizations .	146
3.3.5 Numerical Results II: Plastic Indicators	154

References	161
List of Figures	169
List of Tables	173
List of Symbols	175
Index	179



<http://www.springer.com/978-3-540-43055-1>

Wavelets in Numerical Simulation
Problem Adapted Construction and Applications
Urban, K.
2002, XV, 181 p., Softcover
ISBN: 978-3-540-43055-1