

Contents

<i>Preface</i>	v
1. Introduction	1
1.1 The Spectrum of Applications	1
1.2 Brief Historical Perspective	4
1.3 Local Averages and Their Extremes	9
2. Fundamentals of Analysis of Random Fields	13
2.1 Types of Random Fields	13
2.2 Basic Probabilistic Description	18
2.3 Expectation and Conditional Expectation	31
2.4 Characteristic Functions	39
2.5 Gaussian and Related Probability Distributions	42
2.6 Optimal Linear Prediction and Updating	53
2.7 Purely Random Fields and Markov Processes	59
2.8 New Quantum-Physics-Based Probability Distributions	74
3. Second-Order Analysis of Homogeneous Random Fields	85
3.1 Preview, Definitions, and Notation	85
3.2 Correlation Function of a Homogeneous Random Field	87
3.3 Spectral Representation of Random Processes on the Line	92
3.4 Spectral Analysis of Homogeneous Random Fields	101
3.5 Input-Output Relations for Invariant Linear Systems	114
3.6 Derivatives and Local Integrals of Random Fields	119
3.7 Moving Average and Autoregressive Models	129

3.8	Space-Time Correlation Structure: Basic Relations	138
4.	Spectral Parameters, Level Crossings, and Extremes	145
4.1	Spectral Moments and Related Parameters	145
4.2	Statistics of Partial Derivatives	152
4.3	Basic Envelope Statistics	154
4.4	Threshold-Crossing Statistics and Extremes	161
4.5	Expected Size of Regions of Excursion	170
4.6	Statistics of Level Excursions and Extremes	175
4.7	Spectral Parameters of Common Correlation Models	179
4.8	Some Extensions to Nonhomogeneous Random Fields	187
5.	Local Average Processes on the Line	189
5.1	Variance Function and Scale of Fluctuation	189
5.2	Scale of Fluctuation: Frequency-Domain Interpretation	199
5.3	Covariance of Local Integrals or Local Averages	205
5.4	Mean Square Derivative and Spectral Moments	214
5.5	Level-Crossing and Extreme-Value Statistics	219
5.6	Invariant and Regenerative Properties	222
5.7	Parallel Results for Random Series and Point Processes	226
5.8	Role of the Scale of Fluctuation in Optimal Sampling	230
5.9	Composite Random Processes and the Scale Spectrum	231
6.	Two-Dimensional Local Average Processes	239
6.1	Variance Function and Measure of Correlation	239
6.2	Important Special Cases	245
6.3	Conditional Variance Functions and Scales of Fluctuation	249
6.4	Covariance of Local Averages	257
6.5	Statistics of Level Excursions and Extremes	263
6.6	Invariants for 2-D Homogeneous Random Fields	266
6.7	Space-Time Processes: Frequency-Dependent Scale of Fluctuation	268
6.8	Space-Time Processes: Frequency-Dependent Variance Function	277
7.	Multi-Dimensional Local Average Processes	281
7.1	Variance Function and Correlation Measures	281
7.2	Conditional Variance Functions and Correlation Measures	291

7.3	Frequency-Dependent Spatial Random Variation	298
7.4	Some Tractable Space-Time Correlation Models	305
7.5	Covariance of Local Averages	309
7.6	Stochastic Finite Element Analysis	311
7.7	Partial Derivatives of Local-Average Fields	315
7.8	Statistics of High-Level Excursions and Extremes	318
8.	Overview of Findings	323
	<i>Bibliography</i>	337
	<i>Index</i>	347