

Contents

1	Introduction	1
1.1	Multi-level Systems	1
1.1.1	Levels and Complexity	1
1.1.2	Related Concepts and Theories	3
1.2	Levels of Reality and Categories	6
	References	9
2	Methodological Resources.....	11
2.1	Random Systems	11
2.2	Non-Archimedean Analysis.....	13
2.3	Categorical Frames	14
2.3.1	Introducing Category Theory	14
2.3.2	Higher Dimensional Categories	16
2.3.3	Models Categorification	18
2.3.4	Synthetic Differential Geometry	19
2.4	Closure.....	21
2.4.1	Semantic Closure	21
2.4.2	Two Levels Modeling	22
2.4.3	Integrative Closure.....	24
	References	31
3	Conventional PSM Frames	35
3.1	One Conditioning Level Frame	35
3.2	Multiple Conditioning Levels.....	38
3.3	Illustrative Case Studies	41
3.3.1	Mixing in Turbulent Flow	41
3.3.2	Diffusion on a Hierarchical Space.....	44
3.3.3	Different Views for the Same Phenomenon	48
	References	51
4	New PSM Frames	53
4.1	General Frameworks for PSM	53
4.1.1	Basic Categorical Frameworks.....	53
4.1.2	Multiple Levels	55
4.2	Time Frames	61
4.2.1	The Problem of Time Frame	61
4.2.2	Frame of Infinitesimals	62
4.3	Probabilities and Possibilities	63

4.3.1	Frame of Infinitesimals for Probabilities and Possibilities.....	63
4.3.2	Non Well Founded Sets and Probabilities.....	65
4.4	Models Categorification Methodology.....	66
4.4.1	Frame of Infinitesimals for PSM.....	66
4.4.2	NA Difference Equation.....	68
	References.....	69
5	Mixing in Chemical Reactors	71
5.1	Discrete Model of Imperfect Mixing.....	71
5.1.1	Residence Time Distribution, RTD.....	71
5.1.2	Discrete Model for Residence Time Distributions.....	75
5.1.3	Local Anesthetic Effects.....	80
5.1.4	Stochastic Features. Real Field Probabilities.....	81
5.1.5	PSM Frame for Discrete Model.....	83
5.1.6	Comparison with Theory.....	84
5.2	Continuous Model of Imperfect Mixing.....	85
5.2.1	The Continuous Model.....	85
5.2.2	PSM Frame for Continuous Model.....	89
5.2.3	Comparison with Theory.....	90
5.2.4	SDG Solution for Imperfect Mixing.....	93
	References.....	94
6	Compartmental Systems	95
6.1	Compartmental Models.....	95
6.2	Discrete Models for a Series of Imperfectly Mixed Vessels.....	97
6.3	Continuous Time Model.....	99
6.3.1	Residence Time Distributions.....	99
6.3.2	Interaction of Chemical Compound with Membranes.....	103
	References.....	105
7	Turbulent Mixing	107
7.1	Dispersion.....	107
7.1.1	The Dispersion Equation.....	107
7.1.2	The Frame of Infinitesimals.....	109
7.1.3	Hydrological Experiments.....	113
7.1.4	SDG Solution for Dispersion.....	115
7.1.5	Convection Model.....	117
7.2	Intermittency by Vortex Line Stretching.....	118
7.2.1	Conventional Frame.....	118
7.2.2	Multi-level Frame.....	120
	References.....	123
8	Entropy.....	125
8.1	Background.....	125
8.2	Informational Entropy.....	127
8.3	Entropy Production for Biosystems.....	129

8.4 Entropy and Integrative Closure	135
8.5 Cooperative Model for Nerve Excitation.....	138
References	141
9 Formal Concept Analysis.....	143
9.1 Galois Lattices	143
9.2 Separation Lattice	144
9.3 Drugs Mixture.....	148
9.4 Failure Analysis	149
9.5 Triadic Context Analysis	151
9.6 Rough Set Approximations.....	153
9.7 Hierarchical Class Analysis.....	156
9.8 Tetradic Context Analysis	158
9.9 Security Management Architectures.....	160
References	162
10 Existential Graphs	165
10.1 Systems of Existential Graphs	165
10.2 Continuum and Existential Graphs	170
10.3 Separation Flow Sheets.....	173
References	176
11 Evolvable Designs of Experiments	179
11.1 Pharmaceutical Pipeline.....	179
11.2 Designs of Experiments for Drug Discovery	182
11.3 Drugs Development	184
11.3.1 General PSM Framework for Discovery and Development....	184
11.3.2 Informational Tools.....	185
11.3.3 Anesthetics Mixtures.....	187
11.3.4 Acylthiocarbamates Library Design.....	190
11.4 Reliability Management System	193
References	196
12 Autonomous Systems Perspective	199
12.1 Autonomous Experimentation	199
12.2 Case Based Reasoning Systems.....	200
12.3 Belief Desire Intention Agents	203
12.4 Autonomic and Organic Computing	205
12.5 Autonomous Animats	207
12.6 Viable Systems Models	208
12.7 Meta-modeling Architectures	209
References	211
Appendices	213
Appendix 1: Non-Archimedean Analysis.....	213
A1.1 Valued Fields.....	213
A1.2 Normed Linear Spaces and Orthogonality.....	214
References.....	217

Appendix 2 Category Theory218

A2.1 Category Theory218

A2.2 The n-Categories.....219

A2.3 Periodic Table.....220

A2.4 Categorification and Coherence.....222

A2.5 Toposes Modeling SDG.....225

References226

Index229