## Contents

### Part I  Algebra

**Mathematics: As an Infrastructure of Technology and Science**  
Hiroyuki Ochiai  
3

**Remarks on Quantum Interaction Models by Lie Theory and Modular Forms via Non-commutative Harmonic Oscillators**  
Masato Wakayama  
17

**Introduction to Public-Key Cryptography**  
Tsuyoshi Takagi  
35

**Code-Based Public-Key Encryption**  
Kirill Morozov  
47

**Gröbner Basis and Its Applications**  
Takafumi Shibuta  
57

### Part II  Geometry

**Stability Analysis for Variational Problems for Surfaces with Constraint**  
Miyuki Koiso  
71

**Discrete Models of Isoperimetric Deformation of Plane Curves**  
Jun-ichi Inoguchi, Kenji Kajiwara, Nozomu Matsuura and Yasuhiro Ohta  
89

**Computing Optimal Cycles of Homology Groups**  
Emerson G. Escolar and Yasuaki Hiraoka  
101

**Singularity Theory of Differentiable Maps and Data Visualization**  
Osamu Saeki  
119
Part III  Analysis

Mathematical Analysis for Pattern Formation Problems 133
Shin-ichiro Ei

Models and Applications of Organism Transportation 141
Atsushi Tero

The Renormalization Group Method for Ordinary Differential Equations 151
Hayato Chiba

A Phase Field Approach to Mathematical Modeling of Crack Propagation 161
Masato Kimura and Takeshi Takaishi

Variational Methods in Differential Equations 171
Michiaki Onodera

Part IV  Probability and Statistics

Finite Markov Chains and Markov Decision Processes 189
Tomoyuki Shirai

Introduction to the Premium Principle Based on the Wang Transform 207
Shingo Saito

Stochastic Process Models 219
Hiroki Masuda

Signal Detection and Model Selection 239
Yoshiyuki Ninomiya

Regression Analysis and Its Development 249
Ryuei Nishii

Stochastic Analytical Models in Mathematical Finance 263
Setsuo Taniguchi

An Introduction to the Minimum Description Length Principle 279
Jun’ichi Takeuchi
An Introduction to Ergodic Theory ........................................... 297
Khanh Duy Trinh

Part V  Applied Mathematics

Discrete Optimization: Network Flows and Matchings ............... 313
Naoyuki Kamiyama

Strict Feasibility of Conic Optimization Problems ............... 325
Hayato Waki

Theory of Automata, Abstraction and Applications ............... 337
Yoshihiro Mizoguchi

Markov Chain Monte Carlo Algorithms ......................... 349
Osamu Maruyama

Modeling of Fluid Flows by Nonlinear Schrödinger Equation ...... 365
Yasuhide Fukumoto

Financial Applications of Quasi-Monte Carlo Methods .............. 379
Shu Tezuka

Pure Mathematics and Applied Mathematics are Inseparably Intertwined: Observation of the Early Analysis of the Infinity ...... 393
Masahito Takase

High Performance Computing for Mathematical Optimization Problem ........................................... 401
Katsuki Fujisawa

Part VI  Application of Mathematics

Modeling of Head-Disk Interface for Magnetic Recording ........... 425
Kanzo Okada

Nonstationary Analysis of Blast Furnace Through Solution of Inverse Problem and Recurrence Plot ........................................... 439
Junichi Nakagawa

Time-Periodic Nonlinear Steady Field Analysis ....................... 453
Kenji Miyata
Mathematical Models in First-Principles Calculations for Materials Science ..................................... 467
Hajime Kobayashi

Mathematics and Manufacturing: The Symbolic Approach ............. 481
Ryusuke Masuoka and Hirokazu Anai

Error Correcting Codes Based on Probabilistic Decoding and Sparse Matrices ..................................... 495
Hironori Uchikawa

Index .......................................................... 505
A Mathematical Approach to Research Problems of Science and Technology
Theoretical Basis and Developments in Mathematical Modeling
2014, XII, 507 p. 149 illus., 68 illus. in color., Hardcover
ISBN: 978-4-431-55059-4