

Contents

Preface	vii
Chapter 1. Four-Dimensional Vector Spaces and Linear Mappings	1
1.1. Minkowski Vector Space V_4	1
1.2. Lorentz Mappings of V_4	8
1.3. The Minkowski Tensors	13
Chapter 2. Flat Minkowski Space-Time Manifold M_4 and Tensor Fields	20
2.1. A Four-Dimensional Differentiable Manifold	20
2.2. Minkowski Space-Time M_4 and the Separation Function	25
2.3. Flat Submanifolds of Minkowski Space-Time M_4	35
2.4. Minkowski Tensor Fields on M_4	41
Chapter 3. The Lorentz Transformation	48
3.1. Applications of the Lorentz Transformation	48
3.2. The Lorentz Group $\mathcal{L}_4$	55
3.3. Real Representations of the Lorentz Group $\mathcal{L}_4$	59
3.4. The Lie Group $\mathcal{L}_4^+$	63
Chapter 4. Pauli Matrices, Spinors, Dirac Matrices, and Dirac Bispinors	72
4.1. Pauli Matrices, Rotations, and Lorentz Transformations	72
4.2. Spinors and Spinor-Tensors	79
4.3. Dirac Matrices and Dirac Bispinors	85
Chapter 5. The Special Relativistic Mechanics	89
5.1. The Prerelativistic Particle Mechanics	89
5.2. Prerelativistic Particle Mechanics in Space and Time $\mathbb{E}_3 \times \mathbb{R}$	95

5.3. The Relativistic Equation of Motion of a Particle	100
5.4. The Relativistic Lagrangian and Hamiltonian Mechanics of a Particle	108
Chapter 6. The Special Relativistic Classical Field Theory	120
6.1. Variational Formalism for Relativistic Classical Fields	120
6.2. The Klein–Gordon Scalar Field	133
6.3. The Electromagnetic Tensor Field	140
6.4. Nonabelian Gauge Fields	147
6.5. The Dirac Bispinor Field	151
6.6. Interaction of the Dirac Field with Gauge Fields	160
Chapter 7. The Extended (or Covariant) Phase Space and Classical Fields	168
7.1. Classical Fields	168
7.2. The Generalized Klein–Gordon Equation	175
7.3. Spin- $\frac{1}{2}$ Fields in the Extended Phase Space	190
Answers and Hints to Selected Exercises	202
Index of Symbols	204
Subject Index	207