Contents

Preface VII

List of Symbols and Notations XIV

Chapter I Preliminaries 1

1. Selection of Basic Concepts from Algebra 1
A. Matrices and Determinants 1
B. Vectors in Three-dimensional Euclidean Space 7
C. Vector Spaces 15
D. Mappings of Sets and Vector Spaces 21
2. Basic Concepts from Group Theory. 28
3. Basic Topological Concepts 35
4. Differential Geometry of Curves and Ruled Surfaces in E_3 49
5. Differentiable Manifolds, Lie Groups 69

Chapter II Motion on the Unit Sphere 94

1. Definition of Spherical Motion 94
2. Various Ways of Representing Motion, Euler Angles 107
A. Relations between the Groups O (3), ad J, SU (2) 107
B. Introducing Euler Angles 109
3. Directing Cones, Centrodes, and Invariants of Spherical Motion 119
4. Invariants of the Trajectory of a Point, Special Motions 163
5. Kinematics of Spherical Motion 189

Chapter III Kinematics of Space Motion 197

1. Lie Group of Congruences of E_3 and its Lie Algebra 197
2. Klein Quadrics 206
3. Representation of Space Motion, Associated Spherical Motion 212
4. Directing Cones of Space Motion, Axoids, Elementary Motions 223
5. Invariants of Motion 239
6. Invariants of Axoids and Relations between the Invariants of Motion and the Invariants of Axoids 262
7. Trajectory of a Point 270

8. Special Motions 294
9. Dual Vectors and Trajectories of Lines 318
10. Fields of Velocities and Acceleration 345
11. Kinematic Generation of Average Envelopes 365
12. Application of Average Envelopes 372
A. Conjugate Surfaces of the Tool and Workpiece 372
B. Average Envelopes in Gearing Theory 394

References 410

Subject Index 419