

Contents

1	Introduction	1
1.1	Introduction	1
1.2	Mechanisms and Machines	2
1.2.1	Definition and Types	2
1.2.2	Kinematic Pairs and Kinematic Chains	3
1.2.3	Mobility and Range of Motion	5
1.3	Kinematic Analysis and Synthesis of Plane Mechanisms	9
1.3.1	Types of Functions of Mechanisms	9
1.3.2	Displacement, Velocity and Acceleration Analysis	12
1.3.3	Kinematic Synthesis of Plane Mechanisms	19
1.4	Actuators	27
2	Miniaturization and Microsystems	31
2.1	Miniaturization	31
2.1.1	Current Trend	32
2.1.2	Miniaturization: Advantages and Impact on Design	34
2.2	Microsystems	36
3	Scaling Laws: Science of Miniaturization	39
3.1	Scaling and Scaling Laws	39
3.2	Geometric Scaling	40
3.3	Scaling in Mechanics	43
3.4	Scaling in Electromagnetism and Electrostatics	46
3.5	Scaling of Common Forces	48
3.6	Scaling in Micromechanisms	48
4	Micromechanisms	51
4.1	Micromechanisms and Revival of Mechanism Theory	51
4.2	Assembled Micromechanisms	53
4.3	Monolithic Systems: Compliant Micromechanisms	55

5	Design of Micromechanisms	57
5.1	Design of Micromechanisms with Multiple Members	57
5.2	Compliant Micromechanisms	60
5.2.1	Compliant Micromechanisms with Flexure Hinges	61
5.2.2	Micromechanisms with Distributed Compliance	77
6	Dynamics of Micromechanisms	81
6.1	Dynamical Problems at Small-Scale Systems	81
6.2	Dynamics of Compliant Micromechanisms with Flexure Hinges	82
6.2.1	Free Oscillation	84
6.2.2	Forced Oscillation	86
6.3	Dynamics of Mechanisms with Flexible Links	94
7	Microactuators	97
7.1	Basic Principles and Considerations	97
7.1.1	Scaling Effects	98
7.1.2	Design Considerations	99
7.2	Electric Microactuators	102
7.2.1	Electromagnetic Microactuators	102
7.2.2	Electrostatic Actuators	107
7.3	Functional Material-Based Microactuators	118
7.3.1	Piezoelectric Microactuators	118
7.4	Shape Memory Alloy (SMA) Microactuators	123
7.4.1	Electroactive Polymer (EAP)-Based Microactuators	126
7.5	Miscellaneous Microactuators	129
7.5.1	Bimetallic Thermal Actuators	129
7.5.2	Magnetostrictive Actuators	130
8	Microfabrication and Futuristic Issues	133
8.1	Introduction: Top-Down Versus Bottom-Up Processes	133
8.2	Conventional ‘Top-Down’ Processes	136
8.2.1	Diamond Micromachining	136
8.2.2	Microelectric Discharge Machining	138
8.2.3	Laser Micromachining	140
8.3	Lithographic Processes	142
8.3.1	Basic Features	143
8.3.2	Bulk and Surface Micromachining	146
8.3.3	LIGA Process	147

8.4	Generative Processes	148
8.4.1	Rapid Prototyping Processes	149
8.4.2	Self-assembly	152
Bibliography		155
Index		157

Introduction to Micromechanisms and Microactuators

Ghosh, A.; Corves, B.

2015, XV, 161 p. 164 illus., Hardcover

ISBN: 978-81-322-2143-2