- Section I Manufacturing
- 1 Manufacturing Systems and Their Design Principles
- 1.1 Introduction p. 1
- 1.2 Major Manufacturing Paradigms and Their Objectives p. 2
- 1.3 Significance of Functionality/Capacity Adjustments in Modern Manufacturing Systems p. 4
- 1.4 Critical Role of Computers in Modern Manufacturing p. 5
- 1.5 Design Principles of Modern Manufacturing Systems p. 6
- 1.6 Future Trends and Research Directions p. 9
- Selected References p. 9
- 2 Computer-Aided Process Planning for Machining
- Abstract p. 11
- 2.1 Introduction p. 12
- 2.2 What Is Computer-Aided Process Planning (CAPP)? p. 12
- 2.3 Review of CAPP Systems p. 13
- 2.4 Drivers of CAPP System Development p. 18
- 2.5 Characteristics of CAPP Systems p. 19
- 2.6 Integrating CAD with CAPP: Feature Extraction p. 20
- 2.7 Integrating CAPP with Manufacturing p. 29
- 2.8 CAPP for New Domains p. 31
- 2.9 Conclusions p. 33
- References p. 34
- 3 Discrete Event Control of Manufacturing Systems
- 3.1 Introduction p. 39
- 3.2 Background on the Logic Control Problems p. 40
- 3.3 Current Industrial Practice p. 44
- 3.4 Current Trends p. 46
- 3.5 Formal Methods for Logic Control p. 48
- 3.6 Further Reading p. 57
- Acknowledgments p. 58
- References p. 58
- 4 Machine Tool Dynamics and Vibrations
- 4.1 Introduction p. 61
- 4.2 Chatter Vibrations in Cutting p. 62
- 4.3 Analytical Prediction of Chatter Vibrations in Milling p. 66
- References p. 73
- 5 Machine Tool Monitoring and Control
- 5.1 Introduction p. 75
- 5.2 Process Monitoring p. 75
- 5.3 Process Control p. 79
- 5.4 Conclusion p. 81
- References p. 81
- 6 Process Monitoring and Control of Machining Operations
- 6.1 Introduction p. 85
- 6.2 Force/Torque/Power Generation p. 86
- 6.3 Forced Vibrations and Regenerative Chatter p. 90

- 6.4 Tool Condition Monitoring and Control p. 94
- 6.5 Other Process Phenomena p. 97
- 6.6 Future Direction and Efforts p. 99
- Acknowledgments p. 101
- References p. 101
- 7 Forming Processes: Monitoring and Control
- 7.1 Introduction: Process and Control Objectives p. 105
- 7.2 The Plant or Load: Forming Physics p. 107
- 7.3 Machine Control p. 114
- 7.4 Machine Control: Force or Displacement? p. 115
- 7.5 Process Resolution Issues: Limits to Process Control p. 116
- 7.6 Direct Shape Feedback and Control p. 118
- 7.7 Summary p. 118
- References p. 118
- 8 Assembly and Welding Processes and Their Monitoring and Control
- 8.1 Assembly Processes p. 121
- 8.2 Monitoring and Control of Resistance Welding Process p. 123
- 8.3 Monitoring and Control of Arc Welding Processes p. 127
- References p. 134
- 9 Control of Polymer Processing
- 9.1 Introduction p. 139
- 9.2 Process Description p. 140
- 9.3 Process Variability p. 142
- 9.4 Modeling p. 143
- 9.5 Process Control p. 144
- 9.6 Conclusions p. 147
- References p. 148
- 10 Precision Manufacturing
- 10.1 Deterministic Theory Applied to Machine Tools p. 151
- 10.2 Basic Definitions p. 152
- 10.3 Motion p. 153
- 10.4 Sources of Error and Error Budgets p. 163
- 10.5 Some Typical Methods of Measuring Errors p. 169
- 10.6 Conclusion p. 177
- 10.7 Terminology p. 177
- References p. 179
- Section II Vibration Control
- 11 Active Damping of Large Trusses
- Abstract p. 181
- 11.1 Introduction p. 181
- 11.2 Active Struts p. 181
- 11.3 Active Tendon Control p. 187
- 11.4 Active Damping Generic Interface p. 191
- 11.5 Microvibrations p. 192
- 11.6 Conclusions p. 193
- Acknowledgment p. 194

- References p. 195
- 12 Semi-Active Suspension Systems
- 12.1 Introduction p. 197
- 12.2 Semi-Active Suspensions Design p. 199
- 12.3 Adjustable Suspension Elements p. 203
- 12.4 Automotive Semi-Active Suspensions p. 209
- 12.5 Application of Control Techniques to Semi-Active Suspensions p. 213
- 12.6 Practical Considerations and Related Topics p. 217
- References p. 217
- 13 Semi-Active Suspension Systems II
- 13.1 Concepts of Semi-Active Suspension Systems p. 221
- 13.2 Control Design Methodology p. 226
- 13.3 Properties of Semi-Active Suspensions: Performance Indexes p. 232
- 13.4 Examples of Practical Applications p. 233
- References p. 237
- 14 Active Vibration Absorption and Delayed Feedback Tuning
- 14.1 Introduction p. 239
- 14.2 Delayed Resonator Dynamic Absorbers p. 241
- 14.3 Multiple Frequency ATVA and Its Stability p. 264
- Acknowledgments p. 278
- References p. 278
- 15 Vibration Suppression Utilizing Piezoelectric Networks
- 15.1 Introduction p. 281
- 15.2 Passive and Semi-Active Piezoelectric Networks for Vibration Absorption and Damping p. 282
- 15.3 Active-Passive Hybrid Piezoelectric Network Treatments for General Modal Damping and Control p. 285
- 15.4 Active-Passive Hybrid Piezoelectric Network Treatments for Narrowband Vibration Suppression p. 289
- 15.5 Nonlinear Issues Related to Active-Passive Hybrid Piezoelectric Networks p. 293
- 15.6 Summary and Conclusions p. 294
- Acknowledgments p. 295
- References p. 295
- 16 Vibration Reduction via the Boundary Control Method
- 16.1 Introduction p. 299
- 16.2 Cantilevered Beam p. 301
- 16.3 Axially Moving Web p. 304
- 16.4 Flexible Link Robot Arm p. 307
- 16.5 Summary p. 311
- Acknowledgments p. 312
- References p. 312
- Section III Dynamics and Control of Aerospace Systems
- 17 An Introduction to the Mechanics of Tensegrity Structures
- Abstract p. 316
- 17.1 Introduction p. 316
- 17.2 Planar Tensegrity Structures Efficient in Bending p. 326

- 17.3 Planar Class K Tensegrity Structures Efficient in Compression p. 341
- 17.4 Statics of a 3-Bar Tensegrity p. 363
- 17.5 Concluding Remarks p. 375
- Acknowledgment p. 376
- Appendix 17.A Nonlinear Analysis of Planar Tensegrity p. 377
- Appendix 17.B Linear Analysis of Planar Tensegrity p. 379
- Appendix 17.C Derivation of Stiffness of the C4Tli Structure p. 381
- References p. 386
- 18 The Dynamics of the Class 1 Shell Tensegrity Structure
- Abstract p. 389
- 18.1 Introduction p. 389
- 18.2 Tensegrity Definitions p. 392
- 18.3 Dynamics of a Two-Rod Element p. 397
- 18.4 Choice of Independent Variables and Coordinate Transformations p. 400
- 18.5 Tendon Forces p. 409
- 18.6 Conclusion p. 417
- Acknowledgment p. 417
- Appendix 18.A Proof of Theorem 18.1 p. 418
- Appendix 18.B Algebraic Inversion of the Q Matrix p. 427
- Appendix 18.C General Case for (n, m) = (i, 1) p. 430
- Appendix 18.D Example Case (n,m) = (3,1) p. 435
- Appendix 18.E Nodal Forces p. 438
- References p. 449
- Section IV Robotics
- 19 Robot Kinematics
- 19.1 Introduction p. 451
- 19.2 Description of Orientation p. 452
- 19.3 Direct Kinematics p. 456
- 19.4 Inverse Kinematics p. 462
- 19.5 Differential Kinematics p. 465
- 19.6 Differential Kinematics Inversion p. 470
- 19.7 Inverse Kinematics Algorithms p. 476
- 19.8 Further Reading p. 483
- References p. 484
- 20 Robot Dynamics
- 20.1 Fundamentals of Robot Dynamic Modeling p. 490
- 20.2 Recursive Formulation of Robot Dynamics p. 497
- 20.3 Complete Model of Robot Dynamics p. 503
- 20.4 Some Application of Computer-Aided Dynamics p. 507
- 20.5 Extension of Dynamic Modeling--Some Additional Dynamic Effects p. 509
- Appendix Calculation of Transformation Matrices p. 519
- References p. 523
- 21 Actuators and Computer-Aided Design of Robots
- 21.1 Robot Driving Systems p. 524
- 21.2 Computer-Aided Design p. 540
- References p. 555

- 22 Control of Robots
- 22.1 Introduction p. 557
- 22.2 Hierarchical Control of Robots p. 558
- 22.3 Control of a Single Joint of the Robot p. 561
- 22.4 Control of Simultaneous Motion of Several Robot Joints p. 577
- References p. 586
- 23 Control of Robotic Systems in Contact Tasks
- 23.1 Introduction p. 587
- 23.2 Contact Tasks p. 587
- 23.3 Classification of Robotized Concepts for Constrained Motion Control p. 588
- 23.4 Model of Robot Performing Contact Tasks p. 592
- 23.5 Passive Compliance Methods p. 596
- 23.6 Active Compliant Motion Control Methods p. 599
- 23.7 Contact Stability and Transition p. 621
- 23.8 Synthesis of Impedance Control at Higher Control Levels p. 627
- 23.9 Conclusion p. 633
- References p. 634
- 24 Intelligent Soft-Computing Techniques in Robotics
- 24.1 Introduction p. 639
- 24.2 Connectionist Approach in Robotics p. 641
- 24.3 Neural Network Issues in Robotics p. 648
- 24.4 Fuzzy Logic Approach p. 656
- 24.5 Neuro-Fuzzy Approach in Robotics p. 677
- 24.6 Genetic Approach in Robotics p. 678
- 24.7 Conclusion p. 680
- References p. 681
- 25 Teleoperation and Telerobotics
- 25.1 Introduction p. 685
- 25.2 Hand Controllers p. 686
- 25.3 FRHC Control System p. 693
- 25.4 ATOP Computer Graphics p. 695
- 25.5 ATOP Control Experiments p. 698
- 25.6 Anthropomorphic Telerobotics p. 701
- 25.7 New Trends in Applications p. 703
- Acknowledgment p. 703
- References p. 705
- 26 Mobile Robotic Systems
- 26.1 Introduction p. 707
- 26.2 Fundamental Issues p. 707
- 26.3 Dynamics of Mobile Robots p. 716
- 26.4 Control of Mobile Robots p. 720
- References p. 726
- 27 Humanoid Robots
- 27.1 Zero-Moment Point--Proper Interpretation p. 728
- 27.2 Modeling of Biped Dynamics and Gait Synthesis p. 735
- 27.3 Control Synthesis for Biped Gait p. 743

- 27.4 Dynamic Stability Analysis of Biped Gait p. 752
- 27.5 Realization of Anthropomorphic Mechanisms and Humanoid Robots p. 765
- 27.6 Conclusion p. 774
- References p. 775
- 28 Present State and Future Trends in Mechanical Systems Design for Robot Application
- 28.1 Introduction p. 779
- 28.2 Industrial Robots p. 780
- 28.3 Service Robots p. 794
- References p. 811
- Index p. 813