

Contents

Chapter 1

General About Robots 1

1.1. Dedication and classification of robotic systems 1

1.2. General features of robotic mechanisms and its classification 14

1.3. Specificities of manipulation robots 23

1.3.1. Definition of position of an object in space 23

1.3.2. Structure of an industrial manipulation robot 23

1.3.3. Disposition of segments and their connections 24

1.3.4. Simple chain structure types 25

1.3.5. Mobility index and degrees of freedom of a
manipulation robot 26

1.3.6. Redundancy and singularity 28

1.3.7. Degrees of freedom of a task: (d.o.f.t.) 29

1.3.8. Compatibility 29

1.3.9. Decoupling the orientation and the position of the
terminal device 29

1.3.10. Different minimal configurations 30

1.3.11. Workspace 31

1.3.12. Comparison of the workspaces of different minimal
configurations 32

References 34

Chapter 2

Computer Forming of Mathematical Model of Manipulation Robots Dynamics 35

2.1. General about computer-oriented procedures for forming of
mathematical models of robot dynamics 35

2.2. Complete mathematical models of manipulation robots	54
2.3. Influence of mechanical vibrations on dynamic behaviour of manipulation robots	57
Example	60
2.4. Dynamics of manipulation robots with gripper constrained motion	64
Example	78
2.5. Dynamic analysis of manipulation robots	88
Example	109
2.6. Dynamics of flexible manipulation robots	112
Approximate method for dynamic analysis of flexible manipulation robots	128
2.7. Dynamics of cooperative manipulation	146
References	158

Chapter 3

Computer Method for Linearization and Parameter Sensitivity of Manipulation Robots Dynamic Models	160
3.1. Introduction	160
3.2. Method of computer linearization of dynamic models based on general theorems of mechanics	161
3.3. Sensitivity analysis of manipulation robots dynamic models .	172
References	186

Appendix 1

Connection Between the Moving and Fixed System	187
References	193

Appendix 2

Manipulator Kinematical Model	194
Examples	206
References	214

Appendix 3

Determining Velocities and Accelerations	215
References	217

Appendix 4	
Momentum of Rigid Body with Respect to a Fixed Pole	218
References	220
Appendix 5	
Specificities of Lever-Mechanisms Dynamics	221
Appendix 6	
Mathematical Models of Driving Units	227
Introduction	227
Permanent-magnet DC servomotor	227
AC servomotor	230
Synchronous motors with permanent magnet rotor (SM)	236
Direct-drive motor	240
Brushless DC servomotors	245
Electrohydraulic actuators	253
Electropneumatic actuators	273
References	283
Appendix 7	
Automatic Forming of Dynamic Models	284
Example 1: "Cylindrical" Mechanism (Basic Configuration)	284
Introduction	285
Example 2: "Stanford" Manipulator (Basic Configuration)	300
Introduction	300
Appendix 8	
Dynamics of "ASEA" Mechanism (Basic Configuration)	334
Kinematics	335
Dynamics	342
Source file for the computation of "ASEA" mechanism driving torques	348
Appendix 9	
Programme Support for Dynamics Modelling of Manipulation Robots	353
Subject Index	468