

# Contents

<b>Preface</b> .....	xi
<b>1 Beginnings of the Theory of Machines</b> .....	1
1.1 Beginning of the Wheel .....	1
1.2 Archimedes (287–212 BC) .....	2
1.3 Water Wheels .....	3
1.4 Wind Mills .....	4
1.5 Renaissance Engineers .....	4
1.6 Industrial Revolution .....	5
1.7 The Nature of This Book .....	6
<b>2 Planar Mechanisms</b> .....	9
2.1 Basic Kinematic Concepts .....	10
2.2 Elementary Mechanisms .....	18
2.3 Grübler’s Criterion for Planar Mechanisms .....	18
2.4 Four-Link Chains .....	22
2.5 Kinematic Inversion .....	25
2.6 Additional Problems .....	34
<b>3 Kinematic Analysis of Mechanisms</b> .....	37
3.1 Velocities by the Centro Method .....	40
3.2 Relative Velocity Equation .....	47
3.2.1 Rotation of a Rigid Link about a Fixed Axis .....	47
3.2.2 Relative Velocity Equation of Two Points on a Rigid Body .....	48
3.2.3 Relative Velocity Equation of Two Coincident Points Belonging to Two Rigid Bodies .....	54
3.3 Relative Acceleration Equation .....	59
3.3.1 Rotation of a Rigid Link about a Fixed Axis .....	59
3.3.2 Relative Acceleration of Two Points on a Rigid Body .....	60

3.3.3	Relative Acceleration Equation of Two Coincident Points Belonging to Two Rigid Bodies .....	67
3.4	Acceleration Analysis of Reciprocating Engine Mechanism .....	74
3.4.1	Klein's Construction .....	74
3.4.2	Ritterhaus Construction .....	76
3.4.3	Bennet's Construction .....	77
3.5	Analytical Determination of Velocity and Acceleration of the Piston .....	77
3.5.1	Harmonic Analysis for Velocity and Acceleration of the Piston .....	79
3.6	Additional Problems .....	80
<b>4</b>	<b>Straight Line Motion and Universal Coupling .....</b>	<b>85</b>
4.1	Condition for Exact Straight Line Motion .....	86
4.2	Exact Straight Line Motion Mechanisms .....	87
4.2.1	Paucellier Mechanism .....	87
4.2.2	Hart Mechanism .....	87
4.2.3	Scott–Russel Mechanism .....	89
4.3	Approximate Straight Line Motion Mechanisms .....	89
4.3.1	Modified Scott–Russel (Grasshopper) Mechanism .....	89
4.3.2	Watt Mechanism .....	90
4.3.3	Tchebicheff Mechanism .....	91
4.3.4	Robert Straight Line Mechanism .....	93
4.3.5	Pantograph .....	95
4.3.6	Beam Engine .....	95
4.3.7	Richards Indicator .....	95
4.3.8	Crosby Indicator .....	96
4.3.9	Dobbie–McInnes Mechanism .....	97
4.4	Steering Gear Mechanism .....	97
4.4.1	Davis Steering Gear Mechanism .....	97
4.4.2	Ackermann Steering Gear Mechanism .....	101
4.5	Hooke's (Cardan, Universal) Joint or [Universal Coupling] .....	101
4.5.1	Double Hooke's Joint .....	104
4.6	Solved Problems .....	105
4.7	Additional Problems .....	116
<b>5</b>	<b>Cams .....</b>	<b>117</b>
5.1	Types of Cams and Followers .....	117
5.2	Displacement Diagrams .....	121
5.3	Disk Cam with Knife-Edge Follower .....	140
5.4	Translating Roller Follower .....	141
5.5	Translating Flat Follower .....	151
5.6	Oscillating Flat Follower .....	155
5.7	Cams of Specified Contour .....	157
5.8	Solved Problems .....	163

5.9	Additional Problems	185
<b>6</b>	<b>Spur Gears</b>	187
6.1	Classification of Gears	187
6.2	Types of Motion	192
6.3	Nomenclature	194
6.4	Law of Gear Tooth Action	198
6.5	Involute as a Gear Tooth Profile	199
6.6	Layout of an Involute Gear Set	201
6.7	Producing Gear Teeth	205
6.8	Meshing Gears and Line of Contact	207
6.9	Interference of Involute Gears	207
6.10	Minimum Number of Teeth to Avoid Interference	210
6.11	Contact Ratio	212
6.12	Cycloidal Tooth Profiles	215
6.13	Cycloidal and Involute Tooth Forms	218
6.14	Solved Problems	218
6.15	Additional Problems	227
<b>7</b>	<b>Helical, Spiral, Worm and Bevel Gears</b>	229
7.1	Involute Helicoid	229
7.2	Helical Gear Tooth Relations	229
7.3	Contact of Helical Gear Teeth	233
7.4	Helical Gear Calculations	235
7.5	Spiral [Crossed Helical] Gears	235
7.6	Worm Gearing	236
7.7	Bevel Gears	239
7.8	Formation of Bevel Gears	240
7.9	Solved Problems	242
7.10	Additional Problems	247
<b>8</b>	<b>Gear Trains</b>	249
8.1	Classification of Gear Trains	249
8.2	Simple Gear Trains	250
8.3	Compound Gear Trains	251
8.4	Synthesis of Gear Trains	252
8.5	Gear Train Applications to Machine Tools	253
8.6	Epicyclic Trains	257
8.7	Inversions of Epicyclic Trains	258
8.8	Differential Trains	261
8.9	Torque Distribution in Epicyclic Trains	262
8.10	Example of an Epicyclic Train	263
8.11	Coupled Epicyclic Trains	264
8.12	Wilson Four-Speed Automobile Gear Box	267

8.13 Solved Problems .....	268
8.14 Additional Problems .....	277
<b>Index</b> .....	<b>279</b>

Kinematics of Machinery Through HyperWorks

Rao, J.S.

2011, XII, 282 p. 226 illus., 200 illus. in color. With  
online files/update., Hardcover

ISBN: 978-94-007-1155-6