

Contents

1	Introduction	1
	References	9
2	Linear and Angular Momentums	11
2.1	Linear Momentum for Body Separation	12
2.2	Angular Momentum for Body Separation	13
2.3	Linear Momentum for Body Addition	14
2.4	Angular Momentum for Body Addition	15
3	Discontinual Mass Variation	19
3.1	Discontinual Mass Separation	20
3.1.1	Velocity After Mass Separation	21
3.1.2	Angular Velocity After Mass Separation	22
3.2	Discontinual Mass Addition	22
3.2.1	Velocity After Mass Addition	23
3.2.2	Angular Velocity After Mass Addition	24
3.2.3	Conclusion	25
3.3	In-Plane Discontinual Mass Variation	25
3.4	In-Plane Body Separation	28
3.4.1	Some Special Cases	30
3.5	In-Plane Addition of the Body	33
3.6	Analytical Procedure	36
3.6.1	Lagrange-D'Alembert Principle	36
3.6.2	Virtual Work of the Impulse of the Impact Force and Torque	37
3.6.3	Modified Lagrange's Equations	38
3.6.4	Kinetic Energy Variation for the In-Line Particle Mass Variation	43

3.7	Separation of a Part of the Rotor	45
3.7.1	Motion of the Initial Rotor.	46
3.7.2	Rotor Separation.	47
3.7.3	Motion of the Rotor After Mass Separation	49
3.8	In-Plane Separation of a Beam	50
3.9	Separation from a Four-Particle-System.	55
3.9.1	In-Plane Particle Separation from a System	57
3.9.2	Dynamics of the System After Particle Separation.	59
3.9.3	Friction Force is Dominant	60
3.9.4	Damping Force Acts	67
3.9.5	Conclusion.	76
3.10	Mass Variation of a Wind Turbine	76
3.10.1	Dynamics of a Wind Turbine Due to Bending of the Shovel	77
3.10.2	Dynamics of a Wind Turbine During Separating of the Shovel	79
3.11	Conclusion	82
	References	84
4	Continual Mass Variation.	85
4.1	Dynamics of the Mass Variable Body	86
4.1.1	Discussion of Differential Equations of Motion	90
4.2	Band is Winding up on a Drum	92
4.2.1	Geometric and Physical Properties of the Drum with Band	93
4.2.2	Forces Acting on the System	94
4.2.3	Shaft is Rigid.	96
4.2.4	Shaft is Elastic	97
4.3	Analytical Mechanics for Mass Variation.	99
4.4	Lagrange-D'Alembert Principle	100
4.5	Lagrange's Second Order Differential Equations.	100
4.6	Lagrange's Equation for Body with Variable Mass	103
4.7	Lagrange's Equation and Lagrangian	106
4.8	Conservation Laws	107
4.9	Conservation Law of Energy Type	108
4.9.1	Ciolkowsky Problem.	109
4.10	Conservation Law of Arbitrary Type.	114
4.10.1	Killing's Equations	116
4.10.2	Conservation Law for a Vibrating Machine with Variable Mass.	118
4.11	Conservation Law for Truly Nonconservative System	122
4.11.1	Conservation Law for an Oscillator with Variable Mass.	123
	References	126

5	Oscillator with Continual Mass Variation	129
5.1	One-Degree-of-Freedom Oscillator	130
5.1.1	Qualitative Analysis	130
5.1.2	Period of Vibration for the Mass Variable Oscillator	133
5.2	Analytical Solving Procedure	141
5.3	Mathematical Model of the Truly Nonlinear Oscillator	144
5.4	Approximate Ateb Function Solution	145
5.4.1	Oscillator Without Influence Force	150
5.4.2	Oscillator Without Reactive Force.	154
5.4.3	Oscillator with Linear Damping	155
5.5	Truly Nonlinear Oscillator with Variable Mass.	158
5.5.1	Approximate Solution	160
5.5.2	Van der Pol Oscillator.	162
5.6	Approximate Trigonometric Solution.	163
5.6.1	Oscillator with Reactive Force and Small Viscous Damping	166
5.6.2	Oscillator with Linear Mass Variation	166
5.7	Vibration of Jeffcott Rotor.	169
5.7.1	Rotor with Small Nonlinearity	171
5.7.2	Single Frequency Solution	174
5.7.3	Rotor with Strong Nonlinear Elastic Force.	175
5.8	Two Mass Variable Bodies System.	179
5.8.1	Two Mass Variable Duffing Oscillator	181
5.9	Conclusion	182
	References	183
6	Conclusion and Contribution	185
	Appendix: Ateb function	189
	Index	191

Dynamics of Bodies with Time-Variable Mass

Cveticanin, L.

2016, XVII, 193 p., Hardcover

ISBN: 978-3-319-22055-0