Contents

.

	Preface	ix
1	Introduction	1
2	The Einstein Equivalence Principle and the	
	Foundations of Gravitation Theory	13
2.1	The Dicke Framework	16
2.2	Basic Criteria for the Viability of a Gravitation Theory	18
2.3	The Einstein Equivalence Principle	22
2.4	Experimental Tests of the Einstein Equivalence Principle	24
2.5	Schiff's Conjecture	38
2.6	The $TH \varepsilon \mu$ Formalism	45
3	Gravitation as a Geometric Phenomenon	67
3.1	Universal Coupling	67
3.2	Nongravitational Physics in Curved Spacetime	68
3.3	Long-Range Gravitational Fields and the Strong	
	Equivalence Principle	79
4	The Parametrized Post-Newtonian Formalism	86
4.1	The Post-Newtonian Limit	87
4.2	The Standard Post-Newtonian Gauge	96
4.3	Lorentz Transformations and the PPN Metric	99
4.4	Conservation Laws in the PPN Formalism	105
5	Post-Newtonian Limits of Alternative Metric	
	Theories of Gravity	116
5.1	Method of Calculation	116
5.2	General Relativity	121
5.3	Scalar–Tensor Theories	123
5.4	Vector-Tensor Theories	126
5.5	Bimetric Theories with Prior Geometry	130
5.6	Stratified Theories	135
5.7	Nonviable Theories	138

	Contents	viii
6	Equations of Motion in the PPN Formalism	142
6.1	Equations of Motion for Photons	143
6.2	Equations of Motion for Massive Bodies	144
6.3	The Locally Measured Gravitational Constant	153
6.4	N-Body Lagrangians, Energy Conservation, and the Strong	100
	Equivalence Principle	158
6.5	Equations of Motion for Spinning Bodies	163
7	The Classical Tests	166
7.1	The Deflection of Light	167
7.2	The Time-Delay of Light	173
7.3	The Perihelion Shift of Mercury	176
8	Tests of the Strong Equivalence Principle	184
8.1	The Nordtvedt Effect and the Lunar Eötvös Experiment	185
8.2	Preferred-Frame and Preferred-Location Effects:	
	Geophysical Tests	190
8.3	Preferred-Frame and Preferred-Location Effects: Orbital Tests	200
8.4	Constancy of the Newtonian Gravitational Constant	202
8.5	Experimental Limits on the PPN Parameters	204
9	Other Tests of Post-Newtonian Gravity	207
9.1	The Gyroscope Experiment	208
9.2	Laboratory Tests of Post-Newtonian Gravity	213
9.3	Tests of Post-Newtonian Conservation Laws	215
10	Gravitational Radiation as a Tool for Testing Relativistic Gravity	221
10.1	Speed of Gravitational Waves	223
10.2	Polarization of Gravitational Waves	227
10.3	Multipole Generation of Gravitational Waves and Gravitational	
	Radiation Damping	238
11	Structure and Motion of Compact Objects in	
	Alternative Theories of Gravity	255
11.1	Structure of Neutron Stars	257
11.2	Structure and Existence of Black Holes	264
11.3	The Motion of Compact Objects: A Modified EIH Formalism	266
12	The Binary Pulsar	283
12.1	Arrival-Time Analysis for the Binary Pulsar	287
12.2	The Binary Pulsar According to General Relativity	303
12.3	The Binary Pulsar in Other Theories of Gravity	306
13	Cosmological Tests	310
13.1	Cosmological Models in Alternative Theories of Gravity	312
13.2	Cosmological Tests of Alternative Theories	316
	References	320
	Index	338