CONTENTS

EXCERPTS FROM THE PREFACES TO THE FIRST AND SECOND EDITIONS	ix
Preface to the Fourth English Edition	x
Notation	xi
CHAPTER 1. THE PRINCIPLE OF RELATIVITY	1
1 Velocity of propagation of interaction	. 1
2 Intervals	3
3 Proper time	7
4 The Lorentz transformation	9
5 Transformation of velocities	. 12
6 Four-vectors	14
7 Four-dimensional velocity	22
Chapter 2. Relativistic Mechanics	24
8 The principle of least action	24
9 Energy and momentum	25
10 Transformation of distribution functions	29
11 Decay of particles	31
12 Invariant cross-section	34
13 Elastic collisions of particles	36
14 Angular momentum	40
Chapter 3. Charges in Electromagnetic Fields	43
15 Elementary particles in the theory of relativity	43
16 Four-potential of a field	44
17 Equations of motion of a charge in a field	46
18 Gauge invariance	49
19 Constant electromagnetic field	50
20 Motion in a constant uniform electric field	52
21 Motion in a constant uniform magnetic field	53
22 Motion of a charge in constant uniform electric and magnetic fields	55
23 The electromagnetic field tensor	60
24 Lorentz transformation of the field	62
25 Invariants of the field	63
CHAPTER 4. THE ELECTROMAGNETIC FIELD EQUATIONS	66
26 The first pair of Maxwell's equations	66
27 The action function of the electromagnetic field	67
28 The four-dimensional current vector	69
29 The equation of continuity	71
30 The second pair of Maxwell equations	73
31 Energy density and energy flux	75
32 The energy-momentum tensor	77
33 Energy-momentum tensor of the electromagnetic field	80
34 The virial theorem	84
35 The energy-momentum tensor for macroscopic bodies	85

vi CONTENTS

CHAPTER 5. CONSTANT ELECTROMAGNETIC FIELDS	88
36 Coulomb's law	·> 88
37 Electrostatic energy of charges	89
38 The field of a uniformly moving charge	91
39 Motion in the Coulomb field	93
40 The dipole moment	96
41 Multipole moments	97
42 System of charges in an external field	100
43 Constant magnetic field	101
44 Magnetic moments	103
45 Larmor's theorem	105
Chapter 6. Electromagnetic Waves	108
46 The wave equation	108
46 The wave equation 47 Plane waves	110
48 Monochromatic plane waves	114
49 Spectral resolution	118
50 Partially polarized light	119
51 The Fourier resolution of the electrostatic field	124
52 Characteristic vibrations of the field	125
Chapter 7. The Propagation of Light	129
53 Geometrical optics	129
54 Intensity	132
55 The angular eikonal	134
56 Narrow bundles of rays	136
57 Image formation with broad bundles of rays	141
58 The limits of geometrical optics	143
59 Diffraction	145
60 Fresnel diffraction	150
61 Fraunhofer diffraction	153
Chapter 8. The Field of Moving Charges	158
62 The retarded potentials	158
63 The Lienard-Wiechert potentials	160
64 Spectral resolution of the retarded potentials	163
65 The Lagrangian to terms of second order	165
CHAPTER 9. RADIATION OF ELECTROMAGNETIC WAVES	170
66 The field of a system of charges at large distances	170
67 Dipole radiation	173
68 Dipole radiation during collisions	177
69 Radiation of low frequency in collisions	179
70 Radiation in the case of Coulomb interaction	181
71 Quadrupole and magnetic dipole radiation	188
72 The field of the radiation at near distances	190
73 Radiation from a rapidly moving charge	194
74 Synchrotron radiation (magnetic bremsstrahlung)	198
75 Radiation damping	204
76 Radiation damping in the relativistic case	210
77 Spectral resolution of the radiation in the ultrarelativistic case	213
78 Scattering by free charges	217
79 Scattering of low-frequency waves	222
80 Scattering of high-frequency waves	22:

CONTENTS	vii
CHAPTER 10. PARTICLE IN A GRAVITATIONAL FIELD	226
81 Gravitational fields in nonrelativistic mechanics	226
82 The gravitational field in relativistic mechanics	227
83 Curvilinear coordinates	230
84 Distances and time intervals	234
85 Covariant differentiation	237
86 The relation of the Christoffel symbols to the metric tensor	242
87 Motion of a particle in a gravitational field	244
88 The constant gravitational field	248
89 Rotation	254
90 The equations of electrodynamics in the presence of a gravitational field	255
CHAPTER 11. THE GRAVITATIONAL FIELD EQUATIONS	259
91 The curvature tensor	259
92 Properties of the curvature tensor	262
93 The action function for the gravitational field	268
94 The energy-momentum tensor	270
95 The Einstein equations	274
96 The energy-momentum pseudotensor of the gravitational field	280
97 The synchronous reference system	286
98 The tetrad representation of the Einstein equations	291
Chapter 12. The Field of Gravitating Bodies	295
99 Newton's law	295
100 The centrally symmetric gravitational field	299
101 Motion in a centrally symmetric gravitational field	306
102 Gravitational collapse of a spherical body	309
103 Gravitational collapse of a dustlike sphere	316
104 Gravitational collapse of nonspherical and rotating bodies	321
105 Gravitational fields at large distances from bodies	330
106 The equations of motion of a system of bodies in the second approximation	330
Chapter 13. Gravitational Waves	345
107 Weak gravitational waves	345
108 Gravitational waves in curved space-time	347
109 Strong gravitational waves	350
110 Radiation of gravitational waves	352
Crupping 14. Bay any any and a control of the contr	250
CHAPTER 14. RELATIVISTIC COSMOLOGY	358
111 Isotropic space	358
112 The closed isotropic model	362
113 The open isotropic model	366
114 The red shift	369
115 Gravitational stability of an isotropic universe	376
116 Homogeneous spaces	381
117 The flat anisotropic model	387
118 Oscillating regime of approach to a singular point	390
119 The time singularity in the general cosmological solution of the Einstein equations	394
Index	399