

# Contents

<i>Preface</i>	<i>page xi</i>
<i>Glossary of notation</i>	xv
<i>Introduction</i>	1
<b>I Tensors in linear spaces</b>	11
1 Linear and affine spaces	12
2 Differential calculus	21
3 Tensor algebra	27
4 Alternating products	31
5 Special relativity	37
6 The uses of covariance	44
<b>II Manifolds</b>	51
7 Manifolds	52
8 Tangent vectors and 1-forms	59
9 Lie bracket	68
10 Tensors on manifolds	72
11 Mappings	77
12 Cotangent bundle	84
13 Tangent bundle	90
14 Vector fields and dynamical systems	94
15 Contact bundles	99
16 The geometry of thermodynamics	108
<b>III Transformations</b>	115
17 Lie groups	115
18 Lie derivative	121
19 Holonomy	132

20	Contact transformations	136
21	Symmetries	141
<b>IV</b>	<b>The calculus of differential forms</b>	<b>147</b>
22	Differential forms	147
23	Exterior calculus	153
24	The $*$ operator	159
25	Metric symmetries	169
26	Normal forms	173
27	Index notation	176
28	Twisted differential forms	183
29	Integration	194
30	Cohomology	202
<b>V</b>	<b>Applications of the exterior calculus</b>	<b>207</b>
31	Diffusion equations	207
32	First-order partial differential equations	213
33	Conservation laws	219
34	Calculus of variations	225
35	Constrained variations	233
36	Variations of multiple integrals	239
37	Holonomy and thermodynamics	245
38	Exterior differential systems	248?
39	Symmetries and similarity solutions	258
40	Variational principles and conservation laws	264
41	When not to use forms	268
<b>VI</b>	<b>Classical electrodynamics</b>	<b>271</b>
42	Electrodynamics and differential forms	272
43	Electrodynamics in spacetime	282
44	Laws of conservation and balance	285
45	Macroscopic electrodynamics	293
46	Electrodynamics of moving bodies	298
<b>VII</b>	<b>Dynamics of particles and fields</b>	<b>305</b>
47	Lagrangian mechanics of conservative systems	306
48	Lagrange's equations for general systems	311
49	Lagrangian field theory	314
50	Hamiltonian systems	320
51	Symplectic geometry	325
52	Hamiltonian optics	333
53	Dynamics of wave packets	338

<b>VIII Calculus on fiber bundles</b>	347
54 Connections	349
55 Parallel transport	354
56 Curvature and torsion	358
57 Covariant differentiation	365
58 Metric connections	367
<b>IX Gravitation</b>	371
59 General relativity	372
60 Geodesics	374
61 Geodesic deviation	377
62 Symmetries and conserved quantities	382
63 Schwarzschild orbit problem	387
64 Light deflection	393
65 Gravitational lenses	395
66 Moving frames	402
<i>Bibliography</i>	409
<i>Index</i>	411