

Contents

<i>Preface</i>	<i>page xi</i>
Part I The road to unification	1
1 The electromagnetic current and its properties	3
1.1 Introduction	3
1.2 The current for hadronic states	6
1.3 Parity-violating form factors	9
References	10
Select bibliography	11
2 The weak currents	12
2.1 The weak currents and some of their properties	12
2.2 The partially conserved axial current	16
2.3 Regularities among the forces	18
Problems for Chapters 1 and 2	19
References	19
Select bibliography	20
3 The quark model	21
3.1 Introduction	21
3.2 Current algebra	22
3.3 Quantum chromodynamics	26
Problems for Chapter 3	28
References	28
Select bibliography	29
Part II Field theories with global or local symmetries	31
4 Yang–Mills theories	33
4.1 The Yang–Mills field	33
4.2 Gauge invariance in scalar electrodynamics	36

Problems for Chapter 4	39
Select bibliography	40
5 Spontaneous breaking of symmetries	41
5.1 Spontaneous breaking of global symmetries: discrete symmetry	42
5.2 Continuous global symmetries	44
5.3 Spontaneous breaking of local symmetries	49
Problems for Chapter 5	51
Select bibliography	52
6 Construction of the model	53
Select bibliography	56
7 The Higgs mechanism in the Glashow–Salam–Weinberg model	57
7.1 Masses for gauge bosons	57
7.2 Masses for leptons	61
Problems for Chapter 7	62
References	62
Select bibliography	62
8 The leptonic sector	64
8.1 Feynman rules	64
8.2 Predictions in the leptonic sector	68
8.3 Leptonic neutral currents	70
8.4 Weak effects in electron–positron annihilation	76
Problem for Chapter 8	77
9 Incorporating hadrons	78
9.1 The mixing matrix	78
9.2 Flavor-changing neutral couplings (FCNCs)	82
9.3 The elements of the mixing matrix	84
References	92
Select bibliography	92
Part III Experimental consequences and comparisons	93
10 Deep inelastic scattering	95
10.1 Kinematics for deep inelastic scattering	95
10.2 Hadronic structure functions	99
10.3 Scaling and the total cross section	101
10.4 The parton model	104
10.5 The Drell–Yan process	108
Problems for Chapter 10	110
References	111
11 Charged-current reactions	112
11.1 Deep inelastic scattering	112
11.2 Evolution of distribution functions	117

11.3	Quasi-elastic scattering	120
	References	123
12	Neutral currents in semileptonic reactions	124
12.1	Neutrino–hadron neutral-current interactions	124
12.2	Model-independent predictions	126
12.3	Neutral-current cross sections	128
12.4	Parity violation in electron scattering	130
	Problems for Chapter 12	132
	References	135
13	Physics of neutrinos	136
13.1	Neutrino masses	136
13.2	Neutrino oscillations	139
13.3	Experimental results	145
13.4	Majorana neutrinos	148
13.5	Neutrinoless double beta decay	150
	Problems for Chapter 13	152
	References	154
	Select bibliography	154
14	Heavy quarks	155
14.1	Introduction	155
14.2	Semileptonic and inclusive B-meson decays	158
14.3	Exclusive semileptonic decays	163
14.4	Heavy-quark effective theory	164
14.5	The effective Lagrangian: $1/m_Q$ corrections	167
14.6	The top quark and its physical properties	171
14.7	Loop diagrams with heavy quarks	173
	Problems for Chapter 14	178
	References	179
	Select bibliography	179
15	CP violation: K mesons	180
15.1	Introduction	180
15.2	General properties	181
15.3	Time development of states	184
15.4	The K^0 – \bar{K}^0 transition amplitude	189
15.5	CP violation in amplitudes	191
15.6	The effective Hamiltonian	194
15.7	Calculation of a penguin diagram	198
	Problems for Chapter 15	201
	References	201
	Select bibliography	202

16 CP violation: D and B mesons	203
16.1 Introduction	203
16.2 The D^0 – \bar{D}^0 transition amplitude	203
16.3 Comparison of K^0 and B^0 mesons	206
16.4 Mixing in the B_d system	207
16.5 Decay rates and CP violation	210
16.6 Mass and lifetime differences for B_s mesons	215
Problems for Chapter 16	216
References	217
Select bibliography	217
17 Higgs particles	218
17.1 Higgs-boson couplings	218
17.2 Precision tests of the theory	220
17.3 Bounds on masses from general principles	224
17.4 Decays	225
17.5 Production in electron–positron colliders	227
17.6 Production in hadron colliders	229
17.7 Other symmetry-breaking schemes	231
Problems for Chapter 17	232
References	233
Select bibliography	233
<i>Epilogue</i>	234
<i>Appendix A Conventions, spinors, and currents</i>	236
<i>Appendix B Cross sections and traces</i>	239
<i>Appendix C Identities for quark bilinears</i>	242
<i>Index</i>	243