

Contents

1.1	Noether's Theorem – Classical	2
1.2	Examples	4
1a.1	Local Quantum Field Theory	11
1a.2	Composite Operators	18
1b.1	Noether's Theorem – Field Theory	20
1b.2	Gauge Theories	23
1b.3	Global Symmetries of Gauge Theories	25
2.1	The electron	28
2.2	$SU(2) \times U(1)$	28
2.3	Renormalizability? An Interlude	31
2.4	Spontaneous Symmetry Breakdown	33
2.5	The Goldstone Theorem	34
2.6	The σ -Model	36
2.7	The Higgs Mechanism	39
2.8	Neutral Currents	43
2.9	$e^+e^- \rightarrow \mu^+\mu^-$	44
3.1	Color $SU(3)$	48
3.2	A Toy Model	50
3.3	Quark Doublets	53
3.4	GIM and Charm	54
3.5	The Standard Six-Quark Model	55
3.6	CP Violation	59
4.1	Weak Decays of Light Hadrons	62
4.2	Isospin and the Determination of V_{ud}	62
4.3	f_π	65
4.4	Strangeness Changing Currents	66
4.5	PT Invariance	67
4.6	Second Class Currents	68
4.7	The Goldberger-Treiman Relation	69
4.8	$SU(3) - D$ and F	70
5.1	$SU(3) \times SU(3) \rightarrow SU(3)$	74
5.2	Effective Low-Momentum Field Theories	74
5.3	Sources	77
5.4	Symmetry breaking and light quark masses	78
5.5	What Happened to the Axial $U(1)$?	80
5.6	Light Quark Mass Ratios	81
5.7	The Chiral Currents	82
5.8	Semileptonic K Decays	83

5.9	The Chiral Symmetry-Breaking Scale	85
5.10	Important Loop Effects	87
5.11	Nonleptonic K Decay	88
6.1	How Do the Baryons Transform?	91
6.2	A More Elegant Transformation Law	92
6.3	Nonlinear Chiral Quarks	94
6.4	Successes of the Nonrelativistic Quark Model	96
6.5	Hyperon Nonleptonic Decays	98
6a.1	Electromagnetic Interactions and $\pi^0 \rightarrow 2\gamma$	103
6a.2	The Steinberger Calculation	108
6a.3	Spectators, gauge invariance and the anomaly	109
7.1	Mode Counting	121
7.2	Heavy Quark Decay	123
7.3	Deep Inelastic Lepton-Hadron Scattering	125
7.4	Neutrino-Hadron Scattering	128
7.5	Neutral Currents	130
7.6	The SLAC Experiment	131
8.1	Choosing a Gauge	132
8.2	Effective Field Theories	136
8.3	The Symmetries of Strong and Electroweak Interactions	138
8.4	The ρ Parameter	139
8.5	M_W and M_Z	140
8.6	Neutrino-hadron scattering	144
8.7	Technicolor	145
9.1	Why We Can't Calculate	148
9.2	The Renormalization Group	149
9.3	Charm Decays	152
9.4	Penguins and the $\Delta I = \frac{1}{2}$ Rule	154
10.1	$K^0 - \bar{K}^0$ Mixing	159
10.2	The Box Diagram and the QCD Corrections)	161
10.3	The Gilman-Wise $\Delta S = 2$ Hamiltonian	164
10.4	CP Violation and the Parameter ϵ	166
10.5	$K_L \rightarrow \pi\pi$ and the Parameter ϵ'	169
A	Review of Dimensional Regularization	173
A.1	n Dimensional Integration	173
A.2	Regularization	175
B	Background Field Gauge	177
B.1	The β function	182