Quantum Field Theory-III **Prof. G. Isidori**
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Detailed list of topics

and bibliographic material for the preparation of the exam

1. Introduction to Effective Field Theories (*Lecture notes* + [1, 2])
Decoupling of heavy fermions in QED
The Appelquist-Carrazone theorem
General formulation of EFT via the path integral
Renormalizability and matching procedure
Four-fermion weak interactions

2. Chiral Lagrangians (*Lecture notes* + [2, 3])
Symmetries of the QCD Lagrangian
The Callan–Coleman–Wess–Zumino formalism
The lowest-order chiral Lagrangian
Renormalization in CHPT
Coupling to external fields
Explicit breaking of chiral symmetry and pion masses

3. The SM as an EFT (*Lecture notes*)
The SM Lagrangian
Custodial symmetry
Neutrino masses
The hierarchy problem
Classification of the SM-EFT operators with $d > 4$

3. Introduction to Supersymmetry(*Lecture notes* + [4])
The Lorentz group
Representations of $SL(2, C)$ and Weyl spinors
The SUSY algebra
Representations of the SUSY algebra
Superfields and superspace
The chiral superfield
The vector superfield

SUSY invariant actions with chiral superfields
Kähler potential and superpotential
The $N = 1$ super Yang-Mills action
Super YM action with matter

4. The Minimal Supersymmetric extension of the SM (*Lecture notes* + [5])
Soft supersymmetry breaking
The Minimal Supersymmetric extension of the SM
The MSSM superpotential and R–parity
Soft-breaking terms in the MSSM
The SUSY flavor problem (*only a brief overview*)
Spontaneous SUSY breaking (*only a brief overview*)
The Higgs sector of the MSSM

References

[1] A. V. Manohar, *Effective field theories*, Lect. Notes Phys. **479** (1997) 311 [hep-ph/9606222].

[2] D. B. Kaplan, *Five lectures on effective field theory*, nucl-th/0510023.

[3] G. Colangelo and G. Isidori, *An Introduction to ChPT*, hep-ph/0101264.

[4] M. Bertolini, *Lectures on Supersymmetry*, `http://people.sissa.it/ bertmat/susycourse.pdf`

[5] S. P. Martin, *A Supersymmetry primer*, Adv. Ser. Direct. High Energy Phys. **21** (2010) 1 [hep-ph/9709356].