

Standard Model of Elementary Particles (PHZ6358): SYLLABUS

0. Introduction: Quarks, Leptons, Vector Bosons and Their Interactions (QFT Notes, chapter 16)
1. Feynman Diagrams and Rules.(QFT notes, Chapter 17; S, Sections 58, 61),
 - Propagators for spins 0, 1/2, 1
 - Vertices and rules for spinor and scalar QED
 - Ultraviolet divergences of Feynman diagrams: Degree of divergence.
2. Scattering Amplitudes in Quantum Field Theory (QFT Notes 18; S, 59))
 - Reduction Formalism
 - Examples
3. Quantum Electrodynamics: 1 Loop Corrections (QFT Notes Chapter 19,20)
 - Higher order Processes (S 62-65)
 - Ultraviolet divergences
 - Ward identities (S 67–68)
 - Mass and Charge Renormalization
 - Anomalous Magnetic Moment; Lamb shift
 - Positronium and Quarkonium
 - Infrared Divergences; Soft Photon Bremsstrahlung; Gauge Invariance (QFT Notes, 14.)
4. Non abelian Gauge Field Theories (S, 69-72)
 - Review Path Integral for Gauge Theories
 - Some gauge groups
 - Gauge-fixing—Fadeev-Popov prescription
 - BRST symmetry
 - Renormalization
 - Quantum Field Theory of the Standard Model: Chiral Asymmetry
5. Systematics of Renormalization

- Renormalized Perturbation Theory
 - Two loop examples
 - Renormalization Group and Callan-Symanzik Equation
6. Renormalization and the Short Distance Properties of QCD
- Asymptotic Freedom
 - Renormalization Group
 - Background Field Methods
 - Operator Product Expansion
7. Spontaneous Breaking of Global Symmetry: Chiral Dynamics
- Effective Action and Potential
 - Goldstone Bosons and Soft Pion Theorems
 - Adler-Weisberger and Other Sum Rules
 - Effective Chiral Lagrangians
8. Gauge Invariance and Anomalies (QFT Notes 21)
- Gauge Invariance and Ultraviolet Divergences
 - Axial current anomalies
 - $\pi_0 \rightarrow 2\gamma$ decay
 - Consequences of Anomalies for the Standard Model
9. Spontaneous Breaking of Gauge Symmetry; The Higgs Mechanism
- Scalar Fields: Global Symmetries, Goldstone Bosons
 - Gauge Symmetries, the Abelian Case
 - Gauge Symmetries, the Non-abelian case
 - Perturbation theory with spontaneous symmetry breaking
10. Leptons and their Electro-weak Interactions
- Electron, QED processes
 - Muon
 - Tau
 - Neutrinos