

Advanced QFT exam topics

Under each topic, a list of recommended background material is give. In many cases the lectures closely follow these sources; however, in some cases my exposition is not directly based on existing literature, and the sources can be read as alternative exposition of the same topics.

1. Divergences, power counting. Self-energy in the ϕ^3 model.
CR 3.1-3.3
2. Dimensional regularization and its properties. Trace anomaly.
CR 4
3. Minimal subtraction scheme. Recursive definition of counter terms to Feynman diagrams.
CR 3.5-3.6, 5.1-5.4
4. Locality of counter terms. Independence of regularisation scheme. Relation to Lagrangian counter terms.
CR 5.6, 5.8, 5.10
5. Renormalization of composite operators. Operator mixing.
CR 6.1-6.5
6. Equation of motion, Ward identity. Nonrenormalization of conserved currents.
CR 6.6
7. Generating functionals for full and connected correlations. Dyson-Schwinger equations. Tree diagrams. Mean field approximation.
RF 1-2.1
8. 1PI generating functional. Effective action. Quasi-local expansion and the effective potential. Background field method.
RF 2.2-2.3, 4.6 ; *AS* 3.3-3.7
9. Effective potential in the linear sigma model. Renormalization and symmetry. Goldstone theorem at the quantum level.
PS 11.1-11.6
10. Radiatively generated symmetry breaking. Renormalization group improved effective potential.
PS 13.2
11. The effective potential in a general renormalisable QFT at one-loop level. Convexity and reality.
RF 13.1-13.2, 13.5-13.6 ; *CW*
12. Instantons and tunnelling. Decay of the false vacuum.
AS 7.6
13. Quantisation of non-Abelian gauge theories.
PS 16.1-16.2

References

- CR:* J.C. Collins: *Renormalization*, Cambridge University Press, 1984.
- RF:* R.J. Rivers: *Path Integral Methods in Quantum Field Theory*, Cambridge University Press, 1990.
- AS:* S. Coleman: *Aspects of Symmetry*, Cambridge University Press, 1985.
- PS:* M.E. Peskin & D.V. Schroeder: *An Introduction to Quantum Field Theory*, Perseus Books Publishing, 1995.

Further recommended reading

- CW:* http://www.scholarpedia.org/article/Coleman-Weinberg_mechanism