Schedule FYS5120 – Advanced Quantum Field Theory, spring 2022

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While this course is a self-study course, we will hold weekly discussion sessions for those interested. In general, we will have these sessions on Wednesdays 10.15-12.00. The reading schedule below is not meant strictly, i.e. the dates are there just as an indication of where we are in the syllabus. The exercises can be used as a guide to what is essential in this course. However, note that there are no exercises on *infrared divergences* or *asymptotic freedom and QCD* while these are part of the syllabus.

The syllabus for this self-study course is based on the book *Quantum Field Theory and the Standard Model* by Matthew D. Schwartz (MS) and *An Introduction to Quantum Field Theory* by Michael E. Peskin and Daniel Schroeder (PS). For some topics, I will provide lecture notes (LN). Now, I should apologize in advance; the schedule and reading list are all over. I am not a fan of the order in which PS and MS present the topics, hence, the mess. Thus, the exercises should be used as a guide, and the books will help in calculations and understanding. Also, some of the exercises go beyond what is mentioned in PS and MS. The motivation behind this approach is that you can not expect PS, MS (or textbooks in general) to answer all of your scientific problems. Hence, it would help if you learned to use all available literature to solve problems sooner rather than later.

Tentative Schedule

- **Wednesday, Jan 19, 10.15 – 12.00** :
  Introduction to the course and overview.
- **Wednesday, Jan 26, 10.15 – 12.00** :
  Path Integrals in QM. Correlation functions, generating functions and Wick's theorem.
  - PS: Chapter 9.1

  - MS: Chapter 14.1, 14.2
  - LN: Chapter 1 note on Wilsonian Renormlization

- **Wednesday**, **Feb 02**, **10.15 – 12.00** :
  Path Integrals in field theory. Quantization of Scalar fields and Grassmann variables to work with fermions.
  - PS: Chapter 9.2, 9.5
  - MS: Chapter 14.3.1, 14.4, 14.6

- **Monday**, **Feb 14**, **14.15 – 16.00** :
  Quantization of Abelian and non-Abelian gauge theories.
  - PS: Chapter 9.3, 16.1, 16.2
  - MS: Chapter 14.5, Chapter 25.4.1
  - LN: Quantization of Gauge Theories

- **Wednesday**, **Feb 16**, **10.15 – 12.00** :
  Feynman rules in path integral formalism.
  - PS: Chapter 9.5 (Not so well covered)
  - MS: Chapter 14.3.3

- **Wednesday**, **Feb 23**, **10.15 – 12.00** :
  Symmetries of the Path Integral.
  - PS: Chapter 9.6
  - MS: Chapter 14.7, 14.8

  More on gauge theories and BRST-invariance.
  - PS: Chapter 16.4
  - MS: Chapter 25.4.2

- **Wednesday**, **Mar 02**, **0910.15 – 12.00** :
  Wilsonian Renormalization
  - PS: Chapter 12.1
  - MS: Chapter 23.6
  - LN: Chapter 2, 3 note on Wilsonian Renormalization

- **Wednesday**, **Mar 23**, **10.15 – 12.00** :
  Regularization
  - PS: Not covered as a separate concept in PS, but can be found in Chapter 6

  - MS: Chapter 15
  - LN: Note on Regularization of Distributions (for those interested in a different viewpoint)

- **Wednesday, Mar 23 − 30, 10.15 − 12.00** :
  Radiative Corrections
  - PS: Chapter 6.1, 6.2, 6.3 and Chapter 7.1, 7.2 and 7.5
  - MS: Chapter 16, 17 and 18

- **Wednesday, Apr 06, 10.15 − 12.00** :
  Perturbative Renormalization
  - PS: Chapter 10.1, 10.2
  - MS: Chapter 19

- **Wednesday, Apr 13, 10.15 − 12.00** :
  Renormalizability of QED
  - PS: Chapter 10.3, 10.4 and 10.5
  - MS: Chapter 21

- **Wednesday, Apr 20, 27, 10.15 − 12.00** :
  Continuum Renormalization Group Equations
  - PS: Chapter 12.2, 12.3
  - MS: Chapter 23.1, 23,2, 23,3, 23.4 and 23.5

- **Wednesday, May 4, 11, 10.15 − 12.00** :
  Infrared Divergences
  - PS: Chapter 6.4, 6.5
  - MS: Chapter 21
  - LN: Note on Regularization of Distributions (for those interested in a different viewpoint)

- **Wednesday, May 18, 10.15 − 12.00** :
  Asymptotic Freedom and QCD
  - PS: Chapter 16.5, 16.6, 16.7, 17.1, 17.2, 17.3
  - MS: Chapter 26, 32.1 and 32.2