Quantum Field Theory II

Topics for Final Projects

1. Grand Unified Theories
   Gauge Theories of Elementary Particle Physics, Cheng and Li, Ch. 14;
   Unification and Supersymmetry, R. Mohapatra, Ch. 5, 6, 7.

2. Renormalization Group Equations and Critical Exponents
   Introduction to Modern QFT, M.Peskin, Ch. 13;
   Condensed Matter Field Theory, Altland and Simons, Ch. 8.

3. The Kosterlitz-Thouless Phase Transition
   Condensed Matter Field Theory, Altland and Simons, Ch. 8.6;
   Field Theories of Condensed Matter Systems, E. Fradkin, Ch. 4.6;
   Scientific Background on the Nobel Prize of Physics 2016,
   https://www.nobelprize.org/prizes/physics/2016/summary/

4. Effective Field Theory of the Strong Interactions at Low Energies
   Lucas Gabriel Rabelo
   The Quantum Theory of Fields II, S. Weinberg, Ch. 19;
   Dynamics of the Standard Model, Donoghue, Golowich and Holstein, Ch. 4 and 7;
   Effective Lagrangians for the Standard Model, A. Dobado, A. Gomez-Nicola, A. Maroto and J. Pelaez, Ch. 6.

5. Axions and the Strong CP Problem
   The Quantum Theory of Fields II, S. Weinberg, Ch. 23.6;
   Dynamics of the Standard Model, Donoghue, Golowich and Holstein, Ch. 3.

6. Chern-Simons Field Theory, Anyons, etc. **Rafael Albertini Silva**
   Chern-Simons Theory, Gerald Dunne, arxiv:hep-th/9902115.

7. The Quantum Hall Effect(s) and Topology **Gabriel Giulianno Pimentel**
   Condensed Matter Field Theory, Altland and Simons, Ch. 9;
   Field Theory of Condensed Matter Physics, E. Fradkin, Ch. 12, 13, 14. *The Quantum Hall Effect*, David Tong, arxiv.1606.06687, Ch.2, 3, 4 and 5.

8. Early Universe Phase Transitions **Victor Roberto Soares**
   The Early Universe, E. Kolb and M. Turner, Ch. 7;
   Finite Temperature Field Theory and Phase Transitions, M. Quiros, hep-ph/9901312;
   Effective Potential at Finite Temperature in the Standard Model, M. Carrington, Physical Review D 45, 2933 (1992).

9. Supersymmetric Field Theories **Vicente Viater Figueira**
   The Quantum Theory of Fields III, S. Weinberg, First few chapters;

Advanced Topics in Quantum Field Theory, M. Shifman, Ch. 10, sections 44-49;
Unification and Supersymmetry, R. Mohapatra, Ch. 9, 10;
Modern Supersymmetry J. Terning, First few chapters.

10. Gravity as an Effective Quantum Field Theory **Rhaycen Prates**
`https://arxiv.org/pdf/gr-qc/9512024.pdf`
and `https://arxiv.org/pdf/1209.3511.pdf`, by John Donoghue, ;
Also see Scholarpedia article by Donoghue:
`http://www.scholarpedia.org/article/Quantum_gravity_as_a_low_energy_effective_field_theory`,
and references therein.

11. Quantum Field Theory in Curved Space and Gravitational Particle Production
Lincoln Pereira
Quantum Field Theory in Curved Space, by Birrell and Davies (1984). The standard reference, but a bit old. Chapters 3 and 5 mainly.
A more modern introduction is
Quantum Field Theory in Curved Spacetime, by Parker and Toms (2009); Chapters 2. Maybe a bit of chapters 3 and 4.
A good pedogogical introduction, by L. Ford, can be found in
`https://arxiv.org/pdf/gr-qc/9707062.pdf`.

12. Instantons and Baryon Number Non-Conservation in the Standard Model
João Victor da Costa
Advanced Topics in Quantum Field Theory, by M. Shifman. Chapter 5;
The Quantum Theory of Fields, by S. Weinberg. Chapter 23.5.

13. The Operator Product Expansion
An Introduction to Quantum Field Theory, by M. Peskin and D. Schroeder. Sections 12.4 and 12.5 and Chapter 18.

14. From the Parton Model to QCD: Parton Evolution, Parton Distribution Functions, etc
Gabriel Guimarães
Introduction to Modern QFT, M.Peskin, Final Project between Chapter 17;
The Quantum Theory of Fields II, S. Weinberg, Chapter 20.6;
QCD and Collider Physics, by K. Ellis, W. Sterling and B. Webber, Chapters 4 and 5.

15. Lower Dimensional Gravity **Arthur Xavier Belluci**
Lower Dimensonal Graviy, by J. D. Brown, plus original papers referenced therein.

16. Effective Field Theory and the Euler-Heisenberg Lagrangian
Vinicius Zilio Rocca
Quantum Field Theory, by C. Itzykson and J-B. Zuber, Chapter 4, Sections 4.3.3 and 4.3.4;

Heisenberg-Euler Effective Lagrangians, G.V. Dunne, https://arxiv.org/pdf/hep-th/0406216.

17. Monopoles and Applications **Diana Cruz Pestana**
Advanced Topics in QFT, by M. Shifman, Chapter 9;
Monopoles, Instantons and Confinement, by G. 't Hooft,
in `https://arxiv.org/abs/hep-th/0010225v1`

18. False Vacuum Decay and the Standard Model **Bruno Gehlen**
Advanced Topics in QFT, by M. Shifman, Chapter 7;
Instability of hot electroweak theory: Bounds on m_h and m_t, by P. Arnold and S. Vokos, Phys. Rev **D44** 3620 (1991);
On the Metaestability of the Standard Model Vacuum, by G. Isidori, G. Ridolfi and A. Strumia, Nucl. Phys. B609, 387, 2001,
`https://arxiv.org/pdf/hep-ph/0104016.pdf`; *Higgs mass and vacuum stability in the Standard Model at NNLO*, by G. Degrassi *et al.*,
`https://arxiv.org/pdf/1205.6497.pdf`;