Quantum Field Theory II

Topics for Final Projects

1. Grand Unified Theories **Lucas Santos Souza**
   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
   João Armando Galdino
   Introduction to Modern QFT, M.Peskin, Ch. 13;
   Condensed Matter Field Theory, Altland and Simons, Ch. 8.

3. The Kosterlitz-Thouless Phase Transition
   Lucas Roda Ximenes dos Santos
   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. Meissner Effect and the Anderson-Higgs Mechanism in Superconductivity
   Gabriel Moniz Arantes *Condensed Matter Field Theory*, Altland and Simons, Ch. 6;
   The Quantum Thoery of Fields II, S. Weinberg, Ch. 21.6.

5. Effective Field Theory of the Strong Interactions at Low Energies
   Matheus Fogaça
   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.

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

7. Chern-Simons Field Theory, Anyons, etc. **Ysla Adans**
   Chern-Simons Theory, Gerald Dunne, arxiv:hep-th/9902115.

8. The Quantum Hall Effect(s) and Topology **Carlo Bellinati**
   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.

9. Early Universe Phase Transitions **Lua Figueiredo**
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).

10. Supersymmetric Field Theories **Heitor Ribeiro**
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.

11. Gravity as an Effective Quantum Field Theory **Patrick Andriolo**
`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.

12. Conformal and S-Matrix Boostrap **Bruno Siqueira**
EPFL on Conformal Field Thory in $D \geq 3$ Dimensions , by Slava Rychkov,
`https://arxiv.org/pdf/1601.05000.pdf`;
TASI Lectures on the Conformal Boostrap Program, by David Simmons-Duffin,
`https://arxiv.org/pdf/1602.07982.pdf`;
For a more complete review,
The Conformal Bootstrap: Theory, Numerical Techniques and Applications, by David Poland, Slava Rychkov and Alessandro Vichi,
Rev. Mod. Phys. 91, 15002 (2019), `https://arxiv.org/pdf/1805.04405.pdf`.

13. Quantum Field Theory in Curved Space **Paulo Derolle**
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`.

14. Instantons and Baryon Number Non-Conservation in the Standard Model
Matheus Balisa
Advanced Topics in Quantum Field Theory, by M. Shifman. Chapter 5;
The Quantum Theory of Fields, by S. Weinberg. Chapter 23.5.

15. The Operator Product Expansion
Henrique Rodrigues Martins Fontes
An Introduction to Quantum Field Theory, by M. Peskin and D. Schroeder. Sections 12.4 and 12.5 and Chapter 18.

16. The Coleman-Weinberg Potential and Radiative Spontaneous Symmetry Breaking
Felipe Aparecido Araujo
Phys. Rev. **D7** *1888 (1973)*, by S. Coleman and E. Weinberg;
The Quantum Theory of Fields II, S. Weinberg, Chapter 16
Introduction to Modern QFT, M.Peskin, Final Project between Chapters 13 and 14; plus some application (e.g. to superconductivity or electroeak symmetry breaking).

17. From the Parton Model to QCD: Parton Evolution, Scaling Violation
Rafael Baptista
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.

18. Consequences of Anomalies: Anomalies and Chiral Gauge Theory, Matching, etc.
Francisco Neme
Introduction to Modern QFT, M.Peskin, Chapter 19.4;
The Quantum Theory of Fields II, S. Weinberg, Chapter 22.

19. Monopoles and Applications **Pedro Correa**
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`

20. False Vacuum Decay and the Standard Model **Marvin Janini**
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`;

21. Particle Jets in Quantum Field Theory
Maria Monalisa de Melo Paulino
QCD and Collider Physics, by K. Ellis, W. Stirling and B. Webber, Chapters 5, 6 and 7.