# **PHYS 342** *QUANTUM FIELD THEORY*

Literature:
*Mandl and Shaw*, Quantum Field Theory, Chapters 1–10.

1 Photons and the Electromagnetic Field

- Harmonic Oscillator
- Non-relativistic approach to Quantum Electrodynamics
- Dipole Approximation
- Thomson Scattering

2 Lagrangian Field Theory

- Euler-Lagrange Equations of Motion
- Field Quantization
- Symmetries and Conservation Laws

3 The Klein-Gordon Field

- The Real Klein-Gordon Field
- The Complex Klein-Gordon Field
- Covariant Commutation Relations
- Scalar-Field Feynman Propagator

4 The Dirac (Fermion) Field

- The Dirac Equation, Quantization
- Fermion Feynman Propagator
- Coupling to the Photon Field

5 The Photon Field

- Classical Fields
- Covariant Quantization, Gupta-Bleuler Formalism
- Photon Feynman Propagator

6 The S-Matrix Expansion

- The Interaction Picture

- The S-Matrix Expansion, Wick's Theorem

7 Feynman Diagrams and Rules in QED

- Feynman Diagrams in Configuration Space
- Feynman Diagrams in Monentum Space
- Feynman Rules for QED
- Other Leptons

8 QED Processes in Lowest Order

- Cross Sections
- Spin Sums, Photon Polarization Sums
- Muon Pair Production in Electron-Positron Annihilations
- Bhabha Scattering
- Compton Scattering
- Scattering by an External Field
- Bremsstrahlung
- The Infra-Red Divergence

9 Radiative Corrections

- Second-Order Radiative Corrections
- Photon Self-Energy, Electron Self-Energy
- External-Line Renormalization
- Vertex Modification, Anomalous Magnetic Moment
- Infrared Divergence

10 Regularization

- Mathematical Preliminaries
- Cut-Off Regularization: Electron Mass
- Dimensional Regularization
- Vacuum Polarization
- Anomalous Magnetic Moment