QM II; FS 2018; Adrian Signer

Literature

[**BJ**] Quantum Mechanics, B.H. Bransden and C.J. Joachain, Pearson

[**SN**] Modern Quantum Mechanics, J.J. Sakurai and J. Napolitano, Addison-Wesley/Pearson

[**Sc**] Quantum Mechanics, F. Schwabl, Springer

[**S***] Advanced Quantum Mechanics, J.J. Sakurai, Addison-Wesley

[**Sc***] Advanced Quantum Mechanics, F. Schwabl, Springer

and many, many more

Syllabus

1. Time-independent perturbation theory (week 1)
   - 1.1 Solving a QM system [QM I]
   - 1.2 Non-degenerate PT [BJ 8.1] [SN 5.1]
   - 1.3 Time-independent PT, degenerate case [BJ 8.3] [SN 5.12]
   - 1.4 Variational principle [BJ 8.3] [SN 5.4]

2. The hydrogen atom (week 2,3)
   - 2.1 Basics from QM I [BJ 7.2,7.5] [SN 3.7]
   - 2.2 Relativistic corrections [BJ 8.2] [SN 5.3] [Sc 12.1]
   - 2.3 Spin-orbit term [BJ 8.2] [SN 5.3] [Sc 12.2]
   - 2.4 Darwin term [BJ 8.2] [Sc 12.3]
   - 2.5 Fine structure of hydrogen [BJ 8.2] [SN 5.3]

3. Many-electron atoms (week 3,4)
   - 3.1 Identical particles [BJ 10.2] [SN 7.1,7.2] [Sc 13.1]
   - 3.2 Thomas-Fermi approximation [Sc 13.4]
   - 3.3 Hartree approximation [Sc 13.3]
   - 3.4 Hartree-Fock approximation [Sc 13.3]
   - 3.5 The periodic table and Hund's rules [Sc 13.5]

4. Approximation methods for time-dependent problems (week 5, 6)
   - 4.1 Time-dependent perturbation theory [BJ 9.1] [SN 5.7]
   - 4.2 Constant perturbation [BJ 9.2]
   - 4.3 Harmonic perturbation [BJ 9.3] [SN 5.7]
   - 4.4 The interaction picture [Sc 16.3] [SN 5.5]
   - 4.5 The adiabatic approximation [BJ 9.4] [SN 5.6]

5. Interaction with (classical) radiation (week 6)

   5.1 Basics from EM and QM I [BJ 11.1] [Sc 16.4]
   5.2 Induced emission and absorption [BJ 11.2-3] [SN 5.8]
   5.3 Dipole approximation and selection rules [BJ 11.4]

6. Potential scattering (week 7, 8)

   6.1 Scattering and cross sections [BJ 13.1-2]
   6.2 Partial-wave analysis [BJ 13.3-4] [SN 6.4] [Sc 18.3]
   6.3 Coulomb scattering [BJ 13.7] [Sc 18.11]
   6.4 The Lippmann-Schwinger equation and Green function [BJ 13.5] [SN 6.2]
   6.5 The Born approximation [BJ 13.6] [SN 6.3]

7. General scattering theory[1] (week 9)

   7.1 Dynamics of scattering
   7.2 Moller and scattering operator

8. Quantization of radiation field (week 10, 11, 12)

   8.1 Quantization of free photon field [SN 7.6] [S* 2.1,2.3] [Sc* 14.1-4]
   8.2 Fock space [S* 2.2] [Sc* 1.3]
   8.3 Photon emission and absorption [S* 2.4]
   8.4 Scattering of photons by atoms [S* 2.5]

9. Second quantization (week 12, 13)

   9.1 Creation and annihilation operators for bosons and fermions [Sc* 1.3-4]
   9.2 Field operators [Sc* 1.5]
   9.3 Observables in second quantization [Sc* 1.6]

10. Quantum statistics[2] (week 14)

    10.1 Fermi-Dirac and Bose-Einstein distribution [BJ 14.4, 14.6]

[1] Literature: A. Messiah, Quantum Mechanics, Vol II, parts of Chapter 19
[2] Literature: D. Griffiths, Introduction to Quantum Mechanics, Chapter 5.4