Course Syllabus

Course: Quantum Mechanics III (Physics 918)

Spring 2016, MWF, 11:30A - 12:20P, JH 245

Instructor: Prof. Alexey A. Kovalev, JH 310K, tel. 472-2880
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Office Hours: MWF 1:00P - 2:00P

Students with disabilities are encouraged to contact the instructor for a confidential discussion of their individual needs for academic accommodation. It is the policy of the University of Nebraska-Lincoln to provide flexible and individualized accommodation to students with documented disabilities that may affect their ability to fully participate in course activities or to meet course requirements. To receive accommodation services, students must be registered with the Services for Students with Disabilities (SSD) office, 132 Canfield Administration, 472-3787 voice or TTY.

Text: F. Mandl and G. Shaw, Quantum Field Theory, second edition (J. Wiley, 2010).
PLUS lecture notes available on the blackboard in the section Course Documents

Recommended reading:

This course requires a good knowledge of nonrelativistic quantum mechanics and classical electrodynamics. For updating and/or refreshing your background in these, the following books are recommended:

1. D. J. Griffiths, Introduction to Electrodynamics, Prentice Hall, 1999. (This undergraduate course is enough for our purposes, but you can also use Jackson, of course).

2. C. Cohen-Tannoudji, B. Diu and F. Laloe, Quantum Mechanics (the textbook used by Dr. Starace for Quantum II).

3. B. H. Bransden and C. J. Joachain, Introduction to Quantum Mechanics, This book was used by me for teaching Quantum I and II. It also gives a good introduction to the relativistic quantum mechanics in Chapter 15.

Supplemental reading for this course (not required):

1. J.J. Sakurai, Advanced Quantum Mechanics. Addison-Wesley, 1967, or a later print.
   This book was used for 918 before. Some material and some homework problems will be taken from this book. However, you are not required to purchase it.

2. A. S. Davydov, Quantum Mechanics (Pergamon, 1965 or a later edition). This book contains some applications of quantum field theory methods to many-body and condensed-matter physics (interacting bosons, electron gas, phonons and the theory of superconductivity).

3. D. M. Gingrich, Practical Quantum Electrodynamics (Taylor and Francis, 2006). Practical recipes for writing and evaluating Feynman diagrams without the use of the QFT formalism.

4. V. B. Berestetskii, E. M. Lifshitz and L. P. Pitaevskii, Quantum Electrodynamics (Pergamon, 1982).
   An advanced relativistic QED course with more QED processes considered.

5. R. Shankar, Principles of Quantum Mechanics, Plenum Press; 2 edition (March 16, 2011)

6. A. Altland, B. D. Simons, Condensed Matter Field Theory Cambridge University Press; 2 edition (April 30, 2010)
   Applications of quantum field theory in condensed matter physics.

Outline: (1) Quantization of e.-m. field and nonrelativistic QED
(2) Lagrangian formalism and relativistic quantum fields
(3) S-matrix expansion in QED, propagators and Feynman diagrams
(4) QED processes
(5) Introduction to gauge theories

Homework: specific assignments and due dates are given on the blackboard; Homework should be turned in in the hardcopy form (electronic files will not be accepted) by 5 p.m. on the due date by giving it to the instructor personally or placing it in the instructor's mail box.
Homework turned in after the due dates lose two points per day. No homework is accepted one week after the due day. In case of illness or a personal emergency the new terms should be negotiated with the instructor. Note that travel (personal or to a conference) is not an excuse for turning in homework late.
In doing homework you are allowed to discuss problems with each other, but you are NOT allowed to cooperate on writing down the solutions on the paper.

Exams: four quizzes, one Midterm Exam and Final Exam. All quizzes are closed-book. At the exams you are allowed to use the textbook, but not allowed to use notes.
All necessary information from the lecture notes will be given on the question sheet

QUIZZES (in-class): 1/29, 2/19, 4/1, 4/22 (tentative)
It is the student's responsibility to be in class when quizzes are given. No make-up quizzes will be given unless in case of illness or personal emergency.

MIDTERM EXAM: Tuesday, 3/8, 5:30-7:30 p.m. (tentative)

FINAL EXAM: Monday, 5/2, 10:00-12:00 noon

Grades: midterm exam - 30%; final exam - 30%; quizzes - 20%; homework - 20%

Tentative grade scale

%	grade
>96%	A+
90-96%	A
85-90%	A-
80-85%	B+
75-80%	B
70-75%	B-
65-70%	C+
60-65%	C
55-60%	C-
50-55%	D
<50%	F

Tentative schedule

1/11 - 1/15 Classical electromagnetic field and its quantization. Gaussian and Lorentz-Heaviside units. Heisenberg and interaction representations.
1.1-1.2, 1.5; lecture notes

1/18 MARTIN LUTHER KING DAY

1/20 - 1/22 QED processes in nonrelativistic approximation.
1.3-1.4, 6.2 and lecture notes.

1/25 - 1/29 Lagrangian formalism and the Klein-Gordon equation.
Chapter 2 and 3.

2/1 - 2/5	The Klein-Gordon field; Dirac equation Chapter 3, 4.1-4.2, lecture notes.
2/8 - 2/12	Dirac equation: Plane-wave solutions and nonrelativistic limit. 4.1-4.2, Appendix A and lecture notes.
2/15 - 2/19	Dirac equation: Heisenberg equation of motion and hydrogen atom problem. Lecture notes.
2/22 - 2/26	Quantization of the Dirac field 4.3-4.5
2/29 - 3/4	Photons: Covariant theory Chapter 5;
3/7 - 3/11	S-matrix expansion; Feynman diagrams and Feynman rules in QED 6.1-6.3; 7.2-7.4
3/14 - 3/18	QED processes 8.1-8.5
3/21 - 3/25	SPRING BREAK
3/28 - 4/1	QED processes 8.6-8.9
4/4 - 4/8	The photon and electron self-energy; the Lamb shift. 9.1-9.5, 9.6.2.
4/11 - 4/15	Gauge theories; weak interaction. 11.1, 11.2, 16.1
4/18 - 4/22	Spontaneous symmetry breaking and Higgs boson 18.1-18.2
4/25 - 4/29	Review and discussion