PHYS 4500

Relativistic Quantum Fields and Particles
Fall 2024

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Lectures: TTH 11:00am-12:15pm, Academic Bldg 250

Textbook: A Standard Model Workbook by Thomas A. Moore
Further suggested reading: Quantum Field Theory by Lewis Ryder, second edition

Course description
PHYS 4500: Relativistic Quantum Fields and Particles
3 Credit Hours
Prerequisite: PHYS 3710 and MATH 2203
This course is an introduction to relativistic quantum mechanics, quantum field theory, elementary particle physics, and gauge theory. Students will learn how the combination of the two revolutionary physics theories of the first half of the 20th century, relativity and quantum mechanics, leads us to the concept of quantum fields and the description of the fundamental forces and particles in the universe. Students will see how electromagnetism, the strong and weak nuclear interactions, and even gravity, can be described in a unified way as gauge theories.

Learning outcomes
1. Learn how to derive relativistic Klein-Gordon and Dirac equations.
2. Learn how to use gauge symmetries to derive conservation laws in physics.
3. Analyze the quantization of scalar, vector, and spinor fields.
4. Use perturbation theory in elementary particle interactions.
5. Describe fundamental interactions in nature in terms of unitary groups.

Grading
Homework 30%
Tests 45% (3 tests, 15% each)
Final Exam 25%

Grades: A >90%; B 80%-90%; C 70%-80%; D 60%-70%; F <60%

Withdrawal

Last day to withdraw is October 25.

Tentative Schedule

August 13-15
Relativistic kinematics; Klein-Gordon equation

August 20-22
Dirac Equation; antiparticles

August 27-29
Lagrangian formulation for particles and fields; Noether's theorem; canonical quantization of scalar fields

September 3-5
Test 1; Quantization of spinor fields; local gauge invariance

September 10-12
Quantization of gauge fields

September 17-19
Perturbation theory

September 24-26
Feynman diagrams; Quantum Electrodynamics

October 1-3
Test 2; Cross sections

October 8-10
Ultraviolet and infrared divergences; dimensional regularization

October 15-17
Renormalization

October 22-24
Path-integral quantization

October 29-31
Test 3; Non-abelian gauge theories; SU(2) and Electroweak theory

November 5-7
Spontaneous symmetry breaking; Higgs mechanism

November 12-14
SU(3) and Quantum Chromodynamics

November 19-21
QCD and asymptotic freedom; soft gluons

November 26-28
Fall break; no classes

Final Exam
Tuesday, December 3, 10:30am-12:30pm

Exam Policy
Please note that any mobile device that transmits a signal is not permitted to be used in an exam. All mobile devices should be deactivated during exams. Final exam make-up is only for documented and excused emergencies or for scheduling conflicts with other final exams.

Academic Integrity
Every KSU student is responsible for upholding the provisions of the Student Code of Conduct, as published in the Undergraduate and Graduate Catalogs.

Attendance & Participation
Students are expected to attend all lectures, take all tests and exams, and complete all homework assignments.

Federal, BOR and KSU Student Policies

KSU Student Resources

Contact Info

Kennesaw Campus
1000 Chastain Road
Kennesaw, GA 30144

Marietta Campus
1100 South Marietta

Phone
470-KSU-INFO
(470-578-4636)

kennesaw.edu/info

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