

תורת השדות 86-804-01

מרצה הקורס: פרופ' יבגני קוגן

סוג הקורס: הרצאה

שנת לימודים: תשע"ט סמסטר: ב' היקף שעות: הרצאה 3 שעות

א. מטרת הקורס ותוצרי למידה (מטרות על / מטרות ספציפיות):

The purpose of the course is to teach students the basics of the Quantum Field Theory, especially the way the theory is applied in modern Condensed Matter Physics.

ב. תוכן הקורס:

I. CLASSICAL FIELDS

- A. Hamilton's Principle
- B. Scalar Fields
- C. Vector Field
- D. Noether Theorem

II. CANONICAL QUANTIZATION

- A. Quantum Harmonic Oscillator Revisited
- B. Canonical Quantization of the Klein--Gordon Field
- C. Canonical Quantization of the Electromagnetic Field
- D. Gauge Invariance

III. FEYNMAN PATH INTEGRALS

- A. Propagator
- B. Path Integral Representation of the Propagator
- C. The Harmonic Oscillator Propagator

IV. FUNCTIONAL INTEGRALS IN QUANTUM FIELD THEORY

- A. Scalar Field Mediated Interaction (Yukawa Potential)
- B. Vector Field Mediated Interaction (Coulomb Law)

V. FEYNMAN PATH INTEGRALS AND STATISTICAL MECHANICS

- A. Partition Function
- B. Harmonic Oscillator
- C. Particle on a Ring
- D. Quantum Particle in a Dissipative Environment

VI. SECOND QUANTIZATION AND COHERENT STATES

- A. Second Quantization
- B. Coherent States of Bosons
- C. Coherent states of Fermions

VII. FUNCTIONAL INTEGRALS AND STATISTICAL MECHANICS

- A. Field Integral for the Quantum Partition Function
- B. Partition Function for Relativistic Field.

VIII. FUNCTIONAL INTEGRALS: FREQUENCY REPRESENTATION

- A. Frequency Representation
- B. Partition Function of Non-Interacting Gas
- C. Matsubara Frequency Summation

IX. GREEN FUNCTIONS ZOO

- A. Imaginary Time Green Function
- B. Real Time Green Function
- C. Linear Response
- D. Connection Between Different Green Functions
- E. Dynamic Structure Factor

X. SPONTANEOUS SYMMETRY BREAKING

- A. Bose-Einstein Condensation in an Ideal Gas
- B. Bose-Einstein Condensation in a Non-Ideal Gas
- C. Superfluid Phase in Low Dimensions

XI. DIAGRAMMATIC PERTURBATION THEORY

- A. Wick Theorem
- B. Dyson Equation

XII. QUANTUM DOT

- A. Coulomb Blockade
- B. Action of a Tunnel Junction
- C. Electromagnetic Response of a Quantum Dot

ג. דרישות קדם:

The prerequisite for the course are the courses of Quantum Mechanics and Statistical Physics.

ד. חובות / דרישות / מטלות:

To pass exams the student will have to show his/her ability to solve the problems similar to those which were taught at the lectures and/or assigned as a home task.

ה. מרכיבי הציון הסופי:

The exams will consist of 4 problems assigned to the student. Correct solution of all problems will correspond to the grades 100. Correct solution of one problem and partial solution of the second one will correspond to the grades 60.

ז. שם הקורס באנגלית:

Field theory.