10753 – 754 (8) Many-body theory (1.5L, 1.5P)

2021

Course summary:

Multi-particle wave functions and the symmetrisation postulate; creation and annihilation operators for fermions and bosons (second quantization); applications of second quantization; variational principles and the Hartree-Fock approximation; Boqoliubov transformations; superconductivity.

Module relevance in programme:

Many-body theory is one of the fundamental pillars for any modern physics program and an essential component in the training of students.

Outcomes of course:

One aim of the course is to give students a basic working knowledge of the formalism of second quantization (creation and annihilation operators) and its application to many-body systems. This includes the ability to formulate and interpret a many-body problem in the context of second quantization and the ability to use basic approximation methods to solve such problems. At the end of the course students should also be familiar with some basic results regarding interacting many body systems in a condensed matter setting.

Lecturer:

Prof FG Scholtz
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Mentor:

The Department of Physics has appointed a staff member as mentor for each year of its physics programme to be available to students for consultation. Students should feel free to discuss general issues related to the physics programme or specific modules in the programme with the relevant mentor, in addition to usual consultations with their individual lecturers of modules.

The mentor for the Honours programme and its modules is Dr GW Bosman gwb@sun.ac.za

Course content:

Formal lectures

This course is usually presented in the second semester and constitutes a first exposure to second quantization in Quantum Mechanics. Many-body systems of identical particles, symmetries of the many-body wave function and the formalism of occupation number representation are covered in detail. Several applications are covered to familiarize the student with the technique. Mean field methods as an approximation tool are introduced. Finally, the BCS description of the superconducting state, is studied.

Laboratory work

None

Practical (Tutorials):

Six 2-hour tutorials: These are used to work through homework assignments. They also offer students the opportunity to consult the lecturer on the work or homework assignments and serve as feedback sessions.

Study material:

A set of notes will be provided.

Learning opportunities:

Assessment:

Methods of Assessments
One homework project per week for the duration of the course. Each project will contribute approximately 10% of the total mark. One open book test at the end of the course weighing 50%.

Venue and time of assessment opportunities
See timetable

Availability of marks:

Calculation of final mark for the module:
Each of five homework projects will contribute approximately 10% of the total mark. One closed book test at the end of the course weighing 50%.