# 12998 – 314 (16) Statistical Physics A (Introductory Thermodynamics and Statistical Mechanics) (3L, 3P)

## 2022 Course summary:

The three laws of thermodynamics are formulated, analysed and applied to simple thermodynamical systems; statistical and thermodynamic functions; phase equilibrium; statistical basis of thermodynamics. Fermi and Bose statistics, the ideal gas, black body radiation and other applications.

*Method of assessment: Flexible assessment*

*Prerequisite modules:*

- *Physics 254*

*Mathematics 214, 244 or Applied Mathematics 214, 244*

## Language policy:

Afrikaans and English in the same class groups:
During each lecture, all information is conveyed at least in English. Summaries and/or explanation of the core concepts will also be given in Afrikaans. Questions in Afrikaans and English will, at the least be answered in the language of the question. Students will be supported in Afrikaans and English during a combination of appropriate facilitated learning opportunities.

## Module relevance in programme:

Statistical physics can be considered one of the basic pillars in physics, together with mechanics (classical and quantum) and electromagnetism. The first part of this module builds on the 114 introduction to thermodynamics. This module first introduces statistical physics through a classical thermodynamics approach. The second part of the module introduces statistical physics of quantum mechanical systems building on the 254 quantum mechanics module. This introduction to the basics of statistical physics prepare the foundation for the modules in statistical physics in the hons course (721) and solid state physics (713).

## Outcomes of course:

The course establishes a basic working knowledge of thermodynamics, statistical mechanics, their relation and applications. Given the central role of thermodynamics and statistical mechanics in physics and physical applications, it is a core course on which many other applications build. It also lays the foundations for more advanced courses in statistical physics.

## Lecturers:

Prof. EG Rohwer
E-mail address: egr@sun.ac.za

Prof. KK Müller-Nedebock
E-mail address: kkmn@sun.ac.za

## 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 third year programme and its modules is **Mr GL Andrews** (glandrews@sun.ac.za).

## Course content:

The laws of thermodynamics are formulated, analysed and applied to simple thermodynamic systems. An early emphasis is put on the statistical basis of entropy and the partition function to serve as a link between statistical physics and thermodynamics. Applications are made to the classical ideal gas, the ideal quantum gas, paramagnetic systems, heat engines, refrigerators and phase transformations. In particular the Clausius-Clapeyron relation and van der Waals model are discussed. Boltzmann statistics and its applications are studied in detail. In conjunction with the Gibbs factor this background is used to introduce the quantum statistics of bosons and fermions. Applications include the ideal Fermi gas, black body radiation, the Debye theory of solids and Bose-Einstein condensation.

## Practical (Tutorials):

Face-to-face tutorial: 1 Tutorial every week as per schedule provided at start of course. Tests or quizzes may take place during tutorials.

## Study material:

DV Schroeder, ***An Introduction to Thermal Physics*** (Addison-Wesley, 1999)

## Learning opportunities:

3 Lectures per week

The offerings in this module are face-to-face, with materials, as appropriate, available on SUNLearn. Please observe all relevant protocols, and only come to class if you are without Covid-19 symptoms, and not self-isolating or not quarantined. In these cases contact your lecturer, who will assist with the materials.

## Assessment:

Tests for this module are sit-down (not online). There will be homework assignments, and perhaps some formative assessments that occur online.

***Methods of Assessments***
Flexible Assessment

***Venue and time of assessment opportunities***
Merensky Building
Test schedule: See ***timetable*** on Physics home page

***Availability of marks:***
2 weeks after test

***Calculation of final mark for the module:***
*25%* Tasks,
25% Tutorial tests
25% Test 1,
25% Test 2