1. **Title of the module**

PHYS6050 (PH605) - Thermal and Statistical Physics

1. **School or partner institution which will be responsible for management of the module**

Physical Sciences

1. **The level of the module (Level 4, Level 5, Level 6 or Level 7)**

Level 6

1. **The number of credits and the ECTS value which the module represents**

15 credits (7.5 ECTS)

1. **Which term(s) the module is to be taught in (or other teaching pattern)**

Spring

1. **Prerequisite and co-requisite modules**

Prerequisites:

PHYS3000 Mathematics

PHYS3010 Physics

PHYS5020 Quantum Physics

PHYS5030 Atomic Physics

1. **The programmes of study to which the module contributes**

BSc/BSc with Foundation Year/MPhys Physics

BSc/MPhys Physics with Astrophysics

BSc/MPhys Astronomy Space Science and Astrophysics

This is not available as a wild module.

1. **The intended subject specific learning outcomes.  
   On successfully completing the module students will be able to:**

Have:

1. Knowledge and understanding of physical laws and principles in Thermal and Statistical Physics, and their application to diverse areas of physics. (A1)
2. An ability to identify relevant principles and laws when dealing with problems in Thermal and Statistical Physics, and to make approximations necessary to obtain solutions. (B1)
3. An ability to solve problems in Thermal and Statistical Physics using appropriate mathematical tools. (B2)
4. An ability to use mathematical techniques and analysis to model physical behaviour in Thermal and Statistical Physics. (B4)
5. An ability to present and interpret information graphically. (C2)
6. An ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning. (C6)
7. **The intended generic learning outcomes.  
   On successfully completing the module students will be able to:**

Have a knowledge and understanding of:

1. Problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area. (D1)
2. Analytical skills – associated with the need to pay attention to detail and to develop an ability to manipulate precise and intricate ideas, to construct logical arguments and to use technical language correctly. (D4)
3. **A synopsis of the curriculum**

1. Thermodynamics

Review of zeroth, first, second laws. Quasistatic processes. Functions of state. Extensive and intensive properties. Exact and inexact differentials. Concept of entropy. Heat capacities. Thermodynamic potentials: internal energy, enthalpy, Helmholtz and Gibbs functions. The Maxwell relations. Concept of chemical potential. Applications to simple systems. Joule free expansion. Joule-Kelvin effect. Equilibrium conditions. Phase equilibria, Clausius-Clapeyron equation. The third law of thermodynamics and its consequences – inaccessibility of the absolute zero.

2. Statistical Concepts and Statistical Basis of Thermodynamics

Basic statistical concepts. Microscopic and macroscopic descriptions of thermodynamic systems. Statistical basis of Thermodynamics. Boltzmann entropy formula. Temperature and pressure. Statistical properties of molecules in a gas. Basic concepts of probability and probability distributions. Counting the number of ways to place objects in boxes. Distinguishable and indistinguishable objects. Stirling approximation(s). Schottkly defect, Spin 1/2 systems. System of harmonic oscillators. Gibbsian Ensembles. Canonical Ensemble. Gibbs entropy formula. Boltzmann distribution. Partition function. Semi-classical approach. Partition function of a single particle. Partition function of N non-interacting particles. Helmholtz free energy. Pauli paramagnetism. Semi Classical Perfect Gas. Equation of state. Entropy of a monatomic gas, Sackur-Tetrode equation. Density of states. Maxwell velocity distribution. Equipartition of Energy. Heat capacities. Grand Canonical Ensemble.

3. Quantum Statistics

Classical and Quantum Counting of Microstates. Average occupation numbers: Fermi Dirac and Bose Einstein statistics. The Classical Limit. Black Body radiation and perfect photon gas. Planck’s law. Einstein theory of solids. Debye theory of solids.

1. **Reading list (Indicative list, current at time of publication. Reading lists will be published annually)**

* Statistical Physics - A. M. Gue´nault
* Statistical Physics - F. Mandl
* Thermal physics - Baierlein, Ralph

1. **Learning and teaching methods**

Total contact hours: 30

Private study hours: 120

Total study hours: 150

1. **Assessment methods**
   1. Main assessment methods

Take-home test 1 (10 hour, 15%)

Take-home test 2 (10 hour, 15%)

Examination (2 hours 70%)

13.2 Reassessment methods

Like-for-like

1. **Map of module learning outcomes (sections 8 & 9) to learning and teaching methods (section12) and methods of assessment (section 13)**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Module learning outcome** | *8.1* | *8.2* | *8.3* | *8.4* | *8.5* | *8.6* | *9.1* | *9.2* |
| **Learning/ teaching method** |  |  |  |  |  |  |  |  |
| **Private Study** | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| Lecture | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** |
| **Assessment method** |  |  |  |  |  |  |  |  |
| *Take Home Tests* | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |
| *Examination* | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** |

1. **Inclusive module design**

The School recognises and has embedded the expectations of current equality legislation, by ensuring that the module is as accessible as possible by design. Additional alternative arrangements for students with Inclusive Learning Plans (ILPs)/declared disabilities will be made on an individual basis, in consultation with the relevant policies and support services.

The inclusive practices in the guidance (see Annex B Appendix A) have been considered in order to support all students in the following areas:

a) Accessible resources and curriculum

b) Learning, teaching and assessment methods

1. **Campus(es) or centre(s) where module will be delivered**

Canterbury

1. **Internationalisation**

Physics is an international subject with laws of physical sciences discovered and techniques developed and refined by physical scientists across the globe. Mastery of the subject-specific learning outcomes, will equip students to apply the theories and techniques of this module in a wide range of international contexts. In fact, Physics is Universal and so limiting this section to internationalisation is unnecessarily limiting. The module team is drawn from the School of Physical Sciences, which includes many members of staff with international experience of teaching and research collaboration. In compiling the reading list, consideration has been given to the range of texts that are available internationally. The support SPS provides to its students is also attuned to our international student body.

**FACULTIES SUPPORT OFFICE USE ONLY**

**Revision record – all revisions must be recorded in the grid and full details of the change retained in the appropriate committee records.**

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| --- | --- | --- | --- | --- |
| Date approved | Major/minor revision | Start date of the delivery of revised version | Section revised | Impacts PLOs (Q6&7 cover sheet) |
| 10/07/2019 | Minor | January 2020 | 6, 13, 14 |  |
|  |  |  |  |  |