1. **Title of the module**

PHYS7520 (PH752) - Magnetism and Superconductivity

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

School of Physical Sciences

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

Level 7

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

15 (ECTS 7.5)

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

Autumn and Spring.

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

Prerequisite: PHYS6060 Solid State Physics.

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

MPhys Physics/Physics with Astrophysics.

MSc (Euromasters) in Physics.

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. An understanding of the underlying physics of magnets and superconductors. (A2, A3, B7)
  2. An appreciation of the rich variety of physics dependent correlated electrons. (A2, B7, C2)
  3. An ability to solve problems in the science of magnetism and superconductivity. (B1, B2, B4, B6, B7, D1, D4)
  4. An appreciation of the role of magnets and superconductors in devices and industry. (A2, B10)

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

Have a knowledge and understanding of:

1. Enhancement of problem solving abilities, particularly mathematical approaches to problem solving. (B1, B2, B4, B5, B6, C7, D1, D4)
2. To use appropriate sources as part of directed self-learning. (C6, C10)
3. Enhancement of the ability to interpret theory. (C2, C6, C7)
4. A deeper appreciation of the connection of the role played by fundamental science in society generally. (A3)
5. **A synopsis of the curriculum**

Introduction. Magnetism, magnetometry and measuring techniques, Localised magnetic moments, spin and orbital moments, magnetic moments in solids. Paramagnetism. Exchange interactions, direct, indirect and superexchange, Magnetic structures, ferro, ferri, antiferromagnetism. Neutron and X-ray scattering. Spin waves, magnons. Magnetic phase transitions. Superconductivity: Introduction to properties of superconductors, Thermodynamics and electrodynamics of superconductors, Type I and Type II superconductors, the flux lattice Superconducting phase transitions. Microscopic superconductivity, correlations lengths, isotope effect, Cooper pairs, Froehlich Interaction, BCS theory. High Tc superconductors, superfluids, liquid helium.

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

S. Blundell; Magnetism in Condensed Matter (2001).

J. F. Annett; Superconductivity, Superfluids and Condensates (2004).

R. M. White; Quantum theory of magnetism: magnetic properties of materials (2010).

P. G. de Gennes; Superconductivity of Metals and Alloys (1999).

1. **Learning and teaching methods**

Total contact hours: 30

Private study hours: 120

Total study hours: 150

Achievement of module learning outcomes:

• Lectures and workshops (8.1-4, 9.1-4)

• Private study (8.1-4, 9.1-4)

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

Assignment (15%)

Assignment (15%)

Examination (70%)

* 1. 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* | *9.1* | *9.2* | *9.3* | *9.4* |  |  |  |  |
| **Learning/ teaching method** | **Hours allocated** | **18.75** | **18.75** | **18.75** | **18.75** | **18.75** | **18.75** | **18.75** | **18.75** |  |  |  |  |
| **Private Study** |  | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  |  |  |  |
| *Lectures* |  | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  |  |  |  |
| *Workshops* |  |  |  | **X** |  | **X** |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **Assessment method** |  |  |  |  |  |  |  |  |  |  |  |  |  |
| *Examination* |  | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** |  |  |  |  |
| *Coursework* |  | **X** | **X** | **X** | **X** | **X** | **X** | **X** | **X** |  |  |  |  |

1. **Inclusive module design**

The School/Collaborative Partner *(delete as applicable)* 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**

Please highlight aspects of this module where internationalisation is actively incorporated or intended. Refer to any relevant internationally-focused learning outcomes and, where possible, identify internationalisation in any of the following: subject content, assessment tasks, teaching methods/activities and support activity.

The topics to be covered in this module were developed collaboratively by scientists all over the world over many centuries. For example, the oldest magnetic instrument was a compass from the Han Dynasty in China, while the discovery of superconductivity was carried out in the Netherlands (as a by-product of the fierce competition to be the first to liquefy Helium between Kammerlingh-Onnes in Leiden and Dewar at the Royal Institution in London). These and other fascinating stories of international collaboration and competition are emphasized throughout the module.

**If the module is part of a programme in a Partner College or Validated Institution, please complete sections 18 and 19. If the module is not part of a programme in a Partner College or Validated Institution these sections can be deleted.**

1. **Partner College/Validated Institution**
2. **University School responsible for the programme**

**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.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 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 | September 2019 | 13 |  |
|  |  |  |  |  |