1. **Title of the module**

PHYS5020 (PH502) - Quantum 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 5

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)**

Autumn

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

None

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

Physics (BSc, BSc with Foundation Year, BSc with a Year in Industry, MPhys, MPhys with Year Abroad)

Physics with Astrophysics (BSc, BSc with a Year in Industry, MPhys, MPhys with Year Abroad)

 Astronomy Space Science and Astrophysics (BSc, BSc with a Year in Industry, MPhys, MPhys with Year Abroad)

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

8.1 Display knowledge and understanding of physical laws and principles in Quantum Physics, and their application to diverse areas of physics. (A1)

 8.2 Display an ability to identify relevant principles and laws when dealing with problems in Quantum Physics, and to make approximations necessary to obtain solutions. (B1)

 8.3 Display an ability to solve problems in Quantum Physics using appropriate mathematical tools. (B2)

 8.4 Display an ability to use mathematical techniques and analysis to model physical behaviour in Quantum Physics. (B4)

 8.5 Display an ability to present and interpret information graphically. (C2)

 8.6 Display an ability to make use of appropriate texts, research-based materials or other learning resources as part of managing their own learning. (C6)

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

9.1 Display problem-solving skills, in the context of both problems with well-defined solutions and open-ended problems. Numeracy is subsumed within this area. (D1)

 9.2 Display 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)

1. **A synopsis of the curriculum**

This module provides an introduction to quantum mechanics, developing knowledge of wave-functions, the Schrodinger equation, solutions and quantum numbers for important physical properties. Topics include: 2-state systems. Bras and kets. Eigenstates and Eigenvalues; Superposition Principle; Probability Amplitudes; Change of Basis; Operators. The Schrodinger equation. Stationary states. Completeness. Expectation values. Collapse of the wave function. Probability density. Solutions of the Schrodinger equation for simple physical systems with constant potentials: Free particles. Particles in a box. Classically allowed and forbidden regions. Reflection and transmission of particles incident onto a potential barrier. Probability flux. Tunnelling of particles. The simple harmonic oscillator. Atomic vibrations.

1. **Reading list (Indicative list, current at time of publication. Reading lists will be published annually)**
* Quantum Mechanics – Bransden, B. H., Joachain, C. J., 2000
* Quantum Mechanics: Concepts and Applications – Zettili, Nouredine, 2009
* Introduction to the Structure of Matter – Brehm, John J., Mullin, William J., 1989
* Quantum Mechanics – Rae, Alastair I. M., c2008
* Feynman Lectures in Physics – Vol. 3
* The Theoretical Minimum: Quantum Mechanics – Leonard Susskind & Art Friedman (Penguin Books 2014)
1. **Learning and teaching methods**

Total contact hours: 40

Private study hours: 110

Total study hours: 150

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

Problem sheet 1 (10 hours, 15%)

Problem sheet 2 (10 hours, 15%)

Exam 70% - 2 hours

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** |
| Lectures | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** |
| Workshops | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** |
| **Assessment method** |  |  |  |  |  |  |  |  |
| Examination | **X** | **X** | **X** | **X** | **X** |  | **X** | **X** |
| Assignments | **X** | **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**

The topics to be covered in this module were developed collaboratively by scientists in several countries (mostly Germany and other European countries, including the U.K.) during the first decades of the Twentieth century. Throughout the teaching of this module emphasis will be made on how contributions from different countries, each having their own approach to Physics, interacted to create the theory we have today, which like all established scientific theories transcends national boundaries.

**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 | 12, 13 |  |
|  |  |  |  |  |