# University of the West of Scotland

## Module Descriptor

## Session: 2024/25

| **Title of Module: Quantum Mechanics** | | | |
|---|---|---|---|
| **Code: PHYS09008** | **SCQF Level: 9 (Scottish Credit and Qualifications Framework)** | **Credit Points: 20** | **ECTS: 10 (European Credit Transfer Scheme)** |
| **School:** | School of Computing, Engineering and Physical Sciences | | |
| **Module Co-ordinator:** | David O'Donnell | | |

**Summary of Module**

This module is a core module at Level 9 on Institute of Physics (IoP) accredited Physics programmes.

The module covers fundamental concepts as well as some applications of **Quantum Mechanics**. General Syllabus details of the module are as follows.

- The Time-Independent Schrödinger Equation: harmonic oscillator, introduction to one-dimensional scattering theory, tunneling.
- Formalism of QM: Dirac notation, Ehrenfest's theorem, generalised uncertainty principle, Hilbert spaces, dual vectors, projectors, second quantisation, momentum representation
- QM in Three Dimensions: the Schrödinger equation in spherical coordinates and angular momentum, spin, hydrogen atom
- Perturbation theory, WKB

We have defined a set of Graduate Attributes that are the skills, personal qualities and understanding to be developed through your university experience that will prepare for life and work in the 21st century (https://www.uws.ac.uk/current- students/your-graduate-attributes/). The Graduate Attributes relevant to this module are listed below.

- Graduate Attributes - Academic: critical thinker; analytical; inquiring; knowledgeable; digitally literate; problem solver; autonomous; incisive; innovative
- Graduate Attributes - Personal: effective communicator; influential; motivated
- Graduate Attributes - Professional: collaborative; research-minded; enterprising; ambitious; driven

**Module Delivery Method**

| Face-To-Face | Blended | Fully Online | HybridC | Hybrid 0 | Work-Based Learning |
|---|---|---|---|---|---|
| ☒ | ☐ | ☐ | ☐ | ☐ | ☐ |

| **See Guidance Note for details.** |
|---|

| **Campus(es) for Module Delivery** | | | | | | |
|---|---|---|---|---|---|---|
| The module will **normally** be offered on the following campuses / or by Distance/Online Learning: (Provided viable student numbers permit) (tick as appropriate) | | | | | | |
| Paisley: | Ayr: | Dumfries: | Lanarkshire: | London: | Distance/Online Learning: | Other: |
| ☒ | ☐ | ☐ | ☐ | ☐ | ☐ | Add name |

| **Term(s) for Module Delivery** | | | | | |
|---|---|---|---|---|---|
| (Provided viable student numbers permit). | | | | | |
| Term 1 | ☒ | Term 2 | ☐ | Term 3 | ☐ |

| **Learning Outcomes: (maximum of 5 statements)**<br>**These should take cognisance of the SCQF level descriptors and be at the appropriate level for the module.**<br>At the end of this module the student will be able to: | |
|---|---|
| L1 | To gain basic understanding of Quantum Mechanics - the foremost intellectual achievement of the 20th century that forms much of the foundation of Modern Physics. |
| L2 | To be able to apply the principles of quantum mechanics to solve relevant problems in their further study, in particular, in atomic physics, in solid state physics, and in nuclear physics. |
| L3 | To significantly improve and broaden their maths knowledge, in particular, in differential equations and special functions. |

| **Employability Skills and Personal Development Planning (PDP) Skills** | |
|---|---|
| **SCQF Headings** | During completion of this module, there will be an opportunity to achieve core skills in: |
| Knowledge and Understanding (K and U) | SCQF Level **9**<br>• A broad knowledge of basic principles of quantum mechanics.<br>• A critical understanding of a selection of principles, concepts and terminology. |

<table>
<tr><td>Practice: Applied Knowledge and Understanding</td><td colspan="2">SCQF Level 9<br><br>Using a selection of the principal skills, techniques, practices enabling further studies of advanced subjects such as atomic physics, statistical physics, solid state physics, nuclear physics, etc.</td></tr>
<tr><td>Generic Cognitive skills</td><td colspan="2">SCQF Level 9<br><br>• Presenting and evaluate arguments, information and ideas in physics.<br>• Using a range of approaches to addressing problems and issues in physics.</td></tr>
<tr><td>Communication, ICT and Numeracy Skills</td><td colspan="2">SCQF Level 9<br><br>Using a wide range of routine skills and some advanced skills in physics. For example:<br><br>• To convey ideas in well-structured and coherent form<br>• To use standard applications to process and obtain a variety of information and data<br>• To use a range of numerical and graphical skills in combination<br>• To use numerical and graphical data</td></tr>
<tr><td>Autonomy, Accountability and Working with others</td><td colspan="2">SCQF Level 9<br>Exercising some initiative and independence in carrying out defined activities associated with the study of the module material.<br><br>Working towards deadlines.</td></tr>
<tr><td rowspan="3">Pre-requisites:</td><td colspan="2">Before undertaking this module, the student should have undertaken the following:</td></tr>
<tr><td>Module Code:<br>PHYS08002<br>PHYS08004<br>PHYS08006<br>PHYS08007<br>PHYS08009</td><td>Module Title:<br>Optics & Electronics<br>Properties of Matter<br>Mathematics for Physics 1<br>Classical Mechanics<br>Modern Physics</td></tr>
<tr><td>Other:</td><td>or equivalent</td></tr>
<tr><td>Co-requisites</td><td>Module Code:</td><td>Module Title:</td></tr>
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*Indicates that module descriptor is not published.

**Learning and Teaching**

**In line with current learning and teaching principles, a 20-credit module includes 200 learning hours, normally including a minimum of 36 contact hours and maximum of 48 contact hours.**

The course material is primarily presented in lectures. The lecture material is supported by a range of classroom exercises to prepare the students for the final examination and to guide them appropriately through their coursework. The assignments are complex exercises which require private study and further literature research. Thus, in addition to the knowledge and understanding of the course material this module will provide skills development in areas such as independent thought and problem solving.

| **Learning Activities**<br>During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below: | **Student Learning Hours**<br>(Normally totalling 200 hours):<br>(Note: Learning hours include both contact hours and hours spent on other learning activities) |
|---|---|
| Lecture/Core Content Delivery | 36 |
| Tutorial/Synchronous Support Activity | 12 |
| Independent Study | 152 |
| | 200 Hours Total |

****Indicative Resources: (eg. Core text, journals, internet access)**

The following materials form essential underpinning for the module content and ultimately for the learning outcomes:

Introduction to Quantum Mechanics, 3rd edition, by David J. Griffiths and Darrell F. Schroeter, Pearson, 2018 (primary text)

Quantum Mechanics: A Paradigms Approach, by David H. McIntyre, Cambridge, 2023

Quantum Mechanics, 3rd edition, by Eugen Merzbacher, John Wiley and Sons, 1998

Quantum Mechanics (2 vol. set), C. Cohen-Tannoudji et al., Wiley-Interscience, 2006

(**N.B. Although reading lists should include current publications, students are advised (particularly for material marked with an asterisk*) to wait until the start of session for confirmation of the most up-to-date material)

**Attendance and Engagement Requirements**

In line with the Student Attendance and Engagement Procedure: Students are academically engaged if they are regularly attending and participating in timetabled on-campus and online teaching sessions, asynchronous online learning activities, course-related learning resources, and complete assessments and submit these on time.

| **Equality and Diversity** |
|---|
| The University's Equality, Diversity and Human Rights Procedure can be accessed at the following link: UWS Equality, Diversity and Human Rights Code.<br><br>Please ensure any specific requirements are detailed in this section. Module Co-ordinators should consider the accessibility of their module for groups with protected characteristics. |
| (N.B. Every effort will be made by the University to accommodate any equality and diversity issues brought to the attention of the School) |

## Supplemental Information

| | |
|---|---|
| **Divisional Programme Board** | Engineering and Physical Sciences |
| **Assessment Results (Pass/Fail)** | Yes ☐No ☒ |
| **School Assessment Board** | Physical Sciences |
| **Moderator** | Marcus Scheck |
| **External Examiner** | D Faux |
| **Accreditation Details** | Institute of Physics (IoP) |
| **Changes/Version Number** | **4.0**<br>Module descriptor amended to conform to the new template format and to reflect outcomes from ILR 2023.<br><br>Curriculum enhanced to account for PHYS08009 Modern Physics. |

| **Assessment: (also refer to Assessment Outcomes Grids below)** |
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| Assessment 1 – Invigilated closed-book class test (60%) |
| Assessment 2 – Written Coursework (40%) |
| (N.B. (i) **Assessment Outcomes Grids** for the module (one for each component) can be found below which clearly demonstrate how the learning outcomes of the module will be assessed.<br>(ii) An **indicative schedule** listing approximate times within the academic calendar when assessment is likely to feature will be provided within the Student Module Handbook.) |

## Assessment Outcome Grids (**See Guidance Note)**

| **Component 1** |
|---|

| Assessment Type (Footnote B.) | Learning Outcome (1) | Learning Outcome (2) | Learning Outcome (3) | Weighting (%) of Assessment Element | Timetabled Contact Hours |
|---|---|---|---|---|---|
| Invigilated closed-book class test | ✔ | ✔ | ✔ | 60 | 2 |
| **Component 2** | | | | | |
| **Assessment Type (Footnote B.)** | **Learning Outcome (1)** | **Learning Outcome (2)** | **Learning Outcome (3)** | **Weighting (%) of Assessment Element** | **Timetabled Contact Hours** |
| Portfolio of written work | ✔ | ✔ | ✔ | 40 | 0 |
| **Combined Total for All Components** | | | | 100 | 2 |