University of the West of Scotland

Module Descriptor

Session: 2024/25

Title of Module: Selected Topics in Theoretical Physics			
Code: PHYS10013	**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:	Gregory V Morozov		

Summary of Module

This is an optional Level 10 module for the physics programme presented in the second term.

The module will cover selected topics in theoretical physics, such as analytical mechanics and non-linear dynamics, advanced electrodynamics, and general relativity. The exact topics covered will vary each session but will include two subjects from the list below.

Analytical Mechanics and Non-Linear Dynamics
The course will begin by reviewing the Lagrangian and Hamiltonian formalisms, as well as an in-depth discussion of phase space. We will introduce the Gateaux derivative, and discuss the second variation, the Hamilton-Jacobi equations and Poisson brackets. Nonlinear dynamics and chaos, attractors, orbits, period doubling bifurcations, Feigenbaum's number, Lyapunov exponents.

Advanced Electrodynamics
This topic will begin by reviewing Maxwell's equations. We will then discuss Helmholtz decomposition, multipole expansions, vector potentials, gauge transformations, retarded potentials, radiation, Lorentz transformation of EM fields. We will then discuss electrodynamics of continuous media, electromagnetic waves in absorptive and dispersive media, Kramers-Kronig relations, inhomogeneous media, transfer matrix method.

General Relativity
Tensors, contravariance and covariance, geometry of curved spacetime (Riemannian geometry), concept of a metric, Christoffel Symbols, Schwarzschild spacetime, black holes, Robertson-Walker spacetime, Ricci Tensor, Einstein's Field Equations, Friedmann Equations.

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**	**Hybrid0**	**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) **These should take cognisance of the SCQF level descriptors and be at the appropriate level for the module.** At the end of this module the student will be able to:	
L1	Develop a good understanding of a broad range of topics across core theoretical physics.
L2	Improve facility with the mathematical techniques that underpin the physical concepts.
L3	Synthesise knowledge from across the entire degree programme and develop deeper theoretical insights into prior knowledge.
L4	Become a fluent user of computer algebra software to aid visualisation and calculation.

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 **10** Advanced topics in theoretical physics, such as from advanced electrodynamics and special relativity, advanced mechanics, or general relativity. This module will equip the student with a good basis on which to build further study in theoretical physics.

Practice: Applied Knowledge and Understanding	SCQF Level **10** Applying what they have learned throughout their studies to understand some of the pillars of modern theoretical physics.	
Generic Cognitive skills	SCQF Level **10** Advanced knowledge of mathematical physics, and fluency with physics topics in general. Studying theoretical physics at this level demonstrates strong cognitive abilities.	
Communication, ICT and Numeracy Skills	SCQF Level **10** A very high level of numeracy and computational skills. Students who successfully achieve the learning outcomes will be in a good position to demonstrate that they are numerically and computationally literate.	
Autonomy, Accountability and Working with others	SCQF Level **10** Maintaining academic integrity throughout and will continue to foster good communication skills while working as part of a team.	
Pre-requisites:	Before undertaking this module, the student should have undertaken the following:	
	Module Code: PHYS09003 PHYS09007 PHYS09008 PHYS09011	**Module Title:** Electromagnetism Thermodynamics & Statistical Physics Quantum Mechanics Atoms & Nuclei
	Other:	or equivalent
Co-requisites	**Module Code:**	**Module Title:**

*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 lectures for the module will be delivered using the indispensable "chalk and talk" approach. This is the only approach with the fluidity to accommodate the teaching and learning of the advanced mathematical ideas necessary for theoretical physics.. Tutorials will be held in learning studios with white board walls so that students can work collaboratively on the challenging problem sets. There will be ample chance for students to develop computational skills while investigating the problems numerically.	
Learning Activities During completion of this module, the learning activities undertaken to achieve the module learning outcomes are stated below:	**Student Learning Hours** (Normally totalling 200 hours): (Note: Learning hours

	include both contact hours and hours spent on other learning activities)
Lecture/Core Content Delivery	24
Practice Based Learning	24
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:

D. J. Griffiths, "Introduction to Electrodynamics, Fourth Edition", Pearson, 2012.
(or any later edition)

J.D. Jackson, Classical Electrodynamics

L. D. Landau, E. M. Lifshitz, Course of Theoretical Physics, Vols. 1-3 (Mechanics, The Classical Theory of Fields, Quantum Mechanics: Non-Relativistic Theory)

B. Schutz, A First Course in General Relativity

(**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.

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	Maximilien Barbier
External Examiner	D Faux
Accreditation Details	Institute of Physics (IoP)
Changes/Version Number	**2.0** Module descriptor amended to conform to the new template format and to reflect outcomes from ILR 2023.

Assessment: (also refer to Assessment Outcomes Grids below)
Assessment 1 – Class Test (80%)
Assessment 2 – Written Coursework (20%)
(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. (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)**	**Learning Outcome (4)**	**Weighting (%) of Assessment Element**	**Timetabled Contact Hours**
Exam	✔	✔	✔		80	2

Component 2						
Assessment Type (Footnote B.)	**Learning Outcome (1)**	**Learning Outcome (2)**	**Learning Outcome (3)**	**Learning Outcome (4)**	**Weighting (%) of Assessment Element**	**Timetabled Contact Hours**

Portfolio of Written Work	✔	✔	✔	✔	20	0
Combined Total for All Components					100	2