Module Specification
MATH431 – INTRODUCTION TO MODERN PARTICLE THEORY

Contents

1. Module Details

Module Title:	INTRODUCTION TO MODERN PARTICLE THEORY

Short Title:	INTRO TO MODERN PARTICLE THEOR

Module Code:	MATH431

Marketing Module Synopsis:	Modern particle theory is combining special relativity, quantum mechanics and field theory to describe all the fundamental subatomic particles and their interactions. The module develops the relevant concepts that enter into the Standard Model of particle physics. The key concept in modern physics is that of invariance under local symmetries and the conservation laws that they give rise to. The module covers the basic elements that describe modern particle theory, including: Lorentz and Poincare symmetries, which underlie special relativity; Hamilton and Lagrange formalism of classical mechanics and fields, which underlie the modern formalism; basic elements of relativistic quantum mechanics including the Dirac and Klein-Gordon equations; field quantisation; global and local symmetries; global and local symmetry breaking and the Higgs mechanism; unitary groups and the classification of elementary particles; basic elements of grand unified theories and phenomenological aspects. The students will be introduced to many of the modern ideas in Particle Physics at an accessible level.

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Credits:	15
Level:	Level 7
Delivery Location(s)	MUST BE COMPLETED FOR APPROVAL Online
Semester:	Second Semester
Academic Year:	2020-21
Faculty:	Faculty of Science and Engineering
School/Institute (Level 2):	School of Physical Sciences
Curriculum Board (level 1):	Mathematical Sciences
Module Coordinator:	Alon Faraggi
Other staff:	Christopher Egan, Monika Grabias, Thomas Mohaupt, Radu Tatar, Alan Smithson, Simon Fairfax
External Examiner(s):	
Pre-requisites:	N/A
Co-requisites:	N/A
Barred Combinations:	N/A
CE/CPD Provision:	No
Overview:	Costs Information: Standard University Calculator

	There are the following non-modular requirements: MATH 325 (or equivalent for MPhys students) Skill/Other Attribute 1: " Problem solving skills " How this is developed: ""

Notes:	This module is due to commence in November 2018

Maximum Places:	50

Subject:	

HESA Cost Centre(s):	MUST BE COMPLETED FOR APPROVAL Mathematics

Status:	Approved

The table below is automatically completed from programme data held in Curriculum Manager; during 2019/20 it is likely to have no data or incomplete data until all programme records are in Curriculum Manager.

In Programmes:	**Programme Validation Status**	**Module Status:**	**Programme Stage / Group / / Sub-group**
Mathematical Sciences Master of Science (MSc) 2020-21	Validated	Optional	Whole Session Whole Session Optional Modules

In Programmes:	**Programme Validation Status**	**Module Status:**	**Programme Stage / Group / / Sub-group**
Mathematics Master of Mathematics (MMath) 2017-18	Validated	Optional	Year 4 Semester 2 Year 4 Semester 2 Year 4 Semester 2
Mathematical Physics Master of Mathematics (MMath) 2017-18	Validated	Optional	Year 4 Semester 2 Year 4 Semester 2
Theoretical Physics Master of Physics (MPhys) 2017-18	Validated	Optional	Year 4 Year 4 Semester 2 Optional Modules (Level 7)

The table below must be completed for module approval, including confirmation that there are zero costs to the student.

Student Cost(s)					
				Costs range:	
Cost Type:	**Description:**	**Value type** (exact, approximate or max/min range)**:**	**Cost** (exact or approximate):	**Minimum Cost:**	**Maximum Cost:**

2. Aims and Content

Educational Aims:
To provide a broad understanding of the current status of elementary particle theory. To describe the structure of the Standard Model of particle physics and its embedding in Grand Unified Theories.

Outline Syllabus:
Classical mechanics in Lagrange and Hamilton form; Lorentz and Poincare group; elements of quantum mechanics: Klein-Gordon equation, Dirac equation; basic elements of field theory: Field quantization, Feynman diagrams; global, and local symmetries, gauge bosons; classification of elementary particles: charge, spin, mass, Isospin; Unitary groups; The quark model of Gellman and Zweig; beta decay and weak interactions; global and local symmetry breaking; Higgs mechanism; outlook onto extensions of the standard model; Pati-Salam, SU(5) and SO(10) Grand Unified Theories; phenomenological aspects of GUTs;

Reading List:	

3. Module Outcomes (learning outcomes, skills and other attributes)

Ref No.	Learning Outcome / Skill:	Category:
LO1	To understand the Lorentz and Poincare groups and their role in classification of elementary particles.	Learning Outcomes
LO2	To understand the basics of Langrangian and Hamiltonian dynamics and the differential equations of bosonic and fermionic wave functions.	Learning Outcomes
LO3	To understand the basic elements of field quantisation.	Learning Outcomes
LO4	To understand the Feynman diagram pictorial representation of particle interactions.	Learning Outcomes
LO5	To understand the role of symmetries and conservation laws in distinguishing the strong, weak and electromagnetic interactions.	Learning Outcomes
LO6	To be able to describe the spectrum and interactions of elementary particles and their embedding into Grand Unified Theories (GUTs)	Learning Outcomes
LO7	To understand the flavour structure of the standard particle model and generation of mass through symmetry breaking.	Learning Outcomes

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Ref No.	Learning Outcome / Skill:	Category:
LO8	To understand the phenomenological aspects of Grand Unified Theories.	Learning Outcomes
~~LO9~~		~~Learning Outcomes~~
~~LO10~~		~~Learning Outcomes~~
S1	Problem solving skills	Skills
~~S2~~		~~Skills~~

4. Assessments

Assessment Strategy:
MUST BE COMPLETED FOR APPROVAL 1x 50% class test – open book and remote 1x 50% final assessment – open book and remote The module will be delivered in hybrid delivery mode. Asynchronous learning materials (notes/videos/exercises etc) will be made available to students through the VLE. The module will have regular synchronous sessions in active learning mode. We are planning no changes to module content compared to previous years, and expect students to spend a similar amount of time-on-task compared to previous years. These changes will mainly constitute a rebalancing of hours from scheduled directed learning hours to unscheduled directed learning hours as students will have some flexibility as to when they access asynchronous materials.

All fields in the table below must be completed for module approval.

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Method	Description	Type	Units of Length	Length	Min	Max	Description (re length)	Weighting	Assessment period(s)	Group ...	Must Pass	Final Assessm...
Written exam, unseen, managed by SAS Final Assessment	~~Written Exam~~ Final Assessment – open book and remote There is a resit opportunity. Standard UoL penalty applies for late submission. This is an anonymous assessment. Assessment Schedule (When) :Semester 2	Summative	Other	N/A	N/A	N/A	~~2.5 hours~~ 1h time on task	~~100 %~~ 50%	S2	No	MUST BE COMPLETED No	Yes
Coursework	Class Test 1	Summative	Other	N/A	N/A	N/A	Around 60-90 minutes	50%	S2	No	No	No

Please see Appendix 1 for details of the outcomes tested by the above assessments.

5. Learning and Teaching Methods

Summary of Learning and Teaching Methods:
~~Teaching Method 1 - Lecture~~

~~Description:~~
~~Attendance Recorded: Yes~~

~~Teaching Method 2 - Tutorial~~
~~Description:~~
~~Attendance Recorded: No~~

The module will be delivered in hybrid delivery mode. Asynchronous learning materials (notes/videos/exercises etc) will be made available to students through the VLE. The module will have regular synchronous sessions in active learning mode.

We are planning no changes to module content compared to previous years, and expect students to spend a similar amount of time-on-task compared to previous years. These changes will mainly constitute a rebalancing of hours from scheduled directed learning hours to unscheduled directed learning hours as students will have some flexibility as to when they access asynchronous materials.

Synchronous: 12 hours (scheduled, directed)
Asynchronous: 36 hours (unscheduled, directed)
Independent Learning: 102 hours (undirected)

The following table must be completed for module approval, accounting for all hours associated with the credit value of the module, e.g. for 15 credits there should be 150 hours of learning and teaching activity, including independent learning.

Learning and Teaching Method:	**Length (Minutes):**	**Times per Week** (if applicable):	**Number of Weeks** (if applicable):	**Calculated Hours** (if applicable):	**Hours:**
Lecture	N/A	N/A	N/A	N/A	36
Self-Directed Learning	N/A	N/A	N/A	N/A	102
Tutorial	N/A	N/A	N/A	N/A	12

6. Supplementary Information

If a risk assessment is required for this module for students under 18, please record a summary of the risks:	N/A