Physics | Lancaster University

Physics: Undergraduate Courses Handbook

For 1^{st}, 2^{nd}, 3^{rd} & 4^{th} Year Students

Edition 1.7

2016/2017

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1 Introduction

Edition 1.7 2016/2017

This handbook describes all of the undergraduate courses taught in the Department of Physics at Lancaster University.

The online version of the handbook is the definitive version as any errors or omissions are corrected in it as soon as is practicable.

The University Academic Term dates for the 2016/2017 session are:

Term	First Classes				Last Classes		
Michaelmas	7	Oct	2016	to	16	Dec	2016
Lent	13	Jan	2017		24	Mar	2017
Summer	21	Apr	2017		30	Jun	2017

The Department's teaching, lectures and laboratories, takes place during the full weeks of the above Term periods. The first and last days of teaching for the 2016/2017 year are then as follows:

Term	First Classes				Last Classes		
Michaelmas	10	Oct	2016	to	16	Dec	2016
Lent	16	Jan	2017		24	Mar	2017
Summer	24	Apr	2017		30	Jun	2017

Teaching normally occupies the full 10 weeks of the Michaelmas and Lent Terms and 5 weeks of the Summer Term (the remainder of the Summer Term being taken up with examinations).

This document contains information about the undergraduate courses in physics which are offered by the Department of Physics in 2016/2017. It is primarily aimed at undergraduates who are already at Lancaster University.

More general information about Lancaster University, for example the University Rules, Dates of Term, Students Charter etc may be found in the pages published by the Academic Registrar. Further information on matters such as the Examination Timetable, the Undergraduate Registry and the University Undergraduate Handbook may be found in the pages maintained by the Student Registry. Please always refer to ILancaster for the up-to-date timetable for Physics modules.

Your attention is drawn to the University's Plaigarism Framework for full details of unacceptable practices and the sanctions which the University will impose in proven cases. In Appendix E of this handbook, the Department's Plagiarism policy is briefly described, in particular pointing out the limits of collaborative or group work and its subsequent assessment.

1.1 Term Dates 2016 – 2019

To aid planning of students and staff in the longer term, the term dates for the following 3 academic years are included here:

	Term	Start				End			
Academic Year: 2016 – 2017	Michaelmas	7	Oct	2016	to	16	Dec	2016	
	Lent	13	Jan	2017		24	Mar	2017	
	Summer	21	Apr	2017		30	Jun	2017	
Academic Year: 2017 – 2018	Michaelmas	6	Oct	2017	to	15	Dec	2017	
	Lent	12	Jan	2018		23	Mar	2018	
	Summer	20	Apr	2018		29	Jun	2018	
Academic Year: 2018 – 2019	Michaelmas	5	Oct	2018	to	14	Dec	2018	
	Lent	11	Jan	2019		22	Mar	2019	
	Summer	25	Mar	2019		29	Mar	2019	- (week 21)
	Summer	26	Apr	2019		28	Jun	2019	- (weeks 22-30)
Academic Year: 2019 – 2020	Michaelmas	4	Oct	2019	to	13	Dec	2019	
	Lent	10	Jan	2020		20	Mar	2020	
	Summer	17	Apr	2020		26	Jun	2020	

1.2 Points of contact within the Physics Department

Head of Department	Prof R W L Jones	Room B11 P, Tel 94487
Director of Teaching/Examinations Officer	Prof J Wild	Room C25 P, Tel 10545
Careers Advisor	Dr A Marshall	Room A21 P, Tel 94072
Equal Opportunities & Disabilities Officer	Dr N Drummond	Room A42 ST, Tel 92258
Part I Teaching Co-ordinator	Pam Forster	Room A4 P, Tel 94786
Part II Teaching Co-ordinator	Louise Crook	Room A6 P, Tel 93639
Academic Advisors		
1st Year	Prof J Wild	Room C25 P, Tel 10545
1st Year	Dr S Badman	Room C23 P, Tel 93417
2nd Year	Prof G V Borissov	Room B16 P, Tel 94612
2nd Year	Dr H Fox	Room B20 P, Tel 93616
3rd Year	Dr K Dimopoulos	Room A41 ST, Tel 93645
3rd Year	Dr A Marshall	Room A21 P, Tel 94072
4th Year	Dr Q D Zhuang	Room A31 P, Tel 94198
4th Year	Dr J Prance	Room A23 P, Tel 94972
Natural Science	Prof A Stefanovska	Room C506 P, Tel 92784
Study Abroad	Dr D A Burton	Room A40 ST, Tel 92845
Visiting (Erasmus/JYA) students taking Part II modules (all years)	Dr D A Burton	Room A40 ST, Tel 92845

1.3 Communication by e-mail

Shortly after arrival you will have collected a computer username and details of your email account. Make sure that you log on to a campus computer, change your initial password and test your email account. Your email address will include your name then @lancaster.ac.uk.

Your Lancaster email address will be used for all official correspondence from the University. Please check it on a daily basis.

1.4 Student Support

Lancaster has adopted a student-centred approach in which access to high quality support across a range of areas is provided by different agencies in a way which best meets each student's individual circumstances and needs.

Academic support is provided in this department by the module lecturer and through your Academic Advisor (see section 2.5). For many students, the first point of call for most enquiries or problems relating to undergraduate teaching is your friendly Teaching Co-ordinator who is for Part I students Pam Forster and Part II students Louise Crook room A4 and A6 in the Physics Building who will be able to find the right person for you to speak to, either within the Department or the University. In addition, during the first year of study, you will be assigned to a named College Advisor. That person can also provide advice and support to you on accessing these services, or upon any other issues you may need help with.

1.5 Student Representation

The Physics Staff-Student Consultative Committee (see section 3.1) is the forum for canvassing the views of students on teaching matters. It meets termly. Different groups of students elect representatives who canvas student opinion on course problems and report back to the other students on any proposed changes to delivery or course content.

1.6 Safety

Safety is an important consideration in any place of work. In the Physics Department, there are many potentially hazardous places, be that from equipment, radiation, cryogenic liquids or simply people working. Everyone has a duty of care to ensure a safe working environment. All equipment you will come across should have been safety audited but you are still advised to take care – damage can occur. For project work, you will be required to carry out a risk assessment - in other words identify any risk and suggest working practices that minimize the risk. Needless to say, your supervisor will help you!

If you think you see something with regard to safety that you think is dangerous, then:

- if in a laboratory, immediately contact one of the demonstrators
- elsewhere, please contact the Departmental Safety Officer, Shonah Ion immediately. This could also be done through the Teaching Co-ordinators in rooms A4 and A6 in the Physics Building.

Please do so even if you think it won't affect you - it might seriously affect or harm someone else.

A copy of the Department's safety handbook is available on the Departmental website. Whilst this is mainly aimed at academic staff, technical staff and postgraduate students, it does contain useful information.

1.7 Ethical Issues (for projects and/or coursework)

Depending upon the nature of the work you are doing, there may be specific research ethics issues that you need to consider (for example if your project involves human subjects in any way). You may need to complete a research ethics form and you should consult your dissertation / research supervisor for details of the required process.

1.8 Academic Contact Time

Lancaster University has a set of minimum commitments on academic contact.

These commitments indicate the amount of contact time with your tutors that you should typically expect on an annual basis if you take traditionally taught modules, i.e. delivered entirely by lectures / seminars / practicals / workshops etc. However, it should be noted that your actual experience will vary due to your module choices, for example dissertations and modules with a large proportion of blended learning (i.e. using online resources) typically have less face-to-face contact and a greater amount of independent study.

Typically, this department offers 440 hours in Part 1, 390 hours in second year, 290 hours in third year and 265 in the 4th year. Dissertation and projects will typically have at least 20 hours of contact and many hours of unsupervised experimentation or study.

1.9 Independent Learning

The department outlines the independent learning required for each module in the module specifications later in this document. A student's working week consists of 40 hours of study in each term week. Broadly speaking, in a 10 credit module, we expect 100 hours of study. So, if a 10 credit module specifies 25 hours of teaching (contact) time, our expectation is that you will spend a further 75 hours on private study during the module, such as reading through and understanding the lecture notes, further reading of published materials and completion of coursework.

1.10 Provision for contact outside normal teaching

Lecturing staff operate an "office hour" system where they make themselves available during their lecture module at a specific time in their office to answer student queries and problems. The lecturer may also be available at other unspecified times to give help when required - it would be better if you try and arrange a mutually convenient time.

1.11 Examination Regulations

The University publishes information on all matters to do with the conduct of examinations and the assessment of first year (Part I) courses and of modules which contribute to the award of BSc and MPhys degrees. The University Examination Regulations should be consulted for all details on examination procedures.

In October 2011, the University introduced new assessment regulations. These changes were introduced to simplify the regulations, ensure markers use the full range of available marks across all disciplines and deal with mitigating circumstances in a more transparent way.

Included in the Regulations are specific sections on procedures for dealing with:

- examination failure and re-assessment;
- illness and absence from examinations, intercalation;
- appeals and review committees;
- the award of aegrotat degrees;
- malpractice in examinations and coursework.

The University Examination Regulations should be used to supplement the information given in this book.

The overall assessment rules for the MPhys (see Section 7.2) and BSc (see Section 10.2) are summarised in this document. The Part II progression rules for MPhys (see Section 7.3) and BSc (see Section 10.3) are also given. Full details are available in the University Examination Regulations.

1.12 Undergraduate Assessment Regulations - brief overview

The main points relevant to students in the Department of Physics are:

- For modules in the Physics Department, the majority of lecture coursework and examinations are quantitative (marked to a defined marking scheme) and will be marked in percentages. Ultimately, these marks will be converted to an aggregation score on a 24 point scale, see table below.
- Reports and dissertations are deemed qualitative and will be marked using letter grades (A+, A, A-, B+ . . . D-, F1 . . . F4). These are what you will see on returned work. These grades will be converted to an aggregation score on a 24 point scale for the purposes of calculating your overall module results and your final degree class.

- The individual module overviews in this document will specify if marking is quantitative (percentage) or qualitative (letter grade), or a mixture of both.

- Degree classifications will be based on your overall aggregation score and there are clear definitions for borderline scores and departmental criteria for considering borderline cases.

- To progress between years, any failed modules must be resat. Only one resit opportunity is permitted.

- To qualify for a degree any modules which you have not passed must be condoned, that is you are given credit for taking them even though you have not achieved a pass mark. Failed module marks may only be condoned above a minimum aggregation score of 7 indicating a reasonable attempt has been made.

- To be awarded an honours degree, you must attain an overall pass grade and have no more than 30 credits condoned.

- The penalty for work submitted late is a reduction of one full grade for up to three days late. Work submitted more than three days late will be awarded zero marks.

To see the full undergraduate assessment regulations and a student FAQ, with answers to the most common questions relating to how you are assessed and how your overall degree result will be determined, go to:

http://www.lancs.ac.uk/sbs/registry/undergrads/AssessmentRegs.htm.

The following table gives an approximation of the relationship between percentage scores and grades. For more details, see Appendix C or Tables A and B of the document linked above.

Broad descriptor	approx %	Grade	Agg. Score	Class
Excellent	100	A+	24	First
	80	A	21	
	70	A-	18	
Good	67	B+	17	Upper Second
	63	B	16	
	60	B-	15	
Satisfactory	57	C+	14	Lower Second
	53	C	13	
	50	C-	12	
Weak	47	D+	11	Third
	43	D	10	
	40	D-	9	
Marginal fail	31	F1	7	Fail
Fail	18	F2	4	
Poor fail	9	F3	2	
Very poor fail	<9	F4	0	

The final class of your degree is based on the [weighted] average aggregation score of all the modules you study. Further details on the classification and condonation rules can be found in later sections of this document.

1.13 Coursework Submission, Return and Penalties

Clear deadlines are given for all assessed coursework. Work should be submitted with a signed cover sheet using the submission boxes in the entrance foyer of the Physics Building by the specified time. If you submit work without your name or signature, or hand in to the wrong submission box, your work will be treated as late and will receive the appropriate penalty. Coursework handed in after this deadline will be subject to a penalty. Weekly lecture coursework will be returned to you at the subsequent solutions seminar. Other types of work, or late work, will be returned within 4 weeks of submission. Work submitted at the end of term will be returned at the start of the following term. Work not collected in seminars can be found in the coloured filing boxes in the Physics Building foyer.

In case of illness, coursework may be excused or the deadline extended (as appropriate) provided that a student self-certification medical note is provided (these may be obtained from Part I Co-ordinator Pam Forster, or Part II Co-ordinator Louise Crook, room A4/A6 in the Physics Building). In case of other extenuating circumstances, extensions to coursework deadlines may be granted at the discretion of the module supervisor (or Academic Advisor), provided that these are requested by the student prior to the original deadline.

The penalty for work submitted late that is marked using letter grades is an automatic reduction of one full grade (i.e. B+ $\Longrightarrow$ C+) for up to three days late and a mark of zero thereafter.

In the case of quantitative (percentage) marking, the following penalties apply:

- For marks between 50 and 69 there is a 10% reduction (so, for example, a 58% would become 48%).
- For all other marks (0 - 49 and 70 - 100) the penalty is equivalent to one full grade, resulting in the particular mark indicated in the 'Mark after penalty' column (e.g. 84% $\Longrightarrow$ 65% ; A $\Longrightarrow$ B).

Original mark	Grade equivalent	Mark after penalty	Grade equivalent
87–100	A+	68	B+
74–86	A	65	B
70–73	A-	62	B-
60–69	B+/B/B-	50-59	C+/C/C-
50–59	C+/C/C-	40–49	D+/D/D-
40–49	D+/D/D-	31	F1
31–39	F1	18	F2
18–30	F2	9	F3
0-30	F3/4	0	F4

Note: Failure to submit substantial pieces of coursework without due cause, could lead to an un-condoned fail mark, which would exclude the possibility of being awarded a degree.

1.14 Examination and Coursework Marking Criteria

Marking criteria for both examination and coursework depend on the specific module. Broadly speaking, questions tend to be of three different styles:

- **algebraic:** starting from some specified starting point, carry out a series of mathematical or logical manipulations to determine a formula or result, which may or may not be given in the question. Marks are awarded on the basis of: a clear statement of the basic physics and fundamental equation, with variables defined; style and clarity; the correct fraction of the manipulations carried out.
- **numerical:** very similar to algebraic question but with numbers put into the final result. Marks are awarded on the basis of: a clear statement of the basic physics and fundamental equation, with variables defined; style and clarity; the correct fraction of the manipulations carried out; a clear statement of the numerical result and units. Uncommented upon absurd results may be penalised.
- **mini-essay:** write a broad description on some topic. In this case, the marking scheme will generally consist of a series of key points and marks will be awarded on the basis of the number of these points included and required discussion.

Criteria for practical laboratory work and projects is given in the associated laboratory manuals and handouts.

1.15 Moderation and Exam Board Process

The Department moderates all examination and all coursework accounting for 40% or more of the total course module assessment:

- second year/third year laboratory reports are assessed by **marking and moderation**, marked by the Lab Organiser and then moderated by an independent staff member not associated with the module.
- third year group/industrial projects and fourth year projects are assessed by **unseen double marking**, where student work is independently assessed by a second marker without the knowledge of marks assigned by the first marker.
- all exam papers are **sampled**, where a second marker reviews a representative sample of work by the first marker for the purpose of: checking the consistent application of marking criteria and moderating marks awarded. (A sample is taken to mean square root n where n is the number of scripts for the course and at least five for small courses)

1.16 External Examiners

External examiners are appointed to provide the University with impartial and independent advice incorporating informative comment on the institutions standards and on student achievement in relation to those standards. External examiners help to ensure that the standard of awards is maintained at the appropriate level; and that the standards of student performance are properly judged against these reference points and are comparable with standards in other UK Higher Education Institutions of which the external examiners have experience.

External examiners also provide comment and recommendations on good practice and innovation in relation to learning, teaching and assessment in order to highlight potential to enhance the quality of the learning opportunities provided to students. Consultation with external examiners on draft coursework assignments and examination questions allows the external examiner to inform our teaching practices as they occurs.

The Department's current external examiners are:
Prof Tony Doyle: School of Physics & Astronomy - University of Glasgow Dr Nicholas d'Ambrumenil: University of Warwick

1.17 Careers Information

The Department's careers tutor is Dr A Marshall, who can provide you with advice on the types of careers available to you. Further information is available on the Department's website and Facebook page Lancaster University Physics Careers. Also, the University Careers Service offers advice on information on careers-related matters.

The Lancaster Award

At Lancaster we not only value your academic accomplishments, but also recognise the importance of those activities you engage with outside your programme of study. The student experience is enhanced by including extra-curricular activities and, with more graduates than ever before and increasing competition for jobs upon leaving University, these are vital to your future prospects. We want to encourage you to make the very most of your University experience and to leave Lancaster as a well-rounded graduate. We have a wealth of opportunities to get involved in with initiatives such as work placements, volunteering, extracurricular courses, societies and sports. The Lancaster Award aims to encourage you to complete such activities, help you to pull them together in one place and then be recognised for your accomplishments. We want you to stand out from the crowd - the Lancaster Award will help you to do this. For more information see http://www.lancs.ac.uk/careers/award/.

1.18 E-Learning - Moodle VLE

Moodle

Moodle VLE provides information and resources to support your learning. Lecturers utilise Moodle VLE in a wide variety of ways to deliver learning materials (handouts, presentations, bibliographies etc), engage you in active learning (exercises and online tests, discussion spaces and learning logs) and update you with information about your programme. Key information about the modules you are studying, additional information about teaching and exam timetables.

1.19 Attendance requirement and progress monitoring – Good Academic Standing

The progress of all students is regularly monitored by their Academic Advisor (see section 2.5). After Year 1, you will normally keep the same Academic Advisor until you graduate.

In line with University requirements, the Department is obliged to draw all students' attention to the concept of **Good Academic Standing**.

The Department must report to the University on a regular basis the Academic Standing of each student. Certain attendance and coursework requirements will have to be satisfied in order that a student remains in Good Academic Standing. The exact requirements are set individually by each Department.

In the Physics Department the requirement for all modules in all years is:

1. attendance at no less than 70% of all teaching sessions (lectures, seminars, laboratory/project sessions) are compulsory whilst workshops are optional.

2. submission of no less than 75% of the coursework assignments for a module.

This means that, in a typical lecture based module, students must attend at least 14 of the 20 teaching sessions (lectures and seminars) and attempt at least 3 of the 4 coursework assignments. Exceptions will only be allowed for absence due to illness. In the case of illness, appropriate certification, either a medical note from a Doctor or a self-certification form, should be given to your Co-ordinator.

The relevant Academic Advisor for each year will make the final decision about the status of an individual student.

The normal Departmental and University procedures will be brought into effect for students who are not in Good Academic Standing at the end of each 5 week teaching period for each module.

Students with questions about these rules and procedures should either consult their Academic Advisor (see section 2.5) or the Department's Director of Teaching, Prof J Wild.

1.20 Malpractice in examinations and coursework (plagiarism)

The rules of the University and the examination regulations define in detail the definitions and penalties for dealing with malpractice. You can find these on the university website. It is important that you abide by these rules and don't attempt to gain advantage by any unfair means. When submitting coursework, it must be your own work and any assistance must be correctly acknowledged.

In recent years the Internet has become a source for plagiarism malpractice, however, mechanisms for detecting such practice are also becoming easier and readily available. The Department routinely uses these methods to identify plagiarism. Be warned, it is very effective! See Appendix E for the Department's Plagiarism policy.

The penalties for plagiarism offences are summarised in the following link: http://www.lancs.ac.uk/sbs/registry/facts/plagiarism.htm.

1.21 Enrolment arrangements and absence/leaving options

In October when you arrive, and each subsequent year (normally in April/May) you will be asked to enrol for the individual courses or modules which make up your programme of study. You do need to consider your enrolment choices carefully as the information is used to timetable teaching.

Changes at Part I enrolment will only be accepted in the first three weeks of the course module and at Part II during Michaelmas Term only.

1.21.1 Changing your Major

It is possible, to change your major to one outside physics during the first two weeks of Michealmas term of your first year, but you need to discuss this with your new department. If you think you are enrolled on the wrong physics scheme, i.e. physics is not for you, then please go and speak to your Academic Advisor (see section 2.5) as soon as you can. You may change your intended major to any other physics degree scheme, or change from a three year (BSc) to a four-year course (MPhys/MSci) (or *vice-versa*) at Part II enrolment (which will take place in May). You can collect a change of programme and change of enrolment form from your Teaching Co-ordinator or download from: http://www.lancs.ac.uk/depts/studreg/undergrads/forms.htm. Please note: If you are on a MPhys/MSci course, if you do not meet the progression rules at the end of each year you will be transferred to the BSc version and you will not be permitted to transfer back to your original course.

1.21.2 Intercalations

Sometimes because of medical, financial or personal difficulties students feel they have no alternative but to apply to suspend their studies for a year. Whilst this option can be of benefit to some students, it is not without its drawbacks: one of the major ones being the fact that students are not permitted by the Department of Social Security (DSS) and Housing Benefits Offices to claim benefits if they would normally be excluded under the full-time education rules. The DSS and Housing Benefit Offices regard intercalating students as continuing students on the grounds that they intend to resume their studies.

Don't allow yourself to drift into a situation that ends with intercalation being the only option, because without some assured financial support - a guaranteed job or financial help from your family - you could be left with no source of income.

Do ensure that you seek help early if you are experiencing any problems that may adversely affect your academic work. Speak to someone in the department or any of the various welfare agencies or call into the Student Registry.

If personal circumstances mean that you are left with no alternative but to seek a period of intercalation, please contact the Student Registry first to discuss your application. It is also important to discuss this with your Academic Advisor (see section 2.5). You may also find the Teaching Co-ordinators, Pam Forster and Louise Crook in room A4/A6 in the Physics Building exceedingly helpful.

1.21.3 Withdrawals

If you feel uncertain about carrying on at Lancaster, it is important that you talk it through with your Academic Advisor (see section 2.5) or one of the other support services such as your college personal tutor or someone in the Student Registry. It may be, for example, that you need time to adjust to a new and unfamiliar lifestyle.

Should you decide to leave, it is essential that you do not just walk out. You should contact the Student Registry who will discuss your plans with you and formally approve your withdrawal. The Student Registry will notify your Local Education Authority to have payment of your loan and tuition fees stopped. If you have any books on loan from the Library or are in possession of any university equipment or property, please make sure you return these - it will save you and us a lot of unnecessary letters and telephones calls.

In order to safeguard your entitlement to funding for any future course you should seek advice as soon as possible. Full details on this, and information regarding a transfer to another course/college, may be obtained from the Student Registry.

1.21.4 Repeated years or repeated courses

A widely held, but incorrect, belief is that you can repeat a year of study if you haven't done very well, repeat an individual course, or replace a course in which you have done badly with another one. This is not usually the case. The Universitys Manual of Academic Regulations and Procedures (MARP) contain the following statements:

With the exception of Part I students, it is University policy that no student shall be given an unfair advantage over fellow students through being allowed to automatically repeat individual modules, periods of study or a whole programme of study. Exceptional permission to repeat work may be granted by the designated Pro-Vice-Chancellor, an Academic Appeal or Review Panel as defined in the chapter on Academic Appeals, the Intercalations Committee or by the Standing Academic Committee in cases where a students academic performance has been adversely affected by personal, health or financial problems and where such cases have been properly documented.

With the exception of Part I students, it is University policy that no student shall normally be allowed to automatically replace modules in which he or she has failed or performed poorly by taking a different module in order to achieve better marks. Exceptional permission to do so may be granted by the designated Pro-Vice-Chancellor, by an Academic Appeal or Review Panel, as defined in the chapter on Academic Appeals, the Intercalations Committee or by the Standing Academic Committee in cases where a students academic performance has been adversely affected by personal, health or financial problems and where such cases have been properly documented.

Part I students may undertake a repeat of their first year under the procedures for progression and reassessment as set out in the Undergraduate Assessment Regulations, which include provision for registering on a new degree programme or new modules where the eligibility criteria have been met.

1.22 Complaints procedure

The University Student Complaints Procedure can be found at https://gap.lancs.ac.uk/complaints/Pages/default.aspx

This procedure applies to complaints made by current Lancaster University students, or leavers within 3 months of the date of their graduation or withdrawal (the Complaints Co-ordinator may accept complaints beyond this period if exceptional circumstances apply), in respect of:

- the delivery and/or management of an academic module or programme, or supervised research;
- any services provided by academic, administrative or support services (other than LUSU, who will operate to their own Complaints Procedure)

This procedure does not apply to complaints relating to:

- decisions of Boards of Examiners (these are governed by the Academic Review and Appeal Procedures)
- suspected professional malpractice (if it is established that misconduct of staff or students has occurred that is governed by other disciplinary procedures or external legal systems, then these procedures will be invoked and the complaint will not be dealt with under the student complaints procedure)
- any suspected potential breach of criminal law

2 Physics at Lancaster

Edition 1.7 2016/2017

In order to maintain the high standard of Lancaster Physics teaching and the quality of the both the MPhys and BSc degrees in Physics awarded, the Department requires that its Physics undergraduates take PHYS100, PHYS130, and PHYS110 (or, exceptionally, an equivalent Mathematics course) in Part I. This permits 3 (or 4) full years of Physics teaching as at our competitor universities.

2.1 Pastoral Care and Development

Lancaster has adopted a student-centred approach in which access to high quality support across a range of areas is provided by different agencies in a way which best meets each student's individual circumstances and needs. This is summarised in the Student Support Policy which can be found at http://www.lancaster.ac.uk/about-us/our-principles/student-support.

2.1.1 University Statement

Lancaster University issues the following advice to all its students:

"Please do not forget that it is your degree and your responsibility to seek help if you are experiencing difficulties. The University and the Physics Department will do whatever is possible to assist you, within the Rules and Guidelines of the University, if you are having problems, whether financial, personal or academic, provided that we are aware of those problems. You are urged to contact the department in the first instance, but if you feel for some reason that you cannot speak to the department, you are encouraged to contact one of the following support services available; your college office, your personal tutor, the College Senior Tutor/Administrator, the Counselling Service, the Student Services Office or the Students' Union Advice Centre."

2.1.2 Departmental Pastoral Care

The Department has Academic Advisors (Year Tutors) and various course or scheme Directors of Study whose function it is to assist you in all ways with your course and to provide support and guidance in the event of any problems arising. You should contact your Academic Advisor whenever you need to discuss any matter. Your Academic Advisor will in any case meet you by appointment once per term. Section 2.5 lists the names and contact information for both Academic Advisors and Directors of Study. The Part I Co-ordinator (Pam Forster) and Part II Co-ordinator (Louise Crook) in room A4/A6 in the Physics Building are available to give advice and to direct you to the most appropriate member of staff.

2.1.3 Equal Opportunities and Harassment

This department follows University Policy and strives to make itself an inclusive department. The person to liaise with in the department with any issue concerning equal opportunities or unfair treatment (including harassment) is Dr N Drummond. You may also find it helpful to look at the following web pages for local and national background.

Lancaster equal opportunities web page (includes links to national equalities bodies and organisations):
http://www.lancaster.ac.uk/hr/equality-diversity/

Lancaster University harassment and bullying policy web page (includes links to external organisations):
http://www.lancaster.ac.uk/hr/bullying.html

You can also easily reach the site above via the alphabetical list on the University home page.

2.1.4 Medical Conditions, Disabilities and Specific Learning Difficulties

You are admitted to the University on your academic record. The University welcomes all students and has an array of support services to ensure no student feels disadvantaged.

This department follows University Policy and strives to make itself an inclusive department. It is possible that you have already had support from the Disabilities Service as part of your admission process. Debbie Hill in the Disabilities Service will continue to provide guidance and support by working with the Department to ensure your learning support needs are met, especially with regards to exams and assessments. There is also financial help available.

You can contact the Disabilities Service at any time in your time here if you feel you might need advice (for example you might want to be assessed for dyslexia). The person to liaise with in the Department with any issue concerning disability is Dr N Drummond.

If using the library is an issue because of dyslexia, a disability or medical condition, get in touch with Fiona Rhodes, f.rhodes@lancaster.ac.uk, for advice and help.

Confidentiality: if it is useful for you, do talk in confidence to any of the staff named here, but please remember that you may not be able to access all the support available to you unless we can inform other staff involved in support arrangements.

You may also find it helpful to look at some of the following web pages for local background.

Lancaster Disabilities Service: http://www.lancaster.ac.uk/sbs/disabilities/

You can also easily reach the site above via the alphabetical list on the University home page.

2.2 Part I

The Department offers a series of courses, some modular, to first year students. In general they are available to any student in the University who is suitably qualified.

Detailed descriptions of the first year courses and their constituent modules can be found in section 4.2 for Part I Physics, section 4.3 for Physics Skills, section 4.4 for Physical Systems, and section 5 for Universe as an Art.

Section 4.2 describes the structure and organisation of the Part I Physics Course, consisting of modules in the PHYS100 series, which is a compulsory first year course for Physics majors. The whole course, or a selection of its modules, is available to other suitably qualified students.

Section 4.3 describes the Part I Physics Skills course, consisting of modules in the PHYS130 series. This course is also compulsory for all Physics majors in year 1. The course is available to suitably qualified students majoring in other disciplines.

Section 4.4 describes the Part I Physical Systems course, consisting of modules in the PHYS110 series. This course is normally the compulsory mathematics course for all Physics majors. The course, or a selection of its modules, is available to other suitably qualified students.

All Physics majors are required to take the three Part I courses PHYS100, PHYS110 and PHYS130. Exceptionally a suitable Mathematics course, or series of Mathematics modules may be substituted for PHYS110.

Section 5 describes the Part I Universe as an Art course, consisting of modules in the PHYS120 series. This course is specifically aimed at students majoring on a non-physics degree scheme, in particular an arts based scheme. The course is not available to physics majors.

Section 13 gives details of all undergraduate modules taught by physics, with a physics prefix (PHYS).

2.3 Part II

The Department offers four year MPhys degrees in Physics and in Physics *with* a specialisation; three year BSc degrees in Physics and in Physics *with* a specialisation and the MSci (four year) and BSc (three year) Theoretical Physics and Mathematics. These schemes are described in the following sections together with a description of modules available to students wishing to take Physics as part of a Natural Sciences degree or as a minor module as part of some other degree scheme.

Section 6 gives an introduction to the degree schemes offered by the department and is followed by detailed information on the MPhys, section 7, and BSc, section 10, degree schemes.

Section 7 describes the MPhys degree scheme and its Study Abroad variant where year 3 of the degree scheme is spent at a university abroad. The timetable of modules and the assessment units are detailed in section 8 together with the variant schemes: Theoretical Physics; Physics, Astrophysics and Cosmology; Physics *with* Particle Physics and Cosmology; and Physics, Astrophysics and Space

Science.

Section 10 and section 11 give the same information as noted above for the BSc major schemes in physics. For this scheme the Study Abroad variant has year 2 spent at an overseas university.

MSci Joint Honours, section 9 describes the Theoretical Physics and Mathematics four year joint honours scheme and Section 12 describes the three year joint honours degree schemes.

Section 13 gives details of all modules with a physics prefix (PHYS).

2.4 Aims and Objectives

The overall aims and objectives of the Department of Physics are:

Aims

- To fulfil the commitment declared by Lancaster University in its Mission Statement "...of achieving excellence in research and scholarship and of reflecting this in high quality teaching and learning programmes..."
- To offer courses leading to professional qualifications in Physics: MPhys (4-year) and BSc Physics (3-year), with experimental physics, theory, particle physics/cosmology, astrophysics/cosmology and astrophysics/space science as optional themes; and joint major MSci (4-year) and BSc degrees in Theoretical Physics & Mathematics.
- To ensure that students acquire a knowledge of physical phenomena, an understanding of physical principles, and a competence in appropriate discipline-based and transferable skills.
- To provide a supportive learning environment within which students have the opportunity to reach their full academic potential.
- To enable suitably qualified students to experience alternative teaching styles in a different cultural context by spending a year abroad.

Objectives

On successful completion of the appropriate degree programme, students should have:

BSc (Physics):

- obtained a knowledge and understanding of fundamental areas of physics, in line with accreditation requirements of the Institute of Physics;

- acquired discipline-based skills, experimental, mathematical, and computational, as appropriate to the theme chosen;
- developed transferable skills of reasoning and analysis, independent learning and written and oral communication.

MPhys:

- in addition to the above, obtained a more detailed knowledge of selected areas;
- become aware of recent advances in topics relating to Departmental research activity;
- acquired experience in planning, carrying out and reporting a self-organised investigation, in preparation for post-graduate training or for future physics-based employment.

Joint Major (Theoretical Physics & Mathematics):

- appreciated the relevance and application of physics to their chosen interdisciplinary field;
- acquired the necessary physics-based knowledge, understanding and skills.

Study Abroad exchange:

- in addition, been further challenged by a year spent in the demanding environment of a selected institution abroad.

2.5 Course Management

The Physics Teaching & Learning Committee (see section 3.1) is responsible for the day-to-day management of all Physics courses. It reports to the Science and Technology Faculty Undergraduate Teaching Committee, which includes student representation.

The Director of Teaching, Prof J Wild, coordinates all teaching activity within the Department and represents it on a number of committees, including the Faculty Undergraduate Teaching Committee.

The Physics Staff-Student Consultative Committee (see section 3.1), chaired by the Director of Teaching, Prof J Wild, meets once per term and is the forum at which student views on all matters to do with undergraduate and postgraduate teaching are canvassed. Student representatives from each of the major degree schemes provide feed-back to staff members and raise matters for discussion or complaint.

The Part I Co-ordinator (Pam Forster) is responsible for keeping Part I student records. Her office is A4 in the Physics Building. The Part II Physics Co-ordinator (Louise Crook) is responsible for keeping Part II student records. Her office is A6 in the Physics Building.

Academic Advisors

Every student in the department has a Academic Advisor. The member of staff concerned has both an academic and pastoral role and he or she provides the link between the students on the course and the Physics Teaching & Learning Committee (see section 3.1). For most students, the Academic Advisor is the first port-of-call when guidance or advice is needed, when there are problems which students cannot resolve themselves or when they need to discuss their academic progress. The Department also has Degree Scheme/Course Managers (see section 2.5) who may be consulted on academic matters. In addition the Physics Co-ordinators are able to advise students on who they should contact on any particular subject and are able to provide general information about physics courses and have experience of the general operation of the Department and University.

Academic Advisors

Part II	2nd Year Physics	Prof G V Borissov & Dr H Fox
	3rd Year Physics	Dr A Marshall & Dr K Dimopoulos
	4th Year Physics	Dr Q D Zhuang & Dr J Prance
	Natural Sciences	Prof A Stefanovska
	Study Abroad	Dr D A Burton
	Visiting (Erasmus/JYA) students taking Part II modules (all years)	Dr D A Burton

In addition to the academic and pastoral support provided by the Department, Lancaster University has a strong student support network. Student Services co-ordinates all of the welfare facilities on campus, as well as offering advice and support from the Support Services team.

The Student Support Office, which can be found in "The Base" on the ground floor of University House, provides both specialist and general guidance and support to students and assists individual students if they encounter serious difficulties that cannot easily be resolved by their college or academic department.

Degree Schemes/Directors of Study

In Part II the Director of Study is responsible for the overall structure of a particular Part II degree scheme. The responsibility covers both the BSc and MPhys schemes. The core physics courses, a part of all schemes, are the responsibility of the Director of Teaching, Prof J Wild.

Degree Scheme	Director of Study
MPhys/BSc Physics	Prof J Wild
MPhys/BSc Physics (Study Abroad)	Dr D A Burton
MPhys/BSc Physics, Astrophysics & Cosmology	Dr J McDonald
MPhys/BSc Physics, Particle Physics & Cosmology	Dr H Fox
MPhys/BSc Physics, Astrophysics & Space Science	Prof J Wild
MPhys/BSc Theoretical Physics	Dr N Drummond
MSci/BSc Theoretical Physics & Mathematics	Dr N Drummond

3 Organisation of Physics Teaching

Edition 1.7 2016/2017

The following sections describe the outline terms of reference of the committees within the Department and their relationship to the relevant University Committees. The responsibilities of the members of the Department as far as their teaching duties are concerned are also outlined.

3.1 Departmental Committees

Physics Committee

The Physics Committee is the main departmental committee. Its membership is the whole staff of the Department and it is chaired by the Head of Department, Prof R W L Jones. The Physics Committee is the final ratifying body for all matters to do with undergraduate teaching, but all detailed matters are devolved to the Teaching & Learning Committee (see section 3.1).

Teaching & Learning Committee

The Teaching & Learning Committee has overall responsibility for all teaching matters within the department. Its membership consists of all the Academic Advisors, Directors of Study and the Admissions Tutor. All members of teaching staff are able to attend.
The Director of Teaching chairs the committee whose major responsibilities are: Establishing all undergraduate teaching policy. Monitoring all courses and degree schemes and instigating changes where necessary. Assigning individual staff to undergraduate teaching duties. Ratifying proposed actions on students with failed units of assessment.

Mitigating Circumstances Committee

The primary responsibility of the Mitigating Circumstances Committee is to consider actions or events outside the control of the student which may have caused the student to fail to attend an examination, submit work or perform at a lesser academic standard than might have been expected. If such circumstances are identified, the committee will make recommendations to the examining board on what action to take.

The 2016/2017 membership of the Part II Mitigating Circumstances Committee is as follows:
Chair Prof P V E McClintock
Director of Teaching Prof J Wild
Academic Advisors: Prof G V Borissov, Dr H Fox, Dr K Dimopoulos, Dr A Marshall, Dr J Prance, Prof A Stefanovska, Dr D A Burton
Part II Teaching Co-ordinator Louise Crook.

The 2016/2017 membership of the Part I Mitigating Circumstances Committee is as follows:
Chair Prof J Wild
Academic Advisors: Prof J Wild, Dr S Badman, Prof A Stefanovska, Dr D A Burton
Part I Teaching Co-ordinator Pam Forster.

Staff Student Consultative Committee Business: The discussion of all non-restricted items relating to all academic courses and facilities for graduate and undergraduate students within the Department of Physics.

Meetings: Three per year with occasional additional meetings as required.

All members of the Physics Teaching & Learning Committee (see section 3.1) are expected to attend. Other members of the Department are entitled to attend and will receive a notice of meeting and upon request will receive the Agenda. The Director of Teaching Prof J Wild will chair the meetings.

Student representation is as follows:

Postgraduate: One representative.

Undergraduate:

(i) One representative from Part I Physics (PHYS100).

(ii) One representative from Physical Systems (PHYS110).

(iii) One representative from Part I Physics Skills (PHYS130).

(iv) One representative from Part I The Universe as an Art (PHYS120).

(v) One representatives from Part II Second Year to represent BSc and MPhys Physics.

(vi) One representatives from Part II Third Year to represent BSc and MPhys Physics.

(vii) One representative from Part II Fourth Year.

(viii) One representative from Part II Natural Science.

(ix) One representative of Study Abroad or overseas students.

(x) One representative from Part I or Part II Theoretical Physics with Maths.

Elections: Nominations for student representatives are invited in October and elections held if necessary. Representatives serve for one calendar year and are eligible for re-election.

Examination Committees

The 2016/2017 membership of the Part II examinations committees is as follows

Year 2 Prof I A Bertram (Chair), Dr N Drummond, Dr Q D Zhuang, Dr J Prance
Years 3&4 Dr J McDonald (Chair), Dr O Kolosov, Dr A Grocott, Prof G V Borissov, Prof Y Pashkin

The duties of the examination committees are as follows

1. Liaise with the Department Part II Co-ordinator on the examination timetable
2. Request sample questions and marking schemes from module lecturers and adapt as necessary
3. Check questions are within the scope of the module syllabus and are at the correct level
4. Assemble examination papers, proof read them and check validity of specimen answers and the relative mark allocation
5. Submit papers to external examiners for scrutiny
6. Implement suggestions from the external examiners in consultation with the course lecturer
7. The Department Part I Co-ordinator will organise the first marking of scripts; the committee is responsible for a double marking of a sample.
8. Assemble the marks for each module and assessment unit, and report any special circumstances in the assessment process.

3.2 Academic Advisors, Course Directors/Managers, Directors of Study, Module Lecturers/Demonstrators

Director of Teaching

Prof J Wild

The Director of Teaching has overall responsibility for all teaching matters in the Department. These include:

1. Allocation of staff to undergraduate teaching duties.
2. Appointment of postgraduate demonstrators.
3. Chairing the Teaching & Learning Committee (see section 3.1).
4. Chairing the Staff-Student Consultative Committee (see section 3.1).
5. Responsibility for taking all Physics teaching matters to the Physics Committee and to the Faculty of Science & Technology Undergraduate Studies Committee.
6. Convening the Part II examining committee, for examinations in years 3 and 4 and any resit examinations.
7. Chairing the Final Meeting of the Physics Board of Examiners in week 30 of the Summer Term.

The Director of Teaching is responsible for the day to day implementation of the Teaching & Learning Committee (see section 3.1) decisions as ratified by the Physics Committee. Some of these tasks, excluding those which deal with staffing matters, may be delegated to the Part I Course Director To be announced and and Part II Degree Scheme Managers.

Academic Advisor - Physics Year 1

Prof J Wild & Dr S Badman

1. Responsible for all students studying any Physics modules from the courses PHYS100, PHYS110 and PHYS130 in Year 1.
2. Responsible for all Physics student registration changes and ensuring that these stay within approved degree schemes.
3. Monitors student attendance at all compulsory sessions (lectures, seminars, laboratories etc) and takes action where appropriate.
4. Meets all Physics students in year 1, as appropriate, to assess progress and discuss difficulties. Formal interviews are held at least once per Term, additional meetings are held as required/requested.
5. Reports course problems to the Teaching & Learning Committee (see section 3.1).

6. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).

Academic Advisor - Universe as an Art PHYS120

Dr C K Bowdery

1. Responsible for all students studying any Universe as an Art modules in Year 1.
2. Responsible for all student registration changes and ensuring that these stay within approved degree schemes.
3. Available to meet students, as appropriate, unless seen by the Seminar leaders, to assess progress and discuss difficulties.
4. Reports course problems to the Teaching & Learning Committee (see section 3.1).
5. Overall organisation of the weekly seminars, and for the collation of the course work marks.
6. Responsible for the setting and organisation of the end of year examinations, any special JYA assessment and any resit examinations.
7. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).

Course Director - Part I

Prof J Wild

1. Overall Coordination of Part I courses.
2. Curricular design and development of PHYS100, PHYS110 and PHYS130.
3. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).

Course Manager - PHYS100

Dr H Fox

1. Chair of all Committees for PHYS100.

2. Organises all assessment procedures, including examinations, for the course.
3. Overall responsibility for the training of postgraduate demonstrators or markers employed on the course.
4. Reports course problems to the Teaching & Learning Committee (see section 3.1).
5. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).

Course Manager - PHYS130

Dr J Nowak

1. Chair of all Committees for PHYS130.
2. Organises all assessment procedures, including examinations, for the course.
3. Overall responsibility for the training of postgraduate demonstrators or markers employed on the course.
4. Reports course problems to the Teaching & Learning Committee (see section 3.1).
5. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).

Course Manager - PHYS110

Dr J McDonald

1. Chair of all Committees for PHYS110.
2. Organises all assessment procedures, including examinations, for the course.
3. Overall responsibility for the training of postgraduate demonstrators or markers employed on the course.
4. Reports any course problems to the Teaching & Learning Committee (see section 3.1).
5. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).

Course Director - Part II

Prof J Wild

1. Overall Coordination of Part II courses.
2. Chair of Part II Committees for MPhys, MSci and BSc degree schemes: Physics; Physics, Astrophysics & Cosmology; Physics, Particle Physics & Cosmology; Physics, Astrophysics & Space Science; Theoretical Physics; Theoretical Physics with Mathematics.
3. Overall responsibility for the training of postgraduate demonstrators or markers employed on Part II courses.
4. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).

Academic Advisor - Year 2

Prof G V Borissov & Dr H Fox

1. Responsible for all students studying any Physics modules in Year 2.
2. Responsible for all student registration changes and ensuring that these stay within approved degree schemes.
3. Monitors student attendance at all compulsory sessions (lectures, seminars, laboratories etc.) and takes action where appropriate.
4. Meets all students in year 2 at least once in Michaelmas and Lent terms to assess progress and discuss difficulties; additional meetings are held as required/requested.
5. Reports course problems to Part II Course Director and the Physics Committee.
6. Member of the Staff-Student Consultative Committee (see section 3.1), the Teaching & Learning Committee (see section 3.1), and the Mitigating Circumstances Committee (see section 3.1).
7. Continues as Academic Advisor for this cohort as they progress to years 3 and 4.

Academic Advisor - Year 3

Dr K Dimopoulos & Dr A Marshall

1. Responsible for all students studying any Physics modules in Year 3.
2. Responsible for all student registration changes and ensuring that these stay within approved degree schemes.
3. Monitors student attendance at all compulsory sessions (lectures, seminars, laboratories etc.) and takes action where appropriate.
4. Meets all students in year 3 at least once in Michaelmas and Lent terms to assess progress and discuss difficulties; additional meetings are held as required/requested.
5. Reports course problems to Part II Course Director and the Physics Committee.
6. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).
7. Continues as Academic Advisor for this cohort as they progress to year 4.

Academic Advisor - Year 4

Dr J Prance & Dr Q D Zhuang

1. Responsible for all students studying any Physics modules in Year 4.
2. Responsible for all student registration changes and ensuring that these stay within approved degree schemes.
3. Monitors student attendance at all compulsory sessions (lectures, seminars, laboratories etc.) and takes action where appropriate.
4. Meets all students in year 4 at least once in Michaelmas and Lent terms to assess progress and discuss difficulties; additional meetings are held as required/requested.
5. Reports course problems to Part II Course Director and the Physics Committee.
6. Member of the Staff-Student Consultative Committee (see section 3.1) and the Teaching & Learning Committee (see section 3.1).

Director of Study - Physics

Prof J Wild

1. Liaises with the Part II Academic Advisor over the registration of students on the Physics degree schemes, MPhys and BSc.
2. Monitors the laboratory based modules offered as part of the degree scheme.
3. Brings any proposals for modification of the theme dependent parts of the degree scheme to the Teaching & Learning Committee (see section 3.1).
4. Provides academic advice on the specialist theme and on the choice of dissertation topic or project, and if necessary guidance on the choice of an external minor.
5. Member of the Teaching & Learning Committee (see section 3.1).

Director of Study - Theoretical Physics

Dr N Drummond

1. Liaises with the Part II Academic Advisor over the registration of students on the Physics degree schemes, MPhys and BSc.
2. Monitors the special theoretical modules offered as part of the degree scheme.
3. Brings any proposals for modification of the theme dependent parts of the degree scheme to the Teaching & Learning Committee (see section 3.1).
4. Provides academic advice on the specialist theme and on the choice of dissertation topic or project, and if necessary guidance on the choice of an external minor.
5. Member of the Teaching & Learning Committee (see section 3.1).

Director of Study - Physics, Astrophysics & Cosmology

Dr J McDonald

1. Liaises with the Part II Academic Advisor over the registration of students on the Physics degree schemes, MPhys and BSc.
2. Monitors the specialist modules offered as part of the degree scheme.
3. Brings any proposals for modification of the theme dependent parts of the degree scheme to the Teaching & Learning Committee (see section 3.1).

4. Provides academic advice on the specialist theme and on the choice of dissertation topic or project, and if necessary guidance on the choice of an external minor.
5. Member of the Teaching & Learning Committee (see section 3.1).

Director of Study - Physics, Particle Physics & Cosmology

Dr H Fox

1. Liaises with the Part II Academic Advisor over the registration of students on the Physics degree schemes, MPhys and BSc.
2. Monitors the specialist modules offered as part of the degree scheme.
3. Brings any proposals for modification of the theme dependent parts of the degree scheme to the Teaching & Learning Committee (see section 3.1).
4. Provides academic advice on the specialist theme and on the choice of dissertation topic or project, and if necessary guidance on the choice of an external minor.
5. Member of the Teaching & Learning Committee (see section 3.1).

Director of Study - Physics, Astrophysics & Space Science

Prof J Wild

1. Liaises with the Part II Academic Advisor over the registration of students on the Physics degree schemes, MPhys and BSc.
2. Monitors the specialist modules offered as part of the degree scheme.
3. Brings any proposals for modification of the theme dependent parts of the degree scheme to the Teaching & Learning Committee (see section 3.1).
4. Provides academic advice on the specialist theme and on the choice of dissertation topic or project, and if necessary guidance on the choice of an external minor.
5. Member of the Teaching & Learning Committee (see section 3.1).

Director of Study - Physics (Study Abroad)

Dr D A Burton

1. Liaises with the Part II Academic Advisor over the registration of students on the MPhys and BSc (Study Abroad) degree schemes.
2. Monitors all physics modules taken in Lancaster both before and after the one year study abroad.
3. Brings any proposals for modification of the physics parts of the degree scheme to the Teaching & Learning Committee (see section 3.1).
4. Provides academic advice on the modules to be taken in Lancaster before going abroad to University.
5. Advise and guide students on the choice of study abroad University.
6. Liaise with the study abroad Universities where students are placed.
7. Member of the Teaching & Learning Committee (see section 3.1).

Lecturer

The lecturer is responsible for:

1. Delivering the required number of lectures and seminars in the module.
2. Fixing the times for office hours for the module and encouraging students to make appropriate use of office hours to aid progress.
3. Setting and arranging the assessment of the coursework sheets and monitoring any marking done by postgraduate demonstrators to ensure comparability of standards.
4. Providing copies of all set work to the Department Co-ordinators.
5. Returning the mark sheets to the Department Co-ordinators.
6. Ensuring attendance records are made and returned promptly to the Co-ordinators.
7. Informing the relevant Academic Advisor of any particular problems encountered with students where appropriate.
8. Supplying the required number of examination questions and solutions to the appropriate examining committee.

9. Responsible for the *first* marking of all examination scripts on the module.

Demonstrator

The Demonstrator is responsible for:

1. Delivering the required number of weekly classes in the module.
2. Supervising the postgraduate demonstrators if allocated, and ensuring their level of training.
3. Arranging the assessment of the weekly work, marking of laboratory log-book.
4. Returning the mark sheets to the Co-ordinators.
5. Ensuring attendance records are made and returned promptly to the Co-ordinators.
6. Informing the appropriate Academic Advisor of any student who misses two successive laboratory or computing classes.

3.3 Teaching Modules

Modules typically last between 5 and 10 weeks. Exceptions include 3^{rd} and 4^{th} year project modules.

Lectures The number of contact hours varies per module. Please refer to the "Timetable of Modules" within each degree scheme for detailed information.

Coursework Sheets

1. Sheets will be distributed at least one week in advance of the seminar.
2. Questions should be of a suitable mix to challenge all students, and will often include past examination paper questions.
3. Sheets should clearly state which questions will be marked and assessed.
4. Marking of student work to be done during the course and normally returned at the start of the seminar.

Office Hours

1. The lecturer/supervisor of each taught module will be available, in his/her office, for at least 1 hour each week to help students with the taught material.
2. The office hour(s) for a particular module will be arranged by the lecturer, by consulting the students, during the first lecture of the module.
3. The lecturer may also be available at other unspecified times to give help when required - appointments can be made.

Module Assessment

Normally modules will be assessed via both examination and coursework.

In this context the word *examination* normally refers to a written examination organised by the University where between one and three lecture modules are examined on a paper which students have between one and three hours to complete.

Coursework assessment takes different forms in different modules. For lecture based modules, it is based on the weekly worksheet which is marked by the lecturer or an assistant. For laboratory modules, the log-book and any reports are the basic material, but an oral presentation on the subject of one of the reports may be necessary. For projects, the project log-book and report are the basic material, but in addition there is also an oral presentation. All of these methods of assessment are classed as coursework in the module descriptions.

As in the case of examinations, any cases of cheating or fabrication of results (known collectively as plagiarism) will not be condoned. See Appendix E for the Department's Plagiarism policy and also the University's Plagiarism Framework for full details of unacceptable practices and the sanctions which the University will impose in proven cases.

In Part I, PHYS10q and PHYS11q, the assessment is 40% coursework and 60% examination. PHYS13q is 70% coursework and 30% examination. PHYS12q is 50% coursework and 50% examination.

In Part II the normal assessment is 80% examination and 20% course work with 5% contribution from each of the coursework sheets for lecture based modules. Laboratory modules and project or dissertation modules are normally 100% coursework assessment. A presentation by the student is an integral part of the assessment of laboratory modules and projects.

Examinations

In Part I there are two examination periods, the *mid-Term* examinations in early January and the end of Part I examinations

examinations are held in the later weeks of the Summer Term.

In Part II there are separate examination periods for year 2 and for years 3 & 4. The year 2 examinations are normally held in weeks 26 & 27 of the Summer Term. The third (and fourth) year modules are examined between weeks 23 & 26.

In the Part II examination papers Question 1 is compulsory. Questions 2, 3 (and 4 in a number of exams) provide a choice of material. The rubric for each module should be read very carefully.

The compulsory question (Question 1) covers a large range of the module syllabus, possibly via short questions, and is designed to determine whether the basic/fundamental module material has been understood. The remaining questions (Questions 2, 3, and sometimes 4) concentrate on more specific aspects of the modules, usually structured with a straightforward introductory part, a substantive middle section, and a more difficult final section to challenge the best students.

Tutorials

Tutorials are offered to students in Part I to help develop problem solving skills and to ease the transition to university based study. Additional tutorials are available to Part I students who require extra help with Mathematical skills.

Workshops

Workshops are usually one hour in duration and are held to help students prepare more effectively for the topic in hand.

Laboratory or Computing Class

Modules involve typically 3-6 contact hours per week in a practical laboratory or computer laboratory.

Assessment, normally via weekly topics and end of module reports, is 100% coursework. A presentation by the student may be necessary as part of the assessment of such modules.

As in the case of examinations, any cases of cheating or fabrication of results (known collectively as plagiarism) will not be condoned. See Appendix E for the Department's Plagiarism policy and also the University's Plagiarism Framework for full details of unacceptable practices and the sanctions which the University will impose in proven cases.

3.4 Physics Undergraduate Courses

The Department offers the following single major degree schemes:

MPhys/BSc Physics
MPhys/BSc Physics (Study Abroad)
MPhys/BSc Theoretical Physics
MPhys/BSc Physics, Astrophysics & Cosmology
MPhys/BSc Physics, Particle Physics & Cosmology
MPhys/BSc Physics, Astrophysics & Space Science - switching is no longer available - being laid down

In addition, we offer joint degree schemes, MSci/BSc Theoretical Physics with Mathematics and MSci Theoretical Physics with Mathematics (Study Abroad), with the Mathematics department. Detailed information on all these degree schemes are given in this handbook. The single major schemes follow a common structure which is discussed below (deviations for the Study Abroad schemes can be found elsewhere in this handbook). Each module is labelled by the mnemonic PHYSxyz where x usually gives the year in which the module is taught, y usually labels the stream/flavor and z usually labels the timing (only for Part I modules).

Part I - Year 1

All single major Physics degree schemes normally require the three part I courses, PHYS100, PHYS110 and PHYS130. These form three parallel streams in year 1. Each course consists of five, 5 week, modules which run consecutively. The overall Part I structure is shown in the table below. (Here, the "half term" specifies the timing, so: 1.1 indicates the first half of Michaelmas term in year 1; 1.2 indicates the second half of Michaelmas term in year 1; 1.3 indicates the first half of Lent term in year 1; 1.4 indicates the second half of Lent term in year 1; 1.5 indicates the first half of Summer term in year 1). The second half of Summer term is devoted to examinations.

		Streams	
Half Term	*Physics*	*Physical Systems*	*Physics Skills*
1.1	PHYS101	PHYS111	PHYS131
1.2	PHYS102	PHYS112	PHYS132
1.3	PHYS103	PHYS113	PHYS133
1.4	PHYS104	PHYS114	PHYS134
1.5	PHYS105	PHYS115	PHYS135

The modules which comprise the Part I physics courses are as follows:

PHYS101	The Physical Universe
PHYS102	Classical Mechanics
PHYS103	Electric & Magnetic Fields
PHYS104	Thermal Properties of Matter
PHYS105	Quantum Physics
PHYS111	Functions & Differentiation
PHYS112	Integration
PHYS113	Series & Differential Equations
PHYS114	Complex Methods
PHYS115	Vector Calculus
PHYS131	Vectors & Vector Algebra IT Skills
PHYS132	Basic Physics Skills Communication Skills
PHYS133	Oscillations & Waves Practical Laboratory I
PHYS134	Electrical Circuits & Instruments Practical Laboratory II
PHYS135	Optics & Optical Instruments Practical Laboratory III

Part II - Years 2, 3 & 4

In Part II, the major Physics degree schemes are structured into 4 parallel streams (so in general, at any particular time, 4 different modules are running in parallel). Some streams contain "core" material which is common to all schemes, others contain specific modules related to the particular degree scheme flavour, while others contain optional modules. The overall structure of the schemes is given in the tables below. A list of the associated module titles are given below the tables. In the tables, the different columns separate the core and scheme specific material: the first column lists the core modules, the remaining columns specify the modules specific to the different schemes labelled as:

Phys:	MPhys/BSc Physics
Theo:	MPhys/BSc Theoretical Physics
Astr:	MPhys/BSc Physics, Astrophysics & Cosmology
PCos:	MPhys/BSc Physics, Particle Physics & Cosmology
Spac:	MPhys/Bsc Physics, Astrophysics & Space Science - switching is no longer available - being laid down

Half Term	*Core*	*Phys*	*Theo*	*Astr*	*PCos*	*Spac*
2.1	PHYS211,222,222,281					
2.2	PHYS211,222,232,281					
2.3	PHYS213,223,233	253	273	263	263	263
2.4	PHYS213,223,233	254	265	265	265	268
2.5	PHYS232	255	274	264	256	264
3.1	PHYS311,321	352or355	375	361	361	368
3.2	PHYS311,322, Opts	353or355	375	363	353(or364)	363
3.3	PHYS313, Opts	353,351or355	379,366	364	366,(353or364)	369
3.4	PHYS313,320, Opts		379	364,362	364,367	369,362
4.1	PHYS451,452, Opts		481	411,461	411,461	
4.2	PHYS451, Opts		482	464	412	463
4.3	PHYS451, Opts					
4.4	PHYS451, Opts				462	

In year 4, MPhys students take the major MPhys Project, PHYS451/452, in a subject appropriate to their degree theme.

The optional modules, labeled Opts in the tables, are chosen by the student as appropriate to their degree scheme/interests and agreed with the Academic Advisor. The full list of modules is given below (detailed module descriptions are given in section 13).

PHYS211 Maths I
PHYS213 Maths II
PHYS221 Electromagnetism
PHYS222 Electromagnetism, Waves & Optics
PHYS223 Quantum Mechanics
PHYS232 Relativity, Nuclei & Particles
PHYS233 Thermal Properties of Matter

PHYS252 Introduction to Experimental Lab
PHYS253 Experimental Lab I
PHYS254 Experimental Lab II
PHYS255 Experimental Lab III
PHYS256 Experimental Particle Physics

PHYS263 Astronomy
PHYS264 Astrophysics I
PHYS265 Cosmology I
PHYS268 Space Physics

PHYS272 Exp. Phys., Skills & Mechanics
PHYS273 Theor.Phys.I - Mech.& Vars.
PHYS274 Theor.Phys.II - Class.Fields

PHYS281 Scientific Programming & Modelling Project

PHYS311 Particle Physics
PHYS313 Solid State Physics
PHYS320 Gen Phys Exam
PHYS321 Atomic Physics
PHYS322 Statistical Physics
PHYS323 Physics of Fluids

PHYS351 Semiconductor Physics Laboratory
PHYS352 Low Temperature Physics Laboratory
PHYS353 Particle Physics Group Project
PHYS354 Literature Review
PHYS355 Industrial Group Project

PHYS361 Cosmology II
PHYS362 Astrophysics II
PHYS363 Astrophysics Laboratory
PHYS364 Cosmology Group Project
PHYS366 Groups & Symmetries
PHYS367 Flavour Physics
PHYS368 Aurora-Atmospheric Physics
PHYS369 Space Science Group Project

PHYS375 Theoretical Physics Independent Study
PHYS378 TPM Independent Study
PHYS379 Theory & TPM Group Project

PHYS384 Physics of Living Systems
PHYS385 Adv. Nanoscale Microscopy
PHYS386 Physics of Global Warming
PHYS388 Energy
PHYS389 Computer Modelling
PHYS390 Space & Auroral Physics

PHYS411 Adv. Rel. & Gravity
PHYS412 Experimental Methods in Particle Physics

PHYS451 MPhys Project
PHYS452 MPhys Literature Review

PHYS461 Cosmology III
PHYS462 Gauge Theories
PHYS463 Solar-Planetary Physics
PHYS464 Astrophysics III - Galaxies

PHYS481 Advanced Magnetism
PHYS482 Quantum transport in low dimensional nanostructures
PHYS483 Quantum Information Processing
PHYS484 Adv. Electrodynamics & Grav.
PHYS485 Matter at Low Temp
PHYS486 Lasers and Applications
PHYS487 Semiconductor Device Physics

4 Year 1 - all schemes

Edition 1.7 2016/2017

The first year in Physics for both MPhys and BSc is an integrated year consisting of three Lancaster Part I courses. These are:
(i) the PHYS100 series consisting of the lecture modules PHYS101, PHYS102, PHYS103, PHYS104 and PHYS105
(ii) the PHYS110 series consisting of the lecture and workshop modules PHYS111, PHYS112, PHYS113, PHYS114 and PHYS115
(iii) the PHYS130 series consisting of the lecture and laboratory modules PHYS131, PHYS132, PHYS133, PHYS134 and PHYS135.

This integrated first year provides a self-contained survey of physics designed to meet the interests of both specialists and non-specialists. The modules are essential prerequisites for all Part II Physics (BSc and MPhys) degree schemes.

The normal minimum A-level (or equivalent) requirements for non-Physics major students who might wish to take any of the Part I Physics courses or modules, are B grades in Mathematics and in a Physical Science subject (e.g. Physics, Chemistry, Engineering Science, Physical Science).

The topics covered include fundamental Newtonian mechanics and applications to real systems, the thermal properties of matter, mechanical waves and sound, electricity and magnetism, and quantum physics.

4.1 Organisation & Communication

The Academic Advisors for Part I Physics are Prof J Wild (Room C25 P, Tel 10545) and Dr S Badman (Room C23 P, Tel 93417). They are available to discuss problems and deal with enquiries about any aspect of the three courses PHYS100, PHYS110 & PHYS130, and/or to talk to students about their progress. They will interview each Part I Physics student once per Term.

The Course Director for Year 1 Physics is Prof J Wild (Room C25 P, Tel 10545). He has overall curricular responsibility for the courses PHYS100, PHYS110 & PHYS130. He can most readily be readily contacted by e-mail.

The Department has a Staff-Student Consultative Committee on which Part I Physics students are represented. Students will be invited to elect their representative during the first half of the Michaelmas Term.

Communication

All notices relating to the courses will be displayed on the Part I notice boards in the Physics Building foyer. You should check regularly for details of lectures, examination timetables etc. They will also be posted onto Moodle on the Part I page.

The Part I Co-ordinator for Physics, Pam Forster, works in room A4 in the Physics Building. She will be glad to help students who need further information about the course when the Academic Advisor is not available.

The Department sometimes needs to get in touch with individual students. Students should make sure that they notify any changes of address (home or local) to Pam Forster as well as to the University's Undergraduate Records Office. Students are required to register for e-mail. This should be checked for messages daily.

4.2 Physics Part I - PHYS100

4.2.1 Academic Aims & Learning Outcomes

During the year we aim:

- to teach a wide range of physics at a basic level, appropriate to the first year of a physics degree.
- to stimulate the interest of students in physics by exposing them to some of the issues at the frontiers of knowledge.
- to allow all students, independently of their entry attainments, to reach a similar level of understanding in physics, with the necessary skills in mathematics to solve simple problems in physics.

On completion of the course, students should be able to:

- recognise the fundamental physics in a wide range of physical processes.
- explain a wide range of physical processes from underlying basic principles.
- explain the interrelationship between some physical parameters.
- calculate or estimate solutions to some simple physical problems.

4.2.2 Organisation & Communication

The Course Manager for Part I Physics, PHYS100, is Dr H Fox (Room B20 P, Tel 93616). He can most readily be readily contacted by e-mail.

There is a committee (Course Manager (Dr H Fox, chair), Prof I A Bertram, Dr O Kolosov, Dr H Fox, Dr S Kafanov and Dr J Nowak) which runs the course.

The Department has a Staff-Student Consultative Committee on which Part I Physics students are represented. Students will be invited to elect their representative during the first half of the Michaelmas Term.

Communication

All notices relating to the course will be displayed on the Part I notice boards in the Physics Building foyer. You should check regularly for details of lectures, examination timetables etc. Information concerning individual modules can also be found on Moodle VLE https://mle.lancs.ac.uk/ plus a Part I page for information.

The Part I Co-ordinator for Physics, Pam Forster, works in room A4 in the Physics Building. She will be glad to help students who need further information about the course when the Academic Advisor is not available.

The Department sometimes needs to get in touch with individual students. Students should make sure that they notify any changes of address (home or local) to Pam Forster as well as to the University's Undergraduate Records Office. Students are required to register for e-mail. This should be checked for messages daily.

Textbooks

There is a single essential textbook for the course. Each of the lecture modules (see next paragraph) is defined by reference to chapters and sections in H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015. Problems for the weekly coursework sheet will be set from this textbook throughout the year.

4.2.3 Lectures, Seminars, Workshops and Tutorials

Each five-week module is made up of 16 lectures and 4 seminar classes. Attendance at all these classes is **compulsory**. Each week there are normally three lectures and one seminar.

Where there is significant overlap with the "core" A-level topics, material will only be revised as necessary. New material or that which is only dealt with in some A-level option courses will be covered in detail. Private study of the textbook will be necessary throughout the course.

The lecturers may not necessarily treat the material in the same way as in the textbook, which should be used to complement the lectures and to help with revision. Where necessary, relevant mathematical techniques will be introduced and discussed by the lecturer.

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS101	The Physical Universe	M1-5	16L,4W,4S	Prof I A Bertram
PHYS102	Classical Mechanics	M6-10	16L,4W,4S	Dr O Kolosov
PHYS103	Electric & Magnetic Fields	L11-15	16L,4W,4S	Dr H Fox
PHYS104	Thermal Properties of Matter	L16-20	16L,4W,4S	Dr S Kafanov
PHYS105	Quantum Physics	S21-25	16L,4W,4S	Dr J Nowak

Students are required to complete a weekly assignment which normally will be one or more questions taken from the textbook, past examination papers or specifically set by the lecturer to illustrate a particular point. This work, which contributes to the continuous assessment, is normally discussed in a weekly seminar held at the end of the week.

A one hour optional workshop is held each week in which students may receive one-to-one help with the course material/assignments from a postgraduate teaching assistant, alternatively help may be sort from the lecturer, either during the allotted office hour or otherwise. Small group tutorials are also held once every two weeks (more frequently if required) to discuss the course material/coursework problems/practice past paper questions as required.

Deadlines

It is most important for students to hand in work for assessment regularly and on time. The weekly seminar work will be available in good time. A submission deadline will be clearly indicated for each piece of work. Late work may be marked but will be penalised. Marked work will be returned for the weekly seminar class.

4.2.4 Assessment - Physics Part I

Written examinations are held in January (a two hour examination covering modules PHYS101, and PHYS102) and in June (a three hour examination and covering modules PHYS103, PHYS104 and PHYS105). For each module the written examination will contribute 60% to the total mark and the set work the remaining 40%.

Work is marked on a percentage scale then, at the end of each module, the percentage mark is converted into a score on a University-wide scale using aggregation points (see Section 1.12). Students must achieve a minimum average in PHYS100 of 10.3 aggregation points **and** a minimum of 9.0 aggregation points in both examination and coursework elements to proceed to a major degree in Physics (but see section MPhys, section 4.5 for higher requirements for certain schemes). A minimum average in PHYS100 of 9.0 aggregation points allows a student to take a minor in Physics. The University normally requires that all three Part I subjects be passed before students are allowed to proceed to Part II. To major in Physics, a minimum average of 10.3 aggregation points is required in all three separate Part I courses. Students who fail to gain the required grades after the first exams will normally be required to take and pass resit papers during the Summer vacation before they are allowed to proceed to Part II. The form of the resit will be determined by the Part I Physics Board of Examiners.

4.2.5 Learning Outcomes

After completing any one of the five physics modules in the PHYS100 course you should be able to:

Understand the basic physics principles involved and be able to explain them clearly.

Recall the more important mathematical formulae which describe the physical laws and physical principles.

Apply these principles both to simple exercises and to more complex problems involving situations not previously met.

Seminars encourage oral and written communication, group discussions, problem analysis and problem solving, private study, self organisation, self confidence, responsibility.

Lectures require accurate note taking and organisation of materials; use of textbooks and reference books to reinforce and amplify the lectures; encourage private study and self motivation.

4.3 Physics Skills - PHYS130

This course (PHYS130 series) is designed to introduce students to basic experimental techniques in a physics context and will be accessible to both specialists and non-specialists. In addition further physics and mathematics will be taught in these modules, The course is an essential prerequisite for all Part II Physics (BSc and MPhys) major courses. The modules PHYS131, PHYS132, PHYS133, PHYS134 and PHYS135 make up the integrated course.

Experimental laboratory sessions will be supported by lectures on electronic and electrical measurements, basic keyboard skills, word-processing, spreadsheets, the Internet, statistical interpretation of experimental data, and problem solving techniques.

The format of the course is 10 lectures per module together with a compulsory weekly seminar class and a laboratory afternoon of 3 hours each week. The precise nature of the laboratory session will depend on the nature of the module being taught. For example, standard physics practical sessions would be held in the Physics undergraduate teaching laboratory whilst computing practical sessions will take place in a PC laboratory with directed study to enable completion of set work. The practical sessions for module PHYS131 are designed to teach and improve IT skills, while PHYS133, PHYS134 and PHYS135 are 'hands-on' experimental practicals. Module PHYS132 is designed to improve presentational skills.

For non-Physics majors wishing to register for the course or for modules from it, the normal minimum prerequisites is an A2-level (or equivalent) pass in a Physical Science subject (e.g. Physics, Chemistry, Engineering Science, Physical Science).

Physics is an experimental science - the test of a theory is ultimately whether it fits the observed facts. Therefore understanding the nature of experimentation forms an important part of Physics. In the laboratory classes students use apparatus and techniques which are loosely associated with the lecture material. On most afternoons the work consists of tackling an experiment with assistance and guidance available from staff demonstrators and from the laboratory script which describes the experiment. Students keep a record of their experimental work in a laboratory notebook which is marked each week by one of the demonstrators.

4.3.1 Academic Aims & Learning Outcomes

During the year we aim:

- to develop skills in experimentation and particularly in experimental physics.

- to stimulate the interest of students in physics as an experimental science.
- to develop skills in the statistical interpretation and presentation of data.
- to develop transferable skills, particularly in report writing.

On completion of the course, students should be able to:

- use a range of experimental apparatus and techniques to make physical measurements.
- assess the experimental uncertainties in physical measurements.
- explain concepts in simple circuits.
- prepare short reports and talks.

4.3.2 Organisation & Communication

The Course Manager for Physics Skills is Dr J Nowak (Room B28 P, Tel 92743). He is available to discuss problems and deal with enquiries about any aspect of the course, and/or to talk to students about their progress. He can be readily contacted by e-mail.

A committee consisting of the lecturers and demonstrators and the Course Manager (Dr J Nowak, chair) is responsible for all aspects of the course.

Communication

All notices relating to the course will be displayed on the Part I notice board in the Physics Building foyer. You should check regularly for details of lectures, examination timetables etc. Information concerning individual modules can also be found on Moodle

The Part I Co-ordinator for Physics, Pam Forster, works in room A4 in the Physics Building. She will be glad to help students who need further information about the course when the Academic Advisor is not available.

The Department sometimes needs to get in touch with individual students. Students should make sure that they notify any changes of address (home or local) to Pam Forster as well as to the University's Undergraduate Records Office. Students are required to register for e-mail. This should be checked for messages daily.

Textbook

There is an essential textbook for the course which can be used in conjunction with other Part I Physics courses. This is H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015. You will be set problems from this textbook during the year. You will also find the following text very useful particularly for PHYS132 but also generally throughout the course: "A Practical Guide to Data Analysis for Physical Science Students", L Lyons (Cambridge University Press).

4.3.3 Lectures, Seminars, Laboratories and Workshops

Each five-week module is made up of 11 lectures and 4 seminars and a weekly 3 hour afternoon laboratory session. The compulsory seminars will discuss course work and material presented in the lectures. A one hour optional workshop is held each week in which students may receive one-to-one help with the course material / assignments from a postgraduate teaching assistant, alternatively help may be sort from the lecturer, either during the allotted office hour or otherwise. There is not necessarily a direct link between the lectures and laboratory sessions although some of the lecture material will be of use in the laboratory. The content of some of the lecture modules is defined by reference to chapters and sections in 'Young & Freedman' and 'Lyons'. Private study of the textbooks will be necessary throughout the course.

The lecturers may not necessarily treat the material in the same way as in the textbooks, which should be used to complement the lectures and to help with revision. Where necessary, relevant mathematical techniques will be introduced and discussed by the lecturer.

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS131	Vectors & Vector Algebra IT Skills	M1-5	11L,4S,4W,15P	Lect: Dr J Prance Lab: Dr J Nowak Dr H Fox Prof A Stefanovska
PHYS132	Basic Physics Skills Communication Skills	M6-10	11L,4S,4W,15P	Lect: Dr A Koch Lab: Dr A Marshall Prof R W L Jones
PHYS133	Oscillations & Waves Practical Laboratory I	L11-15	11L,4S,4W,15P	Lect: Dr A Marshall Lab: Dr L Ray Prof Y Pashkin Dr A Marshall
PHYS134	Electrical Circuits & Instruments Practical Laboratory II	L16-20	11L,4S,4W,15P	Lect: Dr A Grocott Lab: Dr L Ray Prof Y Pashkin Dr A Marshall
PHYS135	Optics & Optical Instruments Practical Laboratory III	S21-25	11L,4S,4W,15P	Lect: Prof G V Borissov Lab: Dr L Ray Prof Y Pashkin Dr A Marshall

Coursework

Students are required to complete weekly coursework which normally will be one or more questions taken from the textbook or specifically set by the lecturer to illustrate a particular point. This work contributes to the continuous assessment and will be discussed in the seminars. The laboratory work is marked each week with the markers giving written feedback and guidance.

Points which require further discussion can be raised with the relevant lecturer in one of the weekly seminars or during an office hour. Lecturers will announce the times of office hours at the beginning of their module and the times announced on the Part I notice boards in the Physics Foyer.

Deadlines

It is most important for students to hand in work for assessment regularly and on time. A submission deadline will be clearly indicated for each piece of work. Late work will be penalised.

4.3.4 Assessment - Physics Skills

The course is examined with a written examination in June. This is a two and a half hour examination covering modules PHYS131, PHYS132, PHYS133, PHYS134 and PHYS135. For each of these modules the written examination will contribute 30% to the total mark, the coursework 20% and laboratory the remaining 50%.

Work is marked on a percentage scale then, at the end of each module, the percentage mark is converted into a score on a University-wide scale using aggregation points (see Section 1.12). Students must achieve a minimum average in PHYS130 of 10.3 aggregation points **and** a minimum of 9.0 aggregation points in both examination and coursework elements to proceed to a major degree in Physics (but see section MPhys, section 4.5 for higher requirements for certain schemes). To major in Physics, a minimum average of 10.3 aggregation points is required in all three separate Part I courses. For minor students, a minimum average in PHYS110 of 9.0 aggregation points is required to proceed to Part II in their major discipline. The University normally requires that all three Part I subjects be passed before students are allowed to proceed to Part II. Students who fail to gain the required grades after the first exams will normally be required to take and pass resit papers during the Summer vacation before they are allowed to proceed to Part II. The exact form of the resit will be determined by the Part I Physics Board of Examiners.

4.3.5 Learning Outcomes

On completion of the course students will have improved their oral and written communication skills, data handling and practical skills. They will have become experienced in data reduction and analysis, and have developed the ability to draw conclusions from analysed data. They will have shown initiative, originality, decision making ability and will have undertaken co-operative work.

4.4 Physical Systems - PHYS110

The Physical Systems course is designed to form part of an integrated first year scheme of study for students taking Physics in Part I. It is open to other non-Physics major students who are suitably qualified. The aim is to apply mathematical techniques to a wide variety of physical and engineering problems: this is achieved through the modelling of physical information in mathematical terms and subsequently analysing the model by mathematical methods to derive a solution which can be interpreted in physical terms.

The course consists of five modules normally taken as a package. It is not recommended for non-Physics major students to register for individual modules. Some topics overlap with core A-level mathematics but many topics will be completely new to many students.

There are two weekly lectures to emphasise important topics and difficult areas. The method of presentation is intended to be flexible so that students can progress at a rate consistent with their aptitude and knowledge. There is an optional weekly workshop where students can get help from the lecturer or graduate student demonstrators and a weekly seminar.

4.4.1 Academic Aims & Learning Outcomes

During the year we aim

- to develop mathematical knowledge and skills to enable students to cope with the mathematical requirements of their Part II degree schemes in year 2. On a particular route, all students from a broad range of backgrounds should be brought to a similar level of knowledge in mathematics.
- to provide instruction in applying mathematics to physics.
- to develop mathematical modelling techniques.
- to develop study skills by the use of self-teaching modules.

On completion of the course, students should:

- have a knowledge of a range of basic mathematical techniques appropriate to their degree scheme including algebra and functions, vectors and geometry, basic differentiation and integration.
- be able to recognise the appropriate technique to solve a physical problem.
- be able to apply these techniques to physical problems.
- be able to manipulate and calculate as appropriate to the problem.
- have experience of the techniques required to create and solve a mathematical model of a physical system.

4.4.2 Organisation & Communication

The Course Manager for Physical Systems is Dr J McDonald (Room A35 ST, Tel 92845). He is available to discuss problems and deal with enquiries about any aspect of the course. He can be readily contacted by e-mail.

The Physical Systems Committee consisting of the Course Manager, Dr J McDonald (chair), and the lecturers on the course has responsibility for the day to day management and organisation of the course. The Department has a Staff-Student Consultative Committee on which Physical Systems students are represented. Students will be invited to elect their representative during the first half of the Michaelmas Term.

Communication

All notices relating to the course will be displayed on the Part I notice boards in the Physics Building foyer. You should check regularly for details of lectures, workshops, examination timetables etc. Information concerning individual modules can also be found on Moodle.

The Part I Co-ordinator for Physics, Pam Forster, works in room A4 in the Physics Building. She will be glad to help you if you need further information about the course when the Academic Advisor is not available.

The Department sometimes needs to get in touch with individual students. Students should make sure that they notify any changes of address (home or local) to Pam Forster as well as to the University's Undergraduate Records Office. Students are required to register for e-mail. This should be checked for messages daily.

Textbooks

The course book used is D W Jordan & P Smith, Mathematical Techniques, OUP. One or more of the following may prove useful for additional reference for some of the PHYS110 modules:

M L Boas, Mathematical Methods in the Physical Sciences (Wiley)

E Kreyszig, Advanced Engineering Mathematics (Wiley)

G Stephenson, Mathematical Methods for Science Students (Longman)

4.4.3 Lectures, Workshops and Seminars

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS111	Functions & Differentiation	M1-5	11L,4W,4S	Dr D Sobral
PHYS112	Integration	M6-10	11L,4W,4S	Dr A Mazumdar
PHYS113	Series & Differential Equations	L11-15	11L,4W,4S	Dr J McDonald
PHYS114	Complex Methods	L16-20	11L,4W,4S	Prof I Hook
PHYS115	Vector Calculus	S21-25	11L,4W,4S	Dr J Stott

Workshops

Attendance at the workshop are optional. They are designed to give extra assistance for students who are experiencing problems with the taught material.

Coursework & Deadlines

Coursework is an integral part of the course and counts toward the assessment. It is essential that the work is completed, as fluency in the techniques only comes through practice. Guidance is available in the workshops, where a *core-skills* quiz may be set. This allows regular assessment of progress and facilitates decisions on any remedial action required. Students must hand in their work for assessment by the date and time specified on the coversheet. Late work will be marked but penalised by by the equivalent of one full letter grade, as described in Section1.13, if received before the seminar session. Any work handed in after the seminar will receive zero marks.

Solutions to coursework are normally given in the seminar. Marked work will normally be returned at the seminar.

4.4.4 Assessment - Physical Systems

Written examinations are held in January and in June. The January paper is a two hour examination covering modules PHYS111 and PHYS112. The June paper is a three hour examination and covers modules PHYS113, PHYS114 and PHYS115. For each module the written examination will contribute 60% to the total mark and the weekly coursework 40%.

Work is marked on a percentage scale then, at the end of each module, the percentage mark is converted into a score on a University-wide scale using aggregation points (see Section 1.12). Students must achieve a minimum average in PHYS110 of 10.3 aggregation points **and** a minimum of 9.0 aggregation points in both examination and coursework elements to proceed to a major degree in Physics (but see section MPhys, section 4.5 for higher requirements for certain schemes). To major in Physics, a minimum average of 10.3 aggregation points is required in all three separate Part I courses. For minor students, a minimum average in PHYS110 of 9.0 aggregation points is required to proceed to Part II in their major discipline. The University normally requires that all three Part I subjects be passed before students are allowed to proceed to Part II. Students who fail to gain the required grades after the first exams will normally be required to take and pass resit papers during the Summer vacation before they are allowed to proceed to Part II. The form of the resit will be determined by the Part I Physics Board of Examiners.

4.4.5 Skills Taught as Part of Physical Systems

By the time that you have completed the course, you should have acquired the following skills:

1. Study Skills
    - to consolidate and widen your mathematical abilities by working through textbook material with confidence;
    - to practice solving mathematical exercises on your own so as to achieve fluency;
2. Discipline Skills
    - to model physical information in terms of mathematics as a language;

- to apply mathematical techniques to a wide variety of physical problems;
- to analyse the resulting models so as to derive solutions that can be interpreted in terms of physics.

4.5 Progression Rules for entry into Part II

A wide choice of Part II degree schemes involving physics is available for those with appropriate grades in Part I. For the various BSc and MPhys schemes, students must have at least an average 10.3 aggregation points, after resits, in all three Part I subjects, Physics Part I PHYS100, Physical Systems PHYS110 and Physics Skills PHYS130. In addition, at least a minimum of 9.0 aggregation points, after resits, is required in both the coursework and exam components of each of these Part I subjects.

For the MPhys and BSc (Study Abroad) schemes there are higher requirements of 15.0 aggregation points at the first sitting in both Part I Physics and Physical Systems, and 12.0 at the first sitting in Physics Skills. If resits are required, you will be transferred to a Lancaster-based scheme. These progression rules are summarised in the tables below.

Degree Scheme	PHYS100	PHYS110	PHYS130
MPhys (Physics)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
MPhys (Physics, Astro & Cos)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
MPhys (Physics with Particle & Cos)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
MPhys (Physics, Astro & Space Science)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
MPhys (Theoretical Physics)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
MPhys (Study Abroad)	$\geq$ 15.0	$\geq$ 15.0	$\geq$ 12.0

Degree Scheme	PHYS100	PHYS110	PHYS130
BSc (Physics)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
BSc (Physics, Astro & Cos)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
BSc (Physics with Particle & Cos)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
BSc (Physics, Astro & Space Science)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
BSc (Theoretical Physics)	$\geq$ 10.3	$\geq$ 10.3	$\geq$ 10.3
BSc (Study Abroad)	$\geq$ 15.0	$\geq$ 15.0	$\geq$ 12.0

The Progression rules for the MSci/BSc (Theoretical Physics & Mathematics) degree scheme are given below.

Degree Scheme	PHYS100	MATH101-4/PHYS115	MATH110
MSci (TP&Maths)	≥ 10.3	≥ 10.3	≥ 10.3
MSci (TP&Maths Study Abroad)	≥ 15.0	≥ 15.0	≥ 12.0
BSc (TP&Maths)	≥ 10.3	≥ 10.3	≥ 10.3

In all cases normal progression from Part I to a Part II degree scheme requires that the student be in Good Academic Standing, see section 1.19 .

Registration for all Part II schemes takes place in April/May and students will be given ample opportunity to discuss the available options with members of staff before making decisions.

The MPhys (Physics) degree forms the standard scheme of study in the Physics department at Lancaster. There are 4 variants of the MPhys degree course available, in order to enable some specialisation and there is also the Study Abroad scheme where year 3 of the scheme is spent at a university overseas.

The four year MPhys courses have been designed for the student who is preparing for a career as a professional physicist, in industry, government laboratory or in higher education. The courses contain all the elements of a traditional three year BSc; core and optional lecture courses, laboratory and project work, computing and communication skills. The MPhys is the recommended route into a research degree.

Specific information on the MPhys and MPhys (Study Abroad) schemes is contained in this document. While it is recommended that all relevant sections of the Handbook are read it is possible to go directly to Sec. 7, the MPhys/MPhys(Study Abroad) section of the handbook.

In addition we offer a three year BSc (Physics) degree which has 5 variants to enable some specialisation. These courses contain all the elements of a traditional three year BSc; core and optional lecture courses, laboratory and project work, computing and communication skills. At the end of the three years the BSc will be awarded for the separate degree schemes.

Specific information on the BSc and BSc (Study Abroad) schemes is also contained in the BSc/BSc (Study Abroad), Sec. 10, section of the handbook.

There is currently one joint honour BSc degree schemes in the department. This is the BSc in Theoretical Physics with Mathematics. The section BSc/BSc (Study Abroad), Sec. 10, should be read to gain general information on the BSc degree schemes.

5 Universe as an Art - PHYS120 - Not Running in 2016/2017

Edition 1.7 2016/2017

"The Universe as an Art" is a Part I course exploring the exciting ideas of physics, presented without mathematics in the style of a humanities course. Each week there will be two lectures and a seminar. Assessment is by 4 essays, group project and an examination.

The course (PHYS120 series) contains the lecture modules PHYS121, PHYS122, PHYS123, PHYS124 and PHYS125.

This course does not lead to any Part II degree scheme - it is intended as a third Part I choice for arts and humanities students and possibly some science students. There are no prerequisites for the course.

5.1 Organisation & Communication

The Academic Advisor for the course is Dr C K Bowdery (email only) who will always be glad to talk with you about the course, your progress or any difficulties you are having.

The course is organised by a committee consisting of the lecturers and chaired by the Academic Advisor. It consists of 5 modules. Students usually take all five but certain subsets of modules can be taken; 121+122, 123+124+125 or 121+122+123+124+125.

Feedback from you is always welcome and you will have a chance to give your opinion anonymously by questionnaires that will be distributed electronically at the end of each module.

Communication

Notices regarding the course will be posted on the "Universe as an Art" section of the Part I notice board in the Physics Building foyer, and will include details of the lecture timetable, seminar groups, and other information. Make a point of looking regularly at this notice board.

The Part I Co-ordinator for the Department of Physics, Pam Forster, is in room A4 in the Physics Building. She will be glad to help you if the Academic Advisor is not available. If you change your address (home or local), you must notify her as well as the Student Registry in University House.

Textbooks

There is no single recommended textbook for this course, but a recommended reading book:

G Gamow & R Stannard, The New World of Mr Tompkins, CUP

Further information about books will be made available in the seminars. The World Wide Web is also an excellent source of free information. Guidance about this will be given by the lecturers.

5.2 Lectures, Seminars & Field Trips

The course as a science but also an art - how will it be done? An exploration of the Universe: from here to infinity, from the start to the end, from the smallest entity to the largest. The philosophical ideas: objective reality (from ‘common sense’ to ‘relative’ to ‘quantum’) reductionism, impermanence of matter.

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS121	Planets, Stars and Galaxies	M1-6	10L,5S	Not Running 2016/2017
PHYS122	Space Time and Gravity	M6-10	10L,5S	Not Running 2016/2017
PHYS123	The Microscopic World	L11-15	10L,5S	Not Running 2016/2017
PHYS124	Origins and Evolution	L16-20	10L,5S	Not Running 2016/2017 Not Running 2016/2017
PHYS125	The Big Issues	S21-25	10L,5S	Not Running 2016/2017

Seminars

Seminars are a compulsory part of the course and they provide opportunities to discuss topics covered in the lectures and to answer questions that you might have. There will be a coursework, which is a short written assignment each week set by the lecturer. In addition, guidance on writing essays will be given and there will be feedback on the set quizzes and assignments. In the Lent Term there will be small group projects and an exhibition in Summer Term.

Field Trips: If there is sufficient interest, a trip to a place of scientific interest will be organised in the Michaelmas Term.

5.3 Assessment - Universe as an Art

There will be two essays of 2500 words to be completed, one at the end of Michaelmas Term and one at the end of Lent Term. There will be 5 end of module written assignments of 1000 words throughout the course. A Group project including a presentation and exhibition during Lent and Summer Term. This coursework makes up 50% of the overall assessment. There will be an essay-type examination in the Summer Term which provides the other 50% of the assessment. Both coursework and examination must be separately passed. The overall assessment is classified on a University-wide scale using aggregation points (see Section 1.12). Students must achieve a minimum average of 9.0 aggregation points to proceed to their major degree. The University normally requires that all three Part I subjects be passed before students are allowed to proceed to Part II. Students who fail will normally be required to take and pass resit papers during the Summer vacation before they are allowed to proceed to any Part II degree scheme. Students who achieve a mark of A- or above overall are awarded a special Departmental Certificate.

6 Part II Organisation

Edition 1.7 2016/2017

The following degree schemes are available:

MPhys and BSc in Physics (Phys)

MPhys and BSc - Physics (Study Abroad) (NoAm)

MPhys and BSc - Physics, Astrophysics & Cosmology (Astr)

MPhys and BSc - Physics with Particle Physics & Cosmology (Pcos)

MPhys and BSc - Physics, Astrophysics & Space Science (Spac)- switching is no longer available - being laid down

MPhys and BSc - Theoretical Physics (Theo)

Details of individual degree schemes are given in later sub-sections.

Degrees in Physics include substantial elements of experimental work; degrees with specialist themes (Astr, PCos, Theo, Spac) include appropriate specialist material and skills.

6.1 Academic Aims & Learning Outcomes

Below are the general aims and learning outcomes of our major degree schemes. Details of individual schemes may also be found in the programme specifications on our teaching web pages.

Year 2

During the year we aim

- to teach the basic physics and all the basic mathematics needed by professional physicists.
- to develop experimental skills in physics and to introduce students to the design and construction of experiments (Phys).
- to teach students to use computers in modelling physical systems.
- to introduce students to more specialist topics in their chosen theme (Astr, Pcos, Theo, Spac).
- develop problem-solving skills in physics.
- develop transferable skills, particularly in written presentation.

At the end of the year, students should

- display a good knowledge of waves and optics, quantum mechanics, thermodynamics, electric and magnetic fields, basic nuclear and particle physics and relativity.
- be able to carry out mathematical operations in Fourier analysis, vector calculus and partial differential equations.
- be able to write word-processed reports at an appropriate level.
- be able to carry out more complex set experiments, to analyse and interpret their results with the appropriate use of analytic methods and to write up their results as a concise laboratory report (Phys).
- display a basic knowledge of specialist topics in their chosen theme (Astr, PCos, Theo, Spac).
- be able to produce and use computer programs to model physical systems.

Year 3

During the year we aim

- to teach the remaining core physics knowledge and skills required by professional physicists.
- to enable students to study a wide range of applications of basic physics and to permit them to select these according to their interests and career objectives.
- to develop the skills necessary to solve problems in physics at a professional level of complexity.
- to develop more advanced experimental skills to allow open-ended experimental research (BSc Phys).
- to introduce students to more advanced topics in their chosen theme and to teach the skills required for open ended research in their chosen theme (Astr, PCos, Theo, Spac).
- to develop transferable skills, in writing and oral presentation.

At the end of the year, students should

- have displayed a good knowledge of particle physics, solid state physics, atomic and nuclear physics, statistical physics and physics of fluids.

- have shown the ability to apply this knowledge of basic physics along with more advanced ideas to specialist areas of physics in their chosen themes.
- have a knowledge of some current areas of physics research to be able to carry out substantial experimental investigations of an open-ended nature and to be able to give a good written oral account of such work at a professional level (BSc Phys).
- show an understanding of some advanced topics in their chosen theme and be able to give a good written and oral account of such work at a professional level.

Year 4

During the year we aim

- to enable students to study a range of physics topics to the depth appropriate for a career in physics and to permit them to select these topics according to their interests and career objectives.
- to teach advanced material and/or skills appropriate to the chosen theme.
- to further develop skills of independent study and open-ended research.

At the end of the year, students should

- have shown the ability to study physics and other, related topics to the depth required for a future research scientist.
- display a knowledge of some of the key research activities in their specialist themes.
- have demonstrated the capacity to work individually and exercise critical faculties by writing a substantial dissertation.
- have demonstrated a capacity for research by carrying out a substantial project.

6.2 Assessment Procedures

The final degree classification is based upon the marks obtained in part II. Each year in part II consists of 120 credits of assessment. So the overall degree classification is based on 240 credits for a BSc and 360 credits for MPhys/MSci degrees. Each module has a specified credit weighting as detailed in later sections. The split between examination and coursework assessment is provided for each module in section 13 and the mode of assessment - quantitative (% style) or qualitative (letter grade) - (see Section 1.12 for details). On the completion of a module, all marks (quantitative or qualitative) will be converted to a final module aggregation score on a 24 point scale. An average (weighted by the credit rating) of these aggregation scores is used to calculate the overall aggregation score. (Further information on module assessment and examinations can also be found in section 3.3.)

The overall aggregation score awarded at the end of each year and the final degree classifications are determined at the final Examiners Board Meeting, involving two external examiners, in week 10 of the Summer Term. However, the Academic Advisor regularly provides updates on students' performance and module marks throughout the year, as well as the overall mark assessments awarded at the end of each year. The full transcript of the final marks is provided by the University at a later date.

University Scale for the Classification of Marks

Each module of assessment is given a module aggregation score from the weighted average of each of the individual pieces of assessed work. The broad module classification is as follows:

Broad descriptor	approx %	Grade	Agg. Score	Class
Excellent	100 – 70	A+/A/A-	24 – 18	First
Good	< 70 – 60	B+/B/B-	<18 – 15	Upper Second
Satisfactory	<60 – 50	C+/C/C-	<15 – 12	Lower Second
Weak	<50 – 40	D+/D/D-	<12 – 9	Third
	< 40 – 22		< 9 – 4	Condonable fail
	< 22		< 4	Uncondonable fail

Details of how these aggregation scores are combined to produce the final degree classification are to be found in later sections: for MPhys see MPhys (see Section 7.2), for MSci (see Section 9.1.3) and for BSc (see Section 10.2).

Except in the case of failure, the University does not normally allow students to be reassessed in completed modules. For any module failed in Part II, a resit of the failed components is required to raise the overall module mark to a pass. In all but the final year, the module mark will be capped at a pass mark (a grade of D-, equivalent to an aggregation score of 9). In the final year, assessment will be for accumulation of sufficient credit only in order to qualify for a degree; reassessment in the final year will not affect the final aggregation score or degree class. Reassessment is not allowed just to improve a mark for a module that has been passed.

When a student, after attempting reassessment (usually late summer), has failed a module, the Examination Board may, at its discretion, condone the failed module if the aggregation score is between 7 and 9. Condonation is not possible with an aggregation score of less than 7. Such a failure is likely to result in exclusion from the University.

A maximum of 30 credits may be condoned for progression. If there are more than 30 credits that require condonation then this will also result in exclusion from the University. In the final year of a degree, condonation by the Examination Board, subject to a maximum limit of 30 credits for BSc schemes and 45 credits for MPhys/MSci schemes, is possible in June without a resit if the aggregation score is between 7 and 9. In such cases, an Honours degree would be awarded. It is also possible for the final Examiners Board to recommend the award of a pass degree with up to 60 credits condoned. In either case, condonation of any module with an aggregation score of less than 7 is not possible.

As a typical physics degree contains many small credit modules, and one bad failure may lead to exclusion, the Examination Board may consider suitably weighted combinations of small credit modules, up to a maximum size of 20 credits, prior to consideration of condonation. For non-final year students, combination is only done after a resit has taken place. Permissible combinations are identified as in Appendix D.

6.3 Teaching Modules and Methods

Attendance at all formal teaching sessions (lectures, seminars, workshops, laboratories) is compulsory and is recorded.

6.3.1 Core and Optional Lecture Modules

Each core and optional lecture module in the second, third and fourth years is programmed into the teaching timetable with a varied number of lectures and seminars in a given period. Material taught in the lectures is developed and understanding is tested by a series of weekly or fortnightly coursework assignments. Often these assignments include past exam paper questions to better prepare students for the summer examinations. The seminar is used to return the marked coursework (with written feedback), discuss the coursework questions, provide model answers, discuss any problem areas, and provide further illustrative examples as appropriate.

6.3.2 Laboratory Modules

All laboratory work is assessed purely on coursework. The coursework is a combination of weekly work, recorded in a log book, and report writing. Oral presentations also often form part of the assessment (individual module details are given in section 13). General physics students do a series of experimental laboratories in year 2, followed by advanced laboratory work and project work in either (PHYS351 Semiconductor Physics Laboratory, PHYS352 Low Temperature Physics Laboratory & PHYS353 Particle Physics Group Project) or PHYS355 Industrial Group Project in year 3. Students taking degrees with particular themes take specialist theme-specific modules in part II, discussed below.

6.3.3 Third Year Group Projects

A group project is an extended piece of experimental, theoretical or computational work involving an open-ended investigation on the part of the student working as part of a team.

The group project modules: PHYS353 Particle Physics Group Project, PHYS364 Cosmology Group Project, PHYS369 Space Science Group Project & PHYS379 Theory & TPM Group Project, are undertaken for 10 weeks in year three and they typically occupy one day per week. The topics covered are described in detail in the module descriptions. A working log book is normally kept and a final group report is written at the end of the investigation.

The assessment is based normally on a group mark awarded for the report and an individual mark awarded for the log book and individual contribution to the team.

In addition, an assessed presentation is made by each individual student at the 3rd year conference "The PLACE" on the results of the group project or individual laboratory work.

Information on report writing will be given to students and this provides guidance on style, content, length and layout. Reports are expected to be word processed and will normally be about 4–5000 words in length. Clear deadlines for both preliminary reports and final reports will be set and full credit can be obtained only if these are met.

6.3.4 Astrophysics and Cosmology

The specialist Astrophysics and Cosmology modules in Year 2 are PHYS263 Astronomy, PHYS264 Astrophysics I and PHYS265 Cosmology I, all of which are lecture-based. These courses are designed to give students a firm foundation in the basics of astrophysics and cosmology.

In Year 3 there are modules PHYS361 Cosmology II lectures, Big-Bang nucleosynthesis and inflation, PHYS363 Astrophysics Laboratory, which is based on astronomical observation using a CCD equipped telescope and computer simulations of observational astronomy, and PHYS364 Cosmology Group Project, which is a theoretical open-ended project on cosmology. Students present their results of one of these investigations at the conference "The PLACE". In addition, there is the lecture-based module PHYS362 Cosmology II which will introduce students to more advanced topics.

For those who continue into Year 4, there is an advanced MPhys lecture course on cosmology, PHYS461 Cosmology III, which will introduce students to topics currently the focus of research, including accelerated expansion and dark energy, structure formation, the cosmic microwave background, scalar field-based inflation models and the theory of primordial density perturbations. Also in year 4 there is also an advanced lecture course on astrophysics, PHYS464 Astrophysics III - Galaxies, which covers the formation and evolution of galaxies, observational methods for studying galaxies and observational tests of cosmological models, in the context of current research.

6.3.5 Particle Physics & Cosmology

In year 2, Particle Physics & Cosmology majors take the specialist modules PHYS263 Astronomy, PHYS256 Experimental Particle Physics, and PHYS265 Cosmology I. These are lecture-based modules designed to give students a firm foundation in the basics of particle physics and cosmology. Further specialist modules are taken in year 3. Specialist lecture based modules are PHYS366 Groups & Symmetries and PHYS367 Flavour Physics. In year 3, students also take PHYS361 Cosmology II lectures plus a group project either PHYS353 Particle Physics Group Project or PHYS364 Cosmology Group Project. Students present the results of one of these projects at the conference "The PLACE".

For those who continue into Year 4, there is an advanced MPhys lecture course on cosmology, PHYS461 Cosmology III, and advanced particle physics modules PHYS412 Experimental Methods in Particle Physics and PHYS462 Gauge Theories, which will introduce students to some current research topics.

6.3.6 Physics, Astrophysics & Space Science

In year 2, Physics with Space Science majors take the specialist modules PHYS263 Astronomy, PHYS264 Astrophysics I, and PHYS268 Space Physics. These are lecture-based modules designed to give students a firm foundation in the basics of space physics. In year 3, students take PHYS368 Aurora-Atmospheric Physics lectures, and specialist laboratory module PHYS363 Astrophysics Laboratory, and a group project PHYS369 Space Science Group Project. Students present the results of one of these modules at the conference "The PLACE". In addition, there is the lecture-based module PHYS362 Astrophysics II which will introduce students to more advanced topics. For those who continue into Year 4, there is an advanced MPhys lecture course on space, PHYS463 Solar-Planetary Physics which will introduce students to some current research topics.

6.3.7 Theoretical Physics

Specialist modules for Theoretical Physics majors PHYS273 Theor.Phys.I - Mech.& Vars., PHYS274 Theor.Phys.II - Class.Fields and PHYS265 Cosmology I are lecture based modules on various topics with an emphasis on the techniques of theoretical physics. Linked seminars provide students with the opportunity to apply these techniques to a variety of physical problems.

All Theoretical Physics majors are required to take one computing (laboratory based) module during their second year. Module PHYS281 Scientific Programming & Modelling Project provides students with basic programming instruction.

In the third year, students take PHYS375 Theoretical Physics Independent Study in weeks 1-10 and PHYS379 Theory & TPM Group Project in weeks 11-20. These will involve a considerable amount of background reading and library research of a selected topic in physics and possibly computer modelling. Students will be required to make a presentation at the conference "The PLACE" on an agreed topic from one of these modules as part of the 3rd year assessment.

6.3.8 Projects

(PHYS355, PHYS451, PHYS452)

A project is an extended piece of experimental, theoretical or computational work involving an open-ended original investigation on the part of the student.

An Industrial Group Project PHYS355 module is undertaken during weeks 1-15 of year three and occupies, on average, two days per week for the whole period. This may be taken by general Physics students as an alternative to PHYS351 Semiconductor Physics Laboratory, PHYS352 Low Temperature Physics Laboratory & PHYS353 Particle Physics Group Project. Please see the module pages for further details.

A major part of the final year for all MPhys/MSci degree schemes is the 4th year project PHYS451/452. Project work gives students the opportunity to carry out research into a specific area of physics appropriate to their chosen degree theme (MPhys Physics students normally do experimental work, MPhys Theoretical Physics students will do theoretical work etc). The project requires students to further develop and apply analytical and problem-solving skills to open ended research, and provides excellent training for students wishing to enroll on a physics research based career. The projects involve use of the library, computer, and other resources as appropriate, working alone or in a small group. The project work will normally be closely connected to a research group and topics will reflect the research expertise in the department. One quarter of the assessment of the project is based on the Literature Search report written by the students during the summer prior to the start of the final year. This gives important background material required for commencement of the project research work. The project itself is done during the Michaelmas and Lent terms, with students typically spending two to three days per week on the research work. The workload from the lecture courses is tailored so that a 5 week period in the Lent term is often free of any other commitments permitting 100% dedication to completing the project. Assessment of the project is made by the supervisor and by a second independent examiner. The assessment is based on the student performance during the project, including a record maintained in a log book, the final report and an oral examination. The project work also forms the basis of an oral and a poster presentation made by the student at a dedicated Fourth Year Conference "The PLACE".

As in the case of examinations, any cases of cheating or fabrication of results (known collectively as plagiarism) will not be condoned. See Appendix E for the Department's Plagiarism policy and also the University's Plagiarism Framework for full details of unacceptable practices and the sanctions which the University will impose in proven cases.

6.4 Teaching Timetables

The timetable of lectures, laboratories, workshops, seminars for all modules are published at the beginning of each academic term. A phone application iLancaster and the Student Portal for your computer are available showing your personal modules. Any updates will automatically be uploaded onto all of the systems.

6.5 Textbooks

Each module will have a list of recommended textbooks. These can be either purchased or obtained from the University library. The module supervisor should be consulted if there are any problems with obtaining any of the recommended texts. Some textbooks are recommended for a number of lecture modules, so are particularly useful, for instance:

Riley, Mathematical Methods for Physics and Engineering; CUP - for modules PHYS211, PHYS213.

W J Kaufmann & Freedman, Universe, W H Freeman - for modules PHYS263, PHYS264, PHYS265.

B W Carroll and D A Ostlie, Modern Astrophysics, Addison Wesley - for modules PHYS263, PHYS264.

M Thomson, Modern Particle Physics - for modules PHYS311,

A M Guénault, Statistical Physics - for modules PHYS322, PHYS485.

6.6 Transferable Skills

Skills training is a part of any modern degree scheme and potential employers always emphasise its importance. One of the more important skills is the ability to use modern computing systems and to understand the elements of programming and systems analysis. As a potential professional Physicist you should know how to approach problem solving using computers. To this end the department has a computer skills course (module 131) which must be taken by all single majors and is scheduled for the Michaelmas term of year one. The course includes elementary word processing, spread sheet and data base management. The department also teaches report writing and presentation skills to Physics majors in their first year.

A degree in physics also provides training in a wide variety of transferable skills which will be of great advantage in careers in science, engineering, commerce and education:

Laboratory Work

encourages: originality, exploration, problem solving, initiative, decision making, presentation skills, communication skills, co-operative work.

Seminar and Tutorial Work

develops: problem solving skills, initiative, oral and written presentation skills, self organisation, self confidence, responsibility.

Lecture Modules

encourage: responsibility, self organisation, motivation, concentration, note taking skills, comprehension.

3rd and 4th Year Conferences (The PLACE - The Physics @ Lancaster Annual Conference & Exhibition)

develop: presentation skills, both oral and in production of transparencies or posters; time organisation, communication, self confidence, responsibility.

7 Part II MPhys (all schemes)

Edition 1.7 2016/2017

The MPhys degree is a four year undergraduate integrated masters honours degree course. The MPhys degree should be the preferred route to postgraduate research in physics and to practice as a professional physicist in industry and the scientific civil service.

The scheme follows the Lancaster pattern of a three subject Part-I followed by a specialised Part-II. All prospective MPhys majors must normally take the Part-I courses PHYS100, PHYS110 and PHYS130. At the beginning of the second year students will be registered for one of the possible themes which lead to an MPhys degree. Up to the end of the second year, they may choose to revert to a three year BSc degree scheme. Thus the second years of the MPhys and BSc schemes are essentially the same. The objectives of the third and fourth years in the MPhys are to provide breadth in core Physics topics, coverage of areas which are excluded from a three year BSc and an opportunity for further specialisation through choice of optional lecture modules. There is also a significant component of project work, particularly in year four. At the end of the four years the MPhys will be awarded for the separate degree schemes: Physics; Theoretical Physics; Physics, Astrophysics and Cosmology; Physics, Astrophysics & Space Science; Physics with Particle Physics & Cosmology. There is also the MPhys Physics (Study Abroad) degree scheme involving a year overseas.

7.1 Academic Advisors

2nd year:	Prof G V Borissov & Dr H Fox
3rd year:	Dr K Dimopoulos & Dr A Marshall
4th year:	Dr Q D Zhuang & Dr J Prance

7.2 MPhys Degree Classification Rules

Under the regulations, a final mark for each module is obtained using the published relative weightings for coursework and examination. This final module mark (either percentage or letter grade) is converted to an aggregation score on a scale of 0 to 24. If a module mark is below an aggregation score of 9, it is deemed to be a fail mark.

Resits and condonation

If the mark profile contains a failed module, then there are several possibilities:

- In any year other than the final year of study, a resit must be attempted, usually during the late summer resit period. This may take the form of an exam, coursework or both.
  - If the subsequent resit mark is above 9 aggregation points, then the module is passed but the mark in the overall profile is capped at 9.

- If the mark is between 7 and 9, the the failure may be **condoned** subject to the limits outlined below on the maximum number of condoned fails.
- If the mark is less than 7, then then you cannot proceed and, subject to the normal appeals process, exclusion from the University will result.

- In the final year of study, year 4 for an MPhys,
  - If the mark is between 7 and 9, then the failure may be **condoned** at the June final board of examiners meeting, subject to the limits outlined below on the maximum number of condoned fails, and a degree awarded.
  - If the mark is less than 7, a resit must be attempted. This means that graduation is not possible in July. The form of the resit may be an exam, coursework or both with exams usually taken during the late summer resit period.
  - To qualify for a degree, the resit mark must not be less than 7. If between 7 and 9, then condonation will be required, subject to the limits outlined below on the maximum number of condoned fails.
  - The resit mark will not change the class of degree awarded; resit is for credit only. The original first attempt mark is used in the classification of your degree.

The maximum number of credits that can be condoned and an honours degree awarded is 45, although progression to the final year is not possible with more than 30 credits condoned by the end of year 3. The examination board can, at its discretion, condone an additional 30 credits to a total of 60 credits maximum to permit the award of a pass degree.

The final aggregation score for the year or degree is calculated using the credit weighted average of the individual module aggregation scores. The final degree classification awarded is determined using the following table

Class	Agg. Score
first class honours	17.5 – 24.0
either 1st or upper second class	17.1 – 17.4
upper second classs honours	14.5 – 17.0
either upper second class or lower second class	14.1 – 14.4
lower second class honours	11.5 – 14.0
either lower second class or third	11.1 – 11.4
third class honours	9.0 – 11.0
discretionary pass degree or fail	8.1 –8.9
fail	0.0 – 8.0

Borderlines

The following rules will be used for deciding the degree class for students whose overall average mark lies in a borderline region between degree classes (the "either ... or ..." ranges in the table above).

- For all students on integrated masters programmes, where a student falls into a borderline then the higher award should be given where half or more of the credits from Part II are in the higher class.
- Borderline students not meeting this criterion would normally be awarded the lower class of degree.
- For all students, borderline or not, Examination Boards should make a special case to the Committee of Senate for any student where the class of degree recommended by the Board deviates from that derived from a strict application of the regulations. Such cases would be based around circumstances pertaining to individual students where these circumstances have not already been taken into account.

Assessment

Normally all Part II lecture modules are assessed by Coursework (20%) and examination (80%). Laboratory modules, projects etc are all 100% coursework assessment (which includes assessed presentations and oral examinations).

7.3 MPhys Progression Rules

The department imposes several progression criteria to be satisfied by students passing through the MPhys schemes. These are to ensure the high quality of MPhys graduates.

To progress from year to year in Part II of MPhys degrees, you must achieve at the first sitting, an overall aggregation score of 14.5 with no more than 30 credits condoned in total in years 2 and 3.
Failure to achieve an overall aggregation score of 14.5 at the end of year 3 will result in the university graduating you with a classification for a BSc degree.

8 MPhys - Timetable and Assessment

Edition 1.7 2016/2017

8.1 MPhys - Physics

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS253	Experimental Lab I	L11-15	30P	Dr Q D Zhuang Prof A Krier
PHYS254	Experimental Lab II	L16-20	30P	Dr Q D Zhuang Prof A Krier
PHYS255	Experimental Lab III	S21-25	30P	Dr Q D Zhuang Prof A Krier
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin

Either

PHYS351	Semiconductor Physics Laboratory	M1-5	30P	Prof A Krier
PHYS352	Low Temperature Physics Laboratory	L11-15	30P	Dr D I Bradley
PHYS353	Particle Physics Group Project	M/L4-13	30P	Dr H O'Keeffe Dr A Blake

and

PHYS263,323,366 PHYS367,384,388 PHYS389,390 PHYS483,485,486	2 - Optional Modules. In total 6 PHYS4xx mods must be taken from the 8 options in Yr3 & Yr4.	M6-10/ L11-15/ L16-20	48L,12S	*Various*

or

PHYS355	Industrial Group Project	M/L/S1-15	90P	Dr M Hayne

and

PHYS263,323,366 PHYS367,384,388 PHYS389,390 PHYS483,485,486	3 - Optional Modules. In total 6 PHYS4xx mods must be taken from the 9 options in Yr3 & Yr4.	M6-10/ L11-15/ L16-20	48L,12S	*Various*

Year 4

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS451	MPhys Project	M/L/S	≈100	*Supervisor*
PHYS452	MPhys Literature Review	S27-30,Vac	≈30	*Supervisor*
PHYS323,366,367 PHYS384,388,389 PHYS390,411,412 PHYS462,481-487	6 - Optional Modules. In total 6 PHYS4xx mods must be taken from the 8 or 9 options in Yr3 & Yr4.	M1-10/ L11-20	96L,24S	*Various*

8.2 MPhys - Physics, Astrophysics & Cosmology

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS263	Astronomy	L11-15	16L,4S	Dr D Sobral
PHYS264	Astrophysics I	S21-24	16L,4S	Dr A Koch
PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS361	Cosmology II	M1-5	16L,4S	Dr A Mazumdar
PHYS362	Astrophysics II	L16-20	16L,4S	Dr C Arridge
PHYS363	Astrophysics Laboratory	M6-10	30P	Dr D I Bradley Dr A Grocott
PHYS364	Cosmology Group Project	L11-20	2L,30P,6W	Dr J McDonald Dr K Dimopoulos
PHYS323,366,367 PHYS384,388,389 PHYS390,483,485 PHYS486	1 - Optional Modules. In total 3 PHYS4xx mods must be taken from the 4 options in Yr3 & Yr4.	M6-10/ L11-15/ L16-20	32L,8S	*Various*

Year 4

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS411	Adv. Rel. & Gravity	M1-5	16L,4S	Dr K Dimopoulos
PHYS451	MPhys Project	M/L/S	≈100	*Supervisor*
PHYS452	MPhys Literature Review	S27-30,Vac	≈30	*Supervisor*
PHYS461	Cosmology III	M1-5	16L,4S	Dr J McDonald
PHYS464	Astrophysics III - Galaxies	M6-10	16L,4S	Prof I Hook
PHYS323,366,367 PHYS384,388,389 PHYS390,412,462 PHYS463,481-487	3 - Optional Modules. In total 3 PHYS4xx mods must be taken from the 4 options in Yr3 & Yr4.	M1-10/ L11-20	64L,16S	*Various*

8.3 MPhys - Physics with Particle Physics & Cosmology

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS256	Experimental Particle Physics	S21-25	30P	Dr A Blake Dr H Fox
PHYS263	Astronomy	L11-15	16L,4S	Dr D Sobral
PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS361	Cosmology II	M1-5	16L,4S	Dr A Mazumdar
PHYS366	Groups & Symmetries	L11-15	16L,4S	Dr J Gratus
PHYS367	Flavour Physics	L16-20	16L,4S	Dr J Nowak

either

PHYS353	Particle Physics Group Project	M/L4-13	30P	Dr H O'Keeffe Dr A Blake

or

PHYS364	Cosmology Group Project	L11-20	2L,30P,6W	Dr J McDonald Dr K Dimopoulos

and

PHYS323,384,388 PHYS389,390 PHYS483,485,486	1 - Optional Module. In total, 2 PHYS4xx mods must be taken from the 3 options in Yr3 & Yr4.	M6-10/ L11-15/ L16-20	16L,4S	*Various*

Year 4

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS411	Adv. Rel. & Gravity	M1-5	16L,4S	Dr K Dimopoulos
PHYS412	Experimental Methods in Particle Physics	M6-10	16L,4S	Dr R Henderson
PHYS451	MPhys Project	M/L/S	≈100	*Supervisor*
PHYS452	MPhys Literature Review	S27-30,Vac	≈30	*Supervisor*
PHYS461	Cosmology III	M1-5	16L,4S	Dr J McDonald
PHYS462	Gauge Theories	L16-20	16L,4S	Dr R Henderson
PHYS323,368,384 PHYS388,389,390 PHYS481-487	2 - Optional Modules. In total, 2 PHYS4xx mods must be taken from the 3 options in Yr3 & Yr4.	M1-10/ L11-20	48L,12S	*Various*

8.4 MPhys - Physics, Astrophysics & Space Science

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS263	Astronomy	L11-15	16L,4S	Dr D Sobral
PHYS264	Astrophysics I	S21-24	16L,4S	Dr A Koch
PHYS268	Space Physics	L16-20	16L,4S	Not Running 2016/2017
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS362	Astrophysics II	L16-20	16L,4S	Dr C Arridge
PHYS363	Astrophysics Laboratory	M6-10	30P	Dr D I Bradley Dr A Grocott
PHYS368	Aurora-Atmospheric Physics	M1-5	16L,4S	Not Running 2016/2017
PHYS369	Space Science Group Project	L11-20	2L,30P,9W	Not Running 2016/2017
PHYS265,323,366 PHYS367,384,388 PHYS389,483,485 PHYS486	1 - Optional Modules. In total, 5 PHYS4xx mods must be taken from the 6 options in Yr3 & Yr4.	M6-10/ L11-15/ L16-20	32L,8S	*Various*

Year 4

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS451	MPhys Project	M/L/S	≈100	*Supervisor*
PHYS452	MPhys Literature Review	S27-30,Vac	≈30	*Supervisor*
PHYS463	Solar-Planetary Physics	M1-5	16L,4S	Dr A Grocott
PHYS361,366,367 PHYS384,388,389 PHYS411,412,462 PHYS481-487	5 - Optional Modules. In total, 5 PHYS4xx mods must be taken from the 6 options in Yr3 & Yr4.	M1-10/ L11-20	80L,20S	*Various*

8.5 MPhys - Theoretical Physics

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos
PHYS273	Theor.Phys.I - Mech.& Vars.	L11-15	16L,4S	Dr A Romito
PHYS274	Theor.Phys.II - Class.Fields	S21-24	16L,4S	Dr J McDonald
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS366	Groups & Symmetries	L11-15	16L,4S	Dr J Gratus
PHYS375	Theoretical Physics Independent Study	M1-10	25L,15W	Dr N Drummond Dr A Romito Dr J Gratus
PHYS379	Theory & TPM Group Project	L11-20	4L,10P,6W	Dr E McCann
PHYS263,323,361 PHYS367,384,389 PHYS390,483,485 PHYS486	1 - Optional Modules. In total, 4 PHYS4xx mods must be taken from the 5 options in Yr3 & Yr4.	M6-10/ L11-15/ L16-20	48L,12S	*Various*

Year 4

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS451	MPhys Project	M/L/S	≈100	*Supervisor*
PHYS452	MPhys Literature Review	S27-30,Vac	≈30	*Supervisor*
PHYS481	Advanced Magnetism	M1-5	16L,4S	Dr D A Burton
PHYS482	Quantum transport in low dimensional nanostructures	M6-10	16L,4S	Dr N Drummond
PHYS323,361,367 PHYS368,384,388 PHYS389,390 PHYS411,412,461 PHYS462,483-487	4 - Optional Modules. In total, 4 PHYS4xx mods must be taken from the 5 options in Yr3 & Yr4.	M1-10/ L11-20	64L,16S	*Various*

8.6 MPhys - Physics (Study Abroad)

The third year of the MPhys (Study Abroad) scheme is spent overseas. Students may follow the following themes; Astronomy, Particle, Physics, Space, Theory. The exact scheme will be decided by the Study Abroad Academic Advisor and the individual student when the destination University is known.

In the fourth year, on return to Lancaster, students will choose a project and optional modules, in consultation with the Study Abroad Academic Advisor, which are appropriate to their particular chosen theme, interests and experience.

Please note: That in order to graduate you must have at least 120 credits at 4^{th} year level. This may influence your choice of courses whilst you are abroad in your 3^{rd} year.

Students normally spend the 3^{rd} year of a 4 year MPhys course overseas.

Progression requirements: In order to progress to the second year, students are normally expected to obtain at least 15 aggregation points in both PHYS100 and PHYS110 and at least 12 aggregation points in PHYS130 at the first attempt. At the end of second year, you must achieve, at the first sitting, an overall aggregation score of 14.5 with no more than 30 credits condoned.

The year abroad is spent at one of several carefully-selected institutions whose courses have been found to be suitably matched to those of the Lancaster Department. Modules taken in Lancaster in the year preceding the year abroad are selected to optimise the progression from Lancaster to overseas university.

The final choice of institution and courses must be approved by the Study Abroad Academic Advisor, Dr D A Burton, taking into account a number of factors, one of which is the student's own preference; however, the main factor to be taken into account is that the courses must facilitate the student's progression into the final year of study at Lancaster University in the student's particular degree scheme.

Whilst overseas students are required to keep in regular contact with their Academic Advisor at Lancaster via e-mail, and any changes to their overseas courses must be first agreed with them.

The grades obtained overseas, on the A, B, C... etc scale, are directly translated into Lancaster marks by an open scheme that has been established using the experience that has been built up over a number of years of student exchanges. The translation of grades is confirmed by the final year examination committee.

Further information on the Physics Study Abroad scheme may be found by consulting the University's International Office. In addition, a handout entitled "Physics Guidance for Study Abroad" is available from the Physics Study Abroad Academic Advisor Dr D A Burton.

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Either

PHYS253	Experimental Lab I	L11-15	30P	Dr Q D Zhuang Prof A Krier
PHYS254	Experimental Lab II	L16-20	30P	Dr Q D Zhuang Prof A Krier
PHYS255	Experimental Lab III	S21-25	30P	Dr Q D Zhuang Prof A Krier

or

PHYS263	Astronomy	L11-15	16L,4S	Dr D Sobral
PHYS264	Astrophysics I	S21-24	16L,4S	Dr A Koch
PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos

or

PHYS256	Experimental Particle Physics	S21-25	30P	Dr A Blake Dr H Fox
PHYS263	Astronomy	L11-15	16L,4S	Dr D Sobral
PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos

or

PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos
PHYS273	Theor.Phys.I - Mech.& Vars.	L11-15	16L,4S	Dr A Romito
PHYS274	Theor.Phys.II - Class.Fields	S21-24	16L,4S	Dr J McDonald

Year 3

Please note: That in order to graduate, you must have at least 120 credits at 4^{th} year level. This may influence your choice of courses whilst you are abroad in your 3^{rd} year.

Year 4 – eg. Physics only

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS451	MPhys Project	M/L/S	≈100	*Supervisor*
PHYS452	MPhys Literature Review	S27-30,Vac	≈30	*Supervisor*
PHYS323,366,367 PHYS384,388,389 PHYS390,411,412 PHYS462,463, PHYS481-487	5 - Optional Modules.	M1-10/ L11-20	80L,20S	*Various*

For the other themes, please refer to the previous MPhys degree details.

Please note that you will also be required to take PHYS320 General Paper in year 4, therefore, you will have 1 optional module less to choose.

9 MSci Joint Honours

Edition 1.7 2016/2017

9.1 Theoretical Physics with Mathematics

The MSci in Theoretical Physics & Mathematics is a four year honours course. This degree scheme exposes students to modern methods and new ideas in Theoretical and Mathematical Physics. In the first two years, it includes both Physics and pure Mathematics courses followed by advanced courses in Theoretical Physics and Mathematical Methods in years 3 and 4. The degree is taught jointly by the Department of Physics and the Department of Mathematics.

Students will obtain research skills in modern techniques of Mathematical Physics built upon a strong foundation in Algebra, Analysis, Group Theory, Differential Geometry and Topology. The programme of the final year involves theoretical studies in Quantum Theory, Electromagnetism, Condensed Matter, Gravitation and Cosmology, fundamental Particle Physics with emphasis on field-theoretic techniques.

Students are offered close individual supervision throughout, and a variety of options from the above courses are available for individual research projects during the third and final years. Able students will develop flexible skills that are transferable to a variety of other professions, or higher research degrees.

Theoretical Physics Director of Study: Dr N Drummond.

Mathematics Tutors:

2nd year: Dr Rebecca Killick

3rd year: Dr Mark MacDonald

4th year: Dr Robin Hillier

9.1.1 Course Structure

Part I

In Part I, students take the first year course in Physics (PHYS101-105,115), a self-contained survey of physics, and the two first year courses Mathematics (MATH101-105 and MATH111-114). Details of all courses taught by the Department of Mathematics may be found on their Web site, the first year Mathematics course description and student handbook is available via Mathematics Courses.

Part II

Part II of the degree scheme, years 2, 3 & 4 comprise approximately equal parts of Theoretical Physics and of Mathematics.

9.1.2 Academic Advisors

2nd Year	Prof G V Borissov	Room B16 P, Tel 94612
2nd Year	Dr H Fox	Room B20 P, Tel 93616
3rd Year	Dr K Dimopoulos	Room A41 ST, Tel 93645
3rd Year	Dr A Marshall	Room A21 P, Tel 94072
4th Year	Dr Q D Zhuang	Room A31 P, Tel 94198
4th Year	Dr J Prance	Room A23 P, Tel 94972

9.1.3 Classification of Degrees

The classification rules for the MSci Theoretical Physics with Mathematics degree are identical to those for the MPhys degree given in section 7.2.

9.1.4 Progression Through the Course

The department places several “hurdles” to be cleared by students passing through the MSci Theoretical Physics with Mathematics course. These are set to ensure students are properly prepared for the more advanced material and to ensure a high quality of graduates. The University Examination Regulations should be consulted for the complete set of rules which govern progression.

Year 1 to Year 2

To progress to the second year of the MSci Theoretical Physics with Mathematics degree, students should normally have at least an average of 10.3 aggregation points in each of PHYS100, MATH100 and MATH110.

Progression in Part II

A student on the MSci Theoretical Physics with Mathematics degree shall normally be required to re-register for a BSc Theoretical Physics with Mathematics degree and be subject to the BSc requirements if they do not achieve, at the first sitting, an average mark of 14.5 aggregation points or more over all modules taken in the second year. In exceptional circumstances the department may exercise discretion.

In order to progress to the fourth year of the MSci Theoretical Physics with Mathematics degree, students must achieve, at the first sitting, an average mark of 14.5 aggregation points over all modules taken in the second and third years with no more than 30 credits condoned in total. At its meeting in June of the third year, the board of examiners shall review the overall performance of all students registered for the MSci scheme. Any student who does not meet the requirement shall be considered for the award of a classified BSc on the basis of the marks obtained.

9.1.5 MSci - Theoretical Physics with Mathematics Timetable and Assessment

The tables following show the compulsory and options choices for your course. For full details of the maths modules please refer to the Mathematics Courses documents.

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS272	Exp. Phys., Skills & Mechanics	M6-10, L11-15	21L,4S,15P	Dr B Robinson Dr C K Bowdery Dr A Romito
MATH211	Intro Real Analysis	M1-5	15L,5T	Prof J M Lindsay
MATH215	Complex Analysis	L11-20	30L,10T	TBA
MATH220	Linear Algebra	M1-10	30L,10T	Dr D A Towers
MATH226	Groups	L11-15	15L,5T	Dr P Levy

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS378	TPM Independent Study	M1-10	20P	Dr N Drummond Dr A Romito Dr J Gratus
PHYS379	Theory & TPM Group Project	L11-20	4L,10P,6W	Dr E McCann

Must take 2 modules from the following:

MATH317	Hilbert Space	M6-10	20L,5T	Prof J M Lindsay
MATH318	Differential Equations	M6-10	20L,5T	Dr D Elton
MATH321	Groups & Symmetry	M1-5	20L,5T	Dr D Elton
MATH325	Representation Theory	L16-20	20L,5T	Dr D A Towers

Year 4

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS451	MPhys Project	M/L/S	≈100	*Supervisor*
PHYS452	MPhys Literature Review	S27-30,Vac	≈30	*Supervisor*

and

PHYS411,481-487	3 - Optional Modules.	M1-10/ L11-20	48L,12S	*Various*
MATH412	Topology & fractals	M6-10	10L,5T	Prof S Power

Must take 1 module from the following:

MATH411	Operator Theory	L11-15	10L,5T	Prof M Lindsay
MATH417	Hilbert Space	M6-10	10L,5T	TBA
MATH425	Representation Theory of Finite Groups	L16-20	20L,5T	Dr D Towers

10 Part II BSc (all schemes)

Edition 1.7 2016/2017

The BSc degree is a three year undergraduate honours degree course.

The scheme follows the Lancaster pattern of a three subject Part-I followed by a specialised Part-II. All prospective Physics majors must normally take the Part-I courses PHYS100, PHYS110 and PHYS130. At the beginning of the second year students will be registered for one of the possible themes which lead to a BSc degree. During the second year students concentrate on the core physics modules, but also commence specialist theme specific modules starting in the Lent term (see section 6.3 for more details). These continue through the third year where there is also a significant component of project work, and an opportunity for further specialisation through choice of optional lecture modules. At the end of the three years, the BSc will be awarded for the separate degree schemes: Physics; Physics, Astrophysics and Cosmology; Theoretical Physics, etc. There is also the BSc Physics (Study Abroad) degree scheme involving a year overseas.

10.1 Academic Advisors

2nd Year	Prof G V Borissov	Room B16 P, Tel 94612
2nd Year	Dr H Fox	Room B20 P, Tel 93616
3rd Year	Dr K Dimopoulos	Room A41 ST, Tel 93645
3rd Year	Dr A Marshall	Room A21 P, Tel 94072

10.2 BSc Degree Classification Rules

Under the regulations, a final mark for each module is obtained using the published relative weightings for coursework and examination. This final module mark (either percentage or letter grade) is converted to an aggregation score on a scale of 0 to 24. If a module mark is below an aggregation score of 9, it is deemed to be a fail mark.

Resits and condonation

If the mark profile contains a failed module, then there are several possibilities:

- In any year other than the final year of study, a resit must be attempted, usually during the late summer resit period. This may take the form of an exam, coursework or both.
  - If the subsequent resit mark is above 9 aggregation points, then the module is passed but the mark in the overall profile is capped at 9.

  - If the mark is between 7 and 9, the the failure may be **condoned** subject to the limits outlined below on the maximum number of condoned fails.
  - If the mark is less than 7, then then you cannot proceed and, subject to the normal appeals process, exclusion from the University will result.

- In the final year of study, year 3 for a BSc,
  - If the mark is between 7 and 9, then the failure may be **condoned** at the June final board of examiners meeting, subject to the limits outlined below on the maximum number of condoned fails, and a degree awarded.
  - If the mark is less than 7, a resit must be attempted. This means that graduation is not possible in July. The form of the resit may be an exam, coursework or both with exams usually taken during the late summer resit period.
  - To qualify for a degree, the resit mark must not be less than 7. If between 7 and 9, then condonation will be required, subject to the limits outlined below on the maximum number of condoned fails.
  - The resit mark will not change the class of degree awarded; resit is for credit only. The original first attempt mark is used in the classification of your degree.

The maximum number of credits that can be condoned and an honours degree awarded is 30. The examination board can, at its discretion, condone an additional 30 credits to a total of 60 credits maximum to permit the award of a pass degree.

The final aggregation score for the year or degree is calculated using the credit weighted average of the individual module aggregation scores. The final degree classification awarded is determined using the following table

Class	Agg. Score
first class honours	17.5 – 24.0
either 1st or upper second class	17.1 – 17.4
upper second classs honours	14.5 – 17.0
either upper second class or lower second class	14.1 – 14.4
lower second class honours	11.5 – 14.0
either lower second class or third	11.1 – 11.4
third class honours	9.0 – 11.0
discretionary pass degree or fail	8.1 –8.9
fail	0.0 – 8.0

Borderlines

The following rules will be used for deciding the degree class for students whose overall average mark lies in a borderline region between degree classes (the ”either ... or ...” ranges in the table above).

- For all students on Bachelors programmes, where a student falls into a borderline then the higher award should be given where either half or more of the credits from Part II are in the higher class or the final year average is in the higher class.
- Borderline students not meeting either of these criteria would normally be awarded the lower class of degree.
- For all students, borderline or not, Examination Boards should make a special case to the Committee of Senate for any student where the class of degree recommended by the Board deviates from that derived from a strict application of the regulations. Such cases would be based around circumstances pertaining to individual students where these circumstances have not already been taken into account.

Assessment

Normally all Part II lecture modules are assessed by Coursework (20%) and examination (80%). Laboratory modules, projects etc are all 100% coursework assessment (which includes assessed presentations and oral examinations).

10.3 BSc Progression Rules

To progress from year 2 to year 3 in BSc degrees, you must achieve, following all opportunities for reassessment, an overall aggregation score of 9.0 with no more than 30 credits condoned.

10.4 Variations for BSc Physics (Study Abroad)

Students spend the 2nd year of a 3 year BSc course overseas.

In order to progress to the year abroad students are normally expected to obtain at least an average of 15 aggregation points in both PHYS100 and PHYS110 and at least 12 aggregation points in PHYS130 at the first attempt. Resits are not possible given the timings of the overseas university terms.

The year abroad is spent at one of a small group of selected institutions whose courses have been found to be suitably matched to those of the Lancaster Department. Modules taken in Lancaster in the year preceding the year abroad are selected to optimise the progression from Lancaster to the overseas university. The final choice of overseas institution and courses to be followed is made by the Study Abroad Academic Advisor, Dr D A Burton, taking into account a number of factors, one of which is the student's own preference.

Whilst overseas students are required to keep in regular contact with their Academic Advisor via e-mail, and any changes to their courses must be first agreed with them.

The grades obtained overseas, on the A, B, C... etc scale, are directly translated into Lancaster marks by an open and flexible scheme involving full consultation with a student.

The basic scheme may be modified significantly by evidence or prior knowledge of various factors, such as the difficulty of the courses in relation to the prerequisites taken at Lancaster, population of the class, for example whether postgraduate/undergraduate, and total number of courses taken. The translation of grades is confirmed by the final year examining committee.

Further information on details of the Study Abroad scheme may be found by consulting the University's International Office.

11 BSc - Timetable and Assessment

Edition 1.7 2016/2017

11.1 BSc - Physics

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS253	Experimental Lab I	L11-15	30P	Dr Q D Zhuang Prof A Krier
PHYS254	Experimental Lab II	L16-20	30P	Dr Q D Zhuang Prof A Krier
PHYS255	Experimental Lab III	S21-25	30P	Dr Q D Zhuang Prof A Krier
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin

either

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS351	Semiconductor Physics Laboratory	M1-5	30P	Prof A Krier
PHYS352	Low Temperature Physics Laboratory	L11-15	30P	Dr D I Bradley
PHYS353	Particle Physics Group Project	M/L4-13	30P	Dr H O'Keeffe Dr A Blake

and

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS263,323,366 PHYS367,384,388 PHYS389,390 PHYS483,485,486	2 - Optional Modules	M6-10/ L11-15/ L16-20	48L,12S	*Various*

or

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS355	Industrial Group Project	M/L/S1-15	90P	Dr M Hayne

and

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS263,323,366 PHYS367,384,388 PHYS389,390 PHYS483,485,486	3 - Optional Modules	M6-10/ L11-15/ L16-20	48L,12S	*Various*

11.2 BSc - Physics, Astrophysics and Cosmology

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS263	Astronomy	L11-15	16L,4S	Dr D Sobral
PHYS264	Astrophysics I	S21-24	16L,4S	Dr A Koch
PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS361	Cosmology II	M1-5	16L,4S	Dr A Mazumdar
PHYS362	Astrophysics II	L16-20	16L,4S	Dr C Arridge
PHYS363	Astrophysics Laboratory	M6-10	30P	Dr D I Bradley Dr A Grocott
PHYS364	Cosmology Group Project	L11-20	2L,30P,6W	Dr J McDonald Dr K Dimopoulos
PHYS323,366,367 PHYS384,388,389 PHYS390,483,485 PHYS486	1 - Optional Modules	M6-10/ L11-15/ L16-20	32L,8S	*Various*

11.3 BSc - Physics with Particle Physics & Cosmology

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS256	Experimental Particle Physics	S21-25	30P	Dr A Blake Dr H Fox
PHYS263	Astronomy	L11-15	16L,4S	Dr D Sobral
PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS361	Cosmology II	M1-5	16L,4S	Dr A Mazumdar
PHYS366	Groups & Symmetries	L11-15	16L,4S	Dr J Gratus
PHYS367	Flavour Physics	L16-20	16L,4S	Dr J Nowak

either

PHYS353	Particle Physics Group Project	M/L4-13	30P	Dr H O'Keeffe Dr A Blake

or

PHYS364	Cosmology Group Project	L11-20	2L,30P,6W	Dr J McDonald Dr K Dimopoulos

and

PHYS323,384,388 PHYS389,390 PHYS483,485,486	1 - Optional Module	M6-10/ L11-15/ L16-20	16L,4S	*Various*

11.4 BSc - Physics, Astrophysics & Space Science

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS263	Astronomy	L11-15	16L,4S	Dr D Sobral
PHYS264	Astrophysics I	S21-24	16L,4S	Dr A Koch
PHYS268	Space Physics	L16-20	16L,4S	Not Running 2016/2017
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS362	Astrophysics II	L16-20	16L,4S	Dr C Arridge
PHYS363	Astrophysics Laboratory	M6-10	30P	Dr D I Bradley Dr A Grocott
PHYS368	Aurora-Atmospheric Physics	M1-5	16L,4S	Not Running 2016/2017
PHYS369	Space Science Group Project	L11-20	2L,30P,9W	Not Running 2016/2017
PHYS265,323,366 PHYS367,384,388 PHYS389,485,486	1 - Optional Modules	M6-10/ L11-15/ L16-20	32L,8S	*Various*

11.5 BSc - Theoretical Physics

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS211	Maths I	M1-10	31L,4S,4W	Prof G V Borissov
PHYS213	Maths II	L11-20	21L,4S,4W	Prof R P Haley
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	L11-20	21L,4S,4W	Prof A Thomas
PHYS265	Cosmology I	L16-20	16L,4S	Dr K Dimopoulos
PHYS273	Theor.Phys.I - Mech.& Vars.	L11-15	16L,4S	Dr A Romito
PHYS274	Theor.Phys.II - Class.Fields	S21-24	16L,4S	Dr J McDonald
PHYS281	Scientific Programming & Modelling Project	M1-10	10L, 40P	Prof I A Bertram Dr J Nowak

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	L16-20	10W	Dr D I Bradley
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS366	Groups & Symmetries	L11-15	16L,4S	Dr J Gratus
PHYS375	Theoretical Physics Independent Study	M1-10	25L,15W	Dr N Drummond Dr A Romito Dr J Gratus
PHYS379	Theory & TPM Group Project	L11-20	4L,10P,6W	Dr E McCann
PHYS263,323,361 PHYS367,384,389 PHYS390,483,485 PHYS486	1 - Optional Modules	M6-10/ L11-15/ L16-20	48L,12S	*Various*

12 BSc Joint Honours

Edition 1.7 2016/2017

12.1 BSc Theoretical Physics with Mathematics

The BSc in Theoretical Physics & Mathematics is a three year honours course. This degree scheme exposes students to modern methods and new ideas in Theoretical and Mathematical Physics. In the first two years, it includes both Physics and pure Mathematics courses followed by advanced courses in Theoretical Physics and Mathematical Methods in year 3. The degree is taught jointly by the Department of Physics and the Department of Mathematics.

Students will obtain research skills in modern techniques of Mathematical Physics built upon a strong foundation in Algebra, Analysis, Group Theory, Differential Geometry and Topology.

Students are offered close individual supervision throughout, and a variety of options from the above courses are available for individual research projects during the third year. Able students will develop flexible skills that are transferable to a variety of other professions, or higher research degrees.

Theoretical Physics Tutors: Dr N Drummond.

Mathematics Tutor: Dr G Tunnicliffe-Wilson.

12.1.1 Course Structure

Part I

In Part I, students take the first year course in Physics (PHYS101-105,115), a self-contained survey of physics, and the two first year courses Mathematics (MATH101-105 and MATH111-114). Details of all courses taught by the Department of Mathematics may be found on their Web site, the first year Mathematics course description and student handbook is available via Mathematics Courses.

Part II

Part II of the degree scheme, years 2 & 3 comprise approximately equal parts of Theoretical Physics and of Mathematics.

12.1.2 Academic Advisor

2nd Year	Prof G V Borissov	Room B16 P, Tel 94612
2nd Year	Dr H Fox	Room B20 P, Tel 93616
3rd Year	Dr K Dimopoulos	Room A41 ST, Tel 93645
3rd Year	Dr A Marshall	Room A21 P, Tel 94072

12.1.3 Classification of Degrees

The classification rules for the BSc Theoretical Physics with Mathematics degree are identical to those for other BSc degrees, given in section 10.2.

12.1.4 Progression Through the Course

The department places several "hurdles" to be cleared by students passing through the BSc Theoretical Physics with Mathematics course. These are set to ensure students are properly prepared for the more advanced material and to ensure a high quality of graduates. The University Examination Regulations should be consulted for the complete set of rules which govern progresssion. The additional rules specific to this scheme are given below.

Year 1 to Year 2

Additional regulations apply to Physics majors. These are:

- Students must normally be in Good Academic Standing, see section 1.19.
- To progress to the second year of the BSc Theoretical Physics with Mathematics degree, students should normally have at least 10.3 aggregation points in PHYS100, MATH100 and MATH110. In addition, at least a minimum of 9.0 aggregation points is required in both the coursework and exam components of each of these Part I subjects.

Progression in Part II

Progression rules in Part II of the BSc Theoretical Physics with Mathematics degree scheme are the same as the progression rules specified for the BSc, Progression all Schemes, see section 10.3. To progress from year 2 to year 3 in BSc degrees, you must achieve, following all opportunities for reassessment, an overall aggregation score of 9.0 with no more than 30 credits condoned.

12.1.5 BSc - Theoretical Physics with Mathematics Timetable and Assessment

The tables following show the compulsory and options choices for your course. For full details of the maths modules please refer to the Mathematics Courses documents.

Timetable of Modules

Year 2

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS222	Electromagnetism, Waves & Optics	M1-10	44L,6S,4W	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	L11-20	31L,4S,4W	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	M6-10, S21-24	26L,4S	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS272	Exp. Phys., Skills & Mechanics	M6-10, L11-15	21L,4S,15P	Dr B Robinson Dr C K Bowdery Dr A Romito
MATH211	Intro Real Analysis	M1-10	15L,5T	Prof J M Lindsay
MATH215	Complex Analysis	L11-20	30L,10T	TBA
MATH220	Linear Algebra	M1-10	30L,10T	Dr D A Towers
MATH226	Groups	L11-20	15L,5T	Dr P Levy

Year 3

Module	Title	Term/Wks	Hours	Lecturer/Organiser
PHYS311	Particle Physics	M1-10	31L,4S	Dr H O'Keeffe
PHYS313	Solid State Physics	L11-20	31L,4S	Dr L Ponomarenko Dr J Prance
PHYS321	Atomic Physics	M1-5	16L,4S	Dr A Blake
PHYS322	Statistical Physics	M6-10	16L,4S	Prof Y Pashkin
PHYS378	TPM Independent Study	M1-10	20P	Dr N Drummond Dr A Romito Dr J Gratus
PHYS379	Theory & TPM Group Project	L11-20	4L,10P,6W	Dr E McCann

select 2 modules from the following

MATH317	Hilbert Space	M6-10	20L,5T	Prof J M Lindsay
MATH318	Differential Equations	M6-10	20L,5T	Dr D Elton
MATH321	Groups & Symmetry	M1-5	20L,5T	Dr D Elton
MATH325	Representation Theory	L16-20	20L,5T	Dr D A Towers

13 Details of Modules

Edition 1.7 2016/2017

The following pages provide details of all the lecture, laboratory and project modules offered to undergraduates taking degree schemes (or part degree schemes) in physics. The following notes should be read in conjunction with them.

The information in this book is correct (to the best of our knowledge!) at the time of publishing. The Department reserves the right to change or withdraw modules whenever necessary. In particular, not all optional modules may be available in a particular year.

All modules are described by a standard page of information as illustrated below:

PHYS*npq* Module Title

Lecturer:	Module Lecturer			
Lect/Sem/WrkShp:	16L,4S			
Timing:	Year	1	Weeks:	Timing
Pre-requisites:	None			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS000			
Credits:	4			
Workload:	Contact time	25 hrs	Private study	55 hrs

Assessment type:

% style:	marking is on a quantitative % marking scheme
letter grade:	work is generally more qualitative e.g. reports, essays - see (see Section 1.12)
mixed % style & letter grade:	a mixture of the above

Academic Aims: Here the Department specifies what its aims are in teaching the module

Learning Outcomes: Here the Department specifies what you, as a student, can be expected to do on completion of the module, both the direct contact part and the private study part.

Syllabus:

Books: Recommended books for this module

Pre-requisites - Unless stated otherwise, these are usually preferred requirements and should be seen as an indicator of the background material which the lecturer (or organiser) will be using as starting point for a particular model. For students coming from other Universities, a course or module at an equivalent level from their home institution should be taken as an appropriate pre-requisite.

Credit refers to the weight of a module. Every year, you enrol for a total of 120 credits.

Linked modules - share common themes or material with the specified module or are part of a series of modules which develop a particular topic in physics.

Module books - are listed in the following categories:

- (E) an essential book
- (R) a recommended book
- (B) background reading

A number of books are recommended for more than one module. Where a book is out of print, it will only be recommended if there are copies in the University Library. Queries about recommended books should be directed to the lecturer or organiser responsible for the particular module.

13.1 Module List

PHYS100	Part I Physics	
PHYS101	The Physical Universe	Prof I A Bertram
PHYS102	Classical Mechanics	Dr O Kolosov
PHYS103	Electric & Magnetic Fields	Dr H Fox
PHYS104	Thermal Properties of Matter	Dr S Kafanov
PHYS105	Quantum Physics	Dr J Nowak
PHYS110	Physical Systems	
PHYS111	Functions & Differentiation	Dr D Sobral
PHYS112	Integration	Dr A Mazumdar
PHYS113	Series & Differential Equations	Dr J McDonald
PHYS114	Complex Methods	Prof I Hook
PHYS115	Vector Calculus	Dr J Stott
PHYS120	Universe as an Art	
PHYS121	Planets, Stars and Galaxies	Not Running 2016/2017
PHYS122	Space Time and Gravity	Not Running 2016/2017
PHYS123	The Microscopic World	Not Running 2016/2017
PHYS124	Origins and Evolution	Not Running 2016/2017 Not Running 2016/2017
PHYS125	The Big Issues	Not Running 2016/2017

PHYS130	Physics Skills	
PHYS131	Vectors & Vector Algebra IT Skills	Lect: Dr J Prance Lab: Dr J Nowak Dr H Fox Prof A Stefanovska
PHYS132	Basic Physics Skills Communication Skills	Lect: Dr A Koch Lab: Dr A Marshall Prof R W L Jones
PHYS133	Oscillations & Waves Practical Laboratory I	Lect: Dr A Marshall Lab: Dr L Ray Prof Y Pashkin Dr A Marshall
PHYS134	Electrical Circuits & Instruments Practical Laboratory II	Lect: Dr A Grocott Lab: Dr L Ray Prof Y Pashkin Dr A Marshall
PHYS135	Optics & Optical Instruments Practical Laboratory III	Lect: Prof G V Borissov Lab: Dr L Ray Prof Y Pashkin Dr A Marshall

PHYS211	Maths I	Prof G V Borissov
PHYS213	Maths II	Prof R P Haley
PHYS221	Electromagnetism	Dr A Mazumdar
PHYS222	Electromagnetism, Waves & Optics	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics
PHYS223	Quantum Mechanics	Dr N Drummond
PHYS232	Relativity, Nuclei & Particles	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles
PHYS233	Thermal Properties of Matter	Prof A Thomas
PHYS252	Introduction to Experimental Lab	Dr B Robinson Dr C K Bowdery
PHYS253	Experimental Lab I	Dr Q D Zhuang Prof A Krier
PHYS254	Experimental Lab II	Dr Q D Zhuang Prof A Krier
PHYS255	Experimental Lab III	Dr Q D Zhuang Prof A Krier
PHYS256	Experimental Particle Physics	Dr A Blake Dr H Fox
PHYS263	Astronomy	Dr D Sobral
PHYS264	Astrophysics I	Dr A Koch
PHYS265	Cosmology I	Dr K Dimopoulos
PHYS268	Space Physics	Not Running 2016/2017
PHYS272	Exp. Phys., Skills & Mechanics	Dr B Robinson Dr C K Bowdery Dr A Romito
PHYS273	Theor.Phys.I - Mech.& Vars.	Dr A Romito
PHYS274	Theor.Phys.II - Class.Fields	Dr J McDonald
PHYS281	Scientific Programming & Modelling Project	Prof I A Bertram Dr J Nowak

PHYS311	Particle Physics	Dr H O'Keeffe
PHYS313	Solid State Physics	Dr L Ponomarenko Dr J Prance
PHYS320	Gen Phys Exam	Dr D I Bradley
PHYS321	Atomic Physics	Dr A Blake
PHYS322	Statistical Physics	Prof Y Pashkin
PHYS323	Physics of Fluids	Dr D A Burton
PHYS351	Semiconductor Physics Laboratory	Prof A Krier
PHYS352	Low Temperature Physics Laboratory	Dr D I Bradley
PHYS353	Particle Physics Group Project	Dr H O'Keeffe Dr A Blake
PHYS354	Literature Review	Prof A Stefanovska
PHYS355	Industrial Group Project	Dr M Hayne
PHYS361	Cosmology II	Dr A Mazumdar
PHYS362	Astrophysics II	Dr C Arridge
PHYS363	Astrophysics Laboratory	Dr D I Bradley Dr A Grocott
PHYS364	Cosmology Group Project	Dr J McDonald Dr K Dimopoulos
PHYS366	Groups & Symmetries	Dr J Gratus
PHYS367	Flavour Physics	Dr J Nowak
PHYS368	Aurora-Atmospheric Physics	Not Running 2016/2017
PHYS369	Space Science Group Project	Not Running 2016/2017
PHYS375	Theoretical Physics Independent Study	Dr N Drummond Dr A Romito Dr J Gratus
PHYS378	TPM Independent Study	Dr N Drummond Dr A Romito Dr J Gratus
PHYS379	Theory & TPM Group Project	Dr E McCann
PHYS384	Physics of Living Systems	Prof A Stefanovska
PHYS385	Adv. Nanoscale Microscopy	Not Running 2016/2017
PHYS386	Physics of Global Warming	Not Running 2016/2017
PHYS388	Energy	Dr M Hayne
PHYS389	Computer Modelling	Prof I A Bertram

PHYS411	Adv. Rel. & Gravity	Dr K Dimopoulos
PHYS412	Experimental Methods in Particle Physics	Dr R Henderson
PHYS451	MPhys Project	*Supervisor*
PHYS452	MPhys Literature Review	*Supervisor*
PHYS461	Cosmology III	Dr J McDonald
PHYS462	Gauge Theories	Dr R Henderson
PHYS463	Solar-Planetary Physics	Dr A Grocott
PHYS464	Astrophysics III - Galaxies	Prof I Hook
PHYS481	Advanced Magnetism	Dr D A Burton
PHYS482	Quantum transport in low dimensional nanostructures	Dr N Drummond
PHYS483	Quantum Information Processing	Prof H Schomerus
PHYS484	Adv. Electrodynamics & Grav.	Dr J Gratus
PHYS485	Matter at Low Temp	Dr S Kafanov
PHYS486	Lasers and Applications	Dr Q D Zhuang
PHYS487	Semiconductor Device Physics	Prof A Krier

13.2 Year 1

13.2.1 PHYS101 The Physical Universe

PHYS101 The Physical Universe				
Lecturer:	Prof I A Bertram		(Shadow:	Prof R P Haley)
Lect/Sem/WrkShp:	16L,4S,5W			
Timing:	Year	1	Weeks:	M1-5
Pre-requisites:	A-Level Maths or equiv			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS102-105, PHYS131-135			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	55 hrs

Academic Aims:

To give a road map of the Part I Physics course and introduce the scales and dimensions of the classical and quantum worlds.

To give a basic understanding of the physical principles which are fundamental to mechanics. The classical laws of Newton relating to forces and motion are discussed.

To give an understanding of the origin of conservation laws.

To give an understanding of the limitations of Newton's laws of motion, particularly in the context of special relativity.

Learning Outcomes:

On completion of the module, students should be able to:

- understand the nature and methods of physics.
- appreciate the different scales of the Universe and the different areas of physics which relate to them.
- recognise the fundamental laws of mechanics, kinematics and dynamics.
- understand the principles of the conservation of energy and momentum.

- understand the concept of special relativity and be able to model simple situations quantitatively.
- apply their knowledge to modelling real phenomena and situations.

Syllabus:

The nature of physics. Experiment and uncertainty. Modelling. Deterministic vs. probabilistic.

Standards and units. Uncertainty and significant figures. Order of magnitude estimates. Dimensional analysis.

Relativity. Frames of reference. Galilean transformation.

Kinematics. Position, displacement, velocity and acceleration vectors. Motion in a straight line with constant acceleration. Motion in 2 dimensions. Projectile, circular motion.

Dynamics. Newton's laws. Concepts of force and energy. Relations between force, momentum, energy, power. Kinetic and potential energy. Conservation of energy and momentum. Collisions, impulse.

Special relativity. Einstein's postulates. Simultaneity, time dilation, length contraction. Lorentz transformation. Momentum, work and energy.

Chapters 1-8, 37 in Y&F

Workshops:

The module includes workshops, run by the lecturer and postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(E) H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

(R) Kaufmann & Freedman, Universe, Freeman

13.2.2 PHYS102 Classical Mechanics

PHYS102 Classical Mechanics				
Lecturer:	Dr O Kolosov		(Shadow:	Dr J Nowak)
Lect/Sem/WrkShp:	16L,4S,5W			
Timing:	Year	1	Weeks:	M6-10
Pre-requisites:	PHYS101 PHYS111 PHYS131, Maths A-Level or equiv			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS103-105, PHYS112, PHYS131-135			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

To apply the ideas of fundamental Newtonian mechanics to real large scale systems such as rotating bodies, planetary systems and classical fluids.

Learning Outcomes:

On completion of the module, students should be able to:

- understand the central importance of gravitation in determining the large-scale behaviour of the Universe.
- appreciate how to extend the principles of basic kinematics and dynamics to rotational situations.
- recognise the concepts involved in basic kinematics and dynamics of rotational situations.
- recognise the working of basic processes in the properties of materials, that is solids, liquids and gases.
- apply their knowledge to modelling real phenomena and situations.

Syllabus:

Relation between force, work and potential energy.

Rotation of rigid bodies. Dynamics of rotational motion. Torque. Energy of rotation.

Moment of inertia. Centre of mass. Angular momentum. Gyroscopes.

Equilibrium. Properties of solids. Elasticity.

The gravitational force. Inertial and gravitational mass. Mach's principle.

Use of gravitational potential energy. Escape speed. Spherical mass distributions. Black holes. Dark matter.

Motion of satellites and planetary orbits.

Properties of fluids. Fluid dynamics. Viscosity.

Y&F chapters 6-7, 9-12, 14.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(E) H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

13.2.3 PHYS103 Electric & Magnetic Fields

PHYS103 Electric & Magnetic Fields

Lecturer:	Dr H Fox		(Shadow:	Dr K Dimopoulos)
Lect/Sem/WrkShp:	16L,4S,5W			
Timing:	Year	1	Weeks:	L11-15
Pre-requisites:	PHYS101 and PHYS102, A-Level Maths or equiv			
Assessment:	Examination	60%	Courswork	40%.
Assessment Type:	% style			
Linked Modules:	PHYS101, 102, 104, 105, PHYS131-135			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

To describe the basic laws and ideas of electromagnetism, starting with electrostatics.

To introduce the ideas of force and potential, already experienced in PHYS101 and PHYS102 in the context of electromagnetism.

To stress the similarities and differences between electric and magnetic fields.

Learning Outcomes:

On completion of the module, students should be able to:

- appreciate the close inter-relation of electricity and magnetism.
- display a familiarisation with fundamental electric and magnetic phenomena.
- understand the basic concepts through which the phenomena are described, in particular those of charge, current, field, and potential.
- apply their knowledge to modelling real phenomena and situations.
- discuss and use the basic concepts of electric and magnetic field and forces

- calculate forces, fields in certain physical situations
- discuss the concepts of force and potential

Syllabus:

Electric charge. Coulomb's law. Electric fields, field lines and forces. Electric dipoles. Electric flux. Gauss's law.

Electric potential and potential energy. Potential difference and gradient. Capacitance. Series and parallel. Energy storage. Dielectrics. Polarisation.

Magnetic field, flux, and force. Motion of charged particles in a magnetic field. Force on a current-carrying conductor. Magnetic dipole/current loop, force and torque.

Origin of magnetic fields. Field due to a (uniformly)moving charge. Force between parallel wires carrying current. Ampere's law and applications.

Electromagnetic induction. Faraday's law, Lenz's law. Motional EMF. Induced fields.

Y&F chapters 22-25 and 28-30

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(E) H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

13.2.4 PHYS104 Thermal Properties of Matter

PHYS104 Thermal Properties of Matter

Lecturer:	Dr S Kafanov		(Shadow:	Prof R P Haley)
Lect/Sem/WrkShp:	16L,4S,5W			
Timing:	Year	1	Weeks:	L16-20
Pre-requisites:	PHYS101, PHYS102, A-Level Maths or equiv			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS101, 102, 103, 105, PHYS131-135			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

To describe the thermal properties of matter and relate these to the fundamental mechanical properties of these systems.

Learning Outcomes:

On completion of the module, students should be able to:

- appreciate the role of thermodynamics in describing macroscopic physical situations.
- display a familiarity with fundamental thermal phenomena.
- understand the basic concepts through which the phenomena are described, in particular those of temperature, work, heat, internal energy and entropy.
- apply their knowledge to modelling real phenomena and situations.

Syllabus:

Temperature and heat. Thermal equilibrium. Zeroth law of thermodynamics. Thermal expansion. Temperature scales. Mechanisms of heat transfer. Phase changes. Black body radiation. Stefan-Boltzmann law.

Equations of state. Kinetic model of an ideal gas. Molecular speeds. Equipartition of energy.

First law of thermodynamics. Work done. Different types of thermodynamic process, Thermodynamic states. Internal energy. Thermal capacity. Especially of an ideal gas.

Second law of thermodynamics. Heat engines. Refrigerators. Carnot cycle. Kelvin temperature scale. Entropy. Microscopic interpretation.

Chapters in 'Young' Ed.11: Temperature and Heat 17; Thermal Properties of Matter and Kinetic Theory 18; Thermodynamics and the 1st Law 19; Heat Engines 20.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(E) H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

13.2.5 PHYS105 Quantum Physics

PHYS105 Quantum Physics				
Lecturer:	Dr J Nowak		(Shadow:	Dr E McCann)
Lect/Sem/WrkShp:	16L,4S,5W			
Timing:	Year	1	Weeks:	S21-25
Pre-requisites:	PHYS101, PHYS102, PHYS103, PHYS104, A-Level Maths or equiv			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS101-104, PHYS131-135			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

The module aims to describe the quantum world, introducing the uncertainty principle and the probabilistic description furnished by quantum mechanics.

Learning Outcomes:

On completion of the module, students should be able to:

- appreciate that the ultimate description of the physical universe requires quantum not classical mechanics.
- display a familiarity with the specific experiments which led to the breakdown of classical physics.
- understand the basic ideas of wave mechanics, especially wave particle duality, the probabilistic nature of phenomena, and the uncertainty principle.
- appreciate the Schrödinger equation and its solution for simple situations.
- apply their knowledge to modelling real phenomena and situations.

Syllabus:

Photoelectric effect. Work function. Energy of a photon. Franck-Hertz experiment. Spectra. Emission and absorption. The hydrogen spectrum.

The nuclear atom. Rutherford scattering experiment. Bohr model of the atom. Discrete energy levels. Stable orbits.

Wave particle duality. De Broglie waves. Electron diffraction. Single slit diffraction. Probabilistic interpretation. Uncertainty principle. Wave function and interpretation.

The Schrödinger equation and pseudo-derivation from classical mechanics. Particles in a box. Potential wells. Tunnelling.

Chapters 38-40 in Y&F

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(E) H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

13.2.6 PHYS111 Functions & Differentiation

PHYS111 Functions & Differentiation

Lecturer:	Dr D Sobral		(Shadow:	Prof J Wild)
Lect/Sem/WrkShp:	11L,4S,5W			
Timing:	Year	1	Weeks:	M1-5
Pre-requisites:	A-Level Maths			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS112-5			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

To provide a sound basis knowledge of functions. To give a sound understanding of differentiation and to apply these to modelling physical systems.

Learning Outcomes:

On completion of the module, students should be able to:

- recognise basic mathematical functions used in the description of physical phenomena, and their graphical representation
- understand the fundamental principle of differentiation, and its relation to the slope of a graph
- differentiate basic functions directly, and to use systematic techniques for combinations of functions
- apply their knowledge to modelling real phenomena and situations.

Syllabus:

Symbolic manipulation. Distinction between arithmetic of numbers and algebra of symbols.

Symbols representing real numbers, their powers and inequalities.

Cartesian coordinates, real valued functions and their graphs in 2D and 3D

Angular measures (radians and degrees) and 2D and 3D polar coordinates.

Periodic functions. Trigonometric functions.

Inverse functions.

Graphical location of real roots of quadratic and cubic equations

Graphs of ax^n for constant $a > 0$.

Exponential function and notion of limits. Natural logarithm. Hyperbolic functions.

Slope of a graph. The derivative of a real valued function of one variable.

Rates of change and derivative of x^n.

Derivatives of sums and multiplication by constants

Derivatives of exponentials, logs and trig functions

Higher order derivatives

Product and chain rule

Logarithmic, parametric and implicit differentiation

Partial differentiation

Determination of extrema of graphs (2D and 3D) and curve sketching. Extraction of small changes.

Workshops:

The module includes a 1 hour workshop each week, run by the lecturer and postgraduate teaching assistants, as an extra learning aid, to develop problem solving skills, and to help tackle coursework assignments.

Books:

(E) D W Jordan & P Smith, Mathematical Techniques, OUP

13.2.7 PHYS112 Integration

PHYS112 Integration				
Lecturer:	Dr A Mazumdar		(Shadow:	Dr J Prance)
Lect/Sem/WrkShp:	11L,4S,5W			
Timing:	Year	1	Weeks:	M6-10
Pre-requisites:	PHYS111			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS111, 113-5			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

To provide a firm grounding in integration techniques.

Learning Outcomes:

On completion of the module, students should be able to:

- understand the fundamental principle of single-variable integration and recognise its relation to the area under a graph
- integrate directly a variety of basic functions of one variable
- use systematic techniques to tackle more complicated integrals of one variable
- tackle important basic integrals over lines, areas and volumes

Syllabus:

- Geometric area under a graph. The relation between anti-derivatives and the signed area generated by a graph
- Limit of a sum represented by a definite integral

- Definite integrals and area
- Indefinite and improper integrals
- Systematic techniques for integration
  - Integration by parts
  - Integration by substitution (change of integration variable)
  - Simplification
- Integrals over lines
  - Parametric evaluation of integrals over lines
- Introduction to integration over areas and volumes

Jordan & Smith chapters 14,15,16,17,33

Workshops:

The module includes a 1 hour workshop each week, run by the lecturer and postgraduate teaching assistants, as an extra learning aid, to develop problem solving skills, and to help tackle coursework assignments.

Books:

(E) D W Jordan & P Smith, Mathematical Techniques, OUP

13.2.8 PHYS113 Series & Differential Equations

PHYS113 Series & Differential Equations				
Lecturer:	Dr J McDonald		(Shadow:	Dr J Gratus)
Lect/Sem/WrkShp:	11L,4S,5W			
Timing:	Year	1	Weeks:	L11-15
Pre-requisites:	PHYS111, PHYS112			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS111, 112, 114, 115			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

To develop a knowledge of series and functions.

To introduce ordinary differential equations (first and second order) and train in methods of their solution.

To develop a knowledge of the Lagrange multiplier method.

Learning Outcomes:

On completion of the module, students should be able to:

- appreciate the representation of functions by series and approximations, in particular binomial and Taylor expansions
- display a familiarity with differential equations and their use in physics
- to solve separable 1st order differential equations and linear 2nd order differential equations
- find maxima and minima subject to constraints using Lagrange multipliers
- apply a range of tests for series convergence.

Syllabus:

Differential equations and their role in physics. Methods for the solution of first order ordinary differential equations. Second order ordinary differential equations with constant coefficients. Methods for the solution of homogeneous and inhomogeneous second-order equations: auxiliary equation and trial solutions. Application to the damped harmoic oscillator.

Summation of infinite geometric series. Convergence tests: ratio, root and integral tests. Power series and radius of convergence. Taylor expansion and Taylor polynomials. Series representations of trigonometric and exponential functions. Binomial series.

Maxima and minima of functions subject to constraints using the method of Lagrange multipliers.

Workshops:

The module includes a 1 hour workshop each week, run by the lecturer and postgraduate teaching assistants, as an extra learning aid, to develop problem solving skills, and to help tackle coursework assignments.

Books:

(E) D W Jordan & P Smith, Mathematical Techniques, OUP

13.2.9 PHYS114 Complex Methods

PHYS114 Complex Methods				
Lecturer:	Prof I Hook		(Shadow:	Dr J McDonald)
Lect/Sem/WrkShp:	11L,4S,5W			
Timing:	Year	1	Weeks:	L16-20
Pre-requisites:	PHYS113			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS111-113, 115			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

To introduce the concepts of complex numbers and relate these to applications in modelling physical ideas.

Learning Outcomes:

On completion of the module, students should be able to:

- understand the principle of complex representation
- manipulate complex functions and to obtain complex roots to equations
- recognise the mathematical simplification resulting from the use of the technique to describe phenomena involving phase and amplitude
- apply their knowledge to modelling real phenomena and situations.

Syllabus:

Imaginary numbers. Real and imaginary parts, complex conjugate and modulus of a complex number. Simplification and rationalisation. Fundamental Theorem of Algebra and roots of real polynomial equations. Complex arithmetic. Argand diagram.

Complex numbers in polar form. Representation on the complex plane and the argument (phase) of a complex number. Principal value. Exponential form and Euler's formula. Use in operations on complex numbers, including roots, reciprocals, real and complex powers.

Demoivre's Theorem. Trigonometric identities, e.g. for $\cos(n\theta)$ and $\sin(n\theta)$. Roots of unity. Complex algebra. Factorizing and simplifying functions.

Relation between trigonometric and hyperbolic functions and complex exponentials. Functions of a complex variable.

Use of complex methods in AC circuit analysis. Complex representation of harmonic waves. Solution of ODE describing 1D damped oscillatory motion using complex methods. Related applications.

Workshops:

The module includes a 1 hour workshop each week, run by the lecturer and postgraduate teaching assistants, as an extra learning aid, to develop problem solving skills, and to help tackle coursework assignments.

Books:

(E) D W Jordan & P Smith, Mathematical Techniques, OUP

13.2.10 PHYS115 Vector Calculus

PHYS115 Vector Calculus				
Lecturer:	Dr J Stott		(Shadow:	Prof A Stefanovska)
Lect/Sem/WrkShp:	11L,4S,5W			
Timing:	Year	1	Weeks:	S21-25
Pre-requisites:	PHYS114			
Assessment:	Examination	60%	Coursework	40%.
Assessment Type:	% style			
Linked Modules:	PHYS111-114			
Credits:	8			
Workload:	Contact time	20 hrs	Private study	60 hrs

Academic Aims:

To develop a firm grounding in vector algebra and coordinate geometry in a physical context.

Learning Outcomes:

On completion of the module, students should be able to:

- recognise the extension of elementary ideas of functions and calculus to a 3D description based on vector fields and potentials
- to manipulate, differentiate and integrate functions of several variables
- understand the derivation and significance of concepts of div, grad and curl.
- apply their knowledge to modelling real phenomena and situations.

Syllabus:

Real functions of many variables, and their partial derivatives.

Implicit differentiation of functions of many variables and the chain rule.

Scalar and vector fields in 3D. Gradient vector in 3D. Normal vector to a surface in 3D and its tangent plane.

Directional derivatives in terms of the gradient field. Perfect differentials and relation to potentials for force fields.

Parametric representation of curves, surfaces and volumes in space. Calculation of areas and volumes.

Change of variables and the Jacobian determinant. Spherical and polar cylindrical coordinates.

Line and surface integrals and their applications.

Divergence of a vector field and Gauss theorem. Curl of a vector field and Stokes theorem.

The local and global description of electromagnetic phenomena in terms of vector fields, div, grad and curl.

Workshops:

The module includes a 1 hour workshop each week, run by the lecturer and postgraduate teaching assistants, as an extra learning aid, to develop problem solving skills, and to help tackle coursework assignments.

Books:

(E) D W Jordan & P Smith, Mathematical Techniques, OUP.

(R) KF Riley & MP Hobson, Essential Mathematical Methods, CUP.

13.2.11 PHYS121 Planets, Stars and Galaxies

PHYS121 Planets, Stars and Galaxies				
Lecturer:	Not Running 2016/2017		(Shadow:	Not Running 2016/2017)
Lect/Sem:	10L,5S			
Timing:	Year	1	Weeks:	M1-6
Pre-requisites:	None			
Assessment:	Examination	50%	Coursework	50%.
Assessment Type:	mixed % style & letter grade			
Linked Modules:	PHYS122-125			
Credits:	8			
Workload:	Contact time	15 hrs	Private study	65 hrs

Academic Aims:

To inspire students by giving them insight into the fascinating science behind beautiful and extraordinary objects in the Universe.

Learning Outcomes:

On completing this module students should have an appreciation of the scale of the space, know how our understanding of the Universe influenced the birth of physics as a subject, be familiar with objects in space and how astronomers study them.

Syllabus:

Introduction; Astronomical numbers; Copernican revolution; Electromagnetic radiation; Telescopes; Planetary bodies in motion; Introduction to the stars; The life-cycle of a star; Exotic objects; Galaxies.

Books:

(R) W J Kaufmann & R A Freedman, Universe, W H Freeman
(R) MA Seeds & DA Backmon, International Student Edition for Foundations of Astronomy, Brooks/Cole.

13.2.12 PHYS122 Space Time and Gravity

PHYS122 Space Time and Gravity				
Lecturer:	Not Running 2016/2017		(Shadow:	Not Running 2016/2017)
Lect/Sem:	10L,5S			
Timing:	Year	1	Weeks:	M6-10
Pre-requisites:	None			
Assessment:	Examination	50%	Coursework	50%.
Assessment Type:	mixed % style & letter grade			
Linked Modules:	PHYS121-125			
Credits:	8			
Workload:	Contact time	15 hrs	Private study	65 hrs

Academic Aims:

To grasp the simple but profound ideas of Einstein's Relativity which modify our sense of objective reality from absolute lengths and time intervals to relative ones.

Learning Outcomes:

On completing this module students should know about the eff8 of Special Relativity (time dilation and length contraction) and of General Relativity (warped space-time near masses, bending of light, slowing of time).

Syllabus:

Conflict between what is 'obvious' and what is measured. Breakdown of common sense notions when speeds approach light speed. Velocity of light is the same for everyone leads to Einstein's 1905 Theory of Relativity. Unification of 'space' and time. The paradoxes of time passing at different rates and lengths not being the same for everyone.

Einstein's General Theory of Relativity in 1916 extended his earlier idea. The distortion of space and time by bodies is what we call gravity. Extreme distortion leads to black holes.

Books:

Reference book: Distributed notes.

13.2.13 PHYS123 The Microscopic World

PHYS123 The Microscopic World				
Lecturer:	Not Running 2016/2017		(Shadow:	Not Running 2016/2017)
Lect/Sem:	10L,5S			
Timing:	Year	1	Weeks:	L11-15
Pre-requisites:	None			
Assessment:	Examination	50%	Coursework	50%.
Assessment Type:	mixed % style & letter grade			
Linked Modules:	PHYS121,122,124,125			
Credits:	8			
Workload:	Contact time	15 hrs	Private study	65 hrs

Academic Aims:

To appreciate the universe at the smallest scales.

Learning Outcomes:

On completing this module students should know what is meant by atoms, protons, neutrons, quarks, leptons, forces between particles, quantum wave behaviour; know the names and brief biographies of the physicists who discovered all these.

Syllabus:

Atoms from Democritos to Dalton, discovery of electrons, Thomson's atom, Rutherford and the nucleus, Bohr's atoms, de Broglie and waves, Schoedinger, Heisenberg, Dirac and the quantum world, protons and neutrons, the quarks, the Standard Model of matter and forces. Applications of these discoveries to medicine, technology, etc.

Books:

Reference books: J Gribbin - In Search of Schrödinger's Cat, Black Swan.
J Gribbin - Schrödinger's Kittens, Phoenix.
R March - Physics for Poets, McGraw Hill.
The Particle Explosion - Close, Sutton and Marten.

13.2.14 PHYS124 Origins and Evolution

PHYS124 Origins and Evolution				
Lecturer:	Not Running 2016/2017 Not Running 2016/2017		(Shadow:	Not Running 2016/2017 Not Running 2016/2017)
Lect/Sem:	10L,5S			
Timing:	Year	1	Weeks:	L16-20
Pre-requisites:	PHYS121, PHYS122			
Assessment:	Examination	50%	Coursework	50%.
Assessment Type:	mixed % style & letter grade			
Linked Modules:	PHYS121-125			
Credits:	8			
Workload:	Contact time	15 hrs	Private study	65 hrs

Academic Aims:

To apply the ideas of earlier modules to the issues: of the past, present and future of the Universe; of time itself and of life and our place in the scheme of things.

Learning Outcomes:

On completing this module students should know about the Big Bang ideas of cosmology, the physics basis for life on Earth and the cosmic and microscopic world connections with humanity being here today.

Syllabus:

Cosmology from the Big Bang to the Big Crunch or the ever expanding Universe heading towards absolute zero; life on Earth in terms of materials for life, RNA and DNA and the evolution of life from ribozymes, catastrophes including the death of the dinosaurs and the rise of the mammals.

Books:

Hogan - The Little Book of the Big Bang; Kaufmann & Freedman - Universe, 5th Ed., Freeman; R Dawkins - The Blind Watchmaker, Penguin.

13.2.15 PHYS125 The Big Issues

PHYS125 The Big Issues				
Lecturer:	Not Running 2016/2017		(Shadow:	Not Running 2016/2017)
Lect/Sem:	10L,5S			
Timing:	Year	1	Weeks:	S21-25
Pre-requisites:	PHYS121, PHYS122, PHYS123, PHYS124			
Assessment:	Examination	50%	Coursework	50%.
Assessment Type:	mixed % style & letter grade			
Linked Modules:	PHYS121-124			
Credits:	8			
Workload:	Contact time	15 hrs	Private study	65 hrs

Academic Aims:

To learn about topical areas where science meets with society and philosophy and where physics meets with the boundaries of knowledge today

Learning Outcomes:

On completing this module students should know about the topical issues of nuclear power, global warming and genetically modified organisms; about life and possibly intelligence on other planets; have a grasp of the state of philosophy in physics.

Syllabus:

Nuclear power (1 lecture); Genetic engineering (1 lecture); Global warming and climate change (1 lecture); Exobiology and the Search for Extraterrestrial Intelligence, Time (1 lecture); The philosophy of quantum theory (Copenhagen, Many Worlds, Cramer's Transactions, etc), a place for religion?
Some of these lectures will be guest lectures from other departments or from Physics.

Books:

Course specific pages on the WWW; Physics for Poets - March; Schrödinger's Kittens - Gribbin;

13.2.16 PHYS131 Vectors & Vector Algebra - IT Skills

PHYS131 Vectors & Vector Algebra - IT Skills				
Lecturer:	Lect: Dr J Prance Lab: Dr J Nowak Dr H Fox Prof A Stefanovska		(Shadow:	Lect: Dr J McDonald Lab: Prof I A Bertram)
Lect/Sem/Wkshp/Prac:	11L,4S,4W,15P			
Timing:	Year	1	Weeks:	M1-5
Pre-requisites:	A-Level Maths			
Assessment:	Examination	30%	Coursework	70%.
Assessment Type:	% style			
Linked Modules:	PHYS132, 133, 134, 135.			
Credits:	8			
Workload:	Contact time	30 hrs	Private study	50 hrs

Academic Aims:

Lecture component:

To introduce the methodology of vectors and vector algebra. To apply these to 3D motion.

Practical component:

To introduce the basic IT skills in a PC based environment.

Learning Outcomes:

Lecture component:

On completion of the module, students should be able to:

- recognise the orthogonality of the dimensions of space and the use of vectors to describe them
- demonstrate a facility with the techniques of vector algebra, including use of vector products

- apply this knowledge to modelling real phenomena and situations.

Practical component:

On completion of the module, students should be able to:

- operate common PC based word processors, spreadsheets and Internet browsers
- prepare word processed reports

Syllabus:

Lecture component:

Distinction between scalars and vectors. Real displacement vectors in 3D and their addition and multiplication by scalars. Linear independence between sets of vectors. Notion of a basis. Distinction between vectors and their components in different bases. The standard basis $\underline{i}, \underline{j}, \underline{k}$ Scalar product of two vectors and the angle between two vectors. Rotation of axes in 2D. Vector product of two vectors. Basic matrix algebra leading to 2x2 matrix determinants as an aid to calculate the vector product. Vector moment of a force about a point. Vector forces and the equilibrium of a particle under the action of several forces. Motion of a particle in terms of a time-dependent vector. Velocity and acceleration vectors. Motion in polar coordinates. Centrifugal and Coriolis acceleration. Scalar-triple product and volume of a parallelepiped. Moment of a force about an axis of rotation. Vector-triple product. Definition of a rigid body and vector angular velocity.

Y&F

Practical component:

An introduction to the PC, Internet exploration, word processing, spreadsheets, computer graphical presentation of data, symbolic computations. Word processing, including the insertion of tables and graphics into the document, with MS Word and LaTeX. Spreadsheets as an iterative calculation tools for physics problems, work with Excel, Origin and Maple programs. Report writing using Internet search and all software tools considered in this module.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(E) H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

(E) D W Jordan & P Smith, Mathematical Techniques, OUP

13.2.17 PHYS132 Basic Physics Skills - Communication Skills

PHYS132 Basic Physics Skills - Communication Skills				
Lecturer:	Lect: Dr A Koch Lab: Dr A Marshall Prof R W L Jones		(Shadow:	Lect: Prof Y Pashkin Lab: Prof Y Pashkin)
Lect/Sem/Wkshp/Prac:	11L,4S,4W,15P			
Timing:	Year	1	Weeks:	M6-10
Pre-requisites:	A-Level Maths			
Assessment:	Examination	30%	Coursework	70%.
Assessment Type:	% style			
Linked Modules:	PHYS131, 133, 134, 135.			
Credits:	8			
Workload:	Contact time	30 hrs	Private study	50 hrs

Academic Aims:

Lecture component:

PROBLEM SOLVING Identify, Set up, Execute, Evaluate “preparing, planning, working, checking”; good methods in working and presenting answers; exam question “code words”; selecting and testing maths expressions in modelling.

DATA ANALYSIS Systematic, instrumental and random uncertainties; finding values for the mean, median and standard deviation; uncertainty in the mean; combining uncertainties in sum/difference and addition/division cases; significance of uncertainty in results. Uncertainty in counts and count rates; uncertainty in graph drawing; uncertainty in functions; the effect of variously weighting data. Distribution functions (binomial, Poisson and normal Gaussian). Noise and its sources. Linear regression; correlation and its use to find uncertainty in gradients; the “Chi squared” test. Keeping a good laboratory log book.

Learning Outcomes:

Lecture component:

On completion of the module, students should be able to: appreciate the systematic approaches to solving physical problems; have a theoretical understanding of basic principles of measurement and record-keeping; assess the significance of experimental data through consideration of uncertainties and statistical analysis.

Practical component:

To provide the opportunity for learners to acquire skills and awareness that will assist in implementing informed career decisions.

On successful completion of this unit learners will be able to: demonstrate awareness of their own skills, motivations and personal and career development needs and an ability to promote these (self awareness); identify and investigate the range of career opportunities available and relevant to them through work and postgraduate study (opportunity awareness); make career related decisions taking into account personal priorities and constraints (decision learning); demonstrate the ability to apply effectively for jobs and other opportunities (transition learning); demonstrate awareness of ethical behaviour both in the context of an undergraduate physics degree and scientific research in general.

The second part of the course will improve the communication skills: to prepare efficiently a presentation; to learn the standard structure of a scientific report and gain experience in report writing.

Syllabus:

Lecture component:

Problem solving strategies. Common types of problem. Systematic approaches. Assessing the validity of a solution. Order of magnitude approach. Basic experimental skills. Making measurements, assessing errors and uncertainties, systematic and random errors, recording data, keeping log books, report writing. Propagation of uncertainties. Statistical analysis of data. Mean, median, standard deviation. Normal (Gaussian) and Poisson distributions.

Practical component:

Communication skills. Oral presentation. Structure of a formal scientific report. Preparation of OHP slides and poster (group work). Ethical behaviour in science.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

I.G. Hughes and T.P.A. Hase, Measurements and their Uncertainties, Oxford University Press, 2010

13.2.18 PHYS133 Oscillations & Waves - Practical Laboratory I

PHYS133 Oscillations & Waves - Practical Laboratory I				
Lecturer:	Lect: Dr A Marshall Lab: Dr L Ray Prof Y Pashkin Dr A Marshall		(Shadow:	Lect: Dr A Mazumdar Lab : Dr H Fox)
Lect/Sem/Wkshp/Prac:	11L,4S,4W,15P			
Timing:	Year	1	Weeks:	L11-15
Pre-requisites:	PHYS102, PHYS112			
Assessment:	Examination	30%	Coursework	70%.
Assessment Type:	% style			
Linked Modules:	PHYS131, 132, 134, 135.			
Credits:	8			
Workload:	Contact time	30 hrs	Private study	50 hrs

Academic Aims:

Lecture component:

To show how wave and oscillatory phenomena arising in quite different areas of physics can be described in a very similar way.

Practical component:

To teach basic laboratory skills and illustrate physics topics.

Learning Outcomes:

Lecture component:

On completion of the module, students should be able to:

- appreciate the wide applicability of the model of simple harmonic motion
- recognise the wave equation, and the ability to solve it for a general situation

- calculate appropriate physical parameters describing a wave
- understand the universal wave phenomena such as interference, beats, and wave packets.

Practical component:

On completion of the module, students should be able to:

- recognise a wide range of measurement instrumentation
- use and measure with common instrumentation
- appreciate the importance of uncertainties in experimental measurements and be able to apply them in an appropriate manner
- write coherent, structured reports based on their experiments

Syllabus:

Lecture component:

Periodic motion. Hooke's law. Simple harmonic motion. Simple pendulum. Physical pendulum. Driven and damped harmonic motion.

Mathematical description of waves. Speed, polarisation, energy flow. Doppler effect. Waves in gases (sound). Waves in solids (elastic).

Wave interference and normal modes. Standing waves. Resonance. Beats, wave packets.

H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015: chapters 13, 15 & 16.

Practical component:

An introductory laboratory where a range of experiments is available which will allow the development of data taking, analysis and deductive reasoning skills. Familiarisation with different instruments and techniques will occur through the varied range of experiments.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

13.2.19 PHYS134 Electrical Circuits & Instruments - Practical Laboratory II

PHYS134 Electrical Circuits & Instruments - Practical Laboratory II					
Lecturer:	Lect: Dr A Grocott Lab: Dr L Ray Prof Y Pashkin Dr A Marshall		(Shadow:	Lect: Prof A Thomas Lab : Dr H Fox	)
Lect/Sem/Wkshp/Prac:	11L,4S,4W,15P				
Timing:	Year	1	Weeks:	L16-20	
Pre-requisites:	PHYS103				
Assessment:	Examination	30%	Coursework	70%.	
Assessment Type:	% style				
Linked Modules:	PHYS131, 132, 133, 135.				
Credits:	8				
Workload:	Contact time	30 hrs	Private study	50 hrs	

Academic Aims:

Lecture component:

To explore the effect of simple electrical components in DC and AC circuits.

Practical component:

To teach and give practice in oral and written presentation skills.

Learning Outcomes:

Lecture component:

On completion of the module, students should be able to:

- understand the basic principles determining the behaviour of voltage and current in DC and AC circuits
- analyse quantitatively such circuits containing resistance, capacitance and inductance

Practical component:

On completion of the module, students should be able to:

- exhibit practical experience of using common instruments and experimental equipment,
- have developed skills of making experimental measurements, recording and analysing data and writing reports.

Syllabus:

Lecture component:

DC circuits, voltage current, potential difference, EMF, resistance, Ohm's law, Kirchoff's laws, power dissipated. DC Meters.

AC circuits. Combinations of resistance, inductance and capacitance. Phasors and trigonometry. Impedance. Transformers, motors and generators

Chapters in Y&F 26, 27, 31, 32. Recap on induction and induced emf Y&F 30;

Practical component:

Experimental laboratory II to illustrate physical principles described in lectures, and to develop skills of measurement and use of common instrumentation.

A further range of experiments is available which will allow the development of data taking, analysis and deductive reasoning skills. Familiarisation with different instruments and techniques will occur through the varied range of experiments.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

13.2.20 PHYS135 Optics & Optical Instruments - Practical Laboratory III

PHYS135 Optics & Optical Instruments - Practical Laboratory III

Lecturer:	Lect: Prof G V Borissov Lab: Dr L Ray Prof Y Pashkin Dr A Marshall		(Shadow:	Lect: Dr L Willingale Lab : Dr H Fox)
Lect/Sem/Wkshp/Prac:	11L,4S,4W,15P			
Timing:	Year	1	Weeks:	S21-25
Pre-requisites:	PHYS131			
Assessment:	Examination	30%	Coursework	70%.
Assessment Type:	% style			
Linked Modules:	PHYS131, 132, 133, 134.			
Credits:	8			
Workload:	Contact time	30 hrs	Private study	50 hrs

Academic Aims:

Lecture component:

To teach the principles of geometrical optics and apply these to various instruments.

Practical component:

To teach further basic laboratory skills and illustrate physics topics.

Learning Outcomes:

Lecture component:

On completion of the module, students should be able to:

- appreciate and explain commonly encountered optical phenomena,
- display an ability to use the methods of geometrical optics to analyse optical systems,

- understand the functions and basic principles of operation of some important optical instruments.

Practical component:

On completion of the module, students should be able to:

- display a knowledge of instruments used in making optical measurements,
- exhibit practical experience of using common instruments and experimental equipment,
- have developed skills of making experimental measurements, recording and analysing data and writing reports.

Syllabus:

Lecture component:

The nature of light. Coherence. Reflection, refraction, dispersion, polarisation. Geometrical optics. Lenses and mirrors.

Instruments. Microscope. Telescope. Camera. Resolving power. Aberrations. Basic principles and applications, especially telescopes. Optical fibres.

Interference and diffraction. Michelson interferometer. Diffraction grating.

Chapters in Y&F: 34-38.

Practical component:

Experimental laboratory III to illustrate physical principles described in lectures, and to develop skills of measurement and use of common instrumentation.

A final laboratory where a further range of experiments is available which will allow the development of data taking, analysis and deductive reasoning skills. Familiarisation with different instruments and techniques will occur through the varied range of experiments.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

13.3 Year 2

13.3.1 PHYS211 Maths I

PHYS211 Maths I

Lecturer:	Prof G V Borissov		(Shadow:	Dr J Gratus)
Lect/Sem:	30L,5S,5W			
Timing:	Year	2	Weeks:	M1-10
Pre-requisites:	PHYS110,PHYS131 or equivalent.			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	15			
Workload:	Contact time	40 hrs	Private study	110 hrs

Academic Aims:

The module aims to provide a working knowledge and understanding of the basic mathematical techniques required for studying physics at degree level and beyond. In particular:

- to provide a basic working knowledge of linear algebra, transformations, matrices and matrix operations;
- to introduce Pauli matrices, eigenvalues, eigenvectors and commutation relations;
- to provide skills and techniques for solving various common types of linear equations.

A workshop, supervised by postgraduate teaching assistants, is held every two weeks to provide extra one-to-one tuition and help with coursework assignments as required.

Learning Outcomes:

On completion of the module, students should be able:

- to solve problems involving systems of coupled linear equations;
- display a basic competency in matrix manipulations;

- to solve some common types of linear equations, such as the wave equation in 3D using Cartesian, cylindrical and spherical polar coordinates.

Syllabus:

Linear algebra: Systems of coupled linear equations. Linear transformations. Determinant of a matrix. Diagonalisation of matrices. Pauli matrices and practicing in operations with them. Eigenvalues and eigenvectors. Symmetric and Hermitian matrices and their diagonalisation using orthogonal and unitary matrices. Solving systems of linear ordinary differential equations, normal modes of coupled oscillators. Commutation relations involving matrices, invariants of linear transformations.

Hilbert Space: Wave equation in 1D with boundary conditions, separation of variables using standing waves. Wave equation in 3D: separation of variables and resonances in a drum. Bases of functions. Orthogonality of harmonic functions, Kronekker delta-symbol, and completeness of a basis.

Angular harmonics. Operators and their eigenfunctions.Angular harmonics in 2 dimensions, relation between plane waves and cylindrical waves, Bessel functions. Laplace operator in Cartesian, cylindrical and spherical coordinates. Spherical harmonic functions in 3 dimensions. Representation of operators as matrices acting in the Hilbert space, commutation relations between operators.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(R) Mathematical Techniques, D W Jordan, P Smith, OUP.
(R) Mathematical Methods for Physics and Engineering: A Comprehensive Guide, K F Riley, M P Hobson, S J Bence, Cambridge University Press.

13.3.2 PHYS213 Maths II

PHYS213 Maths II				
Lecturer:	Prof R P Haley		(Shadow:	Dr N Drummond)
Lect/Sem:	21L,4S,4W			
Timing:	Year	2	Weeks:	L11-20
Pre-requisites:	PHYS110, PHYS211			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	29 hrs	Private study	71 hrs

Academic Aims:

The LTA strategy is fourfold. Each week the core physics material is developed in the lectures. Students are expected to reinforce and extend the lecture material by private study of the course textbook and other sources. Student's understanding is consolidated and assessed via the fortnightly work sheet, which is completed by students independently, then marked and discussed by the lecturer at the seminar.

A workshop, supervised by postgraduate teaching assistants, is held every two weeks to provide extra one-to-one tuition and help with coursework assignments as required.

Learning Outcomes:

On completion of the module, students should be able to:

express a periodic function as a Fourier series;

find the Fourier transform of a function;

solve linear ODE's and PDE's using Fourier techniques;

solve the diffusion equation with initial conditions and/or spatial boundary conditions.

process verbal information during a lecture and make appropriate notes;

apply their physics and mathematical knowledge to solve problems.

Syllabus:

Fourier series representation of periodic functions: Real and complex Fourier series. Examples of Fourier expansion of periodic functions. Application of Fourier series to physical systems with forced oscillations and dissipation, mechanical and electrical. Parseval's theorem.

Fourier transform: Expression of a function as a Fourier integral. Definition of the Fourier transform and its inverse. The integral representation of the Dirac delta-function. General solution of the wave equation using Fourier transforms. 1-D wave equation with initial conditions - d'Alembert's solution. Convolution.

Boundary and initial condition problems: The diffusion equation, derivation and time-dependent solution with initial conditions. The heat equation. Laplace's equation, the Uniqueness Theorem, arbitrary boundary conditions. Applications to electrostatics.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(R) Mathematical Techniques, Jordan and Smith (Oxford UP)
(R) Mathematical Methods for Physics and Engineering: A Comprehensive Guide, K F Riley, M P Hobson, S J Bence, (Cambridge UP)
(B) Advanced Engineering Mathematics, Kreyszig (Wiley)

13.3.3 PHYS221 Electromagnetism

PHYS221 Electromagnetism				
Lecturer:	Dr A Mazumdar		(Shadow:	Prof G V Borissov)
Lect/Sem:	31L,4S,4W			
Timing:	Year	2	Weeks:	M1-10
Pre-requisites:	PHYS100, PHYS110			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	15			
Workload:	Contact time	39 hrs	Private study	111 hrs

This module is for non-Physics majors, i.e. Natural Science or visiting overseas students.

Academic Aims:

The module aims to provide an understanding of the basic principles of electromagnetism and the skills required to solve some common electromagnetic problems. In particular:

- to provide an understanding of Maxwell's equations, in various forms, and the basic laws of electromagnetism;
- to provide the skills and techniques for using vector calculus in electromagnetism and to solve Maxwell's equations in some common physical problems;
- to provide a understanding of electromagnetic fields and waves;
- to provide a knowledge of the effects of media on the propagation of electromagnetic waves.

A workshop, supervised by postgraduate teaching assistants, is held every two weeks to provide extra one-to-one tuition and help with coursework assignments as required.

Learning Outcomes:

On completion of the module, students should be able:

- to display an understanding of Maxwell's equations, in various forms, for the description of electromagnetic phenomena;
- to appreciate and utilize the power of vector calculus to solve Maxwell's equations in some common physical problems;
- to describe electromagnetic fields and waves created by various simple configurations of charges and currents;
- to understand the effects of media on the propagation of electromagnetic waves.

Syllabus:

Vector and scalar fields. Gauss's law. Potential and its gradient. Charge and current densities. Conductors and dielectrics, permittivity. Capacitance.

Biot-Savart's law. Ampere's law. Vector potential. Magnetic forces, magnetization: (diamagnetism, paramagnetism and ferromagnetism), permeability. Inductance.

Multipole expansion. Electric and magnetic dipoles.

Faraday's law, displacement current. Maxwell's equations in differential and integral forms. Maxwell's equations for potentials. Energy of electromagnetic field, Poynting theorem.

Maxwell's equations in free space. Electromagnetic waves. Plane e/m waves. Propagation in free space and dielectrics. Propagation in conductors, skin depth.

Boundary conditions. Plane waves at boundaries. Reflection and refraction, refractive index. Standing waves.

Radiation of electromagnetic waves. Hertzian oscillator. Antennas. Wave guides. TE wave in a rectangular wave guide. Dielectric wave guides.

Transmission Line Equations. Telegraph line, coaxial cable.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

(E) Introduction to Electrodyanmics, D J Griffiths, Prentice Hall;
(R) Engineering Electromagnetics, Hayt & Buck;

13.3.4 PHYS222 Electromagnetism, Waves & Optics

PHYS222 Electromagnetism, Waves & Optics				
Lecturer:	Dr A Mazumdar Electromagnetism Dr L Willingale Waves & Optics		(Shadow:	Prof G V Borissov Dr Q D Zhuang)
Lect/Sem:	44L,6S,6W			
Timing:	Year	2	Weeks:	M1-10
Pre-requisites:	PHYS100, PHYS110			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	20			
Workload:	Contact time	56 hrs	Private study	144 hrs

Academic Aims:

To provide students with a working knowledge of electromagnetism through Maxwell's equations using the tools of vector calculus.

To make the common connections between the many different phenomena in nature that share the mathematical model of a harmonic oscillator or of a wave.

To describe the basic properties of wave propagation, diffraction and interference, and laser operation.

To enhance problem-solving and mathematical skills by requiring students to apply their mathematical skills and physics understanding to a variety of situations and systems.

To develop skill in processing verbal information during a lecture and making appropriate notes.

To develop the ability to find additional information from a variety of sources including textbooks, the library and the internet.

Learning Outcomes:

On successful completion of this module students will be able to...

appreciate the power of vector calculus and Maxwell's equations for the description of electromagnetic phenomena; to describe electromagnetic fields and waves created by various simple configurations of charges and currents; to understand the effects of media on the propagation of electromagnetic waves; determine image position and magnification using the mirror equation or simple lens equation; describe diffraction experiments using superposition of complex wavelets; discuss thin-film interference fringes and anti-reflection coatings; describe the diffraction grating and the dispersion of light; discuss Fresnel and Fraunhofer diffraction; discuss the origin of polarisation, and the relevance of dichroism; describe the basic elements of a laser, laser operation and important features of laser light. process verbal information during a lecture and making appropriate notes; find information from a variety of sources including textbooks, the library and the internet; apply their physics and mathematics knowledge and problem-solving skills to describe advanced topics.

Syllabus:

PHYS222 covers the topics of Electromagnetism (75%) and Waves and Optics (25%).

Electromagnetism

Vector and scalar fields. Gauss's Law. Scalar potential and its gradient. Charge and current densities. Conductors and dielectrics. Polarisation, permittivity. Capacitance.

Lorentz force, Biot-Savart law. Ampere's law. Vector potential. Magnetisation, permeability. Inductance.

Multipole expansion. Electric and magnetic dipoles. Ohm's law, electromotive force.

Faraday's law, displacement current. Maxwell's equations in differential and integral forms. Maxwell's equations for potentials.

Energy of electromagnetic field, Poynting theorem. Gauge invariance.

Maxwell's equations in free space. Electromagnetic waves. Plane e/m waves. Propagation in free space and dielectrics. Propagation in conductors, skin depth.

Boundary conditions. Plane waves at boundaries. Reflection and refraction, refractive index. Standing waves.

Wave guides, coaxial cable.

Waves and Optics

Fermat's Principle. Revision of basic geometric optics. Reflection and refraction. Mirrors, lenses and prisms.

Summary of wave phenomena: electromagnetic spectrum, light, microwaves, sound, waves on strings and in solids: relation to oscillations.

The wave equation and its solution. Basic concepts: amplitude, phase, normal modes, resonance, superposition, polarisation, dispersion relation, phase and group velocity.

Diffraction. Huygens Principle. Fraunhofer diffraction. Single and multiple slit optical phenomena. Diffraction grating. Dispersion of light. Circular aperture. Rayleigh criterion.

Fresnel diffraction.

Interference and coherence. Experiments: Fresnels biprism, Lloyds mirror, thin films.

Polarisation. Linearly and circularly polarised light. Reflection and refraction at a plane interface. Fresnel Equations. Brewster's angle. Rayleigh scattering. Polarisation by scattering. Polarisation by absorption (dichroism). Polarisation filters and Malus' law. Lasers: stimulated emission, basic elements of a laser: medium, pumping and population inversion, standing waves in optical cavities; the important features of laser light such as coherence, monochromaticity and directionality; examples of laser types.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

Electromagnetism
(E) Introduction to Electrodynamics, D J Griffiths, Prentice Hall.
(R) Engineering Electromagnetics, Hayt & Buck.

Waves and Optics
(E) F L Pedrotti & L S Pedrotti, Introduction to Optics, Prentice Hall.
(R) H D Young & R A Freedman University Physics, Addison-Wesley.
(R) Serway & Faughn, College Physics.

13.3.5 PHYS223 Quantum Mechanics

PHYS223 Quantum Mechanics				
Lecturer:	Dr N Drummond		(Shadow:	Dr J Gratus)
Lect/Sem:	31L,4S,4W			
Timing:	Year	2	Weeks:	L11-20
Pre-requisites:	PHYS100, PHYS110			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	15			
Workload:	Contact time	39 hrs	Private study	111 hrs

Academic Aims:

The module aims to teach the fundamentals of quantum mechanics and the skills necessary to solve some common types of physical problems. In particular the module aims to provide:
A basic working knowledge of nonrelativistic quantum mechanics and the Schrödinger equation; the skills necessary to apply quantum mechanics to simple, exactly solvable problems, including the hydrogen atom, piecewise constant potentials and the quantum harmonic oscillator; a working knowledge of techniques for finding approximate solutions to the Schrödinger equation; and skills necessary to evaluate expectation values and probabilities in the context of experiments on quantum systems, and to understand the significance of these quantities.

Learning Outcomes:

On completion of the module, students should be able to:
Apply quantum mechanics to simple, exactly solvable problems in one and three dimensions, including the hydrogen atom,piecewise constant potentials and the quantum harmonic oscillator by solving the Schrödinger equation; systematically find approximate solutions for systems that are not exactly solvable; work out predictions for expectation values and probabilities in the context of experiments on quantum systems; and understand and appreciate the mathematical consistency of quantum mechanics.

Syllabus:

Revision of essential mathematics for quantum mechanics:
Analysis of trigonometric and exponential functions; ordinary and partial differential equations; and linear algebra with two-component vectors and matrices.

Particle-wave duality and the Schrödinger equation.
Applications in one dimension:
Particle in an infinite square well; piecewise constant potentials; harmonic oscillator; notions of bound state, ground state, zero-point energy, tunnelling and resonance.
Time independent perturbation theory, the WKB approximation and the variational principle.
Applications in three dimensions:
3d particle in a box; 3d harmonic oscillator; angular momentum; hydrogen atom.
Spins and electrons in magnetic fields:
Cyclotron motion; Stern-Gerlach experiment; spin precession; and the Zeeman effect.
Many particles (Pauli principle and chemical table of elements):
Axioms and advanced mathematics of quantum mechanics:
States as vectors (superposition principle); associated linear algebra; Dirac notation; time dependence; observables as operators; associated linear algebra and functional analysis (eigenvalue problems, Fourier analysis); probabilities and expectation values; commutation relations; uncertainty principle; and comparison to classical mechanics.

Workshops:

The module includes workshops, run primarily by postgraduate teaching assistants, as an extra learning aid and to help tackle coursework assignments.

Books:

For preparation: revise Young & Freedman, chpts. 38–40 (PHYS105). For the module: select one (better: two) of:
E Merzbacher, Quantum Mechanics (3^{rd} Edition)
D Griffith, Introduction to Quantum Mechanics
R Liboff, Introductory Quantum Mechanics
J J Sakurai, Modern Quantum Mechanics
R Shankar, Principles of Quantum Mechanics (2^{nd} Edition)
A I M Rae, Quantum Mechanics (4^{th} Edition)

13.3.6 PHYS232 Relativity, Nuclei & Particles

PHYS232 Relativity, Nuclei & Particles					
Lecturer:	Dr K Dimopoulos Relativity Prof A Thomas Nuclei & Particles		(Shadow:	Dr J Prance Dr H Fox	)
Lect/Sem:	26L,4S				
Timing:	Year	2	Weeks:	M6-10, S21-24	
Pre-requisites:	PHYS110 and PHYS100				
Assessment:	Examination	80%	Coursework	20%.	
Assessment Type:	% style				
Credits:	10				
Workload:	Contact time	32 hrs	Private study	68 hrs	

Academic Aims:

To provide students with a working knowledge of Einstein's theory of Special Relativity, both conceptually and mathematically.

To provide students with a qualitative understanding of the Equivalence Principle and its relevance for General Relativity.

To give students a basic understanding of atomic nuclei and of fundamental particles and their interactions.

To develop skill in processing verbal information during a lecture and making appropriate notes,

To develop the ability to find additional information from a variety of sources including textbooks, scientific papers, the library and the internet.

To develop the ability to look for patterns and similarities in various nuclear and particle interactions in order to unpack and simplify seemingly-complicated problems.

To enhance problem-solving and mathematical skills by requiring students to apply their mathematical skills and physics understanding to a variety of problems in relativity.

Learning Outcomes:

On successful completion of this module students will be able to...

explain how Einstein's theory of Special Relativity replaces the Newtonian concepts of absolute space and absolute time; write down the Lorenz transformation and explain its basic consequences; write down expressions for the energy and momentum of a particle, and describe their consequences for simple collision and decay processes; explain how the Equivalence Principle provides a starting point for General Relativity; explain the basic concepts of the physics of the nucleus; describe the principles of fission and fusion; predict the stability of nuclei to beta decay; describe the fundamental forces and the basic building blocks of matter; have an appreciation of the scope and precision of the Standard Model of particle physics; process verbal information during a lecture and making appropriate notes; find information from a variety of sources including textbooks, scientific papers, the library and the internet; apply their physics knowledge and problem-solving skills to describe advanced topics.

Syllabus:

PHYS232 covers the topics of Relativity (50%) and Nuclei and Particles (50%).

Relativity

Absolute space and time in Newtonian mechanics. Inertial frames. Standard Configuration. Galilean Transformation. Principle of Relativity. Luminiferous Aether hypothesis. Michelson-Morley experiment. Aether drag and stellar aberration. Fitzgerald-Lorentz contraction. Special Relativity postulates.

Main effects of Special Relativity: Time dilation, length contraction. Twin Paradox. Simultaneity is relative but not causality. Lorentz transformation. Proper time and proper length. Relativistic energy and momentum. Relativistic mechanics. Relativistic electromagnetism.

Spacetime diagrams. Doppler factor and head lamp effect in pulsars. Relativistic velocity addition. Fizeau's experiment. "Seeing" at relativistic speeds. Spacetime intervals. The light cone: past, future and elsewhere. The causal structure of spacetime.

4-vectors and their scalar products. 4-force and 4-momentum. 4-momentum conservation: inelastic collision and Compton scattering. 4-vectors in electromagnetism.

Elements of General Relativity: the Principle of Equivalence. Spacetime curvature. Non-Euclidean geometry, Einstein's field equations qualitatively. Schwartzschild metric. Schwartzschild black hole. Light speed in curved space. Classical tests of General Relativity: Bending, slowing and lensing of light, perihelion advance for planets, gravitational redshift. Binary pulsar and observation of graviational waves.

Nuclei and Particles

This is an introductory, concepts-based course designed to give students some basic understanding of nuclei and of fundamental particles, i.e. particles with no observed substructure. The course covers the general properties of nuclei, such as composition, the forces within the nucleus, mass, binding energy, isotopes, isobars, and isotones. The Liquid Drop Model of nuclei and the Semi-Empirical Mass Formula are presented.

Alpha, beta and gamma decays, fission and fusion, and nuclear reactions such as neutron activation, are discussed.

Students are then introduced to the Standard Model of Particle Physics, including the three generations of fundamental particles;

the strong, weak and electromagnetic fundamental forces; quark and lepton flavours; the composition of matter; conservation laws such as conservation of baryon number, lepton number or flavour; and the force propagators: photons, W and Z particles, and gluons. The Higgs particle, and factors that affect cross-sections and decay rates are discussed. Examples of measurements from recent and current experiments often are used to illustrate the concepts.

Books:

Spacetime Physics, E F Taylor & J A Wheeler (W H Freeman)
Nuclear and Particle Physics, W S C Williams (Clarendon)
Nuclear and Particle Physics: An Introduction, B R Martin, 2nd Edition, (Wiley)

13.3.7 PHYS233 Thermal Properties of Matter

PHYS233 Thermal Properties of Matter

Lecturer:	Prof A Thomas		(Shadow:	Prof Y Pashkin)
Lect/Sem:	21L,4S,4W			
Timing:	Year	2	Weeks:	L11-20
Pre-requisites:	PHYS100 and PHYS110			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	29 hrs	Private study	75 hrs

Academic Aims:

The module aims to teach a working knowledge and understanding of various fundamental thermal properties of matter. In particular:

- to provide an appreciation of the links between microscopic physics and thermal behavior;
- to show how fundamental properties of solids can be described in statistical terms;
- to provide an appreciation for the use of thermodynamic potentials and associated thermodynamic relations to describe thermal behavior;
- to provide a basic knowledge of phase transition and their classification;
- to provide an understanding of the Third Law of Thermodynamics and its consequences.

Learning Outcomes:

On completion of the module, students should be able to:

- describe the connections between the microscopic and macroscopic pictures of the thermal properties of solids;
- account for some fundamental properties of solids in statistical terms.

- show a familiarity with the use of thermodynamic potentials and associated thermodynamic relations;
- display an awareness of the different kinds of phase transition and how they are classified;
- display an understanding of the evidence for the Third Law of Thermodynamics and how it relates to the unattainabilty of absolute zero.

Syllabus:

Review of thermodynamic equilibrium, temperature, zeroth law, reversible and irreversible processes, heat, work and internal energy, first Law, Carnot cycle, heat engines, heat pumps, refrigerators. Second Law, entropy, determination of entropy changes, direction of natural processes, dU = TdS - PdV for quasistatic processes.

Microscopic v. macroscopic pictures, order and disorder, counting microstates for distinguishable particles, the Boltzmann distribution, possible and most probable distributions, energy and temperature, partition function, Boltzmann-Planck equation, the connection between thermodynamics and statistical mechanics

Statistical properties of solids, 2-level systems, Schottky specific heat anomalies, paramagnetism, transition to ferromagnetism, lattice vibrations and contribution to the heat capacity, defects in solids.

Thermodynamic potentials, Helmholtz function, enthalpy, Gibbs function; throttling process; Maxwell relations.

Phase changes and phase diagrams, phase equilibria, Clausius-Clapeyron equation, first and second order phase transitions, Ehrenfest classification; real gases, van der Waals equation, the critical point, Joule-Kelvin effect.

The Third Law in positive and negative versions.

Books:

C P B Finn, Thermal Physics, Routledge (1987)

M W Zemansky and R H Dittman, Heat and Thermodynamics, McGraw-Hill

A M Guënault, Statistical Physics (2nd Ed), Chapman and Hall (1995)

13.3.8 PHYS252 Introduction to Experimental Lab

PHYS252 Introduction to Experimental Lab				
Lecturer:	Dr B Robinson Dr C K Bowdery	(Shadow:	Dr J Prance)	
Lect/Sem/Prac:	5L,5P			
Timing:	Year	2	Weeks:	M6-10
Pre-requisites:	PHYS100			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

This module is specifically for physics non-majors only, Natural Science & exchange students.

Academic Aims:

To teach students techniques of experimental data collection and analysis, ethical standards in a scientific investigation, health and safety.

To teach how to assess the statistical validity of data and their interpretation.

To teach basic principles of electric circuit analysis, damping and resonance in electric circuits and mechanics, illustrated by experiment.

To provide students with the general and IT skills required for the manipulation and presentation of data, log book and report writing.

Learning Outcomes:

On successful completion of this module students will be able to...

collect experimental data using a variety of common instruments;

exhibit a practical experience of experimental methods;

perform a statistical assessment of the validity of experimental observations and the validity of their model interpretation;

to show a working knowledge of the basic principles DC and AC circuit analysis, transient response and resonance in mechanics and electric circuits;

apply their physics knowledge and problem-solving skills to model problems in science;

systematically record their work in a log book;

work independently and also co-operatively with colleagues;

report their results in written form;

discuss the role of health and safety in scientific experimentation;

demonstrate high ethical standards during a scientific investigation.

Syllabus:

Experimental practical laboratory and essential physics skills

This part includes lectures which teach the basic concepts of statistical analysis of data and uncertainties, ethical behaviour, the role of health and safety in scientific experimentation, IT skills including the preparation of documents, and the basic principles of DC and AC circuit analysis, transients and resonance in the context of mechanics and electrical circuits. There are five 3-hour laboratory sessions, where students perform experiments in optics, mechanics and electric circuits which illustrate and compliment the taught material. In the final week, students are required to write a scientific report (with guidance) on one of the experiments.

Basic experimental skills. Making measurements, assessing errors and uncertainties, systematic and random errors, recording data, keeping log books, report writing. Propagation of uncertainties.

Statistical analysis of data. Mean, median, standard deviation. Normal (Gaussian) and Poisson distributions.

The role of health and safety in scientific experimentation.

Ethical behaviour in science.

Word processing, including the insertion of tables and graphics into a document, with MS Word and LaTeX.

Books:

H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015

13.3.9 PHYS253 Experimental Lab I

PHYS253 Experimental Lab I

Lecturer:	Dr Q D Zhuang Prof A Krier		(Shadow:	Dr A Marshall)
Practical:	5P			
Timing:	Year	2	Weeks:	L11-15
Pre-requisites:	PHYS130 or equiv			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

This is the first of two modules in which a different assignment is completed in each of five weeks. They are designed to teach specific experimental skills and techniques through individual experiments drawn from various topics in physics.

Learning Outcomes:

During this module, students will develop the following skills:

- execution of experimental investigations
- accurate and thorough record keeping
- critical analysis and discussion of results
- minimisation of experimental errors

and will acquire knowledge of:

- a variety of experimental techniques

- how to identify, estimate, combine and quote experimental errors

Syllabus:

A full list of experiments will be published at the beginning of the module. A report is written on one of the completed assignments.

Eight experiments will be available. Normally students would not take more than one session to complete an experiment, but five weeks are allowed for four experiments plus a full report on one of them. We would expect the students to complete all eight of these experiments which teach the basic skills of measurements, uncertainties (errors) and the use of standard instruments, such as oscilloscopes etc.

Books:

Each experiment is described in a laboratory script which is provided for the student. References to relevant text-books for background reading are given in the script.

The following is the recommended book for a discussion of general experimental techniques:

(R) M Pentz, M Shott & F Aprahamian, Handling Experimental Data, Open University Press

13.3.10 PHYS254 Experimental Lab II

PHYS254 Experimental Lab II				
Lecturer:	Dr Q D Zhuang Prof A Krier		(Shadow:	Dr A Marshall)
Practical:	5P			
Timing:	Year	2	Weeks:	L16-20
Pre-requisites:	Normally PHYS253			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

Experimental skills which have been developed in earlier modules (PHYS253) are applied to assignments which are usually open ended. Students, working singly or in pairs, complete experiments which involve an element of choice in method and apparatus. Although the experiments involve topics in physics drawn from all areas covered in second year modules, the primary purpose of this module is to extend and further develop experimental skills.

Learning Outcomes:

During this module, students will develop the following skills:

- organisation and execution of experimental investigations
- accurate and thorough record keeping
- critical analysis and discussion of results
- application of a methodology to a variety of experimental techniques
- identification, estimation and combination of experimental errors

Syllabus:

A full list of experiments will be published at the beginning of the module. A report is written on one of the completed assignments.

Students who join the laboratories later than 253 will be able to undertake experiments from the PHYS253 and PHYS254 modules during the timetabled PHYS255 module.

The experiments are more demanding than those in PHYS253 and students are encouraged to take two sessions to complete them. While none of the experiments will be compulsory, students can consult the Head of Class to choose the most useful experiments for their intended vocations.

There will also be the opportunity to use computer graphics to compare experimental results with theoretical predictions.

Books:

Each experiment is described in a laboratory script which is provided for the student. References to relevant text-books for background reading are given in the script. The following is the recommended book for a discussion of general experimental techniques:

(R) M Pentz, M Shott & F Aprahamian, Handling Experimental Data, Open University Press

13.3.11 PHYS255 Experimental Lab III

PHYS255 Experimental Lab III				
Lecturer:	Dr Q D Zhuang Prof A Krier		(Shadow:	Dr A Marshall)
Practical:	5P			
Timing:	Year	2	Weeks:	S21-25
Pre-requisites:	Normally PHYS253, and/or PHYS254			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

Experimental skills which have been developed in earlier modules (PHYS253-254) are applied to assignments which are usually open ended. Students, working singly or in pairs, complete experiments which involve an element of choice in method and apparatus. Although the experiments involve topics in physics drawn from all areas covered in second year modules, the primary purpose of this module is to prepare students for the project work of year 3.

Learning Outcomes:

During this module, students will consolidate the following skills:

- organisation and execution of experimental investigations
- accurate and thorough record keeping
- critical analysis and discussion of results
- identification, estimation and combination of experimental errors
- application of techniques to one or two extensive investigations.

Syllabus:

A full list of experiments will be published at the beginning of the module. A report is written on one of the completed assignments..

In this module students are normally expected to take multiple laboratory sessions to complete experiments, and possibly even develop them.

Books:

Each experiment is described in a laboratory script which is provided for the student. References to relevant text-books for background reading are given in the script. The following is the recommended book for a discussion of general experimental techniques:

(R) M Pentz, M Shott & F Aprahamian, Handling Experimental Data, Open University Press

13.3.12 PHYS256 Experimental Particle Physics

PHYS256 Experimental Particle Physics				
Lecturer:	Dr A Blake Dr H Fox		(Shadow:	Dr H O'Keeffe)
Practical:	5P			
Timing:	Year	2	Weeks:	S21-25
Pre-requisites:	PHYS133-135			
Assessment:	Examination	%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

During this module, students will consolidate the following skills: Students will gain experimental skills in nuclear and particle physics through a set of three typical experiments. They will learn how to use particle detectors and commonly used readout electronics. They will also develop their expertise in statistical data analysis and uncertainty calculation. Students will learn how to critically review statistical analyses. They will exercise their report writing skills and presentation skills.

Learning Outcomes:

On successful completion of this module students will be able to:
- explain the principles of particle detection;
- display knowledge of the electronic readout chain and signal processing;
- perform a statistical analysis of a large data sample;
- explain the methods and techniques they used to their peers;
- be able to write a scientific report;
- critically review statistical analyses presented to them;
- verbally explain experimental methods and techniques.

Syllabus:

Students will work singly or in pairs on two typical experiments in nuclear and particle physics. Experiments available are the measurement of the angular distribution of cosmic rays, the measurement of nuclear spectra with NaI-counters and the measurement of momentum conservation in positronium decays. Experimental equipment will consist of a particle detector and readout chain with digital data processing. For each experiment, students will have 12 hours available. Students will present the experimental methods and techniques they used to their peers. A written report is required on one of the experiments.

Books:

Each experiment is described in a laboratory script which is provided for the student. A book for background reading is A. Melissinos, "Experiments in Modern Physics"

13.3.13 PHYS263 Astronomy

PHYS263 Astronomy				
Lecturer:	Dr D Sobral		(Shadow:	Dr D I Bradley)
Lect/Sem:	16L,4S			
Timing:	Year	2	Weeks:	L11-15
Pre-requisites:	PHYS100 or equiv			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

The module provides an introduction to the physics of astronomy.

Learning Outcomes:

On completion of this module students should:
Be familiar with our understanding of planets, stars and galaxies and how this developed; understand the properties and uses of electromagnetic radiation in an astronomical context; know how telescopes are designed and built; understand the physical laws of orbital motion and the phenomena which they give rise to; know how to characterise and classify stars.

Syllabus:

Introduction, history, overview and basic concepts: Astronomy and its role in the birth of Physics; a global overview of 13.7 Gyrs; Celestial Mechanics and orbital phenomena

Electromagnetic radiation, telescopes, and intro to stars and star formation: Observing and interpreting the Universe: Electromagnetic radiation; Telescopes and modern Astronomical Instrumentation; Stars and star formation

Stars, planetary systems and extra-solar planets: Stars: properties and evolution; Stellar characteristics; Hertzsprung-Russell diagrams; Planetary systems; the Solar system; Other planetary systems

Our own Galaxy, galaxy formation and evolution: Galaxies: our own neighbourhood; Galaxy formation and evolution: the first Gyrs; Galaxy formation and evolution: the last few Gyrs

Simulations, observations, big open questions: Simulating Universes and confronting them with observations; Introduction to real data in Astronomy and getting physics out of them; Putting it all together and main open questions

Books:

(R) K Holliday, Introductory Astronomy, Wiley.
(R) W J Kaufmann & R A Freedman, Universe, W H Freeman.
(R) B W Carroll and D A Ostlie, An Introduction to Modern Astrophysics, Addison Wesley.

13.3.14 PHYS264 Astrophysics I

PHYS264 Astrophysics I

Lecturer:	Dr A Koch		(Shadow:	Dr M Hayne)
Practical:	16L,4S			
Timing:	Year	2	Weeks:	S21-24
Pre-requisites:	PHYS100 or equivalent & 263			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To describe the physical properties of stars and review the astronomical techniques by which they are determined. To show how classical physics is successful in modelling many properties of main sequence stars and in explaining their formation and evolution. To introduce some of the more complex stellar behaviour that cannot be understood on the basis of classical physics.

Learning Outcomes:

On completion of the module, students should:

- have a broad knowledge of the physical characteristics of the different types of star and nebulae, and the techniques by which they are determined.
- understand the basic physical principles of stellar stability, energy production and energy loss.
- be able to perform simple calculations relating to gravitational collapse, stability, lifetime and energy generation in well-behaved main sequence stars and in nebulae.
- be able to describe, as far as is possible using only classical physics, how stars are born and evolve.

Syllabus:

Overview of directly measurable physical characteristics of stars: Mass, luminosity, spectroscopy, stellar atmospheres, temperature, pressure, composition.

Hertzsprung-Russell diagram, stellar population and stellar evolution, importance of studying binaries and clusters.

Physics of Stellar Stability (main sequence): Gravitationally bound systems, ideal gases. Hydrostatic equilibrium, Virial Theorem.

Estimating central pressure and temperature. Conditions for stellar stability, effects of gas pressure and radiation pressure.

Energy generation in stars: Gravitational contraction, thermonuclear fusion, basic principles. Comparison of energy released and timescales for different stellar collapse processes and fusion processes.

Energy transport in stellar interiors: Radiative diffusion, photon scattering mechanisms, random walk statistics, convection, conduction.

The Sun: A typical main sequence star closely observed. The standard model, variation of physical properties with depth.

HII regions and Star birth: Evolution onto the main sequence. The interstellar medium, Jeans criterion for collapse of a nebula, protostars. HII regions, Strömgren sphere, ionization front (Strömgren radius).

Evolution off the main sequence.

Books:

(R) R J Tayler, The Stars: their sturcture and evolution, CUP

(R) B W Carroll & D A Ostlie, Modern Astrophysics, Addison Wesley

(B) A C Phillips, Physics of Stars, Wiley

(B) W J Kaufmann & R A Freedman, Universe, W H Freeman

13.3.15 PHYS265 Cosmology I

PHYS265 Cosmology I				
Lecturer:	Dr K Dimopoulos		(Shadow:	Dr J McDonald)
Lect/Sem:	16L,4S			
Timing:	Year	2	Weeks:	L16-20
Pre-requisites:	PHYS223			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide a good understanding of the structure and properties of the presently observed Universe as well as its evolution. To introduce main ideas about the early Universe.

Learning Outcomes:

On completion of this Module the student will be familiar with:

- the structure of the Universe from the modern perspective,
- cosmological length and mass scales,
- the expansion of the Universe and its ultimate fate,
- cosmological parameters and models,
- phenomena in the very early Universe, the Big Bang.

Syllabus:

Today's picture of the Universe: Its size and structure. Galaxies and galaxy clusters. Cosmic length and mass scales. Methods of measuring astronomical and cosmological distances. Apparent and absolute magnitude and luminosity. Standard Candles. Cosmic Distance Ladder. Hubble Law.

The Big Bang theory: Universe Expansion. Age and size of the Observable Universe. Scale Factor, Hubble Parameter, Cosmological Redshift. Cosmological Principle. Universe dynamics: Friedmann equation, continuity equation, equation of state, acceleration equation. Curvature of the Universe. Friedmann universes. Critical density. Deceleration parameter.

The content of the Universe: Cosmological constant: dynamics and cosmological constant, Planck mass, cosmological constant problem. Dark Energy. Universe dynamics with spatial flatness. Matter and Radiation Domination. Cosmological constant domination. Phantom Dark Energy. Particle and Event Horizon. Dark Matter: Observational evidence for Dark Matter, Properties of non-baryonic Dark Matter, Candidates for Dark Matter, Problems of CDM, Bullet Cluster.

Books:

(E) A Liddle, An Introduction to Modern Cosmology, Wiley (2nd edition).

(R) M Roos, Introduction to Cosmology, Wiley (3rd edition).

(R) M Berry, Principles of Cosmology and Gravitation, Adam Hilger (1989).

(E) W J Kaufman & R A Freedman, Universe, W H Freeman.

13.3.16 PHYS268 Space Physics

PHYS268 Space Physics				
Lecturer:	Not Running 2016/2017		Shadow:	Not Running 2016/2017)
Lect/Sem:	16L,4S			
Timing:	Year	2	Weeks:	L16-20
Pre-requisites:	PHYS101-105 & PHYS111-115 or equivalent			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

This module aims to teach students about a multiply connected set of space plasma processes stretching from the sun to the surface of the earth and their effects on earth, commonly known as "Space Weather", as a consequence of the behavior of the sun and the nature of Earth's magnetic field. Seminars include independent research on pre-set discussion topics. Students are required to present their findings to the group in the form of oral presentations/posters.

Learning Outcomes:

On completion of this module the student should be able to:

- Explain Sun's magnetic activity and its coupling to solar system
- Describe solar wind, coronal mass ejection and solar flares
- Explain the effect of solar wind on the magnetosphere
- Explain the current system in the magnetosphere
- Calculate the solar-wind driving of the magnetosphere
- Explain the formation of the ionosphere and its layers

- Explain the important role of substorm and geomagnetic storm on energy transfer within the Sun-Earth system
- Explain dynamics of the radiation belts
- Derive the frozen in flux theorem
- Calculate induced currents to geomagnetic storms
- Undertake mathematical manipulations and calculations with generic/universal applicability.
- Explain the governing processes within our solar system.
- Carry out independent research.
- Present material (oral/poster) to a peer-group

Syllabus:

Introduction to solar terrestrial environment. The solar cycle and the solar wind. Magnetospheres in the solar system. Introduction to ionospheric physics. Solar Wind Magnetosphere Coupling - plasma sheet loading and pre-conditioning. Storms and Substorms - delivery mechanisms/plasmaspheric plumes. Particle distributions in the magnetosphere. Magnetospheric current systems. Radiation Belt dynamics and killer electrons. Space weather effects. Detecting and prediction of space weather. Field change, indices, IMF Long term changes in Space Weather. 11/22 year cycle.

Books:

(E) Introduction to Space Physics, M.G. Kivelson & C.T. Russell, Cambridge University Press (1995), ISBN: 0521457149.
(R) The solar-terrestrial environment, J. K. Hargreaves, Cambridge Univ. Press., 1995, ISBN:0521427371.
(R) Basic Space Plasma Physics, Wolfgang Baumjohann and Rudolf A Treumann, Imperial College Press., 1997, ISBN:186094079.
(R) Convection and substorms, Charles F Kennel, Oxford University Press, 1995, ISBN: 0195085299.

13.3.17 PHYS272 Exp. Phys., Skills & Mechanics

PHYS272 Exp. Phys., Skills & Mechanics				
Lecturer:	Dr B Robinson Dr C K Bowdery Dr A Romito	(Shadow:	Dr J Prance Dr D A Burton	)
Lect/Sem/Prac:	21L,4S,5P			
Timing:	Year	2	Weeks:	M6-10, L11-15
Pre-requisites:	PHYS100			
Assessment:	Examination	53%	Coursework	47%.
Assessment Type:	% style			
Credits:	15			
Workload:	Contact time	40 hrs	Private study	110 hrs

This module is specifically for MSci Theoretical Physics and Mathematics majors only.

Academic Aims:

To give on overview of theoretical methods used in classical mechanics.

In particular: to teach methods of integration of equations of motion for dynamical problems in classical mechanics;

to train in using variational calculus in application to functionals;

to exploit the generality of Lagrangian and Hamiltonian techniques by using an appropriate generalised coordinates;

to acquaint students with the concept of the phase space, stability of motion and chaos.

To teach students techniques of experimental data collection and analysis, ethical standards in a scientific investigation, health and safety.

To teach how to assess the statistical validity of data and their interpretation. To teach basic principles of electric circuit analysis, damping and resonance in electric circuits and mechanics, illustrated by experiment.

To develop skill in processing verbal information during a lecture and making appropriate notes.

To enhance problem-solving and mathematical skills by requiring students to apply their mathematical skills to mechanics examples in physics.

To provide students with the general and IT skills required for the manipulation and presentation of data, log book and report writing.

Learning Outcomes:

On successful completion of this module students will be able to...

integrate equations of motion in one and two dimensions;

describe rotation of a rigid body;

use variational methods and to relate Hamiltonian and Langrangian approach to theoretical mechanics and canonical transformations;

collect experimental data using a variety of common instruments;

exhibit a practical experience of experimental methods;

perform a statistical assessment of the validity of experimental observations and the validity of their model interpretation;

to show a working knowledge of the basic principles DC and AC circuit analysis, transient response and resonance in mechanics and electric circuits;

process verbal information during a lecture and make appropriate notes;

apply their physics knowledge and problem-solving skills to model problems in science;

systematically record their work in a log book;

work independently and also co-operatively with colleagues;

report their results in written form;

discuss the role of health and safety in scientific experimentation;

demonstrate high ethical standards during a scientific investigation.

Syllabus:

This module is specifically for Theoretical Physics and Mathematics majors only.

This module is a combination of the Theoretical Physics lecture module "Mechanics and Variations" (2/3) with experimental practical laboratory accompanied by lectures covering essential physics skills (1/3).

Mechanics and Variations

Newton's laws, central forces, dynamics and orbits, integrals of motion.

Solution of one-dimensional dynamical problems, linear and non-linear oscillators.

Lagrangian, its relation to Newton's equations and the least action principle.

Rotation of a rigid body. Symmetries and conservation laws.

Variational technique and Lagrange equations.

Generalised coordinates and momenta, Hamiltonian function, Poisson brackets and canonical transformations.

Phase space, stability of motion and chaos.

Special features: This module includes lectures on analytical methods used both in classical mechanics and in broader areas of theoretical and mathematical physics.

Experimental practical laboratory and essential physics skills

This part includes lectures which teach the basic concepts of statistical analysis of data and uncertainties, ethical behaviour, the role of health and safety in scientific experimentation, IT skills including the preparation of documents, and the basic principles of DC and AC circuit analysis, transients and resonance in the context of mechanics and electrical circuits. There are five 3-hour laboratory sessions, where students perform experiments in optics, mechanics and electric circuits which illustrate and compliment the taught material. In the final week, students are required to write a scientific report (with guidance) on one of the experiments.

Basic experimental skills. Making measurements, assessing errors and uncertainties, systematic and random errors, recording data, keeping log books, report writing. Propagation of uncertainties.

Statistical analysis of data. Mean, median, standard deviation. Normal (Gaussian) and Poisson distributions.

The role of health and safety in scientific experimentation.

Ethical behaviour in science.

Word processing, including the insertion of tables and graphics into a document, with MS Word and LaTeX.

Books:

(E) T.W.B. Kibble & F.H. Berkshire, Classical Mechanics, Longman (4th edition). (E) L.D. Landau & E.M. Lifshitz, Mechanics and Electrodynamics, Pergamon Press Laboratory manual

13.3.18 PHYS273 Theor.Phys.I - Mech.& Vars.

PHYS273 Theor.Phys.I - Mech.& Vars.

Lecturer:	Dr A Romito		(Shadow:	Dr D A Burton)
Lect/Sem:	16L,4S			
Timing:	Year	2	Weeks:	L11-15
Pre-requisites:	PHYS100, PHYS110 or equivalent, PHYS211			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	55 hrs

Academic Aims:

To give on overview of theoretical methods used classical mechanics and to provide the background for later quantum mechanics courses.

In particular:

to teach methods of integration of equations of motion for dynamical problems in classical mechanics;

to train in using variational calculus in application to functionals;

to exploit the generality of Lagrangian and Hamiltonian techniques by using an appropriate generalised coordinates

to acquaint students with the concept of the phase space, stability of motion and chaos.

Learning Outcomes:

On completion of the module, students should be able to:

- to integrate equations of motion in one and two dimensions
- to describe rotation of a rigid body
- to use variational methods and to relate Hamiltonian and Langrangian approach to theoretical mechanics and canonical transformations.

Syllabus:

Newton's laws, central forces, dynamics and orbits, integrals of motion.

Solution of one-dimensional dynamical problems, linear and non-linear oscillators.

Lagrangian, its relation to Newton's equations and the least action principle.

Rotation of a rigid body. Symmetries and conservation laws.

Variational technique and Lagrange equations.

Generalised coordinates and momenta, Hamiltonian function, Poisson brackets and canonical transformations.

Phase space, stability of motion and chaos.

Special features:

This module includes lectures on analytical methods used both in classical mechanics and in broader areas of theoretical and mathematical physics.

Books:

(E) T.W.B. Kibble & F.H. Berkshire, Classical Mechanics, Longman (4th edition).

(E) L.D. Landau & E.M. Lifshitz, Mechanics and Electrodynamics, Pergamon Press

13.3.19 PHYS274 Theor.Phys.II - Class.Fields

PHYS274 Theor.Phys.II - Class.Fields				
Lecturer:	Dr J McDonald		(Shadow:	Dr J Gratus)
Lect/Sem:	16L,4S			
Timing:	Year	2	Weeks:	S21-24
Pre-requisites:	PHYS100 and PHYS110 or equivalent, PHYS211, PHYS222			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

The module aims to teach the basic principles of classical fields used in a variety of Physics applications. In particular:

- to provide the theoretical background, knowledge and understanding of the use of classical fields, such as EM fields, in physics;
- to provide a knowledge and understanding of various conservation laws and boundary conditions;
- to apply the techniques and principles of classical fields to solve some common problems in EM and plasmas.

Learning Outcomes:

On completion of the module, students should be able:

- to display a basic knowledge and understanding of classical fields;
- to show a working knowledge and understanding of boundary conditions and conservation laws in differential and integral form;
- to apply the techniques used in classical fields to tackle some common problems such as the power radiated from accelerating charges, the mode structure of EM fields in simple bounded regions (waveguides and cavities) and plasma waves.

Syllabus:

- General integral relations between current and charge sources and EM potentials in free space. Energy and momentum of EM fields and the use of the Poynting vector to calculate radiated power. Conservation laws in differential and integral form. The notion of retarded potentials. The EM field of an accelerating point charge. EM power radiated by an accelerating charge and an oscillating dipole. Wave solutions of Maxwell's equations in free and bounded space. Behaviour of EM modes in perfectly conducting rectangular and cylindrical waveguides and cavities. Difference between TE, TM and TEM propagating modes. Two-fluid model of plasmas. Dispersion relations for plasma waves.

Books:

- D J Griffiths: Introduction to Electrodynamics
- F F Chen: Introduction to Plasma Physics

13.3.20 PHYS281 Scientific Programming & Modelling Project

PHYS281 Scientific Programming & Modelling Project				
Lecturer:	Prof I A Bertram Dr J Nowak	(Shadow:	Not Available)	
Practical:	10L,20P			
Timing:	Year	2	Weeks:	M1-10
Pre-requisites:	PHYS100 & PHYS110			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	40 hrs	Private study	60 hrs

Academic Aims:

To teach computer programming in JAVA
to allow students to undertake an individual open-ended investigation of a physics problem using computational methods
to teach the fundamental concepts underlying many computer languages
to give students experience in working independently on open-ended project work
to develop existing problem-solving skills
to further develop skills in report writing.

Learning Outcomes:

On completion of this module, students will be able to:
write computer programs that can be used for numerical simulation and data analysis
model simple physical systems using appropriate programming techniques
understand numerical precision and accuracy
independently complete an open-ended project to model a physics-based problem
plan, manage and pursue an open ended project
design, assemble and test software
formulate appropriate conclusions
write a scientific report.

Syllabus:

Programming basics: writing and compiling simple programs, variable types, input and output, and mathematical functions.
Debugging: The identification and classification of programming errors.
Iteration, for, while, do-while loops, and nested loops.
Methods: arguments and signatures.
Arrays: one dimensional, multi-dimensional, passing arrays.
Numerical Methods: using programs to solve numerical problems using numerical integration as an example.
Object Orientated programming: Using objects and methods to represent physical systems, class design, class testing and documentation.
Modelling Project: using object orientated coding to model a 2-dimensional physical system. Introduction to computational approximations such as the Euler Method.

Books:

(R) Introduction to Java Programming, Brief: International Edition, 8/E, Y D Liang, Pearson Higher Education,

OR

(B) H Dietel & P Deitel, Java: How to Program, Prentice Hall,(7th ed).

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13.4 Year 3

13.4.1 PHYS311 Particle Physics

PHYS311 Particle Physics				
Lecturer:	Dr H O'Keeffe		(Shadow:	Prof G V Borissov)
Lect/Sem:	31L,4S			
Timing:	Year	3	Weeks:	M1-10
Pre-requisites:	2nd Yr Core Physics modules			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	15			
Workload:	Contact time	35 hrs	Private study	115 hrs

Academic Aims:

The module aims to provide a general introduction to theoretical and experimental topics in elementary particle physics, essentially the Standard Model of particle physics.

Learning Outcomes:

Knowledge and Understanding: on successful completion of the module students should be able to

(i) describe the main features of the Standard Model of particle physics and understand its place in physics as a whole; (ii) describe major pieces of experimental evidence supporting the key theoretical ideas, including the experimental techniques used (accelerators and detectors); (iii) understand the role of symmetry and conservation laws in fundamental physics;

Skills: on successful completion of the module students should be able to

(i) perform simple calculations of physically observable quantities relevant to the subject; (ii) solve problems based on the application of the general principles of particle physics, e.g. use conservation laws to explain whether specific particle reactions and decays are allowed or forbidden;

Syllabus:

Revision of Special Relativity: 4-vector manipulation, Center-of-mass energy calculations, Boosts. Quarks and Leptons: Standard Model, Fermions & Bosons, Particles & Anti Particles, Free Particle Wave Equation, Helicity States, Quark & Lepton Flavours.

Interactions & Fields: Feynman Diagrams, Electromagnetic Interaction, Strong Interaction, Electroweak Interaction, Interaction Cross-section, Decays & Resonances. Invariance Principles and Conservation Laws: Parity, Parity of pions, particles & antiparticles, Charge conjugation, Baryon & Lepton Conservation. Quark Model: Baryon Decuplet, Baryon Octet, Light Pseudo-Scalar Mesons, Vector Mesons, Tests of the Quark Model. Lepton and Quark Scattering: e+e to mu+mu , e+e to hadrons, Electron-muon scattering, Neutrino-electron scattering, Deep inelastic scattering. QCD: Color Quantum Number, QCD at short and long distances, Jets, Running couplings. Weak Interactions: Lepton Universality, Helicity of the neutrino, V-A, Weak currents, Pion and muon decays, Weak decays of quarks, GIM model and CKM matrix, Neutral kaons. Electroweak Interactions: Neutral Currents, Intermediate Vector Bosons, Couplings of quarks and leptons, Neutrino scattering, Total and Partial Widths of the Z, Higgs Mechanism. Beyond the Standard Model: Supersymmetry, Neutrino Oscillations. Accelerators & Detectors: Accelerator operations, Interactions of particles with matter, Basic detector elements: ionisation chamber, proportional counter and gas amplification, scintillators and photomultipliers, Devices for position and momentum measurements, Particle identification systems, Electromagnetic and hadronic calorimeters, Muon systems, Modern large multi-purpose detector systems for experiments in Particle Physics.

Books:

(E) M Thomson, Modern Particle Physics, Cambridge.
(R) Martin & Shaw, Particle Physics, Wiley.
(R) D J Griffiths, Introduction to Elementary Particles, Wiley.

13.4.2 PHYS313 Solid State Physics

PHYS313 Solid State Physics				
Lecturer:	Dr L Ponomarenko Dr J Prance		(Shadow:	Prof A Krier)
Lect/Sem:	31L,4S			
Timing:	Year	3	Weeks:	L11-20
Pre-requisites:	2nd year core modules			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	15			
Workload:	Contact time	35 hrs	Private study	115 hrs

Academic Aims:

The module aims to provide a general introduction to theoretical and experimental topics in solid state physics at a more advanced level than covered in the 2nd year module Thermal and Structural Properties of Matter

Learning Outcomes:

Knowledge and Understanding: on successful completion of the module students should be able to

- describe the main features of the physics of electrons in solids;
- describe the main features of the optical properties of solids
- describe the main features of crystal lattices and phonons;
- describe the main features of the thermal properties of solids;
- describe major pieces of experimental evidence supporting the key theoretical ideas, including the experimental techniques used;

Skills: on successful completion of the module students should be able to

- perform simple calculations of physically observable quantities relevant to the subject;
- solve problems based on the application of the general principles of solid state physics.

Syllabus:

Reciprocal lattice and diffraction of waves. Electrons and electronic band structure in metals, insulators and semiconductors. Tight-binding and nearly-free electron models. Electrons in metals. Fermi energy and Fermi surface. Electron scattering processes. Electrons in semiconductors. Effective mass. Holes. Intrinsic and extrinsic behaviour. Junctions and devices, Low dimensional structures, interfaces, Qwell, Qdots Optical properties, excitons, impurities, radiative and non-radiative recombination Cyclotron resonance & magnetic effects, Landau levels Quantum Hall effect. Phonons. Acoustic and optic modes. Heat capacity of solids. Thermal conductivity of insulators. Phonon scattering processes. Superconductivity. Meissner effect Metallic and high Tc superconductors. Summary of experimental phenomena. Tunnelling. Josephson Junctions. Outline of BCS theory.Phenomenology of solid state magnetic phenomena: paramagnetism and Curie law, diamagnetism. Van Vleck's diamagnetism. Brief outline of ferromagnetism and antiferromagnetism. Ferromagnetic exchange and the Heisenberg model.

Books:

(E)Kittel, Introduction to Solid State Physics
(E)Hook & Hall, Solid State Physics.

13.4.3 PHYS320 Gen Phys Exam

PHYS320 Gen Phys Exam				
Lecturer:	Dr D I Bradley		(Shadow:	Dr D A Burton)
Workshop:	10W			
Timing:	Year	3	Weeks:	L16-20
Pre-requisites:	BSc & MPhys Yrs 1, 2 & 3			
Assessment:	Examination	100%	Coursework	0%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	10 hrs	Private study	90

Academic Aims:

To examine the range of basic physics principles spanning the core course modules used in the first 3 years of physics teaching and to illustrate the application of problem solving methods to tackle the cross-module problems set in Exam Paper 3.D.

Learning Outcomes:

On completion of this *Examination* the student will demonstrate a broad grasp of the principles of problem solving in physics and show skills in the application of physics methodology to the range of problems likely to arise in Exam Paper 3.D.

Syllabus:

A series of workshops will be given in the Lent term preceding the final examination, in which modelling and problem solving techniques are revised and practised in mock exams. The types of questions set on the 3.D. general physics examination paper are reviewed and the likely range of subject matter is discussed. Students are reminded of the practical methods needed for the analysis and solution of physics-based problems, and shown how to present working in ways approved by examiners. Otherwise there is no specific syllabus. The material which could be examined is contained in all the core physics modules of years 1 to 3.

Books:

General core physics text books, including H D Young, R A Freedman, University Physics with Modern Physics, Pearson, 14th Ed., 2015.

13.4.4 PHYS321 Atomic Physics

PHYS321 Atomic Physics				
Lecturer:	Dr A Blake		(Shadow:	Dr M Hayne)
Lect/Sem:	16L,4S			
Timing:	Year	3	Weeks:	M1-5
Pre-requisites:	PHYS223			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To use the results of basic quantum mechanics to explain the basic characteristics of atomic structure and to describe the processes of atomic transitions.

Learning Outcomes:

On completion of the module the student will be able to

- explain how quantum mechanics can be used to describe the ground states and excited states of atoms with two electrons in the outer shell, and how these ideas can be extended to describe the states of atoms with several such electrons via the Russell - Saunders and j - j approximations.
- apply quantum mechanics to the transitions between atomic states and to explain the origin of selection rules.
- use their understanding of atomic states to explain chemical bonding.
- to be able to solve problems and perform elementary calculations on these topics.

Syllabus:

Revision of quantum mechanics of systems with spherical symmetry, angular momentum and and spin; “One electron” atoms, quantum numbers and level degeneracy; The spin-orbit magnetic interaction, fine and hyperfine structure of atomic levels; Application of quantum mechanics to atomic transitions; Selection rules and parity; Many-electron atoms; The Hartree approximation and the Pauli exclusion principle (weak form); Symmetry of the wave function; Bosons and Fermions; Pauli exclusion principle (strong form); Exchange interaction; Atoms with more than one electron in the outer shell, L-S (Russell-Saunders) and j-j coupling approximations; Hund’s rules; Comparison of atomic states with the shell-model of the nucleus; The periodic table of elements; Quantum mechanics of the chemical bond; The hydrogen molecule.

Books:

(E) R M Eisberg and R Resnick Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley.

13.4.5 PHYS322 Statistical Physics

PHYS322 Statistical Physics				
Lecturer:	Prof Y Pashkin		(Shadow:	Prof A Krier)
Lect/Sem:	16L,4S			
Timing:	Year	3	Weeks:	M6-10
Pre-requisites:	PHYS233			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide a unified survey of the statistical physics of gases, including a full treatment of quantum statistics.

To give fuller insight into the meaning of entropy.

To discuss applications of statistics to various types of gas.

Learning Outcomes:

On completion of the module, students should be able to:

- describe the role of statistical concepts in understanding macroscopic systems;
- deduce the Boltzmann distribution for the probability of finding a system in a particular quantum state;
- deduce the Einstein and Debye expressions for the heat capacity of an insulating solid and compare the theory with accepted experimental results;
- deduce the equation of state and the heat capacity of an ideal gas;
- deduce the Fermi-Dirac and Bose-Einstein distributions;

- describe superfluidity in liquid helium, Bose-Einstein condensation and black body radiation;
- deduce the heat capacity of a electron gas;
- deduce and apply the equipartition theorem.

Syllabus:

Introduction. Review of the ideas, techniques and results of statistical physics. Revision to application to an assembly of localised particles. The Boltzmann distribution.

Gases. The density of states - fitting waves into boxes.

Statistics of gases. Fermions and bosons. The two distributions for gases.

Maxwell-Boltzmann gases. Velocity distribution.

Fermi-Dirac gases. Electrons in metals and semiconductors. Fermi energy. Liquid helium-3.

Bose-Einstein gases. Bose-Einstein Condensation. Superfluid helium-4.

Phoney Bose-Einstein gases. Photon gas and black-body radiation. Phonon gas and thermal properties of solids.

Magnetic properties of spin 1/2 solid with partition function, energy, magnetization, adiabatic demagnetization and qualitative description of limits due to interactions/ ordering. Simple model of paramagnetic to ferromagnetic transition, order parameter, mean field and Curie temperature.

Astrophysical applications. White dwarf stars, neutron stars.

Special features:

The module provides an uncomplicated and direct approach to the subject, using frequent illustrations from low temperature physics.

Books:

(E) A M Guénault Statistical Physics (2nd ed), Chapman and Hall (1995)

13.4.6 PHYS323 Physics of Fluids

PHYS323 Physics of Fluids				
Lecturer:	Dr D A Burton		(Shadow:	Dr O Kolosov)
Lect/Sem:	16L,4S			
Timing:	Year	3	Weeks:	M6-10
Pre-requisites:	PHYS110, PHYS211 and PHYS213			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

The module aims to provide a basic introduction to fluid dynamics and its applications.

Learning Outcomes:

Knowledge and Understanding: on successful completion of the module students should be able to (i) understand the origin, solution and application of the Navier-Stokes equations; (ii) understand the wider applications of the Navier-Stokes theory to bio-, geo- and astrophysical systems; Skills: on successful completion of the module students should be able to (i) perform simple calculations of physically observable quantities relevant to the subject; (ii) solve problems based on the application of the general principles of the physics of fluids

Syllabus:

Introduction to continuum mechanics : mass, body force, contact force, global balance laws, decomposition of the contact force into shear and pressure components, particle trajectories, comoving coordinates, local balance laws and the continuity equation.

Static fluids : contact force in static fluids, equations of global and local hydrostatic equilibrium and their solutions in simple scenarios, derivation of Archimedes' principle.

Ideal Fluids : the Euler equation, incompressibility, steady flow and streamlines, Bernoulli's H-theorem and applications, vorticity and irrotational flow, circulation, Kelvin's circulation theorem and its application to tornados, vortex lines, comparison with magnetostatics, potential flow, no-through-flow boundary condition, fluid contact force on rigid bodies and d'Alembert's paradox with examples.

Newtonian fluids : Stress tensor, Newton's law of viscosity, Navier-Stokes equations, no-slip boundary condition, difficulties with solving the Navier-Stokes equations and the importance of computational fluid dynamics, Reynolds' number and hydrodynamic similarity, boundary layers, vortex shedding and resolution of d'Alembert's paradox, Kutta-Joukowski lift formula and flight, vortex-induced vibration.

Waves : compressible fluids, equations of state, linearised solutions to the fluid equations, gravity waves and their dispersion, acoustic waves and the speed of sound.

Fluid mechanics of plasmas : Two-fluid model of plasmas, stationary approximation for the ions, linearisation of the cold plasma equations, Langmuir oscillations and the plasma frequency, electromagnetic waves in plasmas and their dispersion, group velocity of signals in plasmas, application to long-range communication and pulsar distance measurements.

Books:

(E) Physics of Continuous Matter by B Lautrup

(B) Elementary Fluid Dynamics by D J Acheson
(B) A First Course in Fluid Dynamics by A R Paterson
(B) The Physics of Fluids and Plasmas by A R Choudhuri

13.4.7 PHYS351 Semiconductor Physics Laboratory

PHYS351 Semiconductor Physics Laboratory

Lecturer:	Prof A Krier	(Shadow:	Dr J Prance)	
Practical:	5P			
Timing:	Year	3	Weeks:	M1-5
Pre-requisites:	PHYS130 & pref PHYS250 or equiv			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

To provide an experimental background to lecture courses in solid state physics.
To teach students the basic principles of semiconductor physics and related semiconductor devices.
To demonstrate the main techniques of optical spectroscopy.
To reinforce various physical concepts involved in the description of solid state behaviour.
To prepare students to enable them to undertake fourth year semiconductor projects.
To reinforce experiment methods related to acquiring and analysing data including dealing with measurement uncertainties.
To give students experience of writing a final report.

Learning Outcomes:

At the end of this laboratory module, the student should:
have become acquainted with some of the most important types of semiconductors through working with Si, Ge, GaAs
have obtained hands-on experience of using optical methods to analyse semiconductor properties
have acquired basic spectroscopy experience
have applied the concepts of band theory to analysing optical and electronic properties of common semiconductor
be able to record their work in a logbook
have developed report writing skills.

Syllabus:

This module is designed to introduce the interesting physics of semiconductors through a series of experimental investigations. The course runs for 1 day per week for 5 weeks. At the end of the course, students are required to write an individual report on one of the experiments.

Band theory and relation to optical and electronic behaviour of solids. Shockley-Haynes experiment, transport properties drift, diffusion, recombination, carrier lifetime and mobility.

Important semiconductors and band structure, silicon, germanium, gallium arsenide.

Impurities, n and p-doping, p-n junction, diode equation and diode behaviour.

Direct and indirect band gaps. Properties of light emitting diodes and photo-detectors.

Basic spectroscopy techniques. Analysis of electroluminescence and optical absorption data and determination of refractive index.

Books:

Fox (OUP) Optical Properties of Solids;

Sze (Wiley) Semiconductor Devices, Physics & Technology.

13.4.8 PHYS352 Low Temperature Physics Laboratory

PHYS352 Low Temperature Physics Laboratory				
Lecturer:	Dr D I Bradley	(Shadow:	Dr O Kolosov)	
Practical:	5P			
Timing:	Year	3	Weeks:	L11-15
Pre-requisites:	PHYS130 & pref PHYS250 or equiv			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

To develop skills in the safe handling of cryogenic apparatus.
To investigate the suitability of different thermometers for different temperature regimes.
To investigate the behaviour of superfluids and low temperature superconductors.
To develop team-working skills.
To further develop skills in writing a scientific report.

Learning Outcomes:

At the end of this laboratory module, the student should:
be able to use a range of experimental low temperature apparatus and techniques to make physical measurements; be able to recognise and discuss the properties of superfluids and superconductors; have further developed log-book keeping skills; have further developed time management skills; have further developed skills relating to working as a team; have further developed report writing skills.

Syllabus:

This module is designed to introduce the interesting physics of matter at low temperatures through a series of experimental investigations. The course runs for 1 day per week for 5 weeks. In the first week, an introduction is given to low temperature experimentation including how to perform experiments and use cryogenic liquids safely, a discussion of some of the basic physics investigated in the experiments, a visual demonstration of some of the exotic properties of superfluid ^{4}He and a tour of the ultra-low temperature physics laboratory. In subsequent weeks, students will work in small groups and undertake a different one-day mini-project each week. These include:

- A paper exercise to design an experimental cryostat insert for experiments at 4K. This gives a basic grounding in how to design apparatus for experiments at lower temperatures.
- An experimental investigation of the suitability and use of thermometers over the temperature range from room temperature to near 1K.
- An experimental study of the novel second sound mode (temperature wave) in superfluid ^{4}He.
- Experiments on superconductivity. Two characteristic phenomena of superconductivity are investigated experimentally, namely zero resistivity and magnetic flux exclusion (Meissner effect).
- Experiments on superfluid turbulence using vibrating wire resonators.
- Measurement of the normal fluid component of superfluid 4He using an aerogel experiment (this is analogous to the famous Andronikashvili experiment).

During the experimental work, students are encouraged to devise and perform any additional measurements which they think might give further insights into the physics investigated.

At the end of the module, students are required to write a formal report on one of the experiments including a general discussion of the cryogenic techniques employed and a background to the physics investigated.

Books:

There is no set text for this course since it is based on practical experimentation, however the following books which are available in the University Library will be found useful.

(R) McClintock P V E, Meredith D J and Wigmore J K, Matter at Low Temperatures, Blackie.
(R) Kent A, Experimental Low Temperature Physics, MacMillan, 1993.
(R) Guénault A M, Basic Superfluids, Taylor and Francis, 2003.

13.4.9 PHYS353 Particle Physics Group Project

PHYS353 Particle Physics Group Project				
Lecturer:	Dr H O'Keeffe Dr A Blake		(Shadow:	Dr J Nowak)
Practical:	2L	5P	3W	
Timing:	Year	3	Weeks:	M/L4-13
Pre-requisites:	PHYS130 & pref PHYS250 or equiv			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	20			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

To develop skills in the safe use of nuclear detectors and sources.
To allow students to undertake an open-ended investigation of a particle physics-based problem.
To introduce students to the tasks associated with a research project in Particle Physics.
To enhance existing problem solving skills.
Prepare students to enable them to undertake fourth year practical physics projects.
Give students experience in team activity and in open-ended project work.
To develop skills in report writing and presentation.

Learning Outcomes:

On completion of this module, students will be able to:
Use nuclear particle detectors and sources.
Develop a research project with formulation, literature searches, data gathering, analysis and presentation.
Work co-operatively as part of a team.
Have skills required to pursue an open ended project.
Have the ability to record their work in a log-book.

Write a scientific report

Syllabus:

The Particle Physics Group Project involves an open-ended investigation of a problem related to Particle Physics Detectors. There is no set syllabus and the problem - in general terms - will be defined by the lecturer. Typically, this may be done either by stating the broad requirements of a solution within certain constraints or by posing an open-ended question related to a physical phenomenon. The project will not be tightly-restrained by defined limits, allowing for adaption and many different solutions to a given problem. Students will work as part of a team (typically 4-5) and will submit a group report.

Projects vary from year to year, but examples of project areas may include:
(i) Gamma spectroscopy. Possible questions are: What are differences, strengths and applications of plastic scintillators, NaI crystals and HPGe? What is the radioactive contamination of sand samples at the north west coast of England? Can we find nuclear isotopes from the Fukushima incident in the air?
(ii) Angular correlation. Investigate the consequences of quantum mechanics in nuclear decays: energy and momentum conservation, choice of quantisation axis. Determine the speed of gamma rays.
(iii) Cosmic rays. Investigate cosmic rays: What is the angular distribution and composition of cosmic rays? Does the rate of cosmic rays depend on the elevation, humidity, air pressure or other parameters? Can we confirm Einstein's theory of special relativity using cosmic muons? What is the muon lifetime?
(iv) Z0 boson and weak interaction. What are the decay modes of the Z0 boson? How can one identify electrons, muons, taus and quark-jets? What are the branching ratios? How can one distinguish between electron-positron scattering and electron-positron annihilation? How many light neutrino generations are there?

Books:

Students will find the text "Experiments in Modern Physics" by A Mellissinos particularly useful and a copy is available in the laboratory.

13.4.10 PHYS354 Literature Review

PHYS354 Literature Review				
Lecturer:	Prof A Stefanovska		(Shadow:	Not Available)
Sem/Prac:	Varies			
Timing:	Year	3	Weeks:	M1-10 or L11-20
Pre-requisites:	PHYS252			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	letter grade			
Credits:	15			
Workload:	Total student commitment 100 hrs			

This module is for non-Physics majors, i.e. Natural Science or visiting overseas students.

Academic Aims:

A literature search gives a student an opportunity to review a topic of interest within the degree scheme and to work with an individual staff supervisor.

Learning Outcomes:

On completion of a literature search the student should be able to:
Use information retrieval and storage systems; gather, assimilate, organise, understand and summarise relevant information; write a scientific document which contains reference to the sources, reveals; a structured view of the subject, conveys some understanding and summarises the topic; defend the written presentation orally if required, and thereby give further evidence of understanding.

Syllabus:

There is no set syllabus, literature searches vary from year to year and are tailored to suit the individual student(s) and the available supervisors. Topics are suggested by students or by staff and the title and area are chosen well in advance.

Books:

Appropriate books will be referred to once the topic has been chosen.

13.4.11 PHYS355 Industrial Group Project

PHYS355 Industrial Group Project

Lecturer:	Dr M Hayne		(Shadow:	Dr A Marshall)
Sem/Prac:	Varies			
Timing:	Year	3	Weeks:	M/L/S1-15
Pre-requisites:	PHYS100 & PHYS253 or equivalent			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	letter grade			
Credits:	30			
Workload:	Contact time	60 hrs	Private study	240 hrs

PHYS355 Industrial Group Project may only be taken by students enrolled on BSc/MPhys Physics.
It involves the planning and execution of a project to tackle a 'real' problem posed by a company or other external organisation as part of a team.

Academic Aims:

The module will give students the opportunity to apply their physics knowledge and skills to a practical, industry-motivated project. This requires them to develop and apply analytical and problem-solving skills in a context where there is no pre-determined method. To develop transferable skills including teamwork, problem-solving, time- and project-management, and communication skills (written and oral).

Learning Outcomes:

On successful completion of this module students will be able to:
- apply their physics knowledge to open-ended, industrially-oriented problems;
- investigate an area of physics in a systematic way using appropriate techniques and equipment;
- systematically record their work in a logbook;
- work successfully in a team to tackle large-scale problems;
- effectively communicate their work, both written and orally.

Syllabus:

At the beginning of the module, students will be taught about the fundamentals of project management. For the industrial project itself, there is no set syllabus because projects will vary from year to year, depending on the particular needs of our industrial partners in any given year. Essential skills for generalist article writing and a general introduction to oral dissemination of scientific concepts will be taught and developed at a workshop. Oral presentations will be delivered by students and formally assessed by staff at the 3rd year conference (The PLACE - The Physics @ Lancaster Annual Conference & Exhibition) which is held jointly with the 4th year conference in Week 27.

Books: Books and other literary resources will be project dependent and will be specified at the time.

13.4.12 PHYS361 Cosmology II

PHYS361 Cosmology II				
Lecturer:	Dr A Mazumdar		(Shadow:	Dr J McDonald)
Lect/Sem:	16L,4S			
Timing:	Year	3	Weeks:	M1-5
Pre-requisites:	PHYS265			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide an understanding of modern cosmology, including the areas where our understanding is still incomplete.

Learning Outcomes:

On completion of this module the student will:

- be aware of our current understanding of the observed Universe and the early Universe.
- be able to write down some of the equations that encode this understanding.
- be able to follow new developments at the level of journals like Nature and Scientific American.

Syllabus:

The global dynamics of the Universe. The Friedmann equation. Energy conservation and acceleration equations. The constituents of the Universe content and their evolution with time.

The early Universe. Thermal equilibrium. Decoupling of relics. The cosmic microwave background (CMB). Monopole and dipole moments of the CMB. Neutrino decoupling.

The radiation era of the Hot Big Bang. Adiabatic expansion and the timescale. The formation of the first nuclei one second after the Big Bang. Matter-antimatter annihilation. The mystery of the baryon asymmetry.

Thermal history of the Hot Big Bang cosmology. Phase transitions in the early Universe. The formation of nucleons. The emergence of electromagnetism. The breaking of grand unification.

Cosmic Inflation and the solution of the horizon and flatness problems of Big Bang cosmology. How inflation can provide the source for the formation of structures (e.g. galaxies) in the Universe. Primordial temperature anisotropy in the CMB and structure formation.

The formation of large-scale structure (galactic clusters and super-clusters) in the Universe.

Books:

(E) M Roos, Introduction to Cosmology, John Wiley, 3rd ed

(E) A Liddle, An Introduction to Modern Cosmology, Wiley, 2nd ed

Also available in the University library are:

(R) M Berry, Principles of Cosmology and Gravitation, CUP.

(R) M Lachieze-Rey and E Gunzig, The Cosmological Background Radiation, CUP.

(R) A R Liddle and D H Lyth, Cosmological Inflation and Large Scale Structure, CUP

13.4.13 PHYS362 Astrophysics II

PHYS362 Astrophysics II				
Lecturer:	Dr C Arridge		(Shadow:	Dr D I Bradley)
Lect/Sem:	16L,4S			
Timing:	Year	3	Weeks:	L16-20
Pre-requisites:	PHYS264			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To explain the evolution of stars, stellar remnants, and the interactions between stellar and sub-stellar objects using stellar structure theory, modern physics, and stellar models.
An emphasis is placed on the contributions of modern physics, particularly quantum mechanics, nuclear and particle physics, and relativity, to our understanding of stars and other astrophysical systems.

Learning Outcomes:

On completion of the module the student should:
Apply the equations of stellar structure to carry out calculations on the interiors of stars and to construct and interpret analytical stellar models.
Apply concepts from nuclear physics, particle physics, quantum mechanics and relativity to understand the physical processes inside stars and carry out quantitative calculations.
Explain the physical processes that drive the evolution of low-, intermediate- and high-mass stars and describe their evolution.
Analyse models of stellar evolution to distinguish physical processes, deduce the interior structure of stars, relate this to their tracks on Hertzsprung-Russell diagrams, and draw conclusions regarding the position in the life cycle of a star.
Discuss the origin, physics and phenomenology of white dwarfs, neutron stars, pulsars and black holes, and the describe the observational evidence for their existence.
Discuss binary systems, mechanisms of mass transfer, and the physical processes in accretion discs.

Syllabus:

Stellar models: Equations of stellar structure. Eddingtons model. Homology. Polytropic equations of state; Lane-Emden equation. Numerical stellar models; Kippenhahn diagrams.
Thermonuclear fusion: general concepts; proton-proton chain; CNO cycle; triple-alpha process; solar neutrinos and observational evidence for solar fusion; cross-sections and nuclear reaction rates; quantum tunneling; Gamow peak; temperature dependence of nuclear fusion cycles. Nuclear reaction networks.
Evolution of low and intermediate mass stars: Brown dwarfs. Schnberg-Chandrasekhar limit; helium core and helium shell flashes; sub-giant branch (SGB); red giant branch (RGB); asymptotic giant branch (AGB); dredge-up; post-AGB phase; planetary nebulae. Stellar winds. Stellar pulsations. White dwarf stars; the Chandrasekhar limit.
Accretion discs and binary systems: binary stars; Roche lobes; Roche lobe overflow; one-dimensional models of accretion discs; viscosity in accretion discs; jets; Type 1a supernovae; gravitational waves.
Pulsars: observable properties; dispersion; pulsar magnetospheres; magnetic dipole radiation and slow down; glitches; binary pulsars.
Black holes: Schwarzchild metric; radial null geodesics; time-like geodisc for infalling matter; nature of the event horizon. Gravitational lens and Einstein ring. Observational evidence; supermassive black holes.

Books:

(E) Caroll and Ostlie Introduction to Modern Astrophysics Pearson.

(R) Prialnik An Introduction to the Theory of Stellar Structure and Evolution CUP

13.4.14 PHYS363 Astrophysics Laboratory

PHYS363 Astrophysics Laboratory				
Lecturer:	Dr D I Bradley Dr A Grocott		(Shadow:	Prof G V Borissov)
Practical:	30P			
Timing:	Year	3	Weeks:	M6-10
Pre-requisites:	PHYS133 & PHYS264			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	10			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

- To enable students to obtain an appreciation of some practical aspects of astrophysics and cosmology
- In particular to familiarise them with the telescope and CCD camera
- Give students experience of analysing astronomical data
- Reinforce their understanding of astronomical phenomena
- Prepare students to enable them to undertake 4th year astronomical projects in the observatory
- Give them experience in team activity and in open-ended project work

Learning Outcomes:

On completion of this module the student will:

- Understand the basic principles of, and be able to make simple measurements using the telescope, spectroscope and CCD camera

- Reinforce understanding of basic astronomical phenomena through computer simulations
- Appreciate the statistical nature of astrophysical knowledge through analysis of stellar data relating to luminosity and temperature

Syllabus:

The purpose of this laboratory course is to familiarise students with astronomical experimentation and instrumentation.

This will include practical use of a telescope, CCD cameras as well as manipulation of images taken with such instrumentation.

There are also computer simulations that will develop understanding of key concepts in observational astronomy. The manual is intended only for guidance and during the experimental work, students will be encouraged to devise and perform any additional measurement or modelling which they think might give further insights into the physics investigated. Students will find the techniques learnt here useful for future possible MPhys projects. Possible experiments may include:

- An experiment-based workshop reviewing the basic optical principles of telescopes, and the various factors that determine their performance - field of view, focal length, magnification, aberrations.
- Computer-based simulation of astronomical measurements illustrating some important aspects of stellar and galactic astronomy: e.g. stellar parallax, Cepheid variable stars, mass determination from visual and eclipsing binary stars, and the distribution of mass in a galaxy from galactic rotation curves.
- Practical experience in using a CCD (charge-coupled device) camera and in processing images. The standard laboratory suite of acquisition and software analysis tools will be used to process a library of images taken with the telescope, correct image faults and create composite colour images.
- Astronomical data processing activities giving experience in working with real data relating to the Hertzsprung-Russell diagram and variable star photometry. Raw CCD images will be calibrated and manipulated leading to the time evolution of the magnitude of a variable star, reinforcing the concept of magnitude and the relationship with the observed number of photons.

Books:

Each experiment is described in a laboratory handbook provided. Reference to the following text books could be useful:
K Holliday, Introductory Astronomy, Wiley
W J Kaufmann & R A Freedman, Universe, W H Freeman
B W Carroll, D A Ostlie, Modern Astrophysics, Addison

13.4.15 PHYS364 Cosmology Group Project

PHYS364 Cosmology Group Project				
Lecturer:	Dr J McDonald Dr K Dimopoulos		(Shadow:	Dr A Mazumdar)
Practical:	30P			
Timing:	Year	3	Weeks:	L11-20
Pre-requisites:	PHYS361			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	20			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

To provide an understanding of modern cosmology, including the areas where our understanding is still incomplete.
To investigate an open-ended Cosmology-based problem.
To introduce students to the tasks associated with a research project in Cosmology.
To improve skills in problem solving.
To develop information retrieval skills.
To give students experience in team activity and in open-ended project work.
To further develop skills in report writing and presentation.

Learning Outcomes:

On completion of this module, students will be able to:
Understand the basics of current research topics in Cosmology.
Develop a research project with formulation, literature searches, data gathering, analysis and presentation.
Work co-operatively as part of a team.
Demonstrate the importance of communication skills in presentation of results.

Syllabus:

The Cosmology Group Project involves an open-ended investigation of a Cosmology-based problem. There is no set syllabus and the problem - in general terms - will be defined by the lecturer. Typically, this may be done either by stating the broad requirements of a solution within certain constraints or by posing an open-ended question related to a physical phenomenom. The project will not be tightly-restrained by defined limits, allowing for adaption and many different solutions to a given problem. Projects vary from year to year, but examples of projects may include a description of the Age of the Universe problem and its resolution via a cosmological constant or dark energy. Students will work as part of a team (typically 4-5) and will submit a group report.

Books:

For the project work, appropriate books or other sources (theses, scientific papers etc.) will be referred to once the project has been designed.

13.4.16 PHYS366 Groups & Symmetries

PHYS366 Groups & Symmetries				
Lecturer:	Dr J Gratus		Shadow:	Prof G V Borissov)
Lect/Sem:	16L,4S			
Timing:	Year	3	Weeks:	L11-15
Pre-requisites:	PHYS110, PHYS232			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide students with a basic knowledge and understanding of the concepts and methods used in group theory. To apply these concepts and methods to problems in particle physics, cosmology and field theory.

Learning Outcomes:

On successful completion of the module students should be able to:
Display a knowledge and understanding of the concepts of transformation ,invariance and symmetry and their mathematical descriptions; show a knowledge of the foundations of group theory and the specific properties of orthogonal and unitary groups; apply this knowledge to various problems in particle physics and cosmology.

Syllabus:

The module will cover various topics including: symmetries and transformations; groups, group invariants and generators; irreducible representations; orthogonal groups O(2) and O(3); unitary groups SU(2) and SU(3); applications to spin, isospin, colour and flavour of elementary particles.

Books:

J. Cornwell, Group Theory in Physics: An Introduction, Elsevier, 1997.

13.4.17 PHYS367 Flavour Physics

PHYS367 Flavour Physics				
Lecturer:	Dr J Nowak		(Shadow:	Prof I A Bertram)
Lect/Sem:	16L,4S			
Timing:	Year	3	Weeks:	L16-20
Pre-requisites:	PHYS311			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide students with a basic knowledge & understanding of the phenomenology of flavour mixing in quark sector, neutrino oscillations, physics of b-hadrons and other related topics. To provide a deeper insight on these by examining experimental data.

Learning Outcomes:

On successful completion of the module students should be able to:
Display a knowledge and understanding of the basic ideas, concepts and analyses of the experimental data on flavour mixing in weak interactions of hadrons and neutrino oscillations; display a knowledge of some current topics on the physics of heavy flavours which are likely directions of the experimental particle physics research in Lancaster.

Syllabus:

The module will cover various topics including: CKM matrix and its parameterisations; unitarity constraints and the unitarity triangle; status of experimental measurements; theory and observations of neutrino oscillations; CP violation; current topics of heavy flavour physics, such as c- and b-hadron production and decay analysis, top quark physics.

Books:

(E) The Review of Particle Physics, K. Nakamura et al. (Particle Data Group), J. Phys. G 37, 075021 (2010) - http://pdg.lbl.gov/
(R) M Thomson, Modern Particle Physics, Cambridge.
(R) Martin & Shaw, Particle Physics, Wiley.
(R) D J Griffiths, Introduction to Elementary Particles, Wiley.

(R) D Perkins, Introduction to High Energy Physics, 4th Ed, Cambridge.
(R) W Rolnick, The Fundamental Particles and their Interactions, Addison Wesley.

13.4.18 PHYS368 Aurora-Atmospheric Physics

PHYS368 Aurora-Atmospheric Physics				
Lecturer:	Not Running 2016/2017		(Shadow:	Not Running 2016/2017)
Sem/Prac:	Varies			
Timing:	Year	3	Weeks:	M1-5
Pre-requisites:				
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

This module aims to introduce the student to the physics of the high-latitude upper atmosphere, both neutral and charged, e.g. composition, circulation, currents, waves and energy transport. Small- and large-scale effects of particle precipitation into the atmosphere are studied, e.g. electron and proton aurora, radio wave absorption, and auroral substorms. In addition, the relevant remote sensing techniques are introduced, e.g. radars and night-vision optics.

Learning Outcomes:

On completion of a literature search the student should be able to:

Describe the neutral and charged composition, density and temperature layers with altitude.
Describe the neutral and charged particle motions vertically and horizontally.
Explain the forces acting on parcels of gas.
Explain the atmospheric current systems and energy transport.
Describe the fundamentals of atmospheric and plasma waves.
Explain photon production from electron and proton bombardment of the atmospheric gas.
Describe the side effects of particle precipitation into the atmosphere.
Explain the (dis)advantages of various remote sensing techniques.

Syllabus:

- Earth neutral atmosphere - the thermosphere:
  Composition, density, temperature with altitude; Neutral circulation, horizontal and vertical motions; Forces acting (ion drag, solar pressure, coriollis, advection, viscous); Atmospheric waves (planetary and gravity); Airglow; Observational techniques (e.g. Fabry-Perot interferometer, rocket launches).

- Earth charged atmosphere - the ionosphere:
  Composition, density, temperature with altitude; D-, E- and F-layer properties; Plasmas and instabilities; Ion circulation, horizontal and vertical motions; Current systems (magnetic field-aligned, Hall, Pedersen, electrojets, closure currents); Ionospheric conductivity and Joule heating; Observational techniques (e.g. coherent and incoherent scatter radars, optics).

- Small-scale particle precipitation effects:
  Photon production from electrons; Photon production from protons; Prompt and forbidden states and associated photons; Energy and flux of particle precipitation; Radio wave absorption; Artificial auroras; Observational techniques (e.g. night-vision camera systems, photometers, riometers)

- Large-scale particle precipitation effects:
  Auroral oval; Auroral substorm; Auroral morphology (arcs, westward travelling surges, omega bands, pulsating auroras, black auroras); Observational techniques (e.g. satellite visible and UV imaging systems, night-vision TV system, magnetometers)

Books:

(R) The solar-terrestrial environment, J. K. Hargreaves, Cambridge University press, 1995.
(R) Introduction to space physics, M. G. Kivelson and C. T. Russell, Cambridge University Press, 1995.
(B) The upper atmosphere and solar-terrestrial relations, J. K. Hargreaves, Van Nostrand Reinhold, 1979.
(B) The Earth's ionosphere, M. C. Kelley, Academic Press, 1989.
(B) Physics of the Earth's space environment, G. W. Prlss, Springer, 2004.
(B) Auroral Physics, C.-I. Meng, M. J. Rycroft and L. A. Frank, Cambridge University Press, 1991.

13.4.19 PHYS369 Space Science Group Project

PHYS369 Space Science Group Project

Lecturer:	Not Running 2016/2017		(Shadow:	Not Running 2016/2017)
Sem/Prac:	Varies			
Timing:	Year	3	Weeks:	L11-20
Pre-requisites:	PHYS268			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	20			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

This module has the following aims:
To investigate an open-ended Space-Science-based problem.
To provide an introduction to scientific research techniques including error analysis, Fourier Transforms etc., when applied to real scientific data.
To enhance existing problem solving skills.
To introduce students to the tasks associated with a research project in Space Physics.
To improve skills in problem solving, data analysis, presentation skills.
To introduce the function of peer review in broad terms.
To give students experience in team activity and in open-ended project work.
To develop skills in report writing and presentation.

Learning Outcomes:

On completion of this module, students will be able to:
Understand the basics of current research topics in Space Science.
Develop a research project from formulation, literature searches, data gathering, analysis and presentation. Work co-operatively as part of a team.
Demonstrate knowledge of the function of peer-review in broad terms.

Demonstrate the importance of communication skills in presentation of results.
Use various techniques for data analysis which can be adapted to other areas of science and employment.

Syllabus:

This Space Science Group Project involves an open-ended investigation of a Space-Science-based problem. There is no set syllabus and the problem - in general terms - will be defined by the lecturer. Typically, this may be done either by stating the broad requirements of a solution within certain constraints or by posing an open-ended question related to a physical phenomenon. The project will not be tightly-restrained by defined limits, allowing for adaption and many different solutions to a given problem. Projects vary from year to year, but examples of projects may include (i) the design of part of a space mission plan in which you must identify and satisfy practical constraints, (ii) an investigation of the nature of the relationship between the solar wind and the Earth's magnetosphere by analysing spacecraft data. Students will work as part of a team (typically 4-5) and will submit a group report.

Books:

Handbook of the Solar-Terrestrial Environment, Kamide and Chan, Springer, 2007. ISBN 978-3-540-46314-6.
Understanding Space Weather and the Physics Behind It, D. Knipp, McGraw Hill, 2011. ISBN 978-0-07-340890-3.
Introduction to Space Physics, Kievelson and Russell, Cambridge University Press, 1995., ISBN 0-521-45714-9.
The solar-terrestrial environment, J. K. Hargreaves, Cambridge University Ppress, 1995. ISBN 0-521-42737-1.

13.4.20 PHYS375 Theoretical Physics Independent Study

PHYS375 Theoretical Physics Independent Study				
Lecturer:	Dr N Drummond Dr A Romito Dr J Gratus		(Shadow:	Dr E McCann To be announced)
Lect/Sem:	25L,15W			
Timing:	Year	3	Weeks:	M1-10
Pre-requisites:	PHYS211, PHYS213, PHYS273, PHYS274			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	20			
Workload:	Contact time	40 hrs	Private study	160 hrs

Academic Aims:

To teach analytical recipes of theoretical physics used in quantum mechanics, with the focus on the variational functions method, operator techniques with applications in perturbation theory methods and coherent states of a quantum harmonic oscillator.
To train in the use of the operator algebra of 'creation' and 'annihilation' operators in the harmonic oscillator problem, which will develop a basis for the introduction of second quantisation in many-body systems.
To introduce the algebra of creation and annihilation operators for Bose and Fermi systems.
To introduce second-quantised representation of Hamiltonians of interacting many-body systems.
To analyse Bose-Einstein condensation in one-, two-, and three-dimensional systems and to describe the condensate using the method of coherent states.
To introduce Ginzburg-Landau theory of a superfluid phase transition and to describe vortices in a superfluid.
To relate Bose and Fermi statistics to the symmetry of many-body systems with respect to permutations of identical particles.
To introduce the mathematical basis of complex analysis and its practical use in solving problems in mathematical and theoretical physics.
To develop information retrieval skills.
To enhance existing problem solving skills.
To further develop skills in report writing and presentation.

Learning Outcomes:

On successful completion of this module students will be able to:
Use the variational principle in application to quantum mechanical problems.
Apply the operator algebra of creation and annihilation operators to study non-harmonicity effects in quantum oscillators.
Use coherent states in order to relate quantum and classical motion of harmonic systems.
Perform calculations using Pauli matrices.
Operate with the algebra of creation/annihilation operators for Bose and Fermi gases.
Write down the Hamiltonian describing an interacting Bose/Fermi gas in the second-quantised representation.
Describe Bose-Einstein condensation.
Use the condensate wave function to describe the origin of vortices in a superfluid/superconductor.
Apply complex analysis to problems in physics, including the evaluation of definite integrals.
Retrieve and digest scientific information from various sources.
Manage a number of different tasks successful.
Write a scientific report.

Syllabus:

Theoretical Physics Independent Study (10 weeks) is assessed by coursework, an end-of-module test and an individual report. Independent study in various aspects of theoretical physics is guided by a series of workshops. Topics include analytical recipes in quantum mechanics, many-body and second quantisation techniques, and complex analysis. The guided independent study involves solving problems, intense reading and presentations by students. During the module, each student will undertake coursework assignments and will give a short talk presenting some of the results obtained. Students will also get an opportunity to extend their preliminary studies by undertaking open-ended investigations into various aspects/problems of theoretical physics, and they will write up their findings in a report. Proficiency in complex analysis will be assessed by an end-of-module test.

Analytical Recipes: Relation between the Schrodinger equation and matrix formulation of quantum mechanics and the variational principle. Energy and energy functional. Minimisation of functionals under constraints and Lagrange multipliers. Practical training in the use of the variational function approach. Operators and commutation relations. Creation and annihilation operators in the harmonic oscillator problem. Anharmonicity in nonlinear oscillators, use of creation and annihilation operators in perturbation theory calculations. Evolution operator in quantum mechanics, use of the evolution operator in applications to the harmonic oscillator problem. Coherent states as eigenstates of annihilation operators. Properties of coherent states and classical dynamics of wave packets modelled using coherent states.

Advance Many-body Techniques: Second quantisation operators for Bose and Fermi statistics, operator algebra of creation and annihilation operators. Local operators, their commutation properties, completeness of the single-particle basis. Hamiltonians of interacting many-body systems in the second quantised representation. Bose-Einstein condensation from the statistical physics point of view. Bose-Einstein condensate as a coherent state of a Bose gas. Ginzburg-Landau theory of a super uid phase transition. Vortices in a super uid. Ultracold atomic gases and BEC in atomic traps. Gauge invariance. Ginzburg-Landau theory of superconductivity.

Complex analysis: analytic functions, Cauchy-Riemann conditions. Contour integrals, Cauchy's theorem, Cauchy's integral formula. Laurent series, poles, residues. The residue theorem, methods of finding residues, evaluation of definite integrals. Applications in physics.

Books:

A Messiah, Quantum Mechanics, Pergamon Press (any edition)
L.D.Landau and E.M.Lifshitz, Quantum Mechanics, Pergamon Press (any edition)
L.D. Landau and E.M. Lifshitz, Statistical Physics I, Pergamon Press (any edition)
E M Lifshitz and L P Pitaevski, Statistical Physics - II, Pergamon Press (any edition)
R P Feynmann, Statistical Mechanics, Westview Press
A L Fetter and J D Walecka, Quantum theory of many-particle systems, Dover
J M Howie, Complex Analysis, Springer, 2003
M L Boas, Mathematical Methods in the Physical Sciences, Wiley (any edition)

13.4.21 PHYS378 TPM Independent Study

PHYS378 TPM Independent Study				
Lecturer:	Dr N Drummond Dr A Romito Dr J Gratus		(Shadow:	Dr E McCann)
Lect/Sem:	25L,15W			
Timing:	Year	3	Weeks:	M1-10
Pre-requisites:	PHYS223, PHYS272			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	20			
Workload:	Contact time	40 hrs	Private study	160 hrs

Academic Aims:

To teach analytical recipes of theoretical physics used in quantum mechanics, with the focus on the variational functions method, operator techniques with applications in perturbation theory methods and coherent states of a quantum harmonic oscillator.
To train in the use of the operator algebra of 'creation' and 'annihilation' operators in the harmonic oscillator problem, which will develop a basis for the introduction of second quantisation in many-body systems.
To introduce the algebra of creation and annihilation operators for Bose and Fermi systems.
To introduce second-quantised representation of Hamiltonians of interacting many-body systems.
To analyse Bose-Einstein condensation in one-, two-, and three-dimensional systems and to describe the condensate using the method of coherent states.
To introduce Ginzburg-Landau theory of a superfluid phase transition and to describe vortices in a superfluid.
To relate Bose and Fermi statistics to the symmetry of many-body systems with respect to permutations of identical particles.
To teach computer programming.
To give Theoretical Physics with Mathematics students further opportunity to experience individual project work.
To prepare students to enable them to undertake fourth year theoretical physics projects.
To develop information retrieval skills.
To enhance existing problem solving and computer programming skills.

To further develop skills in report writing and presentation.

Learning Outcomes:

On successful completion of this module students will be able to:
Use the variational principle in application to quantum mechanical problems.
Apply the operator algebra of creation and annihilation operators to study non-harmonicity effects in quantum oscillators.
Use coherent states in order to relate quantum and classical motion of harmonic systems.
Perform calculations using Pauli matrices.
Operate with the algebra of creation/annihilation operators for Bose and Fermi gases.
Write down the Hamiltonian describing an interacting Bose/Fermi gas in the second-quantised representation.
Describe Bose-Einstein condensation.
Use the condensate wave function to describe the origin of vortices in a superfluid/superconductor.
Model simple physical systems using appropriate programming techniques.
Tackle open ended projects.
Retrieve and digest scientific information from various sources.
Manage a number of different tasks successfully.
Write a short computer program to perform simple numerical calculations.
Write a scientific report.

Syllabus:

Independent study in various aspects of theoretical physics is guided by a series of workshops. Topics include analytical recipes in quantum mechanics, many-body and second quantisation techniques. The guided independent study involves solving problems, intense reading and presentations by students. During the module, each student will undertake coursework assignments and will give a short talk presenting some of the results obtained. Students will also get an opportunity to extend their preliminary studies by undertaking open-ended investigations into various aspects/problems of theoretical physics, and they will write up their findings in an individual report.

Analytical Recipes: Relation between the Schrodinger equation and matrix formulation of quantum mechanics and the variational principle. Energy and energy functional. Minimisation of functionals under constraints and Lagrange multipliers. Practical training in the use of the variational function approach. Operators and commutation relations. Creation and annihilation operators in the harmonic oscillator problem. Anharmonicity in nonlinear oscillators, use of creation and annihilation operators in perturbation theory calculations. Evolution operator in quantum mechanics, use of the evolution operator in applications to the harmonic oscillator problem. Coherent states as eigenstates of annihilation operators. Properties of coherent states and classical dynamics of wave packets modelled using coherent states.

Advance Many-body Techniques: Second quantisation operators for Bose and Fermi statistics, operator algebra of creation and annihilation operators. Local operators, their commutation properties, completeness of the single-particle basis. Hamiltonians of interacting many-body systems in the second quantised representation. Bose-Einstein condensation from the statistical physics point of view. Bose-Einstein condensate as a coherent state of a Bose gas. Ginzburg-Landau theory of a super uid phase transition. Vortices in a super uid. Ultracold atomic gases and BEC in atomic traps. Gauge invariance. Ginzburg-Landau theory of superconductivity.

Computer Project: This is an introduction to computer programming for problem-solving and numerical calculations in theoretical and mathematical physics. In the first half (5 weeks), basics of computer programming will be taught through a series of workshops, backed up by independent study. Particular elements of computer programming include syntax; variables; logical expressions; if statements; loops; arrays; strings; numerical integration; debugging code; reading and writing data. In the second half (5 weeks), students will undertake an individual computer project to solve a problem related to theoretical or mathematical physics. Project work will be assessed by submission of an individual report.

Books:

A Messiah, Quantum Mechanics, Pergamon Press (any edition)
L.D.Landau and E.M.Lifshitz, Quantum Mechanics, Pergamon Press (any edition)
L.D. Landau and E.M. Lifshitz, Statistical Physics I, Pergamon Press (any edition)
E M Lifshitz and L P Pitaevski, Statistical Physics - II, Pergamon Press (any edition)
R P Feynmann, Statistical Mechanics, Westview Press
A L Fetter and J D Walecka, Quantum theory of many-particle systems, Dover
J M Howie, Complex Analysis, Springer, 2003
M L Boas, Mathematical Methods in the Physical Sciences, Wiley (any edition)

13.4.22 PHYS379 Theory & TPM Group Project

PHYS379 Theory & TPM Group Project

Lecturer:	Dr E McCann		(Shadow:	Prof H Schomerus)
Lect/Sem:	25L,15W			
Timing:	Year	3	Weeks:	L11-20
Pre-requisites:	PHYS375 or PHYS378			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	20			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

To prepare students to enable them to undertake fourth year theoretical physics projects.
To give students experience in team activity and in open-ended project work.
To develop information retrieval skills.
To enhance existing problem solving skills.
To further develop skills in report writing and presentation.

Learning Outcomes:

On successful completion of this module students will be able to:
Tackle open ended projects.
Keep a log-book.
Retrieve and digest scientific information from various sources.
Manage a number of different tasks successful.
Write a scientific report.
Establish co-operative working practices with colleagues.
Give a verbal presentation about their research.

Syllabus:

The project involves an open-ended investigation of a Theoretical Physics-based problem. There is no set syllabus and the problem -

in general terms - will be defined by the lecturer. Typically, this may be done either by stating the broad requirements of a solution within certain constraints or by posing an open-ended question related to a physical phenomenom. The project will not be tightly-restrained by defined limits, allowing for adaption and many different solutions to a given problem. Projects vary from year to year, but examples of projects may include modelling the properties of electrons in crystal lattices (graphene, topological insulators, Kitaev lattice); dynamics of vortices in superfluids and/or superconductors; particles obeying fractional statistics; problems in mathematical physics. Students will work as part of a team (typically 4-5) and will submit a group report.

13.4.23 PHYS384 Physics of Living Systems

PHYS384 Physics of Living Systems				
Lecturer:	Prof A Stefanovska		(Shadow:	Dr O Kolosov)
Lect/Sem:	16L,4S			
Timing:	Year	3/4	Weeks:	L11-15
Pre-requisites:	PHYS211, 213 & 322			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

The aims of this module are:
To introduce the topic of biomedical physics, and to show how physical principles help one to understand the function of living systems at all levels of complexity - starting at the molecular, via the cellular, to the organ and system levels. To introduce stability analysis of thermodynamically open systems. To convey an appreciation that living systems are structures in time as much as structures in space. To provide an introduction to coupled oscillatory processes characteristic of living systems. To introduce some analytical techniques for analysis of data related to complex, oscillatory systems. Students will be taught how to interpret experimental observations of various biomedical systems by using their physics and mathematics knowledge and by applying problem-solving skills. They will acquire new knowledge and skills that will be applicable to complex systems quite generally, not only in biomedicine.

Learning Outcomes:

On successful completion of the module the students should be able to:
- explain the basic characteristics of living systems as thermodynamically open systems;
- explain the physical principles of the functioning of a cell, how cells make ensembles (tissues and organs), and how they interact within larger biological systems;
- apply their knowledge of physics and mathematics to the understanding of basic principles of living systems - starting from a cell to the cardiovascular system and the brain;

- appreciate the importance of stability analysis to oscillatory dynamical systems and understand basic concepts of synchronization;
- apply knowledge of physics and mathematics to model complex systems quite generally.

Syllabus:

Introduction and revision of physics concepts that will be needed.
What is life?
Stability and synchronization in complex and open interacting systems.
Entropy and information; DNA as an information storage system.
Fundamental rate processes: Boltzmann equation.
Molecular diffusion and Brownian motion.
Ion channel dynamics.
Cellular structure and function: passive and active transport across a cell membrane.
Membrane potential: Nernst-Planck and Goldman equations.
Oscillatory dynamics of membrane potential.
Action potential: Hodgkin-Huxley equations.
Integrate and fire model and functioning of the brain as an information-processing system.
Mechanical and electrical properties of the heart.
Functioning of the cardiovascular system as a system that provides energy and matter to cells.
Oscillations and turbulence in blood flow.
Interactions between cardiovascular oscillations and brain waves.

Books:

Primary text: R Glaser, Biophysics, Springer, 2005.
Secondary text: P Nelson, Biological Physics: Energy, Information, Life, 2008.

13.4.24 PHYS385 Adv. Nanoscale Microscopy

PHYS385 Adv. Nanoscale Microscopy				
Lecturer:	Not Running 2016/2017		(Shadow:	Not Running 2016/2017)
Lect/Sem:	16L,4S			
Timing:	Year	3/4	Weeks:	L11-15
Pre-requisites:	PHYS222			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide core knowledge and understanding of the physics and operating principles of modern optical and spectroscopic methods and related optical instrumentation in nanotechnology, pharmaceutical, biotechnology and biomedical fields.

To provide core knowledge of some modern industrial and research methodologies and to provide an insight into how these are implemented.

Learning Outcomes:

On successful completion of the module the students should be able to:

- demonstrate an understanding of the physical principles behind modern microscopic and spectroscopic approaches used in nano- and bio-technology.
- apply their knowledge of physics to comparative analysis, selection and practical use of modern analytical instrumentation in the fields of nano- and biotechnology.
- understand the dynamics of industrial and research developments in vital areas for modern society.
- analyse scientific and industrial issues with a high public profile.

Syllabus:

- Introduction: physical principles of modern optical measurement and visualization technologies. Methods for spectroscopic analysis. Fundamental principles of microscopes and their implementations.
- Traditional optical microscopy and related techniques: Optical microscopy, various contrasts and sample preparation. optical confocal microscopy, endoscopic fiber optics and camera-in-the-pill methods. Applications and limitations in light microscopy.
- Confocal optical microscopy: Principles. applications and limitations of confocal laser scanning microscopes, instrumentation and preparation techniques. Optical Coherence Microscopy/Tomography.
- Optical spectroscopy techniques: UV-VIS spectroscopy. Vibrational spectroscopy. Raman spectroscopy and microscopy. IR spectroscopy and microscopy; FTIR and ATR methods.
- Fluorescence techniques Fluorescence microscopy - introduction to fluorescent labelling. Analytical features of fluorescence microscopes. Fluorescence correlation spectroscopy.
- Spatial spectroscopic analysis. micro-arrays, genomics and proteomics applications. Introduction to DNA and sequencing and protein identification.
- Near-field microscopy and spectroscopic methods. Principles of Scanning Probe Microscopy. Near-Field Scanning Optical Microscopy. Applications of photo-thermal micro-spectroscopy - polymers and biomaterials. Ultrasonic Force Microscopy and subsurface imaging.
- Complementary optical spectroscopy techniques . Surface Plasmon resonance - applications and limitations, Light correlation spectroscopy- measuring nanoparticles with optical methods.
- Comparative analysis with other imaging and characterization techniques: Comparative analysis of optical methods with other modern imaging techniques like CT, SPECT, acoustic and MRI imaging.
- Data processing of multi-component spectral data: analysis of variance; correlation and regression analysis; chi-squared tests; principles and implementation of chemometry, principal component analysis (PCA), linear discriminate analysis (LDA) and examples of selected modern statistical data packages.

Books:

(E) Modern Optical Spectroscopy With Examples from Biophysics and Biochemistry, Parson, William W. 2007, ISBN: 978-3-540-37535-7 Springer (2007)
Various web-based resources, including analytical instrumentation reference sites.
(R) Hoppert, Michael, Microscopic Techniques in Biotechnology. Practical Approach Book. ISBN-10: 3-527-30198-4. ISBN-13: 978-3-527-30198-0 - Wiley-VCH, Weinheim. (2003)

13.4.25 PHYS386 Physics of Global Warming

PHYS386 Physics of Global Warming				
Lecturer:	Not Running 2016/2017		(Shadow:	Not Running 2016/2017)
Lect/Sem:	16L,4S			
Timing:	Year	3/4	Weeks:	L11-15
Pre-requisites:	PHYS233			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide a broad overview of the physical science behind the global warming debate and the issues involved.

To help students to analyse, review and criticise science issues with a high public profile, to knowledgeably and usefully contribute to science debates in public, and to implement that knowledge in a practical way.

Learning Outcomes:

On successful completion of the module the students should be able to:

- clearly explain the physics of global warming.
- understand the physical processes of the atmosphere relevant to global warming.
- critically review alternative explanations.
- make an informed contribution to the debate.
- review and criticise science issues with a high public profile.

Syllabus:

- An overview of the effects of greenhouse gases on the mean temperature of the Earth and why greater concentrations of greenhouse gases could produce more warming.
- The basic physical principles of energy transfer: Thermal radiation - Stefan's Law, Wien's Law. Imperfect radiators and Kirchoff's law for radiators. The rotational and vibrational spectra of molecules and the effects of these in the absorption of radiation in the atmosphere. Convection and conduction of heat in the atmosphere.
- These ideas will then be applied to model the Earth's atmosphere and particularly its temperature profile. The structure of the atmosphere will be discussed.
- The effect of cosmic rays and whether they could explain global warming will also be discussed.
- The counter arguments that global warming is not man made will be discussed and the methodology of the Intergovernmental Panel on Climate Change will reviewed.
- The emphasis will be on the science that underpins or undermines the various arguments.

Books:

(E) Elementary Climate Physics - F.W. Taylor (OUP)

13.4.26 PHYS388 Energy

PHYS388 Energy

Lecturer:	Dr M Hayne		(Shadow:	Prof I A Bertram)
Lect/Sem:	16L,4S			
Timing:	Year	3/4	Weeks:	L16-20
Pre-requisites:	PHYS233			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide a broad overview of energy and the issues involved from a sound physical basis. To help students to analyse, review and criticise science issues with a high public profile, to knowledgeably and usefully contribute to science debates in public, and to implement that knowledge in a practical way.

Learning Outcomes:

On completion of the module, students should be able to:

- clearly explain the physics of energy and global warming and make an informed contribution to the debate,
- apply their knowledge of physics to solve practical energy problems,
- cost capital projects on a small and large scale,
- review and criticise science issues with a high public profile.

Syllabus:

Introduction: Energy use, past present and future. **Themodynamics and electricity generation**: Review of 0th, 1st and 2nd laws of thermodynamics, entropy and heat engines, Carnot efficiency, electricity generation and distribution, coping with variable demand. **Costing energy**: Time preference for money and discounted cash flow analysis. **Nuclear power**: fission and fission reactors, nuclear fuel cycles and breeder reactors. **Introduction to renewable energy and wind power. Wet renewables**: hydroelectricity, wave and tidal power. **Solar power**: Daily and seasonal variation in solar flux, solar thermal, solar cells. **A planetary view**: Sources of energy on a planetary scale, greenhouse effect, anthropogenic global warming, Milankovitch cycles and the early anthropocene hypothesis. **Clean coal**: Supercritical and integrated gasification combined cycle (IGCC) power stations. **Hydrogen economy**: hydrogen production and storage. An optional tour of Lancaster Renewable Energy Group, Department of Engineering, will be arranged.

Books:

Various Web-based resources, especially from the UK government.

(R) G Boyle, R Everett and J Ramage, Energy Systems and Sustainability: Power for a sustainable future, 2003 OUP, ISBN 0-19-926179-2.
(R) G Boyle, Renewable Energy, OUP, ISBN 0-19-926-179-2.

13.4.27 PHYS389 Computer Modelling

PHYS389 Computer Modelling				
Lecturer:	Prof I A Bertram		(Shadow:	Dr J Nowak)
Practical:	30P			
Timing:	Year	3/4	Weeks:	L16-20
Pre-requisites:	PHYS281 or equivalent			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	30 hrs	Private study	70 hrs

Academic Aims:

This module extends the material taught in PHYS281, including additional elements of the JAVA language, and more sophisticated modeling of physical systems. Successful completion of the final exercise in PHYS281 is a requirement for this course.

Learning Outcomes:

On completion of the module, students should:
Have a more thorough knowledge of the JAVA language, including the use of inheritance and polymorphism.
Have an appreciate of numerical algorithms for modelling physical systems.

Syllabus:

Brief lectures will be given in the early part of the course to introduce new elements of JAVA as required.
Most of the time will be spent on working through a series of exercise in modeling physical systems.
The last two weeks of the course will be spent in an open-ended project based on modelling aspects of particle accelerators.

Books:

Introduction to JAVA Programming, Comprehensive Version, 9th Ed, Y D Liang, Prentice Hall, ISBN-10: 0132936526; ISBN-13: 978-0132936521
or
Introduction to JAVA Programming, Brief Version, 9th Ed, Y D Liang, Prentice Hall, ISBN-10: 0132923734; ISBN-13: 978-0132923736

13.4.28 PHYS390 Space & Auroral Physics

PHYS390 Space & Auroral Physics				
Lecturer:	Prof J Wild		(Shadow:	Dr A Grocott)
Lect/Sem:	16L,4S			
Timing:	Year	3/4	Weeks:	L16-20
Pre-requisites:	PHYS222 or equivalent			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

In this module you will exploit general concepts and skills developed in electromagnetism and apply them to natural space environments to gain an understanding of the controlling plasma physics. This module will enhance your skills in problem solving and the synthesis of research level material.

Learning Outcomes:

On completion of this module the student will have an understanding of the Earths upper atmosphere and be able to explain the role of solar electromagnetic radiation in the formation of the ionosphere and the plasma physics that controls ionospheric structure and dynamics. The student will also be able to demonstrate an understanding the coupling between the terrestrial atmosphere/magnetic field and the near-Earth space environment. In addition to the physical mechanisms and the consequence of this coupling in terms of natural phenomena, such as the aurora borealis, the student will be able to understand their impact on human technology (so-called space weather).

Syllabus:

Solar activity and its influence on interplanetary space. Introduction to the solar-terrestrial environment. The Earths neutral atmosphere. The formation and physics of the Earths ionosphere and its layers. Collisional and collisionless plasmas. Ionospheric conductivity and its control of ionospheric currents. Charged particle precipitation and plasma processes controlling the aurora borealis and terrestrial radiation belts. The role of geomagnetic storms and substorms on energy transfer within the Sun-Earth system. The causes and impacts of space weather.

Books:

The solar-terrestrial environment, J. K. Hargreaves, Cambridge University press, 1995.
Basic Space Plasma Physics, Wolfgang Baumjohann and Rudolf A Treumann, Imperial College Press, 1997.
Physics of the Earths space environment, G. W. Prlss, Springer, 2004.

13.5 Year 4

13.5.1 PHYS411 Adv. Rel. & Gravity

PHYS411 Adv. Rel. & Gravity				
Lecturer:	Dr K Dimopoulos		(Shadow:	Dr J McDonald)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	M1-5
Pre-requisites:	PHYS211,PHYS213,PHYS232 or MATHS equivalent			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	55 hrs

Academic Aims:

The aims of this module are to provide students with a basic knowledge and understanding of the theories of special and general relativity. To give a conceptual understanding of the links between Newtonian mechanics and relativity. To provide a geometrical insight into the properties space-time and relativity. To further develop student's problem solving skills.

Learning Outcomes:

On completion of this module students should be able to:
Display a knowledge and understanding of the basic principles of special and general relativity; describe and perform relativistic calculations; display some geometrical insight into the properties of space-time; display good problem solving skills.

Syllabus:

Equivalence principles. Curved spacetime. Line element and the metric. Calculus of variations. Quadratic action. Geodesics. Tensor calculus. Covariant derivative. Geodesic deviation equation. Riemann tensor. Einstein field equations. Schwarzschild spacetime. Classical tests of General Relativity: gravitational redshift, precession of planetary orbits, gravitational lensing. Black Holes: Schwarzschild black hole, Kerr black hole, electrically charged black holes. Cosmological Spacetimes. Linearised gravity. Gravitational Waves. Wormholes.

Books:

W Rindler, Relativity: Special, General and Cosmological, Oxford University Press, 2006, 2nd Ed.

13.5.2 PHYS412 Experimental Methods in Particle Physics

PHYS412 Experimental Methods in Particle Physics				
Lecturer:	Dr R Henderson		(Shadow:	Dr H Fox)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	M6-10
Pre-requisites:	PHYS311			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

The aims of this module are to provide students with a better knowledge and understanding of particle physics. To provide students with a basic knowledge of experimental measurement and analysis techniques used in modern day particle physics research. To give students an awareness of some recent advances and current problems in particle physics research. To further develop student's problem solving skills.

Learning Outcomes:

At the end of the module, the student should be able to:
Display a knowledge and understanding of the principles of particle detection and measurement; describe and perform basic calculations of statistical tests used in experimental particle physics; describe the successes and weaknesses of the standard model of particle physics and the possible theoretical extensions; display good problem solving skills.

Syllabus:

Particle Detection and Experiments, discoveries in Particle Physics and statistical tests, electroweak symmetry breaking and the Higgs mechanism, CP violation and neutrino oscillations, introduction to supersymmetry and extensions to the standard model of particle physics.

Books:

D H Perkins, Introduction to High Energy Physics 4th Edition (2000), Cambridge University Press.
B Martin & G Shaw, Particle Physics, Wiley.

W Rolnick, The Fundamental Particles and their Interactions, Addison Wesley.

13.5.3 PHYS451 MPhys Project

PHYS451 MPhys Project			
Lecturer:	*Supervisor*	(Shadow:	)
Practical:	Varies		
Timing:	Year 4	Weeks:	M/L/S
Pre-requisites:	PHYS452, possibly some project specific with particular project		
Assessment:	Examination 0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade		
Credits:	45		
Workload:	Total student commitment 450 hrs.		

Academic Aims:

The MPHYS project, PHYS451, is a major open-ended research project completed in the fourth year of the MPhys or MSci Theoretical Physics with Mathematics. Subjects will be chosen to be appropriate to the particular Physics degree specialisation.

Project work gives students the opportunity to carry out research or a detailed investigation into a specific area of physics appropriate to their chosen degree theme (MPhys Theoretical Physics and MSci Theoretical Physics with Maths students will do theoretical work, MPhys Physics with Astrophysics and Cosmology will do a project related to Astrophysics/Cosmology etc). The project requires students to develop and apply analytical and problem-solving skills in an open ended situation. This will involve use of the library, computer, and other resources as appropriate, working alone or in a small group. The project work will normally be closely connected to a research group.

To provide students with the general and IT skills required for information searches and the manipulation and presentation of data. To provide students with the general and IT skills required for designing, producing and delivering written, oral and poster presentations of scientific work. To enhance scientific communication skills including the ability to communicate complex information effectively and concisely by means of written documents, presentations or discussion.

Learning Outcomes:

Students will have conducted a substantial project which will have required them to: plan, manage and execute an investigation an area of physics in a systematic way using appropriate techniques;
formulate conclusions and critically compare with relevant theory (if relevant);

generate and analyse data and critically assess experimental uncertainties (if relevant);
use technical language appropriately.
systematically record their work in a log book;
work independently and also co-operatively with colleagues;
perform information searches;
use their initiative and organise themselves to meet deadlines;
report their results in written and oral form, and defend their results;
design and produce well-structured poster and oral presentations of scientific work;
carry out a risk assessment (for experimental projects);
demonstrate high ethical standards during a scientific investigation.

Syllabus:

There is no set syllabus for the projects. Projects vary from year to year and are tailored to suit the individual student(s) and the available research facilities. Lists of available topics are made available well in advance of the time of the project.

The two-module project commences with a dissertation or literature review PHYS452 (15 credits). This is on the topic chosen for the project work in year 4 but is completed during the Summer Term of year 3 and the Summer Vacation between years 3 and 4. This will form the background to the main project work to be undertaken in year 4 in PHYS451.

The majority of the research side of the project is completed during weeks 1-15 of year 4. The remaining period is dedicated to writing a report on the project work and preparing presentations for the conference (The PLACE - The Physics @ Lancaster Annual Conference & Exhibition) in the summer term.

Skills related to oral presentation of scientific research are developed in weeks 16-18 through workshops (6 hours) and students present their work to their peers in poster and oral format at a conference (The PLACE - The Physics @ Lancaster Annual Conference & Exhibition) in the summer term of the 4th year. The workshops and conference cover organisation, planning and structure of scientific talks and graphical presentation of scientific data. Poster presentation of scientific research, structure and layout of posters, communication of scientific concepts.

The assessment is based on the project report (50%), performance during the project (20%), conference (10%) and a viva (20%) during the summer term of the 4th year.

Further information about MPhys projects can be found here.

Books:

For the project work, appropriate books or other sources (theses, scientific papers etc.) will be referred to once the project has been designed.

For presentation skills, on-line help will be available for any software used. General notes on presentation skills will be provided by the module convenor.

13.5.4 PHYS452 MPhys Literature Review

PHYS452 MPhys Literature Review				
Lecturer:	*Supervisor*		(Shadow:	)
Practical:	Varies			
Timing:	Year	3	Weeks:	S27-30,Vac
Pre-requisites:	Vary with particular project			
Assessment:	Examination	0%	Coursework	100%.
Assessment Type:	mixed % style & letter grade			
Credits:	15			
Workload:	Total student commitment 150 hrs.			

Academic Aims:

The PHYS452 Literature Review gives an opportunity to make an independent and in-depth study of a chosen subject in preparation for the PHYS451 MPhys Project, and to prepare a review of that subject in the form of a written report.

Learning Outcomes:

On completion of a Literature Review the student should be able to:
Use library, journal, textbook and other information resources to investigate a subject; discern, assimilate, organise, understand and summarise relevant information; write a structured scientific document which reveals an understanding of, and critically reviews, a subject.

Syllabus:

There is no set syllabus: The topics vary from year to year, and should be relevant to the particular MPhys Physics degree programme being followed. The topic and supervisor should be chosen from the list available from the Physics Department Web site at the start of the Summer Term of Year 3, or can be suggested by the student with the agreement of a suitable supervisor. The work should be undertaken at the end of the Summer term and during the Summer vacation at the end of Year 3, and will proceed based on a definition of scope and an initial reading list agreed by the student and supervisor at the end of the Summer term. The work will be assessed by means of a written report, which is due in week 2 of the Michaelmas term of the 4th year. Further information about MPhys Literature Review can be found here.

Books: Appropriate books will be referred to once the topic has been chosen.

13.5.5 PHYS461 Cosmology III

PHYS461 Cosmology III				
Lecturer:	Dr J McDonald		(Shadow:	Dr K Dimopoulos)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	M1-5
Pre-requisites:	PHYS265, PHYS361			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To introduce students the concepts of modern inflationary cosmology.

Learning Outcomes:

On completion of the module, students should be able to understand:

- the content and structure of the observed Universe,
- the evidence for recent acceleration of the expansion rate and the need for negative-pressure dark energy,
- cosmological structure formation from primordial density perturbations; the need for dark matter,
- the angular power spectrum of the cosmic microwave background radiation,
- the concepts of particle and event horizon,
- the smoothness and flatness problems of the hot Big Bang model and the need for an inflationary era dominated by negative-pressure matter,
- the concept of the scalar field and its relation to the quantum theory of spin-0 particles; connection with scalar fields in unified particle physics theories,

- the idea of scalar fields in cosmology as negative-pressure matter; the use of scalar fields in the construction of inflation models and the quantum origin of primordial density perturbations.

Syllabus:

The Observed Universe: Overview; Evidence for recent acceleration of the expansion rate from luminosity distance vs. redshift plots; Explanation via negative-pressure matter; Dark Energy and alternatives; Large Scale Structure; Primordial Density Perturbations; Cosmological structure formation from scale-invariant Primordial Density Perturbations and Cold Dark Matter; The Angular Power Spectrum of the Cosmic Microwave Background Radiation.

Inflation: The Horizon and Flatness problems and general conditions for their solution; The Inflationary Era.

Scalar Field Models of Inflation: The concept of scalar fields and their relation to spin-0 particles in particle physics theories; Scalar fields as negative-pressure matter in cosmology; The scalar potential; Scalar field models of inflation; Primordial Density Perturbations from quantum fluctuations of scalar fields; The Spectral Index.

Books:

(B) An Introduction to Modern Cosmology, Liddle. (B) Cosmological Inflation and Large-Scale Structure, Liddle & Lyth.

13.5.6 PHYS462 Gauge Theories

PHYS462 Gauge Theories				
Lecturer:	Dr R Henderson		(Shadow:	Prof G V Borissov)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	L16-20
Pre-requisites:	PHYS222, PHYS311, PHYS366 or maths equiv			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	55 hrs

Academic Aims:

To teach the modern phenomenology of the Standard Model of fundamental particles. To provide the mathematical background and physical insight into the field-theoretical structure of the Standard Model. To give an awareness of modern developments in Quantum Field Theory.

Learning Outcomes:

On completion of the module, students should be able to understand:
Display a knowledge and basic understanding of the ideas and concepts behind the field-theoretical description of the Standard Model of fundamental particles; show a knowledge of future prospects for the Standard Model including gauge theories of the strong and electroweak interactions.

Syllabus:

The module will cover various topics including: Lagrangians and gauge transformations; global and local gauge invariance; gauge group and its representations; QED as a gauge theory; QCD and non-abelian theories; asymptotic friedom; renormalisation group equation; spontaneous symmetry breaking and Higgs mechanism; gauge structure of the electroweak theory; grand unified theories; extensions of the Standard Model.

Books:

I J R Aitchison and A J G Hey (2nd edn, IoP, 1989)

13.5.7 PHYS463 Solar-Planetary Physics

PHYS463 Solar-Planetary Physics				
Lecturer:	Dr A Grocott		(Shadow:	Prof J Wild)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	M1-5
Pre-requisites:	PHYS362			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

The planets that make up our own solar system exhibit huge diversity in terms of their size, structure and influence over the space environment in terms of gravitational and electromagnetic forces. The lectures for this module will introduce students to the physical processes that determine the characteristics of the solar system, and the interactions between the Sun, the planets and their moons. For the seminars, students will be required discuss independent research on pre-set discussion topics and present their findings to the group.

Learning Outcomes:

On completion of the module, students should be able to understand:
Outline different models of solar system formation and the observations that they must account for.
Explain the key similarities and differences between solar system bodies (e.g. rocky/gaseous, magnetic/non magnetic).
Deduce the existence and characteristics of the solar wind.
Explain the role of a planets magnetic field in governing the solar-planetary interaction.
Perform calculations to elucidate the characteristics and dynamics of a planets coupled magnetosphere-ionopshere system.
Explain the role of comparative planetology in our understanding of the solar system.
Realise the importance of combining in-situ and remotely-sensed measurements of planetary environments.

Syllabus:

Solar system formation

The solar wind and the heliosphere
Unmagnetised bodies: Mars and the Moon. Comets.
Planetary magnetospheres within our solar system (Earth, Mercury, Jupiter and Saturn).
Solar wind coupling with magnetised and and un-magnetised bodies
Magnetosphere-ionosphere coupling.
Planetary radiation environments
Internal plasma sources (moons) in magnetospheres and co-rotation versus convection driven magnetospheres.

Books:

Introduction to Space Physics, M.G. Kivelson & C.T. Russell, Cambridge University Press (1995), ISBN: 0521457149.
Planetary Science: The Science of Planets Around Stars, M.M. Woolfson & David Cole, Institute of Physics Publishing (2002), ISBN: 075030815X.

13.5.8 PHYS464 Astrophysics III - Galaxies

PHYS464 Astrophysics III - Galaxies				
Lecturer:	Prof I Hook		(Shadow:	Dr D I Bradley)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	M6-10
Pre-requisites:	PHYS362			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

This module will enhance your skills in problem solving and the synthesis of advanced research level material. The module will also provide you with an understanding of how various forms of data may be generated and analysed, both qualitatively and quantitatively.

Learning Outcomes:

On completion of this module the student will have an understanding of the physics that regulates galaxy formation and evolution. They will be able to explain the theoetical descriptions and observations of active galaxies, and be able to demonstrate an understanding of the different observational techniques required to detect radiation from a range of astrophysical sources. Students will also study the links between the measurements of galaxy properties and the broader, cosmological picture required in order to build an understanding of some of the most fundamental questions about the Universe that lie at the forefront of current observational astrophysics.

Syllabus:

The structure of galaxies. The formation of galaxies, including our Milky Way and its satellites, in a cosmological context. Physics of galaxy formation and evolution. Galaxy scaling relations. Feedback processes including supernovae. Quasars and Active Galactic Nuclei their physics and observability (observations in X- and -rays,radio). Black holes in galactic centres. The interstellar medium. Nucleosynthesis and galactic chemical evolution. The star formation history of the universe, from the first galaxies to now. Large-scale structures, galaxy clusters. Observational techniques for measurement of cosmological parameters.

Books:

Galaxy Formation and Evolution, Mo, van den Bosch & White, Cambridge University Press, 2010.
Galaxies in the Universe: An Introduction (2nd edition), Sparke & Gallagher, Cambridge University Press,2007.

13.5.9 PHYS481 Advanced Magnetism

PHYS481 Advanced Magnetism				
Lecturer:	Dr D A Burton		(Shadow:	Dr N Drummond)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	M1-5
Pre-requisites:	PHYS313			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide students with a basic knowledge and understanding of magnetic and electronic phenomena in condensed matter physics.

To give students an awareness of recent advances and current problems in condensed matter physics, and to further develop their problem solving skills.

Learning Outcomes:

On completion of this module students should be able to:

- display knowledge and basic understanding of magnetic and electronic phenomena in condensed matter;
- solve selected model problems requiring advanced methods from condensed matter theory;
- show an increased awareness of some recent advances and current problems in condensed matter physics;
- delve deeper into the published literature on recent advances in condensed matter physics;
- display good problem solving skills which are transferrable to other areas of physics (in particular, areas utilising quantum mechanics and advanced methods from statistical physics);
- progress to graduate study in condensed matter physics.

Syllabus:

Revision of elements of the theory of electromagnetism: Magnetic field, magnetic induction, magnetic vector potential. Magnetic field of magnetic dipole moment. Phenomenology of solid state magnetic phenomena: paramagnetism (Curie law), diamagnetism. Van Vleck's description of diamagnetism, diamagnetism as quantum phenomenon. Ferromagnetism and antiferromagnetism. Ferromagnetic exchange and the Heisenberg model, self-consistent mean field theory. Description of ferromagnetic phase transitions, Curie temperature. Elements of Ginzburg-Landau theory of magnetic phase transitions. Domains and domain walls. Ferromagnetic insulators and metals. Magnetic memory devices and readheads. Multilayers of normal and ferromagnetic metals, giant magneto-resistance phenomenon and its application.

Books:

(R)C Kittel, Introduction to Solid State Physics, Wiley (any edition); Chapters on magnetism.

13.5.10 PHYS482 Quantum transport in low dimensional nanostructures

PHYS482 Quantum transport in low dimensional nanostructures				
Lecturer:	Dr N Drummond		(Shadow:	Prof H Schomerus)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	M6-10
Pre-requisites:	PHYS313			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide students with a basic knowledge of the physics of nanoscale solid state devices and how these may be manufactured and utilised.

To give students an awareness of recent advances and current problems in condensed matter physics, and to develop further their problem-solving skills.

Learning Outcomes:

On completion of this module students should be able to:

- display knowledge of the physics of nanoscale solid state devices and how these may be manufactured and utilised;
- solve selected model problems requiring advanced methods from condensed matter theory;
- show an increased awareness of some recent advances and current problems in condensed matter physics;
- delve deeper into the published literature on recent advances in condensed matter physics;
- display good problem solving skills that are transferrable to other areas of physics (in particular, areas utilising quantum mechanics and advanced methods from statistical physics);

- progress to graduate study in condensed matter physics.

Syllabus:

Two-dimensional electron systems: heterostructures, quantum wells, field-effect transistors and graphene. Conductivity and resistivity. Drude formula for conductivity and the Einstein relation. Electron scattering and the role of disorder. Screening of impurities in metals. Friedel oscillations of electron density around impurities. Quantum transport in disordered low-dimensional electron systems: interference and the enhanced backscattering of waves in disordered media. Localisation effects in two- and one-dimensional electron systems. Universal conductance fluctuations in small phase-coherent conductors. The Aharonov-Bohm effect in small ('mesoscopic') metallic and semiconductor rings. Semiconductor quantum wires (one-dimension subbands in quantum wires). Carbon nanotubes as ideal one-dimensional conductors. Ballistic wires in semiconductor structures and the conductance quantum. The Büttiker-Landauer conductance formula. Impurities in quantum wires. Electronic transport in a magnetic field and the Hall effect. Skipping orbits and electron focusing. Landau levels. Edge states of Landau levels as ideal one-dimensional conductors. The quantum Hall effect and its relevance for metrology. Metallic point contacts. Atomic break-junctions and the scanning tunnelling microscope. Examples of applications of scanning tunnelling microscopy. Semiconductor quantum dots. The resonant tunnelling phenomenon. The Coulomb blockade phenomenon.

Books:

(R) S Datta, Electronic Transport in Mesoscopic Systems, Cambridge UP (any edition) ISBN 0 521 59943 1; Chapters 1,2,4,5,6.

(R) T Heinzel, Mesoscopic Electronics in Solid State Nanostructures, Wiley-VCH (3rd edition) ISBN 978 3 527 40932 7; Chapters 1,2,3,4,5,6,7,9,10,11

13.5.11 PHYS483 Quantum Information Processing

PHYS483 Quantum Information Processing				
Lecturer:	Prof H Schomerus		(Shadow:	Dr N Drummond)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	L11-15
Pre-requisites:	PHYS223			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

The aim of the module is to provide an introduction to the fundamental concepts of quantum information processing, and to illustrate how these can be implemented in realistic devices.

Learning Outcomes:

On completion of this module students should be able to:

- demonstrate familiarity with fundamental concepts of quantum information, including qubits, superposition and entanglement, quantum circuit design and error correction;
- demonstrate familiarity with experimental implementations in atom-optics and in the solid state;
- work with advanced, efficient quantum-mechanical methods and have deepened their understanding of manipulation, control and measurements.

Syllabus:

Theoretical concepts of quantum information processing: Dirac notation; density matrices and evolution; qubits; entanglement; quantum algorithms, circuit design, error correction.

Illustration via discussion of experimental realizations in atom-optics and in the solid state (photons, trapped ions and atoms, Josephson junctions).

Books:

(R) J Stolze and D Suter, Quantum Computing: A Short Course from Theory to Experiment, 2nd Edition (Wiley VCH, 2008).

(R) MA Nielsen and IL Chuang, Quantum Computation and Quantum Information (Cambridge University Press, 2000).

13.5.12 PHYS484 Adv. Electrodynamics & Grav.

PHYS484 Adv. Electrodynamics & Grav.				
Lecturer:	Dr J Gratus		(Shadow:	Dr D A Burton)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	L16-20
Pre-requisites:	PHYS211, PHYS222, PHYS232, PHYS411			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

The module aims to familiarize physics undergraduates with some of the mathematical language commonly used in modern theoretical physics research, for example string theory. It particular, the module aims to provide an introduction to aspects of modern differential geometry used in theoretical and mathematical physics, with specific application to electromagnetism and gravity.

Learning Outcomes:

On completion of the module, students should be able:

- Demonstrate some familiarity with various concepts used in advanced electrodynamics and gravity, such as manifolds, tensor algebra, the rules of exterior differential calculus and the concept of a linear connection from a coordinate-free perspective;
- Formulate and solve various problems involving Maxwell's equations using differential forms on spacetime, and the geodesic and Lorentz force equation using coordinate-free methods;
- Use orthonormal and null frames to tackle Maxwell's equations and the Einstein equations;
- Formulate coordinate-free expressions of measured quantities using observer frames;
- Appreciate the physical significance of stress-energy-momentum tensors and to apply this to some common problems;

- Demonstrate familiarity with a family of black hole spacetimes and cosmological spacetimes and to use spacetime symmetries to derive constants associated with black hole spacetimes;

Syllabus:

- Introduction to differential geometry and exterior calculus Manifolds, scalar fields, vector fields, covector fields, p-forms, exterior derivative, metrics, Hodge dual, Lie derivative, connections, curvature, Bianchi identities, integration of p-forms.
- Electrodynamics Maxwell equations in terms of the Maxwell 2-form, 4-velocity fields and Lorentz force equation in terms of the Maxwell 2-form.
- Gravity Einstein 3-forms, stress-energy-momentum 3-forms, Einstein equations, symmetry and Killing vectors, conserved quantities, black holes.

Books:

(R) H Flanders, Differential forms with application to the physical sciences, Dover Publications
(R) CW Misner, KS Thorne, JA Wheeler, Gravitation, W.H.Freeman & Co Ltd

13.5.13 PHYS485 Matter at Low Temp

PHYS485 Matter at Low Temp				
Lecturer:	Dr S Kafanov		(Shadow:	Dr D I Bradley)
Lect/Sem:	16L,4S			
Timing:	Year	3/4	Weeks:	L16-20
Pre-requisites:	PHYS322			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

Currently available technology (some of it developed at Lancaster) makes it possible to cool matter to temperatures more than a million times colder than the familiar 290K of everyday life. This module explores a selection of the fascinating phenomena that are found to occur at these temperatures, many of which have great significance both for basic physics and for technology.

Learning Outcomes:

On completion of this *Optional Module* the student will appreciate the relation between temperature and order; know how low temperatures are produced, including dilution refrigerators; be able to describe the phenomena of superconductivity and superfluidity.

Syllabus:

This module focusses on a qualitative description of cryogenics and related experimental techniques, and a phenomenological description of physical phenomena that occur at low temperatures.

The course begins by discussing what physicists mean by high and low temperatures. It looks at the different types of ordering that may occur as systems cool, and asks whether it is possible to achieve an absolute zero in temperature. Then cryogenic techniques used for accessing such low temperatures are described, including the design of useful cryostats. Next we examine the new phenomena that occur when systems are cooled below room temperature. This mainly concerns superconductivity and superfluidity. We discuss electron pairing leading to the zero resistance of superconducting materials, the effect of magnetic fields, and the role of macroscopic quantum mechanical wave functions. We also look at some practical uses in superconducting quantum interference devices (SQUIDs). The macroscopic wave functions of both superfluid ^{4}He and ^{3}He are probed, including the existence of quantised vortices. The properties of ^{4}He/^{3}He mixtures and their use in dilution refrigerators are described.

Books:

(R) A M Guénault, Basic Superfluids, Taylor & Francis, ISBN 0-7484-0892-4 (paperback), 0-7484-0892-6 (hardback)

The following book is out of print but a limited number of copies are available in the Main Library

(R) P V E McClintock, D J Meredith & J K Wigmore, Matter at Low Temperatures, Blackie

13.5.14 PHYS486 Lasers and Applications

PHYS486 Lasers and Applications				
Lecturer:	Dr Q D Zhuang		(Shadow:	Dr R Young)
Lect/Sem:	16L,4S			
Timing:	Year	3/4	Weeks:	L11-15
Pre-requisites:	PHYS222, PHYS223, PHYS321			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

This module explores the properties, operation and applications of laser physics. The basic principles of lasing are reviewed and applied to a variety of important technologies. The course concludes by focusing on industrial, medical and emerging applications of lasers, ranging from holography to telecoms.

Learning Outcomes:

On completion of this *Optional Module* the student will have a broad knowledge of many aspects of lasers and their applications.

Syllabus:

Fundamentals: properties of laser light, requirements for laser action, spontaneous and stimulated emission rates, cavity physics (matrix optics), line broadening, modes of light, Q-switching, mode-locking, second-harmonic generation.

Laser technologies: solid-state (including fibre), gas, chemical, excimer and semiconductor lasers important examples of each will be detailed (and demonstrated where possible).

Applications: Industrial processing, medical, telecoms, holography, LIDAR, fundamental physics (QIP, gravity wave detection, fusion).

Books:

(R) J Wilson & J F B Hawkes - Lasers, Principles and Applications

13.5.15 PHYS487 Semiconductor Device Physics

PHYS487 Semiconductor Device Physics

Lecturer:	Prof A Krier		(Shadow:	Dr J Prance)
Lect/Sem:	16L,4S			
Timing:	Year	4	Weeks:	M6-10
Pre-requisites:	PHYS313			
Assessment:	Examination	80%	Coursework	20%.
Assessment Type:	% style			
Credits:	10			
Workload:	Contact time	20 hrs	Private study	80 hrs

Academic Aims:

To provide an insight into common electronic and optoelectronic materials and devices in everyday life, with reference to; solid state lighting, solar energy, security & infrared imaging, mobile communications and computing technologies. To understand the relevant properties of semiconductor materials and physical principles of device operation in this extremely active and interesting research area. To provide an overview of epitaxial growth techniques for the fabrication of nanostructures and quantum devices, device processing and characterisation.

Learning Outcomes:

On completion of this optional module the student will be able to:
Give a quantitative description of the operating principles of different modern semiconductor devices. Gain an insight into the relevant properties of semiconductor materials and underlying aspects of solid state physics used in the design and fabrication of semiconductor devices. Understand the key properties of quantum wells, superlattices and quantum dots in relation to tailoring device performance.

Syllabus:

Fundamental optical and transport properties of semiconductor materials; Band-gap engineering - how to tailor semiconductors for specific device applications; Operating principles of modern semiconductor devices, including for example: diode lasers, LEDs, solar cells, infrared detectors, high speed transistors, CCDs and memories; Epitaxial growth techniques for the fabrication of state-of-the-art semiconductor nanostructures and quantum devices; An overview of device fabrication, nanolithography, and Moore's

Law.

Books:

(R) C R M Grovenor Microelectronic Materials, Adam Hilger (1989)
(R) S M Sze, Semiconductor Devices: Physics and technology, 2nd Edition, John Wiley & Sons, Inc. (2001)

A Definitions of terms used in this book

Edition 1.7 2016/2017

(with abbreviations as appropriate)

Degree Scheme: a term which denotes the total academic package which makes up a Lancaster degree.

Module: The module is the building block from which assessment is constructed. For example: a series of 16 lectures on a single topic plus 4 seminars forms a lecture module; 5 one-day laboratory classes form a second year laboratory module.

Lecture(L): A 50 minute period of formal teaching/instruction by a member of staff to an audience ranging in size (typically) from 10 to 100. Lecture modules are normally assessed by a formal examination (80%) and by coursework, normally weekly set worksheets (20%).

Seminar(S): A 50 minute lecture period in which a lecturer works through a set of questions which are related to a lecture module and which have been set as compulsory coursework; this is the coursework element of the module assessment. The seminar also provides an opportunity to discuss any aspect of the lecture course.

Workshop(W): A period in which students work through set questions. Help is available from a lecturer or graduate student demonstrator.

Practical(P): A period in which students undertake laboratory work, either experimental or computational. This may be in set classes in years 2 & 3, or in projects in years 3 & 4. Help is available from a lecturer or graduate student demonstrator; during project work an individually assigned staff supervisor is available for guidance. Assessment varies for each particular practical laboratory or project but in general includes (i) laboratory log book, (ii) written reports, (iii) formal presentation and (iv) an oral examination.

End of Module Test: A 50 minute period in which students may be required to complete an appropriate unseen test on the module. This would be included in the overall assessment for that module.

Written Examination: Most lecture modules are assessed by examinations lasting up to three hours. More than one module may be examined on a single paper. The format of each paper is published in the term before the examination is taken.

Presentation: Every Physics major, including MSci & BSc Theoretical Physics & Mathematics administered by the Department of Physics are required to make one formal presentation, normally of about 15 mins total duration, during the assessment of their 3rd and their 4th years. Normally this presentation will be part of the assessment of a Project, Dissertation, Short Projects or other laboratory modules taken in year 3. Exceptionally if none of these are applicable for a given year 3 student then a topic will be agreed with the Projects Organiser. This presentation will normally amount to 10% of the assessment for the particular 30-credit module. The presentation is made to the appropriate mini-Conference.

The PLACE - 3rd Year Conference This *conference* is organised in the period after the third year examinations and it is where all Physics majors, including MSci & BSc Theoretical Physics & Mathematics administered by the Department of Physics are required to make one formal presentation, normally of about 9 minutes followed by a 3 minute question and answer time. All

3rd year students are required to attend the conference which lasts two days. Supervisors and second examiners are also required to attend.

The PLACE - 4th Year Conference This *conference* is organised in the period after the fourth year examinations and it is where all MPhys and MSci Theoretical Physics & Mathematics students are required to make a formal presentation on their project, normally of about 12 minutes followed by a 3 minute question and answer time. All 4th year students are required to attend the conference which lasts two days. Supervisors and second examiners are also required to attend.

Oral Examination: Dissertations and projects include an oral examination at which a student discusses his or her work with two members of staff, one of whom is the supervisor. The examination follows the submission of the dissertation or project report and the presentation which the student makes on that project or dissertation. The oral examination would not normally exceed 30 minutes duration. This is part of the assessment procedure for the module.

Coursework Assessment(cwa): applies to any component of assessment which is gained by non-examination methods. It may be derived from project work or a dissertation or set work from a seminar or workshop and includes any assessment deriving from presentations or oral examinations.

Viva Examination: Final year majors for all degree schemes administered by the Department of Physics, MPhys, MSci & BSc, should note that they must be available if required for viva examinations which normally take place in the Department on the Monday of week 10 of the Summer Term. Those students requested to attend a viva examination will be notified a few days beforehand. Viva examinations are rarely used, and usually only for students within or just below a class borderline. The External Examiners meet these students individually for about 30 minutes to ascertain the level of knowledge achieved during their degree thus awarding the appropriate class. The student's Director of Study is normally present during the viva.

B Teaching Code of Practice

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This code is not intended to lay down formal rules to be interpreted in a legalistic way. Instead it suggests what staff and students can reasonably expect of one another, and provides general information for this purpose.

- Details of all undergraduate courses and modules in the Department are provided in booklets such as this one and are made available to students at appropriate times (e.g. registration) during the year.
- There is a Staff Student Consultative Committee for the Department. Student representatives are elected on an annual basis in October each year. The names of the student representatives are posted on the notice-board in the foyer of the Physics Building.
- Attendance at lectures, laboratory classes and seminars is expected and a register of attendance will be taken. If you cannot attend any particular lecture, class or laboratory you should provide the lecturer or head of class concerned with an explanation in advance. If you are ill, or if any other unforeseen circumstance prevents attendance, then you should fill out a self certification sick note or provide the explanation. Amongst other things, such notification allows the assessment for the course or module to be adjusted when you have good reason for absence. If you are ill for a longer period then a doctor's note must be supplied.
- The formal lectures are supplemented by seminar classes and sometimes by small group tutorials. Weekly worksheets are set for most modules and specific deadlines are always given. Full marks can only be awarded for work handed in by the stated deadline. You are normally expected to prepare for seminars or tutorials by reading around the subject, identifying topics in the module you would like help with, or discussed in the seminar. The staff member leading the seminar will ensure that your weekly work is marked and returned to you and will also go over the solutions to the problems. In some modules longer essays or laboratory reports are required; these will also have deadlines for submission and the staff undertake to mark and criticise them constructively and return them to you within a reasonable time. Normally all weekly worksheets or module essays contribute significantly to your continuous assessment, the department will inform you of the proportion of continuous assessment to the total assessment for each module.
- You will be given an opportunity to comment on the content and presentation of each module through the use of formal questionnaires distributed at the end of each module. Also you can discuss individual problems associated with any lecture or laboratory module with the lecturer, head of class or with the seminar leader. Each degree scheme has a Director of Study who will always be prepared to discuss any aspect of your course. Remember also that the Staff Student Committee is a good forum for discussion and resolution of more general problems.
- If you have any problem then it is usually a good idea to contact your Teaching Co-ordinator first (Pam Forster or Louise Crook in rooms A4 and A6 in the Physics Building). They will either solve your problem immediately, refer you to the most appropriate member of staff or member of the University administration.

C Definitions of the Assessment Grades

Edition 1.7 2016/2017

Marking of work under the assessment regulations

Assessed work can be either qualitative (where there is an element of subjective analysis) or quantitative (marked to a defined marking scheme and often largely numerical or multiple choice tests). Under the new assessment regulations both types of work will be marked slightly differently.

For **qualitative** work the marker will assign a letter grade. Work will be assessed against level descriptors (see Table A) and an appropriate grade given.

For **quantitative** work the marker will assign a percentage.

For degree classification purposes, both types of mark will be converted to an aggregation score; see Table A (grade mapping) and Table B (percentage mapping).

Table A Criteria for grading qualitative assessment:

Result	Broad Descriptor	Grade	Aggregation Score	Primary level descriptors for attainment of intended learning outcomes	Honours Class
Pass	Excellent	A^+ A A^-	24 21 18	Exemplary range and depth of attainment of intended learning outcomes, secured by discriminating command of a comprehensive range of relevant materials and analyses, and by deployment of considered judgement relating to key issues, concepts and procedures	First
Pass	Good	B^+ B B^-	17 16 15	Conclusive attainment of virtually all intended learning outcomes, clearly grounded on a close familiarity with a wide range of supporting evidence, constructively utilised to reveal appreciable depth of understanding	Upper Second
Pass	Satisfactory	C^+ C C^-	14 13 12	Clear attainment of most of the intended learning outcomes, some more securely grasped than others, resting on a circumscribed range of evidence and displaying a variable depth of understanding	Lower Second
Pass	Weak	D^+ D D^-	11 10 9	Acceptable attainment of intended learning outcomes, displaying a qualified familiarity with a minimally sufficient range of relevant materials, and a grasp of the analytical issues and concepts which is generally reasonable,albeit insecure	Third
Fail	Marginal Fail	F1	7	Attainment deficient in respect of specific intended learning outcomes, with mixed evidence as to the depth of knowledge and weak deployment of arguments or deficient manipulations	Fail
Fail	Fail	F2	4	Attainment of intended learning outcomes appreciably deficient in critical respects, lacking secure basis in relevant factual and analytical dimensions	Fail
Fail	Poor Fail	F3	2	Attainment of intended learning outcomes appreciably deficient in respect of nearly all intended learning outcomes, with irrelevant use of materials and incomplete and flawed explanation	Fail
Fail	Very Poor Fail	F4	0	No convincing evidence of attainment of any intended learning outcomes, such treatment of the subject as is in evidence being directionless and fragmentary	Fail

Table B Conversion table for calculating an aggregation score from a given percentage:

1 = 0.225	2 = 0.450	3 = 0.675	4 = 0.900	5 = 1.125	6 = 1.350	7 = 1.575	8 = 1.800	9 = 2.025	10 = 2.250
11 = 2.475	12 = 2.700	13 = 2.925	14 = 3.150	15 = 3.375	16 = 3.600	17 = 3.825	18 = 4.050	19 = 4.275	20 = 4.500
21 = 4.725	22 = 4.950	23 = 5.175	24 = 5.400	25 = 5.625	26 = 5.850	27 = 6.075	28 = 6.300	29 = 6.525	30 = 6.750
31 = 6.975	32 = 7.200	33 = 7.425	34 = 7.650	35 = 7.875	36 = 8.100	37 = 8.325	38 = 8.550	39 = 8.775	40 = 9.000
41 = 9.300	42 = 9.600	43 = 9.900	44 = 10.200	45 = 10.500	46 = 10.800	47 = 11.100	48 = 11.400	49 = 11.700	50 = 12.000
51 = 12.300	52 = 12.600	53 = 12.900	54 = 13.200	55 = 13.500	56 = 13.800	57 = 14.100	58 = 14.400	59 = 14.700	60 = 15.000
61 = 15.300	62 = 15.600	63 = 15.900	64 = 16.200	65 = 16.500	66 = 16.800	67 = 17.100	68 = 17.400	69 = 17.700	70 = 18.000
71 = 18.300	72 = 18.600	73 = 18.900	74 = 19.200	75 = 19.500	76 = 19.800	77 = 20.100	78 = 20.400	79 = 20.700	80 = 21.000
81 = 21.150	82 = 21.300	83 = 21.450	84 = 21.600	85 = 21.750	86 = 21.900	87 = 22.050	88 = 22.200	89 = 22.350	90 = 22.500
91 = 22.650	92 = 22.800	93 = 22.950	94 = 23.100	95 = 23.250	96 = 23.400	97 = 23.550	98 = 23.700	99 = 23.850	100 = 24.000

D Combination of small-credit modules

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No module may be condoned with an aggregation score of less than 7 after resit. If the mark is less than 7, then, subject to the normal appeals process, exclusion from the University will result. Within the physics department, there are a number of small-credit modules. In the event of an uncondonable failure of a module of **fifteen** or less credits, this module may be combined with another module of **up to fifteen** credits, up to a maximum of **thirty** credits, for the consideration of condonation. Permissible combinations are identified by grouping all modules of **fifteen** or less credits as shown in the following table:

	2nd year core lectures	2nd year lab and/or theme	3rd year core lectures	3rd year options or theme	4th year lectures
MPhys/BSc Physics	213 232 233	281 253 254 255	321 322 320	opt 1 opt 2 opt 3	opt 1; opt 2 opt 3; opt 4 opt 5; opt 6
MPhys/BSc Physics, Astrophysics and Cosmology	213 232 233	281 263 264 265	321 322 320	362 opt 1 opt 2	411; 461 opt 1; opt 2 opt 3; opt 4
MPhys/BSc Physics, Astrophysics and Space Science	213 232 233	281 263 264 268	321 322 320	362 opt 1 opt 2	463; opt 1 opt 2; opt 3 opt 4; opt 5
MPhys/BSc Physics with Cosmology and Particle Physics	213 232 233	281 263 265 256	321 322 320	366 367 opt 1	411; 412 461; 462 opt 1; opt 2
MPhys/BSc Theoretical Physics	213 232 233	281 273 274 265	321 322 320	opt 1 opt 2 opt 3	481; 482 opt 1; opt 2 opt 3; opt 4
MSci/BSc Theoretical Physics with Mathematics	N/A	N/A	321 322 opt 1	N/A	opt 1; opt 2 opt 3

Each cell in the table shows a group of modules within which pairing of modules is permissible for the purpose of condonation. Within each group, the procedure for combining modules will follow these rules:

1. If a student has a failed module of fifteen or less credits, which is below the condonable threshold of 7 after reassessment, then, and only then, will the module be combined with another module(s) within the same group.

2. The procedure will be

(a) all the student's modules in a given group with credit values of fifteen or less will be put in rank order from highest aggregation score to lowest.

(b) the module at the bottom of the list, that with the lowest aggregation score, will be combined with the module at the top of the list to a maximum of 30 credits in total. The aggregation score of the combination will be a weighted average of the component aggregation scores.

(c) the combination can be condoned if the resulting aggregation score is 7 or above:

  (i) if the resulting aggregation score is 9 or above, the number of condoned credits will be equal to that of the original badly failed module;

  (ii) if the resulting aggregation score is between 7 and 9, so that condonation is required, the number of condoned credits is equal to that of the combination;

  (iii) once a condonable or better mark is achieved, this process stops and no further modules may be combined with this combination.

(d) if there is more than one uncondonable failed module, the process repeats.

(e) no module may be used in a combination more than once.

E Plagiarism (copying) and Fabrication of Results

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We regard these as major examples of academic misconduct on a par with cheating in examinations. They are all examples of students obtaining an unfair advantage with a view to achieving a higher grade or mark than their abilities and efforts would otherwise secure. The University rules define the procedures to be followed when such misconduct comes to light (see the Plagiarism Framework published by the University; this gives additional details and also lists the sanctions which the University would impose in proven cases). In severe cases the offender may be expelled from the University. In order to clarify the position for students on physics-based courses, it may be helpful to set out the kind of collaborative efforts we wish to encourage while defining the boundaries beyond which you should not stray.

Collaboration

When learning new material or grappling with difficult seminar or laboratory problems it is common practice for students to talk things over with each other, compare approaches or to ask for help in overcoming blocks. There is nothing wrong with that and it is common experience that the process of explaining a problem or a possible solution to someone helps the person doing the explaining as much as it helps the listener. When people collaborate in this way, both participants learn from it and we enthusiastically approve, provided the individuals then go away and prepare their answer/solution on their own. Where we object is when one person works out the answers and another one slavishly copies these. These are most obvious when the originator makes a silly or glaring mistake and this finds its way into another student's answer.

Sharing data in the laboratory can be an 'academic offence' of the same kind. Data can only be shared if you are working officially with another student or group of students. If we find evidence of unauthorised sharing we shall either give no marks at all, or mark the work once and divide the marks amongst all the 'collaborators' without attempting to discover who copied from whom.

Plagiarism

Another form of copying is when in writing an essay-type piece of course work someone just transfers chunks of text from a book, a review or the internet. This is immediately apparent to the informed reader because of the change in style from that of a student in a hurry to that of an expert writing considered prose at leisure with the aid of a skilled editor. We are not impressed by seeing such undigested passages in an essay and will not give high (or any!) marks for them. By all means find the review or book, read it, make sure you understand it and describe your understanding of the matter in your own words. Direct copying from another students essay is not allowed and the use of "essay banks" is strongly discouraged. If you make a short quotation from a book then make this clear and give the reference. All sources of material, including the internet should be properly referenced.

F Illness

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If you are ill, you should immediately inform your:

1. college office, especially if you believe that the condition is contagious.
2. major department, Teaching Co-ordinators Louise Crook and Pam Forster
3. speak to your Director of Study as soon as possible.

If you feel that your illness or injury is affecting your work, you should complete a **Student Self-Certification Medical Note** form. This will cover you for up to seven days for absences from classes. This self certification form cannot be used if you are forced by illness or injury to miss a University examination or a Departmental assessment test or oral examination. Two consecutive self-certification forms are not allowed. You must produce a medical note from your doctor if the condition persists or if you are forced to miss an examination, test or oral examination.

The self-certification form should be submitted to your Physics Teaching Co-ordinator who will inform your Director of Study.

If you are repeatedly ill during the year, and are therefore frequently submitting self-certification forms, you are *strongly* advised to provide the Department with a medical certificate from your doctor confirming the details of your illness or condition.

G Principles of Public Life

Edition 1.7 2016/2017

The Seven Principles of Public Life
as applied to Teaching in the Department of Physics

Preamble: Throughout the statement below, the words *the Department* mean the Department of Physics and the term *holders of office in the Department* is to be taken to include all paid staff of the Department, all members of the University associated with the Department, and students who undertake paid work for the Department or hold office in the Staff-Student Consultative Committees or in any student physics society.

The Principles from the Nolan Report, as edited for the Department, are –

Selflessness: Holders of office in the Department should take decisions solely in terms of the interest of the Department and University. They should not do so in order to gain financial or other benefits for themselves, their family or their friends.

Integrity: Holders of office in the Department should not place themselves under any financial or other obligation to outside individuals or organisations that might influence them in their performance of their official duties.

Objectivity: In carrying out University or Department business, including making Department appointments, awarding contracts, or recommending individuals for rewards and benefits, holders of office in the Department should make choices on merit in accordance with clearly stated criteria.

Accountability: Holders of office in the Department are accountable for their decisions and actions to the Department as a whole and must submit themselves to whatever scrutiny is appropriate to their office.

Openness: Holders of office in the Department should be as open as possible about all the decisions and actions that they take. They should give reasons for their decisions and restrict information only when the wider interest of the University or individuals' rights to confidentiality clearly demand.

Honesty: Holders of office in the Department have a duty to declare any private interests relating to their University or Department duties and to take steps to resolve any conflicts arising in a way that protects the interests of the University.

Leadership: Holders of office in the Department should promote and support these principles by leadership and example.