UNIVERSITY OF STRATHCLYDE

DEPARTMENT OF PHYSICS

HANDBOOK

FOR

1ST – 5TH YEAR STUDENTS

MPhys

Honours BSc Physics

Honours BSc Physics with Teaching

Honours BSc Mathematics and Physics

This handbook should help guide you through your studies, but if you have any questions please do not hesitate to ask. Our friendly and experienced staff will be glad to help. We are one of the most successful physics departments in the UK as our Research was ranked first in the UK for Quality and in the most recent QAA led review, the teaching provided by the University was thought to be of the highest standard possible. Our courses are accredited by the Institute of Physics. They are designed to be exciting, stimulating and rewarding. We think you will enjoy them.
With best wishes
Prof Erling Riis
Head of Department

This Handbook should be read in conjunction with the University's STUDENT HANDBOOK that can be accessed at http://www.strath.ac.uk/student/

strathclydephysicssociety

facebook.com/groups/strathclydephysicssociety

phys.strath.ac.uk/society
society@phys.strath.ac.uk

Membership only £5

On payment, you will receive your membership card and if you come to our welcome social, you will receive a free drink token that will be redeemable on the night

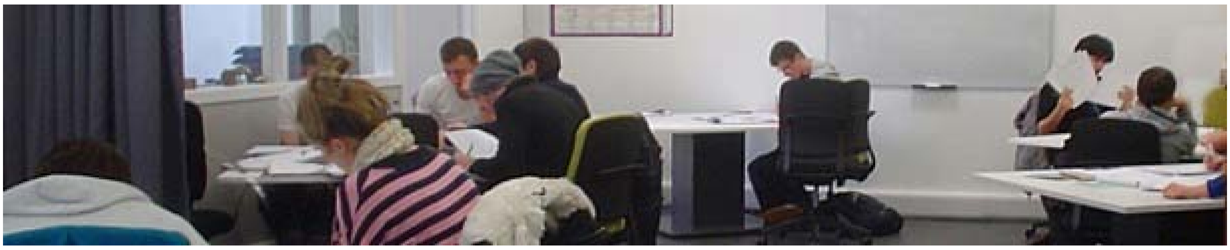
Find us on Facebook!

We will let you know of upcoming events through email and will also make use of MyPlace and our Facebook group so join it at the address above!

Events held Over the Years

- Introduction night for all members
- Social events throughout the year (including ‘Physmas’ – our legendary Christmas night out; Pub Golf and the End of Exams ‘Suck Squeeze Bang Blowout’)
- Career events throughout the year with industry contacts and big employers
- Tours of Physics Labs (we visited CERN in 2013!)
- Affiliation with Physics Department Colloquia
- Gaming Tournaments, Literature Groups, Stargazing
- Super awesome cool Physics Society hoodies!

Maths Skills Support Centre



THE MATHS SKILLS SUPPORT CENTRE PROVIDES ACADEMIC SUPPORT FOR ALL STUDENTS WHO ARE STUDYING MATHEMATICS AT THE UNIVERSITY OF STRATHCLYDE OR WHO REQUIRE AN ELEMENT OF MATHEMATICS IN THEIR CHOSEN DEGREE.

- ***Drop in to get one-to-one help with your mathematical difficulties or to improve your mathematical confidence.***
- ***Make an appointment to talk to Peter or Sandra in the Centre.***
- ***Use our online resources which include summary notes, multiple choice quizzes and diagnostic tests.***

Study in the centre

One-to-one Support

Group Help

Online Resources

- *LT308 in the Livingstone Tower*
- *Website*: www.strath.ac.uk/mathsskills
- *Email:* mathsskills@strath.ac.uk
- *Myplace Classes:* Maths Skills Support Centre

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GENERAL INFORMATION

COURSES

MPhys

This is normally a 5-year degree that places the emphasis on up-to-date physics. In the final year of this course students encounter classes that are necessary to produce a graduate physicist capable of working in a research environment in either industry or academia. In Year 4 students can choose optional classes from a range of diverse topics from theoretical physics through plasma physics to photonics and then extend the depth of coverage of these subjects through Year 5.

Within the MPhys degree structure, there is the opportunity for students to tailor their classes in the final two years to a given specialisation in a particular subject area. This is done by selecting classes relating to an area of expertise offered by the department and pursuing a project over 4^{th} and 5^{th} year in that area.

Honours BSc Physics

This is a 4 year degree course providing students with a thorough grounding in the fundamentals of physics. In the final year of the course, students select optional classes from the same set that are offered to the MPhys degree students.

Honours BSc Physics with Teaching

This degree is offered in conjunction with the School of Education in the Faculty of Humanities and Social Science and is a qualification that is designed to prepare graduates to be teachers of physics in secondary schools. This degree not only covers the same core physics syllabus as the BSc Physics degree but also allows students the time to acquire the educational theory and classroom practice necessary for registration with the General Teaching Council for Scotland.

Honours BSc Mathematics and Physics

The aim of this degree, offered jointly with the Department of Mathematics and Statistics, is to provide students with a joint qualification in Mathematics and Physics by providing the opportunity to pursue both Mathematics and Physics to a high level. It contains the physics necessary for future fundamental and applied work. Again in the 4^{th} year, students can choose optional classes from both the department of Physics and the department of Mathematics and Statistics.

THE ACADEMIC YEAR 2015/2016

Registration: Monday 14th September 2015 – Friday 18th September 2015

An important event, which you must attend during this week, if you are in your first year of study or are new to the Faculty of Science, is:

Faculty Induction Session: Wednesday 16th September 2015 between 12.00 noon – 2.30 pm in room JA3 25 of the John Anderson Building.

An important event, which you must attend if you are in any year is the appropriate *First Day Meeting.* Details of each year's meeting are as follows:

1st Year students:	First Day Meeting on Friday 18th September 2015 from **10.00 – 11.00** in room **JA 3 14**.
2nd Year Students	First Day Meeting on Friday 18th September 2015 from **10.00 – 11.00** in room **JA 3 17.**
3rd Year Students	First Day Meeting on Friday 18th September 2015 from **11.00 – 12.00** in room **JA 3 14**.
4th and 5th Year Students	First Day Meeting on Friday 18th September 2015 from **12.00 – 13.00** in room **JA 3 14**.

Semester I:

University closed	Monday 28th September 2015
Teaching Weeks 1 – 12	Monday 21st September 2015 – Friday 11th December 2015
Christmas Vacation	Monday 21st December 2015 – Monday 4th January 2016
University closed	Thursday 24th December 2015 – Monday 4th January 2016
Revision Period	Monday 14th December 2015
Examination Weeks	Tuesday 5th January 2016 – Friday 15th January 2016

Semester II:

Teaching Weeks 1-12	Monday 18th January 2016 – Friday 22nd May 2016
Spring Vacation	Monday 4th April 2016 – Friday 15th April 2016
University closed	Friday 25th March 2016
University closed	Monday 28th March 2016
Revision Week	Monday 25th April 2016 – Friday 29th April 2016
Examination Weeks	Tuesday 3rd May 2016 – Friday 27th May 2016
University closed	Monday 2nd May 2016
University closed	Monday 30th May 2016
Resit Examinations begin	Wednesday 3rd August 2016 *(normally of two weeks duration)*

These dates are correct at the time of publishing but you are strongly advised to check **http://www.strath.ac.uk/studying/currentstudent/keydates/** *regularly for any changes.*

ADVISERS OF STUDY

Each student in the Department is assigned an Adviser of Study who is responsible for advising the students about their current curriculum. Each year group will meet with their Adviser of Study at the appropriate year group First Day Meeting.

The Course Advisers for 1st year:

MPhys	Dr A Yao
Physics, BSc Honours	Dr A Yao
Physics with Teaching, BSc Honours	Dr A Yao
Mathematics and Physics, BSc Honours	Dr P Knight, Mathematics and Statistics

The Course Advisers for 2nd year:

MPhys	Dr T Han
Physics, BSc Honours	Dr T Han
Physics with Teaching, BSc Honours	Dr T Han
Mathematics and Physics, BSc Honours	Dr L. Kelly, Mathematics and Statistics

The Course Advisers for 3rd year:

MPhys	Dr O Rolinski
Physics, BSc Honours	Dr O Rolinski
Physics with Teaching, BSc Honours	Dr O Rolinski
Mathematics and Physics, BSc Honours	Dr G McKay, Mathematics and Statistics

The Course Advisers for 4th year:

MPhys	Dr B Hourahine
Physics, BSc Honours	Dr B Hourahine
Physics with Teaching, BSc Honours	Dr B Hourahine
Mathematics and Physics, BSc Honours	Dr D Greenhalgh, Mathematics and Statistics

The Course Advisers for 5th year:

MPhys	Dr B. Hourahine

FACULTY OF SCIENCE

The Faculty of Science includes the Departments of Physics, Mathematics and Statistics, Computer and Information Science, Pure and Applied Chemistry as well as the Strathclyde Institute of Pharmacy and Biomedical Sciences which comprises the bioscience departments. The Faculty, one of four in the University, has administrative and financial powers devolved to it by the University.

The current office-holders in the Faculty are:

Dean:	Professor David Littlejohn
Vice-Deans:	Dr Chris Prior (Academic) Dr John Liggat (Knowledge Exchange) Professor Rob Martin (Research)

Permanent administrative staff of the Faculty are:

Faculty Manager:	Ms Bronagh Dallat
Assistant Faculty Manager:	Ms Christine Dowds
Administrative Assistant:	Ms Kayleigh MacAskill

Enquiries to Faculty staff can be presented at the Student Business enquiry desk in the McCance Building.

THE PHYSICS DEPARTMENT

The Department is housed mainly in the John Anderson (JA) building, but some staff have offices and laboratories in the adjacent Colville (Col.) Building, linked at levels 3, 4 and 5. The John Anderson Building is open Monday to Friday from 8.00 am to 6.00 pm.

The Department has over 35 academic staff. The Head of Department is Professor Erling Riis (JA 8.02). Information on the Department and its staff can also be obtained from the Department Website http://www.strath.ac.uk/physics/

Should you need to contact a member of staff, contact details can also be found on the Department Website http://www.strath.ac.uk/staff/?department=Physics Alternatively, messages for staff may be left in their pigeonhole on the 8th floor of the John Anderson Building, outside JA 8.33. (Please note, names are **above** pigeonholes, not under.) Besides its academic staff, the Department also includes research fellows, research assistants and research students who, besides their research activities, participate in the teaching of the Department. Additionally, there are also technical and secretarial staff. Photographs of all the staff are displayed on the 8th Floor of the John Anderson Building outside JA 8.03.

The Department uses the internet to communicate with students and so it is essential that you check both your university email account and any class announcements made through the University VLE MyPlace.

The department makes available JA 8.18 (The Bob Illingworth Room) as a Student Reading Room. You are asked to cooperate by not using 8.18 for conversing, eating or drinking. This room is for students of all years and of all courses. (Please treat it with care or the facilities will be withdrawn.) There is also a Student Common Room located in the Colville Building Col 4.23.

YOUR DEGREE COURSE

COURSE REQUIREMENTS

Each degree course is made up of a number of classes. A full year's curriculum normally totals a minimum of 120 credits. The classes you choose must be agreed with your Adviser of Study (see below) and then you will be able to complete your registration with the University. The details of the core physics and mathematics classes you will take this year are given in Appendix 1. Further information about all the classes offered this Department can be found at http://www.strath.ac.uk/physics/currentstudents/curriculum/

Each degree course is governed by a set of Regulations that specify the compulsory classes you must follow for that degree course as well as the progress requirements to move from one year to the next year of a given degree course. These are detailed in Appendix 1. If there are any changes to these regulations, the department will always use the version of the regulations that is in the best interest of the students.

In addition to the degree specific Regulations you are bound by a set of general regulations and these can be found at
http://www.strath.ac.uk/media/ps/strategyandpolicy/University_Regulations.pdf

Timetables

The timetables for each degree course will be available on the Departmental website at the start of each semester see The videos given there show you how to find the timetable for a given degree programme or class.

PLEASE NOTE THAT AT THE START OF SEMESTER 1, ROOMS ARE SUBJECT TO CHANGE AND YOU SHOULD CHECK THE TIMETABLE FREQUENTLY.

Personal Development Advisers (PDA)

As well as an Adviser of Study, you will also be assigned to a member of academic staff who will act as your Personal Development Adviser (PDA). The role of the PDA is to encourage you to reflect on your study in Physics and help you develop to be a Physicist who is enquiring, engaged, enterprising and ethical, all the attributes necessary for a graduate fit for the 21st Century. Should any problems arise during your study your PDA will be able to direct you to the relevant support staff within the University. If you have any problems then please inform the Department so that we can put measures in place to help you.

Student-Staff Committee

The Department has a Student-Staff Committee (Convener Dr N Langford) that is made up of student representatives from each year and a number of academic staff. Students are invited to choose their own representative in the first two weeks of the first term. The Committee has an important role, resolving difficulties that may arise. The Student Staff Committee will meet in both 1st and 2nd semesters in week 5 and 10.The Students Association offers training on how to be an effective representative. The Committee considers anything that affects the teaching of the courses or Student-Staff relations. Problems that are personal to you should be raised with your PDA or Adviser of Study. Matters affecting a group of students should be raised in the first instance with any staff member directly involved, but if this fails to resolve the matter, or if it raises wider issues, then ask your Student-Staff Committee Representative to raise it at their next meeting. Meeting dates are scheduled for 21st October 2015, 25th November 2015, 17th February 2016 and 23rd March 2016.

Textbooks

It is important that you obtain recommended textbooks at the first opportunity. **First year students must** buy the textbook *Physics for Scientists and Engineers with Modern Physics* by Jewett and Serway, 9th Edition Brooks/Cole Cengae Learning, ISBN-13: 978-1133953999. The book comes with access to a web-based utility that will be used by staff to support your learning. The combined book and web access key is available from the University Bookshop, Curran Building on Cathedral Street. Buy this book as soon as possible since you will need it from week 1 onwards. This book will be used in the first and second year of each degree course to support the compulsory classes.

In addition, for the classes PH 355 Physics Skills and PH 451 Physics Skills you are allowed to take a textbook into the examination and this is one of the allowed textbooks. Another is University Physics (Revised Edition) by H. Benson, Wiley 1996 (ISBN 0 471 00689 0). Please seek the advice of the class lecturers regularly on the use of other books.

Report Writing

A key skill for any physicist is to communicate the outcomes of an investigation to a wider audience. During your course you will be expected to write formal reports on the practical work that you undertake in years 1 to 3 and the final year projects that you take in your 4th and 5th year of study. During the first three years of your study at Strathclyde the Department will give you the necessary training on how to write reports and this will include advice on the structure and content of the report, how to reference and how to avoid plagiarism, the unaccredited use of another person's work. The Department will use the anti-plagiarism software Turnitin https://turnitin.com/static/index.php to check for plagiarism. **BY SUBMITTING ANY WORK THROUGH TURNITIN, YOU ARE ACKNOWLEDGING THAT YOU ARE THE AUTHOR OF THE WORK.**

ADVICE FOR STUDENTS WITH SPECIAL NEEDS

Equality and Diversity

The University of Strathclyde is committed to achieving and promoting equality of opportunity in the learning, teaching, research and working environments.
We value the diversity of our students and support the development of mutual respect and positive relations between people.
The University has in place Equality Outcomes which meet the requirements the Equality Act 2010. You are advised to familiarise yourself with the University approach on equality and diversity and relevant developments and information by visiting the website:
www.strath.ac.uk/equalitydiversity/equalityinformationforstudents/

If you have any queries please bring these to the attention of staff or the University's Equality and Diversity office.

Email: equalopportunities@strath.ac.uk
Telephone: 0141 548 2811
www.strath.ac.uk/equalitydiversity/

Students with disabilities

The University is committed to providing an inclusive learning and working environment for disabled people.
If you have, or think you have, a disability we encourage you to disclose it as soon as possible. Declaring your disability will enable you to access any additional support that you may need and

help to ensure you become a successful student. The information you provide will be treated as confidential and will not be shared with other staff without your consent.

The University has a dedicated Disability Service that offers specific advice, information and assistance to disabled students, including information on the Disabled Students Allowance (DSA). Further information is available from the website: www.strath.ac.uk/disabilityservice/

In addition, each academic Department/ School (for HaSS) has at least one Departmental Disability Contact (DDC), who act as a first point of contact for disabled students. The Departmental Disability Contact list is available on the website at: www.strath.ac.uk/disabilityservice/ddc/

Please inform your course tutor, the DDC and a member of the Disability Service of your needs as soon as possible. The Disability Service will then formally communicate your needs to your Department/ School.

Email: disabilityservice@strath.ac.uk
Telephone: 0141 548 3402
www.strath.ac.uk/disabilityservice

Issues with Physical Access on campus

If you experience an issue with physical access anywhere on campus, please email: physicalaccess@strath.ac.uk where a member of Estates staff will be able to help.

IF YOU HAVE ADDITIONAL SUPPORT NEEDS YOU MUST NOTIFY THE DISABILITY SERVICE AS SOON AS POSSIBLE SO THAT THE NECESSARY ADJUSTMENTS CAN BE PUT IN PLACE.

To ensure the Department meets your needs as defined by the Disability Service, Ms K. Munro (kirsten.munro@strath.ac.uk) and Dr T. Han (t.han@strath.ac.uk) are the Departmental Disability Contacts. Should you have any questions then please do not hesitate to contact either of them.

In addition to the Disability Service the University offers a range of additional support services. Details of these various services can be found at
http://www.strath.ac.uk/student/startatstrath/studentexperienceservices/

SAFETY REGULATIONS

These apply to all parts of the University. Your attention will be drawn to these when they affect you. Particular care needs to be exercised in laboratories, and in general, you are not allowed to work in a laboratory unsupervised. For this reason, it is not usually possible to make up time lost for any reason during a laboratory session by putting in extra time later. The Department's general safety advice is listed further on in this handbook, see page 19.

INFORMATION TECHNOLOGY, PERSONAL TRANSFERABLE SKILLS, PEGASUS AND MYPLACE.

Expertise in *information technology* (IT) and well developed *personal transferable skills* are essential if you are to maximise your performance in the academic work of your chosen course. Essays, laboratory and project reports, for example, must normally be word processed while the ability to analyse and plot experimental data using available software packages is essential for progress in scientific research. Familiarity with IT also allows you to search the internet and electronic databases for reference material to assist in the writing of assignments and dissertations. In the later years of the course, the emphasis on project work trains you in the planning and performance of research, while the preparation and delivery of presentations, gives you the confidence to communicate your results and their relevance to both specialists and non-specialists as is required of professional scientists.

Year 1: Laboratory reports and problem solving. These are covered in the classes PH 150 Experimental Physics, PH 151 Mechanics, Optics and Waves and PH 152 Quantum Optics and Electromagnetism

Year 2: Laboratory reports, problem solving and the preparation and delivery of a talk; use of computers for numerical modelling and problem solving. These are further developed in the classes PH 250 Experimental Physics, PH 251 Mechanics, Optics and Waves, PH 252 Quantum Optics and Electromagnetism, PH 253 Properties of Matter and PH 254 Computational Physics.

Year 3: Laboratory reports, library skills, essay, project training, poster presentation, and problem solving. These skills are refined in core physics classes PH 350 Experimental Physics, PH 352 Quantum Optics and Electromagnetism, PH 353 Properties of Matter and PH 355 Physics Skills

Years 4 & 5: Research project and its written and oral presentation, problem solving, research training and developing an awareness of how to transfer a science idea from lab to business. The classes PH 450 Project, PH 550 Project, PH 451 Physics Skills and PH 551 Research Skills are designed to develop the aforementioned transferable skills.

PEGASUS and MYPLACE

The University has developed its own information server known as PEGASUS that is used to provide services to both staff and students. Please refer to your University Handbook for further information. In addition to PEGASUS the University has a VLE, MYPLACE, and this is used to provide copies of lecture notes, assignments, tutorial questions etc., as well as providing discussion forums for students. As with PEGASUS you will receive training on the use of MYPLACE in the first weeks of your course and information relating to MYPLACE can be downloaded from http://classes.myplace.strath.ac.uk/

Classroom Protocol

At the University we are committed to providing a safe learning environment where dignity is respected and discrimination or harassment does not occur on the basis of age, disability, gender reassignment, marriage and civil partnership, pregnancy and maternity, race, religion or belief, sex, sexual orientation and socio-economic background. No student should intentionally be made to feel threatened or excluded from class participation.

You are reminded of your responsibility for the duration of your studies by showing respect to fellow classmates and staff by remembering the following protocol:

- Attend all scheduled lectures/ seminars and/ or practical sessions such as labs, including any additional learning and teaching sessions.
- Arrive on time and remain in class until the end of the session. If you need to leave early for any reason, please notify the tutor at the beginning or prior to the class.
- Do not disrupt the class by habitually coming in late or coming and going from the classroom during the session. Students arriving late, without justified reasons, may be refused entry.

- Refrain from consistently interrupting another speaker and listen to the ideas of others with respect. Do not be rude or make personal attacks on individuals during group discussions.
- Inform and establish consent of the tutor if you wish to record the lecture. The recording must be used only for personal study.
- Do not bring food into the classroom, other than for medical reasons, e.g. diabetes. Beverages may be permissible at the tutor's discretion if the room utilisation rules allow.
- Inform tutors of specific requirements for example the need to perform prayers for practising students of diverse faiths.
- Seek consent of students and staff before taking any photos in the classroom.
- At any course related external visit you are acting as ambassadors of the University and are reminded to act as such.
- Refrain from smoking on premises as this is prohibited in all University buildings.
- Follow emergency instructions and health and safety procedures.
- Should you have any concerns please bring them to the attention of your tutor and/ or appropriate University staff.

ACADEMIC

ATTENDANCE

ATTENDANCE AT TUTORIALS AND LABORATORY SESSIONS IS MANDATORY AND THE DEPARTMENT WILL BE MONITORING ATTENDANCE AT PHYSICS LECTURES. POOR ATTENDANCE AT THE TUTORIALS FOR A GIVEN CLASS WILL RESULT IN YOU BEING MARKED AS "NOT QUALIFIED (NQ)" TO SIT THE EXAMINATION FOR THAT CLASS. FAILURE TO MAINTAIN A HIGH LEVEL OF ATTENDANCE MAY RESULT IN TERMINATION OF YOUR REGISTRATION.

ASSESSMENT AND PROGRESS

There are a variety of methods by which classes are examined and the lecturer at the start of a class should give the relevant details. You should note that the pass mark for classes at Levels 1 - 4 is 40% and for Level 5 classes it is 50%. Note that the credits associated with a class are indivisible. You cannot be awarded a fraction of its credits for meeting part of its requirements.

The most common assessment method is by examination. The conduct of examinations is covered by University regulations including:

1. You need to produce your student identity card at exams.
2. You are forbidden to have with you in the exam room notes of any sort unless the exam instructions explicitly permit them. [Possession of such notes in the exam room is an offence, irrespective of whether use is made of them.]

In *Physics* examinations you can not take into any examination graphic calculators with memory bank facilities, and in particular, no calculator with alphabetic input. (In *Physics* and *Mathematics* exams, *programmable* calculators are forbidden. Other Departments may have other special restrictions for their examinations.)

PLAGIARISM

Plagiarism most commonly involves the passing off of another person's work as your own and is regarded as a form of academic dishonesty. Plagiarism more often than not involves the copying of another person's work, be it a figure, text, experimental data or homework for example and not acknowledging the source of the work. Plagiarism can be avoided by suitable referencing. For more details on plagiarism please see the University Handbook and follow this link http://www.strath.ac.uk/plagiarism/ for guidelines on plagiarism. If you are unsure of any aspect of this, please contact the department. The department will make extensive use of software capable of detecting plagiarism, in this case Turnitin (https://turnitin.com/static/index.php) to check for plagiarism. Any student caught plagiarising another person's work may be reported to the University Disciplinary committee.

EXAMINATION ATTEMPTS

All students will be entitled to TWO attempts only to gain the credits for any class. For level 1, 2 and 3 classes, these attempts will normally comprise the First Attempt taken in either the January or the May Diet of Examinations and the Second Attempt taken in the August re-sit Diet of Examinations. For level 4 and level 5 classes the resit attempt will be in the exam diet of the following year. For some classes, such as Practical classes or classes with significant elements of continuous assessment, both attempts may take place during the 1st and 2nd semesters. It is the lecturer's responsibility to outline the assessment procedure for the class at the start of the course. **It is important to note that all credit-weighted average calculations are made using the first attempt mark.**

Targets

You should aim to obtain the credits for all your classes because progress to later years of the course and the award of the degree depend on your cumulative credit total.

At all stages of the course, a student must have achieved an approved standard of performance with regard to level of study and academic attainment.

The approved standards are:

MPhys	**-**	**Credit weighted average ≥ 55%**
BSc Hons Physics	**-**	**Credit weighted average ≥ 45%**
BSc Hons Physics with Teaching	**-**	**Credit weighted average ≥ 45%**

For full time students the credit-weighted average is based only on the classes you have taken in the current year of study and is calculated by

$$CWA = \frac{\sum_i c_i m_i}{\sum_i c_i}$$

where c_i is the credit value of the class, m_i is the percentage mark gained in the class. The credit-weighted average is based on the first attempt mark for a class. Failure to achieve these standards may result in you being transferred to a different degree e.g. MPhys to BSc (Hons) Physics.

PROGRESSION REQUIREMENTS FOR 1ST YEAR

	1st Year to 2nd Year
Degree	Credit Requirements
MPhys, BSc (Hons) Physics and Physics with Teaching degrees	In order to progress to the second year of the course, a student must normally have accumulated at least 100 credits from the course curriculum.
BSc (Hons) Mathematics and Physics degree	In order to progress to the second year of any Honours degree course, a student must normally have accumulated at least 100 credits from the course curriculum including the credits for MM 101 and MM 102.

PROGRESSION REQUIREMENTS FOR 2ND YEAR

	2nd to 3rd Year
Degree	Credit Requirements
MPhys and BSc (Hons) Physics degrees	In order to progress to the second year of the course, a student must normally have accumulated at least 220 credits from the course curriculum.
BSc (Hons) Physics with Teaching degree	In order to progress to the third year of the course, a student must satisfy the requirements for entering Initial Teacher Education, be a member of the PVG (Protection Vulnerable Groups) Scheme or, if already a member, must apply for an update and have accumulated at least 220 credits from the course curriculum.
BSc (Hons) Mathematics and Physics degree	In order to progress to the third year of the course, a student must have accumulated at least 220 credits from the course curriculum including those for the class MM 201

PROGRESSION REQUIREMENTS FOR 3RD YEAR

	3rd to 4th Year
Degree	Credit Requirements
MPhys and BSc (Hons) Physics degrees	In order to progress to the fourth year of the course, a student must have accumulated at least 360 credits from the course curriculum including 60 credits at Level 3 or above.
BSc (Hons) Physics with Teaching degree	In order to progress to the fourth year of the Honours course, a student must normally have accumulated at least 360 credits from the course curriculum including 60 credits at Level 3 or above.
BSc (Hons) Mathematics and Physics degree	In order to progress to the fourth year of the course, a student must have accumulated at least 360 credits from the course curriculum including 120 credits at Level 3 or above..

PROGRESSION REQUIREMENTS FOR 4TH YEAR

	4th Year to 5th Year
Degree	Credit Requirements
MPhys degree	In order to progress to the fifth year of the course, a student must normally have accumulated at least 480 credits from the course curriculum.

DEGREE AWARD CREDIT REQUIREMENTS AND CLASSIFICATION

Degree Type	Credit Requirements
BSc Physics degree	To be awarded a BSc Physics degree you must have accumulated 360 credits of which 60 credits must be at Level 3.
BSc (Hons) degree	To be awarded a BSc degree with Honours you must have accumulated 480 credits of which at least 180 credits must be at Level 3 or above and of these 90 must be at Level 4 or above.
MPhys degree	To be awarded a MPhys degree you must have accumulated 600 credits of which at least 220 credits must be at Level 4 and 5 and of these 120 must be at Level 5 or above.

The Honours degrees are classified into four grades, Class I (a "First"), Class II(i) (an "Upper Second"), Class II(ii) (a "Lower Second") and a Class III (a “Third”).

MPhys degrees are classified as for BSc Honours degrees, except there is no Class III.

The level of award is determined by the mark generated by Faculty of Science Degree Award Algorithm (FSDAA), detailed in Appendix 3. The mark required for each class of award is:

Honours Degree Classification	FSDAA Mark
First	≥ 70 %
Upper Second	≥ 60 %
Lower Second	≥ 50 %
Third	≥ 40 %

Students who fail to qualify for a degree may be eligible for the award of the Diploma or Certificate of Higher Education.

Award Type	Credit Requirements
Diploma of Higher Education	To be awarded a Diploma of Higher Education you must have accumulated 240 credits with a minimum of 100 at Level 2
Certificate of Higher Education	To be awarded a Certificate of Higher Education you must have accumulated 120 credits with a minimum of 100 at Level 1

EXTERNAL EXAMINERS

Whichever method of assessment is used to assess a class the mark for that class is approved by an Examination Board. For students in years 1 to 3 this is a General Board of Examiners managed by the Faculty. For 4th and 5th year students the Department manages the Examination Board. The Departmental Examination Board comprises all members of Staff in the Physics Department plus representatives from Mathematics and Statistics and the School of Education. In addition to these two External Examiners sit on the Examination Board and the role of their role is to ensure that the Department has operated in a fair and equitable manner when setting and assessing exam papers and course work. This year the External Examiners are

Dr D Halliday
Department of Physics
University of Durham
Durham DH1 3LE

EXAMINATION BOARD DECISIONS

The General Board meets first in June and then in September, to consider the results of August re-sit examinations, in September. The Department Board only meets in June. The Boards of Examiners will take one of the following decisions which will then be notified through PEGASUS.

The University operates a Compensation Scheme, details of which can be found at: http://www.strath.ac.uk/media/ps/cs/gmap/academicaffairs/policies/compensation_scheme_-_Effective_Sep_14.pdf In summary the compensation scheme works as follows: If your credit-weighted average for the year of study is greater than or equal to 45 % and you fail a class with a mark between 30 and 39 % you will be awarded the credit for that class. This applies to only 20 credits of material and is normally applied to the class which is closest to 40 %. The compensation scheme only applies to the 1st attempt mark for any class and covers years 1 to 3 of the BSc degrees and 1 to 4 of the MPhys.

PASS (*WITH MERIT / WITH DISTINCTION)*

This means that you have passed in all classes for which you were registered and may progress to the next year of the same course. If you are awarded a *Pass with Merit* your credit-weighted average over the year is ≥ 60%. If you are awarded a *Pass with Distinction* your credit-weighted average over the year is ≥ 70%.

RESIT

This decision indicates that you have to resit and pass the examination(s) in the class or classes specified before you can be permitted to proceed to the next year of your course.

MAY PROCEED

This means that although you have not passed in all of your examinations, you have obtained enough passes to go on to the next year of your course. This will apply only after the resit diet of examinations.

SUSPEND

If, by the September Examination Board, you have not satisfied the progress regulations, your registration will be suspended and you will not be permitted to attend classes for the following session

TRANSFER

A student who does not meet the requirements for progress on an honours degree course may be required to transfer to the corresponding degree in the subject

REATTEND

The Examination Board recognises that mitigating circumstances may have affected your performance over the year and have recommended that you repeat the year. (This may have financial implications and you are advised to check with SAAS.)

WITHDRAW

A student whose performance is considered to be so bad that none of the above alternative decisions would be appropriate will be required by the Examination Board to withdraw from his or her present degree course.

You may also have the following comments next to individual class marks

PASS BY COMPENSATION

The University Compensation Scheme has been applied to this class. Your overall level of performance is such that you have been awarded the credit for the class even though the mark that you have achieved for the class is less than the standard pass mark (40 %).

ATTEMPT DISCOUNTED

The Examination Board recognises that factors, such as ill health or adverse weather may have affected your performance in the class. The mark you achieve for the class is discarded and the next attempt at the class is regarded as the first* attempt. (*If the mark discounted is a re-sit the attempt will be regarded as the same number as the re-sit attempt e.g. 2nd, 3rd or 4th attempt.)

Decisions to discount attempts or to allow you to re-attend are made by the Examination Board relevant to your year of study. In order for the Examination Board to make an appropriate decision all personal circumstances must be reported to the Examination Board. Completing the personal circumstances section on PEGASUS, notifying your Adviser of Study or your PDA, can do this. Irrespective of the approach you choose notification must be done before the Examination Boards meet. For General Board A the meeting dates are

June Examination Board A:
Pre Board Wednesday 8th June 2016
Board Friday 17th June 2016

Re-sit Examination Board A:
Pre Board Friday 25th August 2016
Board Thursday 31st August 2016

Final Year Examination Board
Both the Pre Board and Board will meet in the week commencing 6th June 2016. 4th and 5th year students will be notified of the correct dates when these have been agreed with the External Examiners.

MINIMUM CREDIT REQUIREMENTS FOR 1ST – 3RD YEAR INCLUSIVE

For students in Years 1 to 3 your examination performance is considered by the Faculty's General Board of Examiners A, which meets in June and August. The Board makes progress decisions based on your credit totals and below indicates decisions that are made for given credit totals.

CREDIT TOTAL	June Decision	September Decision
First Year		
120	Pass	Pass
100 ≤ x< 120	Resit	May Proceed
60 ≤ x< 100	Resit	Suspend
0 ≤ x< 60	Resit and Caution	Withdraw
Second Year		
240	Pass	Pass
220 ≤ x< 240	Resit	May Proceed
180 ≤ x< 220	Resit	Suspend
120 ≤ x< 180 (including 100 at Level 1 or above)	Resit and Caution	Withdraw – Award CertHE
0 ≤ x< 120	Resit and Caution	Withdraw
Third Year (Honours Degree)		
360	Pass	Pass
300 ≤ x< 360	Resit	Suspend
240 ≤ x< 300	Resit and Caution	Withdraw- Award DipHE
120 ≤ x< 240 (including 100 at Level 1 or above)	Resit and Caution	Withdraw – Award CertHE
Third Year (Pass Degree)		
360 (including 60 at Level 3 or above)	Award	Award
300 ≤ x< 360	Resit	Suspend
240 ≤ x< 300 (including 100 at Level 2 or above)	Resit and Caution	Withdraw- Award DipHE
120 ≤ x< 240 (including 100 at Level 1 or above)	Resit and Caution	Withdraw – Award CertHE

GRADUATION

What is Graduation?

The University holds Degree Congregations each year at which students graduate with degrees of the University. Until you have graduated, in person or "in absentia", you are not entitled to call yourself a graduate. For consideration for many types of employment, it is necessary to be able to show your degree certificate, presented to you at Graduation.

When are the Degree Congregations?

July and November in the Barony Hall. The dates and times for your degree ceremony will be announced in March.

Registration for Graduation

Who should register to Graduate?

All students hoping to graduate should register using the form available from Registry. Registration is essential even if you want to graduate "in absentia" (i.e. the degree is conferred in your absence). The Department advises all students whether on the MPhys or BSc Honours degrees to register for Graduation in their 4th year. If you are studying on the MPhys degree and continue to 5th year the Graduation Office will hold your fee for next year's Graduation.

You cannot graduate twice with any degree. If you expect to qualify for a BSc Degree this year, but hope to go on to Honours, you should consider deferring graduation until your Honours Year. Students who graduate with a BSc Degree and then qualify for an Honours degree may apply for a Post-Graduation Honours parchment setting out the subject and class of Honours awarded. No registration fee is required for Post-Graduation Honours.

When do I need to register?

As soon as the website http://www.strath.ac.uk/graduation/ indicates the relevant dates. Do not wait until you have sat your examinations or until your award is approved - that will be too late. Graduation enrolment should be made via credit or debit card on the online shop at: http://onlineshop.strath.ac.uk

What are the fees?

The fees change each year, but for example in 2013 the Graduation fee was £35 or £20 for those graduating "in Absentia": The fee includes your subscription to the Graduates Association and a small charge for administration. The hire charges for the appropriate hood and gown are about £30.

How do I graduate "in absentia"?

Your degree will be conferred "in absentia" if you wish (tick the appropriate box on the form). Your degree parchment will be sent to the address given on your graduation form 2-3 weeks after the ceremony.

What happens if I do not qualify in time for graduation?

If you have registered to graduate in July but you do not qualify for the degree in time, Registry will assume that you will graduate "in absentia" at the November ceremony; similarly if you register for November but do not qualify in time your registration would be deferred to July.

Debtors

If you owe the University money for any reason (fees, rent, library fines) you will not be permitted to graduate. You should clear any debts with Finance Office or the Library immediately.

Graduation Day

If you have registered to graduate by the appropriate date and have qualified for the award of the degree, Registry will send you information in the week before Graduation. This will include tickets for two guests to attend the ceremony.

***What do I wear*?**

The correct academic dress (i.e. the gown and hood appropriate to your degree), otherwise you will not be permitted to graduate. The University does not provide gowns, but they can be hired.

Male graduands are expected to wear a dark suit, with a white shirt and dark tie. Female graduands are expected to wear a dark skirt and white blouse or a white or dark dress. If you wish, a recognised national dress (including the kilt) may be worn.

Erasmus Scheme

Student Exchange Abroad

The Department has exchange agreements with a number of Universities in Europe, in Austria, Germany, France, Poland, and Switzerland that allow students to spend up to a year studying abroad during their 3rd or 4th year. There are many benefits to studying abroad, from help with foreign language skills to enhancing your CV. You can find more information on the scheme at the Erasmus website http://www.britishcouncil.org/erasmus-benefits.htm. Keep an eye on the notice boards outside Dr F. Papoff's office (Room JA 8.09) on the 8th Floor for news.

If you are interested and would like to know more, see Dr F. Papoff before November. The number of such places is limited and preference is given to those whose academic progress suggests they will benefit from the extra challenge of study abroad.

PRIZES

A number of prizes are given at the end of each year of each course. The value of the prizes is usually quite modest: they are intended only as an incentive and encouragement as you work towards your degree. Details of the prizes can be found in Appendix 4 of this handbook.

DEAN'S LIST

The Dean of Science recognises the excellent performance of students by awarding the Dean's List Certificate.

NATIONAL STUDENT SURVEY

Each year, graduating students are asked to take part in the National Student Survey. The results of this survey, which is run by Ipsos Mori, has much store put in them by the government and the universities funding body as well as being available for future UCAS applicants. The University makes good use of the results of this survey to enhance the student learning experience so we would encourage all eligible students to complete this survey. You can find more information and take the survey by following the link: www.strath.ac.uk/nss/

ABSENCE

Please refer to the University Handbook and website for guidance on absence policy and procedures.
http://www.strath.ac.uk/sees/studentpolicies/policies/attendance/absenceandvoluntarysuspension/

MOVING HOME

It is important to keep Student Business informed of **any change in your address** or else important information (like examination and graduation information) might go astray. Changes of address may be updated through the University's Information Server PEGASUS.

DIFFICULTIES

If you find yourself with a problem or in difficulty the University has people and procedures in place to help (please refer to the University Handbook for contact details of all the main University services) but within the department help is also available. You can go and see your PDA or adviser in the first instance. Do not delay getting help as often the problems are much reduced if tackled early enough. If they cannot give help themselves, they will often know of others who can help.

CAREERS GUIDANCE

1st, 2nd, 3rd years: Have You Thought About Your Future?

Don't leave it until your final year to think about your career! Employers tell us that as well as a good degree they value the other things you have done while at university to develop your skills and your personal attributes. Use the Careers Service from 1st year to explore opportunities to gain work experience through part time work, volunteering, internships and to reflect on the benefits gained from these and all the activities on your course. This self-knowledge will enable you to explore the options open to you.

If you are not sure where to start have a look at the Choosing Your Career section of the Careers Service website which you can revisit throughout your time at university as your ideas change and evolve. The Getting the Right Work Experience section has dates for all our careers fairs and information on how to look for jobs. Register now for our vacancy system to view part time jobs, internships and graduate jobs - you can even set up job alerts so that we tell you when jobs are added. Throughout the year the Careers Service is buzzing with opportunities for you to develop your skills and knowledge and hosts many employer-led skills sessions and talks. Register now on our Events system for more information and to pre-book. Links to all these resources are on the home page of the Careers Service website www.strath.ac.uk/careers/

The good news is that graduate recruitment has returned to pre-recession levels however competition is fierce so it is important to think through what career you might follow well before you graduate. Do this early and take advantage of all the opportunities described above so that you are ready to apply at the start of your final year. Many applications close well before Christmas and job offers can be made subject to your final grades, which is a great motivator to get you through your final year.

4th and 5th Year: Career Planning and Development, Successful Applications

Your final year is the time to follow through on the planning and research you have done into your career choice during 1st, 2nd and 3rd year. This should have helped you to progress your career thinking to a point where you are ready to take some action. However, if you have not yet started to consider the future beyond your degree the whole process will need to be incorporated into this year. You will need to balance the academic demands of your course with the final stages of career planning and job search. Decisions will need to be made at various stages and the timing of these will vary depending on your career focus. Make good use of the Careers Service to help refine your career focus and embark on the job/postgraduate search process. We offer plenty of support, for example:

- Drop-in sessions with a Careers Adviser on Monday, Tuesday and Thursdays, which can be followed up with a more in depth appointment. They will help you clarify your career aspirations and develop an appropriate action plan. Check our website for contact details and opening times
- Our website and resource centre has extensive occupational, postgraduate and employer information to inform your career research as well as resources on making applications
- We also recommend the graduate careers website, Prospects, where you can use Career Planner to see what options might suit you www.prospects.ac.uk/myprospects_planner_login.htm.Target Jobs Careers Report can also help to expand your career ideas http://targetjobs.co.uk/careers-report
- Attend the Scottish Graduate Fair (October 7th & 8th 2015). Free buses run from this campus to the SECC. To pre-register and view the list of exhibitors go to www.strath.ac.uk/careers/sgf/student/
- Develop your CV with help from the Careers Service. You can book CV/application form appointments online from our home page
- Finally, don't forget to register on our Vacancy and Events sites! (see above)

Careers Service staff are happy to help you at whatever stage of the career planning job search process you have reached. They also offer a service to our graduates which is free for the first year, so if you need help beyond your degree, keep in touch. Your counsellor or adviser will provide references for you, if you ask.

SAFETY NOTES

Safety is YOUR business and responsibility at all times. These notes supplement the Department’s Safety Regulations and should be read carefully. Specialised training might be required and it is mandatory to make yourself familiar with and to sign any local rules, risk assessments and methods of work for your specific experiment.

Potential hazards in physics laboratories include fire, electrical, materials and chemicals, machinery, gas cylinders, "common" accidents, ionizing radiation, laser UV, and microwave radiation.

Fire

Be aware of the quickest fire escape routes from the areas that you are in. If the fire alarm sounds (continuous tone) make your way, immediately, to the nearest exit. Do not let waste paper accumulate. Do not leave gas burners on unattended. Electrical equipment, especially older power supplies can go on fire if short circuited and wrongly fused. Rotary pump motors can seize (i.e. jam) and go on fire if not properly protected. In general switch off unattended equipment unless there is a good reason for leaving it on. Know where the fire exits are.

Electrical

Current through heart stops operation of heart. Use safety equipment (see below). When adjusting equipment keep one hand away from equipment and away from any earthed conductor. This reduces current through heart from two-handed contact from 'live' to 'earth'. Know about resuscitation procedures - see notices displayed in every lab.

- Mains operated equipment including 5V power supplies, desk lamps etc.: Safety depends on correct wiring of plug, good quality cable, right fuse, proper earthing. "Tingly feeling" in finger when touching equipment indicates that it is not earthed properly. Report defects to demonstrator or lab technician - do not leave it for someone else.

- High voltage capacitor banks are very dangerous. Lethal charge is stored long after power supply switched off if fault occurs in protection circuits. Safety depends on good insulation and safety checks before alteration or maintenance (forbidden to students).

- Any high voltage equipment. "Tracking" occurs across surface of insulator. High voltage can then appear at unexpected places. Switch off power supply when altering circuit.

- Darkroom equipment - e.g. safety lights, driers etc. Dangerous because the darkroom is usually small, badly lit and wet (you are well earthed and hence at risk).

Materials and chemicals

- Many common chemicals and solvents are toxic - cancer an important risk, e.g. Benzene, Carbon Tetrachloride, Chloroform. Good ventilation important. Tap water is not necessarily drinking water.

- Many solvents are inflammable - especially Benzene.

- Do not tip solvents down sink unless it is certain they will do no harm.

- Unless you have good knowledge of chemistry, do not mix chemicals without first getting expert advice.

- Alkali metals (e.g. sodium, potassium) react explosively with water.

- Mercury fumes are poisonous. If mercury gets spilled, inform demonstrator.

- Liquid nitrogen is cold but causes burns. Make sure it cannot splash into your eyes or onto your clothing.

- Asbestos fibres can lodge in lungs - cancer years later. Be cautious with asbestos and seek advice (there shouldn't be any asbestos in the lab).

- Many chemicals can cause dermatitis or other skin ailments (some people more susceptible than others). Keep your hands away from chemicals (gloves available if needed). Wash your hands if they should come into contact with chemicals of any sort.

- In general - do not eat in labs. Wash hands after leaving lab and before eating. Label all containers of chemicals and never use lemonade or similar bottles to store chemicals in.

Machinery

- In lab, rotary pumps have powerful electric motor with drive belt. Belt guard is not infallible protection against long hair or tie being caught up in belt. Fans on diffusion pumps are also a hazard.

- In machine shop - get expert advice. You should not use machines without supervision.

Gas Cylinders

Contain gas at high pressure (~ 200 atmospheres). If a cylinder topples over, the danger results from its large weight and from the possibility that the cylinder neck may fracture (ejecting the valve). Gas cylinders should be secured to wall. Two valves to operate - get advice from demonstrator the first time you use one.

"Common" accidents, e.g. falling down stairs, tripping over obstacles etc. Keep passageways clear of obstacles (e.g. bench stools, books, unused equipment) - especially in darkened labs. No horseplay in labs.

Radioactive or X-ray sources are covered by special rules. They must not be used without an approved scheme of work signed by the Department Radiation Protection Advisor.

Lasers are divided into classes:

1	Harmless
2 or 3R	Low power but precautions needed
3B	Medium power - severe eye damage possible
4	Severe eye and skin damage possible

Before using any laser other than a class 1 you must have permission from your Supervisor who will arrange for an approved scheme of work countersigned by the Departmental Radiation Supervisor.

Finally your first accident may be one we have not thought of yet. So be careful.

Our best wishes for your studies during this academic year, 2012/2013. We welcome you and hope that you will enjoy your time with us. We cannot hope to make a degree in physics easy: it wouldn't be worthwhile if it was, and it takes many years of hard work - but we will do all we can to make it an enjoyable experience, and to provide you with the facilities to make your studying as effective as possible.

We believe the information provided in this handbook is correct at the date of publishing but may be subject to revision.

N.B. THIS HANDBOOK CAN BE SUPPLIED IN A VARIETY OF FORMATS TO SUIT YOUR NEEDS. PLEASE CONTACT THE DEPARTMENT FOR MORE INFORMATION

APPENDIX 1 – Degree Regulations

These Regulations are correct at the time of publication but you are advised to check http://www.strath.ac.uk/media/ps/strategyandpolicy/University_Regulations.pdf for any changes

12.17 Department of Physics

Physics

MPhys in Physics
MPhys in Physics with Specialisation

Course Regulations
[These regulations are to be read in conjunction with Regulation 12.1]

Status of the Courses

12.17.1 The courses are at Integrated Masters level. Transfer to the BSc in Physics is possible at any time subject to satisfying the appropriate course regulations.

Mode of Study

12.17.2 The courses are available by both full-time and part-time study.

Credit Transfer and Recognition of Prior Learning

12.17.3 Regulations 12.1.1 and 12.1.2 shall apply.
In addition, direct entry to year 4 of the course may be granted to applicants who possess
(i) a first cycle Bologna degree in Physics meeting an approved standard of performance with regard to level of study and academic attainment; or
(ii) a qualification deemed by the Head of Department (or nominee) to be equivalent to (i) above; and
(iii) an approved standard of performance in a recognised test in English as a foreign language.
Such applicants will be deemed to possess 360 credits.

Place of Study

12.17.4 The optional Industrial Placement, normally taken during the summer vacation following third year, is expected to be completed off campus.

Curriculum (Full-time study)
First Year

12.17.5 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
MM 111	Mathematics 1B	1	20
MM 112	Mathematics 2B	1	20
PH 150	Experimental Physics	1	20
PH 151	Mechanics, Optics and Waves	1	20
PH 152	Quantum Physics and Electromagnetism	1	20

Elective Class(es)			20

Second Year

12.17.6 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
MM 211	Mathematics 3B	2	20
PH 250	Experimental Physics	2	20
PH 251	Mechanics, Optics and Waves	2	20
PH 252	Quantum Physics and Electromagnetism	2	20
PH 254	Computational Physics	2	20
PH 258	Condensed Matter Physics	2	10
PH 259	Gases and Liquids	2	10

Third Year

12.17.7 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
MM 311	Mathematics 4B	3	20
PH 350	Experimental Physics	3	40
PH 352	Quantum Physics and Electromagnetism	3	20
PH 355	Physics Skills	3	20
PH 358	Condensed Matter Physics	3	10
PH 359	Statistical Physics	3	10

12.17.8 Students may, with the approval of the Adviser of Study, also undertake a project during the summer vacation following Third Year as follows:

Optional Class			
PH 465	Industrial Project	4	20

Fourth Year

12.17.9 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
PH 499	Physics*	4	120

**PH 499* Physics comprises

PH 450	Project	4	40
PH 451	Physics Skills	4	20

together with 60 credits chosen from:

PH 452	Topics in Physics	4	20
PH 453	Topics in Solid State Physics	4	20
PH 454	Topics in Nanoscience	4	20
PH 455	Topics in Photonics	4	20
PH 456	Topics in Computational and Complex Systems in		

	Physics	4	20
PH 457	Topics in Theoretical Physics	4	20
PH 458	Topics in Quantum Physics	4	20
PH 459	Topics in Atomic, Molecular and Nuclear Physics	4	20

12.17.10 Students may, with the approval of the Adviser of Study, also undertake a project during the summer vacation following Fourth Year as follows:

Optional Class		
If not already taken		
PH 465 Industrial Project	4	20

Fifth Year

12.17.11 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
PH 599	Physics*	5	120

PH 599 comprises			
PH 550	Project	5	40
PH 551	Research Skills	5	20

together with 60 credits chosen from:

PH 552	Advanced Topics in Physics	5	20
PH 553	Advanced Topics in Solid State Physics	5	20
PH 554	Advanced Topics in Nanoscience	5	20
PH 555	Advanced Topics in Photonics	5	20
PH 556	Advanced Topics in Complex Systems in Physics	5	20
PH 557	Advanced Topics in Theoretical Physics	5	20
PH 558	Advanced Topics in Quantum Physics	5	20
PH 560	Advanced Electromagnetism and Plasma Physics	5	20

Curriculum (Part-time study)

12.17.12 Students studying on a part-time basis will normally take classes amounting to 60 credits in each year.

Progress

12.17.13 In order to progress to the second year of the course, a student must have accumulated at least 100 credits from the course curriculum.

12.17.14 In order to progress to the third year of the course, a student must have accumulated at least 220 credits from the course curriculum.

12.17.15 In order to progress to the fourth year of the course, a student must have accumulated at least 360 credits from the course curriculum.

12.17.16 In order to progress to the fifth year of the course, a student must have accumulated at least 480 credits from the course curriculum.

Progress (Part-time study)

12.17.17 Part-time students must satisfy the appropriate progress requirements following each period of 120 credits.

Final Assessment and Classification

12.17.18 On successful completion of the fourth year, a candidate will be awarded 120 Level 4 credits under the class code *PH 499.*

12.17.19 On successful completion of the fourth year, a candidate will be awarded 120 Level 4 credits under the class code *PH 599.*

12.17.20 The final classification for the degree of MPhys will normally be based on:

(i) the first assessed attempt at compulsory and specified optional classes at Levels 4 and 5;

(ii) if appropriate, an oral examination.

12.17.21 Notwithstanding Regulation 12.1.49 the degree in MPhys will be classified in accordance with Regulation 11.1.50.

Award

12.17.22 **MPhys**: In order to qualify for the award of the degree of MPhys in Physics, a candidate must have accumulated no fewer than 600 credits from the course curriculum.

12.17.23 **MPhys with Specialisation:** In order to qualify for the award of the degree of MPhys in Physics with Specialisation in a given topic a candidate must have undertaken *PH 450 Project* and *PH 550 Project* in an area related to the specialisation. In addition to the requirements of Regulation 12.17.21, a candidate must have undertaken 40 credits at Level 4 and 40 credits at Level 5 in subjects related to the specialisation.

Transfer

12.17.24 A student who fails to satisfy the progress or award requirements for the degree of MPhys may be transferred to the degree of BSc with Honours in Physics.

12.18
to 12.21 (Numbers not used.)

11.17 Department of Physics

Physics

BSc with Honours in Physics
BSc in Physics
Diploma of Higher Education in Physics
Certificate of Higher Education in Physics

Course Regulations

[These regulations are to be read in conjunction with Regulation 11.1]

Status of the Courses

11.17.1 All students are normally admitted in the first instance as potential Honours students. Transfer to the MPhys is possible at any time subject to satisfying the appropriate course requirements.

Mode of Study

11.17.2 The course is available by full-time and part-time study.

Curriculum (Full-time study)
First Year

11.17.3 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
PH 150	Experimental Physics	1	20
PH 151	Mechanics, Optics and Waves	1	20
PH 152	Quantum Physics and Electromagnetism	1	20
MM 111	Mathematics 1B	1	20
MM 112	Mathematics 2B	1	20
Elective Class(es)			20

Second Year

11.17.4 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes (all courses)		Level	Credits
PH 250	Experimental Physics	2	20
PH 251	Mechanics, Optics and Waves	2	20
PH 254	Computational Physics	2	20
PH 258	Condensed Matter Physics	2	10
PH 259	Gases and Liquids	2	10
Compulsory Classes (Honours Degree)			
MM 211	Mathematics 3B	2	20
PH 252	Quantum Physics and Electromagnetism	2	20
Compulsory Classes (Ordinary Degree)			
PH 257	Interactive Physics	2	20

and 20 credits chosen from Regulation 11.17.7 or such other classes as may be approved by the Adviser of Study

Third Year

11.17.5 All full-time students shall undertake classes amounting to 120 credits as follows:

PH 350	Experimental Physics	3	40
PH 355	Physics Skills	3	20
PH 358	Condensed Matter Physics	3	10
PH 359	Statistical Physics	3	10

and

for intending Honours students

either

MM 311	Mathematics 4B	3	20
PH 352	Quantum Physics and Electromagnetism	3	20

or

MM 211	Mathematics 3B	2	20
PH 252	Quantum Physics and Electromagnetism	2	20

for other students

either

PH 357	Interactive Physics	3	20

and 20 credits chosen from Regulation 11.17.7 or such other classes as may be approved by the Adviser of Study
Or

MM 211	Mathematics 3B	2	20
PH 252	Quantum Physics and Electromagnetism	2	20

A student with a pass in a class may substitute another class with the approval of the Adviser of Study.

Fourth Year

11.17.6 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
PH 499	Physics*	4	120

**PH 499* Physics comprises

PH 450	Project	4	40
PH 451	Physics Skills	4	20
and if not already taken			
PH 352	Quantum Physics and Electromagnetism	3	20

together with no fewer than 40 credits chosen from the following to bring the total studied a Level 4 to at least 100:

MM 311	Mathematics 4B	3	20
PH 452	Topics in Physics	4	20
PH 453	Topics in Solid State Physics	4	20
PH 454	Topics in Nanoscience	4	20
PH 455	Topics in Photonics	4	20
PH 456	Topics in Computational and Complex Systems in Physics	4	20
PH 457	Topics in Theoretical Physics	4	20
PH 458	Topics in Quantum Physics	4	20
PH 459	Topics in Atomic, Molecular and Nuclear Physics	4	20

Approved Optional Classes

11.17.7

		Level	Credits
PH 160	Introductory Astronomy	1	10
PH 161	Universe and Everything	1	10
PH 162	How Things Work	1	10
PH 163	Images	1	10
PH 164	Physics In the Open Air	1	10
PH 165	Engineering Physics	1	10
PH 166	Foundation Physics	1	20
PH 167	Physical Electronics	1	10
PH 168	Foundation Physics A	1	10
PH 169	Foundation Physics B	1	10
PH 170	All You Ever Wanted To Know About Physics But Were Too Afraid to Ask	1	20
PH 260	Physical Electronics	2	10

MM 211	Mathematics 3B	2	20
MM 311	Mathematics 4B	3	20

Such other classes as may be approved by the Course Director.

Curriculum (Part-time study)

11.17.8 Students studying on a part-time basis will normally take classes amounting to 60 credits in each year.

Progress (Full-time study)

11.17.9 In order to progress to the second year of the course, a student must have accumulated at least 100 credits from the course curriculum.

11.17.10 In order to progress to the third year of the course, a student must have accumulated at least 220 credits from the course curriculum.

11.17.11 In order to progress to the fourth year of the course, a student must have accumulated at least 360 credits from the course curriculum including 60 credits at Level 3 or above.

Progress (Part-time study)

11.17.12 Students studying on a part-time basis must satisfy the appropriate progress requirements following each period of 120 credits.

Final Assessment and Honours Classification

11.17.13 On successful completion of the fourth year, a candidate will be awarded 120 Level 4 credits under the class code *PH 499.*

11.17.14 The final Honours classification will normally be based on:

(i) the first assessed attempt at compulsory and optional Level 3 and Level 4 classes;

(ii) if appropriate, an oral examination.

Award

11.17.15 **BSc with Honours**: In order to qualify for the award of the degree of BSc with Honours in Physics a candidate must have accumulated no fewer than 480 credits from the course curriculum. Notwithstanding Regulation 11.1.10, these must include no fewer than 200 credits at Levels 3 and 4 with at least 100 credits at Level 4.

11.17.16 **BSc:** In order to qualify for the award of the degree of BSc in Physics a candidate must have accumulated no fewer than 360 credits from the course curriculum.

11.17.17 **Diploma of Higher Education:** In order to qualify for the award of a Diploma of Higher Education in Physics, a candidate must have accumulated no fewer than 240 credits from the course curriculum.

11.17.18 **Certificate of Higher Education:** In order to qualify for the award of a Certificate of Higher Education in Physics, a candidate must have accumulated no fewer than 120 credits from the course curriculum.

11.18 to 11.21 (Numbers not used)

Physics with Teaching

BSc with Honours in Physics with Teaching
BSc in Physics with Teaching

Course Regulations
[These regulations are to be read in conjunction with Regulation 11.1]

Status of the Courses

11.29.41 The courses are offered at Degree level only as four year (full-time) courses. All students are admitted in the first instance as Honours students. Transfer to the degree of BSc in Physics is possible at any time, subject to satisfying the appropriate progress regulations.

Mode of Study

11.29.42 The courses are available by both full-time and part-time study.

Place of Study

11.29.43 The School Experience classes will involve placements in schools. To be eligible to undertake school experience, a student must be a member of the PVG (Protecting Vulnerable Groups) Scheme or, if already a member, must apply for an update.

Curriculum (Full-time study)

The first and second year curricula are the same as that for the first and second years of the BSc in Physics.

First Year

11.29.44 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
PH 150	Experimental Physics	1	20
PH 151	Mechanics, Optics and Waves	1	20
PH 152	Quantum Physics and Electromagnetism	1	20
MM 111	Mathematics 1B	1	20
MM 112	Mathematics 2B	1	20

Elective Class(es) 20

Second Year

11.29.45 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
MM 211	Mathematics 3B	2	20
PH 250	Experimental Physics	2	20
PH 251	Mechanics, Optics and Waves	2	20
PH 252	Quantum Physics and Electromagnetism	2	20
PH 254	Computational Physics	2	20
PH 258	Condensed Matter Physics	2	10
PH 259	Gases and Liquids	2	10

A student with a pass in a class may substitute another class with the approval of the Adviser of Study.

Third Year

11.29.46 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
PH 352	Quantum Physics and Electromagnetism	3	20
PH 355	Physics Skills	3	20
PH 358	Condensed Matter Physics	3	10
PH 359	Statistical Physics	3	10
PH 360	Practical Physics	3	20
X9 406	Pedagogy and Placement Learning 1*	4	20
X9 494	Pedagogy and Curriculum Physics with Science 1	4	20

A student with a pass in a class may substitute another class with the approval of the Adviser of Study

*Induction Block (10 days), Serial Days (15 days), June Block (10 days)

Note: Education classes start in the last week of August, prior to the normal beginning of year 3.

Fourth Year

11.29.47 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
PH 460	Physics for Teaching*	4	40
X9 458	Educational Studies 1	4	20
X9 462	Educational Studies 2	4	20
X9 463	Pedagogy and Placement Learning 2**	4	20
X9 499	Pedagogy and Curriculum Physics with Science 2	4	20

*Physics for Teaching comprises

Either

PH 450	Project	4	40

Or

40 credits chosen from the optional Level 4 classes listed in Regulation 15.17.6 or as approved by the Adviser of Study

* Block Placement 1 – Feb/Mar (31 days) * Block Placement 2 – April/May (17 days) Note: Education classes start in the first week of October.

Curriculum (Part-time study)

11.29.48 Students studying on a part-time basis will normally take classes amounting to 60 credits in each year.

Progress (Full-time study)

11.29.49 In order to progress to the second year of the course, a student must have accumulated at least 100 credits from the course curriculum.

11.29.50 In order to progress to the third year of the course, a student must satisfy the requirements for entering Initial Teacher Education, be a member of the PVG (Protection Vulnerable Groups) Scheme or, if already a member, must apply for an update and have accumulated at least 220 credits from the course curriculum.

11.29.51 In order to progress to the fourth year of the Honours course, a student must normally have accumulated at least 360 credits from the course curriculum including 60 credits at Level 3 or above.

Progress (Part-time study)

11.29.52 Students studying on a part-time basis must satisfy the appropriate progress requirements following each period of 120 credits.

Final Honours Classification

11.29.53 The final Honours classification will normally be based on:

(i) the first assessed attempt at compulsory and optional Level 3 and Level 4classes*;*

(ii) if appropriate, an oral examination.

Award

11.29.54 **BSc with Honours**: In order to qualify for the award of the degree of BSc with Honours in Physics with Teaching a candidate must have accumulated no fewer than 480 credits from the course curriculum. Notwithstanding Regulation 11.1.10, these must include

(i) the credits for all the compulsory Level 4 Education classes taken individually;

(ii) no fewer than 200 credits at Levels 3 and 4 with at least 160 credits at Level 4.

11.29.55 **BSc:** In order to qualify for the award of the degree of BSc in Physics with Teaching a candidate must have accumulated no fewer than 440 credits from the course curriculum including the credits for all the compulsory Level 4 Education classes.

11.29.56 **Diploma of Higher Education:** In order to qualify for the award of a Diploma of Higher Education in Physics, a candidate must have accumulated no fewer than 240 credits from the course curriculum.

11.29.57 **Certificate of Higher Education:** In order to qualify for the award of a Certificate of Higher Education in Physics, a candidate must have accumulated no fewer than 120 credits from the course curriculum.

Transfer

11.29.58 A candidate who fails to satisfy the progress or award requirement for the degree of BSc with Honours in Physics with Teaching or the BSc in Physics with Teaching may be transferred to the degree of BSc in Physics.

11.29.59 to 11.29.60 (Numbers not used)

Mathematics and Physics

BSc with Honours in Mathematics and Physics
BSc in Mathematics and Physics
Diploma of Higher Education in Mathematics and Physics
Certificate of Higher Education in Mathematics and Physics

Course Regulations
[These regulations are to be read in conjunction with Regulation 11.1]

Status of the Courses

11.15.41 All students are normally admitted in the first instance as Honours students. Transfer to the BSc in Mathematics and Physics is possible at any time subject to satisfying the appropriate progress requirements.

Mode of Study

11.15.42 The courses are available by full-time and part-time study.

Curriculum (Full-time study)
First Year

11.15.43 All full-time students shall undertake classes amounting to 130 credits as follows:

Compulsory Classes		Level	Credits
MM 101	Introduction to Calculus	1	20
MM 102	Applications of Calculus	1	20
MM 103	Geometry and Algebra with Applications	1	20
PH 150	Experimental Physics	1	20
PH 151	Mechanics, Optics and Waves	1	20
PH 152	Quantum Physics and Electromagnetism	1	20
Elective Class			10

Second Year

11.15.44 All full-time students shall undertake classes amounting to 130 credits as follows:

Compulsory Classes		Level	Credits
MM 201	Linear Algebra and Differential Equations	2	20
MM 202	Advanced Calculus	2	20
MM 206	Mathematical and Statistical Computing	2	20
PH 251	Mechanics, Optics and Waves	2	20
PH 252	Quantum Physics and Electromagnetism	2	20
PH 253	Properties of Matter	2	20
Elective Class			10

Third Year

11.15.45 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Classes		Level	Credits
MM 300	Complex Variables and Integral Transforms	3	20
MM 302	Differential Equations	3	20
PH 352	Quantum Physics and Electromagnetism	3	20
PH 353	Properties of Matter	3	20

Optional Classes

40 credits chosen by Honours students from List A; and by other students from Lists A and B.

List A

MM 305	Mechanics of Rigid Bodies and Fluids	3	20
MM 306	Numerical Analysis	3	20
PH 355	Physics Skills	3	20

List B

PH 254	Computational Physics	2	20

Classes listed in Regulations 11.15.3 and 11.15.4 not previously taken, or further Elective Classes.

Fourth Year

11.15.46 All full-time students shall undertake classes amounting to 120 credits as follows:

Compulsory Class		Level	Credits
Mathematics and Physics			
MM 430	Mathematics and Physics*	4	120

* *MM 430 Mathematics and Physics* comprises a Project and Level 4 classes chosen from the lists below:

MM 401	Project	4	20
or			
PH 450	Project (Physics)	4	40

Optional Classes

Classes chosen from lists A and B so that the curriculum contains no fewer than 40 credits in each subject.

List A

MM 402	Mathematics 41	4	20
MM 403	Mathematics 42	4	20
MM 404	Mathematics 43	4	20
MM 405	Mathematics 44	4	20
MM 406	Mathematics 45	4	20

List B

PH 451	Topics in Physics	4	20
PH 452	Topics in Physics	4	20
PH 453	Topics in Solid State Physics	4	20
PH 454	Topics in Nanoscience	4	20
PH 455	Topics in Photonics	4	20
PH 456	Topics in Computational and Complex Systems in Physics	4	20
PH 457	Topics in Theoretical Physics	4	20
PH 458	Topics in Quantum Physics	4	20
PH 459	Topics in Atomic, Molecular and Nuclear Physics	4	20

Curriculum (Part-time study)

11.15.47 Students studying on a part-time basis will normally take classes amounting to 60/70 credits in each year.

Progress

11.15.48 In order to progress to the second year of the course, a student must have accumulated at least 100 credits from the course curriculum including those for the classes *MM 101 Introduction to Calculus* and *MM 102 Applications of Calculus*.

11.15.49 In order to progress to the third year of the course, a student must have accumulated at least 220 credits from the course curriculum including those for the class *MM 201 Linear Algebra and Differential Equations*.

11.15.50 In order to progress to the fourth year of the course, a student must have accumulated at least 360 credits from the course curriculum including 120 credits at Level 3 or above.

Progress (Part-time study)

11.15.51 Students studying on a part-time basis must satisfy the appropriate progress requirements following each period of 120/130 credits.

Final Assessment and Classification

11.15.52 On successful completion of the fourth year, a candidate will be awarded 120 Level 4 credits under the class code MM 430 Mathematics and Physics.

11.15.53 The final classification for the degree of BSc with Honours in Mathematics and Physics will normally be based on:

(i) the first assessed attempt at compulsory and specified optional classes at Levels 3 and 4 taken in the third and fourth years;

(ii) if appropriate, an oral examination.

Award

11.15.54 **BSc with Honours**: In order to qualify for the award of the degree of BSc with Honours in Mathematics and Physics, a candidate must have accumulated no fewer than 480 credits from the course curriculum. Notwithstanding Regulation 11.1.10, these must include no fewer than 120 credits at Level 4 or above.

11.15.55 **BSc:** In order to qualify for the award of the degree of BSc in Mathematics and Physics, a candidate must have accumulated no fewer than 360 credits from the course curriculum.

11.15.56 **Diploma of Higher Education:** In order to qualify for the award of a Diploma of Higher Education in Mathematics and Physics, a candidate must have accumulated no fewer than 240 credits from the course curriculum.

11.15.57 **Certificate of Higher Education:** In order to qualify for the award of a Certificate of Higher Education in Mathematics and Physics, a candidate must have accumulated no fewer than 120 credits from the course curriculum.

11.15.58 to 11.15.60 (Numbers not used)

APPENDIX 2

CLASS DESCRIPTORS

(Please Note: The staff listed on the following Class Descriptors may not be the class lecturer. Also the content and assessment details may vary as well.)

FACULTY OF SCIENCE
CLASS DESCRIPTOR

University of Strathclyde Science

PH 150 Experimental Physics

Class Code: PH 150		Class Name: Experimental Physics	
Type: Compulsory	Level: 1	Credits: 20	Semester: 1 and 2
Class Coordinator: Dr N. Langford		**Tel:** 3077 **Email:** n.langford@strath.ac.uk	
Teaching Staff: Dr N. Langford			
Pre-requisites: Higher Physics and Mathematics or equivalents			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
12		60	20	108	200

CLASS ASSESSMENT

Format: Continuous Assessment
1st Attempt: Laboratory work 50 %, Formal Report 50 %
Re-sit: Re-draft of Formal Report – Pass / Fail

GENERAL AIMS

An introduction to working in a laboratory environment where they will undertake experiments that are related to the taught components of the first year physics curriculum. Students will also learn how to handle experimental uncertainties. In addition to laboratory work student will also undertake a group project.

LEARNING OUTCOMES

At the end of the course students should be able to
1. Be able to keep a laboratory notebook.
2. Be able to write a Formal Report.
3. Be able to perform simple uncertainty analysis.
4. Be able to make dimensional analysis of physical systems.
5. Be able to design and perform simple experiments.

SYLLABUS

Lecture based material
- What is and why undertake an experiment; physical quantities; dimensional analysis; units of measurement; order of magnitude estimates; accuracy and precision; uncertainty analysis; use of Excel for determining uncertainties; report writing.

Laboratory based work
- Preliminary experiments to develop measurements skills / techniques – simple pendulum, viscosity of a fluid, RC time constant, use of Excel, density of steel.
- Advanced experiments to support 1st Year lecture material – magnetic induction, geometric optics, refraction, atomic spectroscopy, acoustic resonances, standing waves on a string, angular momentum, charge to mass ratio of an electron, dc circuits, Young's modulus.

RECOMMENDED TEXT / READING

Squires Practical Physics 4th Edition ISBN:-, Jewett and Serway; Physics for Scientists and Engineers with Modern Physics

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR PH 151 Mechanics, Optics and Waves

Class Code: PH 151		Class Name: Mechanics, Optics and Waves	
Type: Compulsory, Elective	Level: 1	Credits: 20	Semester: 1
Class Coordinator: Dr N. Langford		**Tel:** 3077 **Email:** n.langford@strath.ac.uk	
Teaching Staff: Dr N. Langford			
Pre-requisites: Higher Physics and Mathematics or equivalents			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24		24	104	200

CLASS ASSESSMENT

Format: Continuous and Examination
1st Attempt: Students will be awarded the credit for the class by either (a) performance at an approved standard in Class Tests or (b) taking the Written Examination
Break down of assessment:
By (a) Class Test 85 %, Homework 15 %
By (b) Examination 70 %, Class Test 15 %, Homework 15 %
Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

Provide students with an understanding of motion of simple mechanical systems, gravitation and simple harmonic motion. Students will also learn about the fundamentals of wave propagation and the superposition of waves as well simple optical phenomena such as diffraction.

LEARNING OUTCOMES

By the end of the course a student shall show
1. Ability to analysis the motion of a particle in two dimensions.
2. Ability to apply Newton's three laws to analysis bodies in different conditions.
3. Ability to explain difference between elastic and inelastic collisions.
4. Ability to address problems on conservation of linear momentum.
5. To understand circular motion .
6. State and apply Newton's Law of Gravity, determine gravitational field strength at a given point.
7. Know the difference between conservative and dissipative forces, work and power.
8. Ability to apply kinematic equations to angular motion and associated rotational forces.
9. To describe conditions necessary for a body to execute simple harmonic motion and determine displacement, velocity and acceleration of body.
10. Define a wave, differentiate between wave types .
11. Identify key parameters associated with harmonic / periodic waves and use different notations to describe wave.
12. Differentiate between travelling and standing waves and write down equations for each type of wave – identify conditions necessary for node and anti-nodes.
13. Understand difference between particle and wave velocity.
14. Explain reflection and transmission of mechanical waves at a boundary.
15. State and apply principle of linear superposition to waves – beats and interference.
16. Understand effect of relative motion between wave source and detector- Doppler Effect.
17. Understand and apply Huygens' Principle to reflection, refraction and diffraction.
18. Explain the concepts of critical angle and total internal reflection

SYLLABUS

Mechanics:

- Motion in 1 dimension: Definitions of velocity and acceleration, equations of motion for constant acceleration.
- Vectors: Addition of vectors, resolution into components, use of unit vectors. Vector multiplication, scalar and vector products.
- Motion in 2 dimensions: Motion in a plane, projectiles.
- Newton's Laws: Statements of Newton's three laws, equilibrium, statics and dynamics, friction forces.
- Linear momentum: Centre of mass, conservation of linear momentum. Impulse and momentum, elastic and inelastic collisions.
- Uniform circular motion: Angular speed, centripetal acceleration, examples of uniform circular motion.
- Work and Energy: Mechanical work, kinetic and potential energy. Conservative and dissipative forces. Gravitational and Elastic Potential Energy functions. Conservation of mechanical energy. Energy and Power.
- Gravitation: Newton's law of gravitation, gravitational field strength (g) and variation with altitude. Motion of satellites.
- Simple Harmonic Motion: Defining equation and its solution. Meaning of amplitude, angular frequency and phase constant. Forces producing simple harmonic motion.
- Rotational Mechanics: Angular velocity and angular acceleration. Kinematic equations for rotation with constant angular acceleration. Moment (Torque) of a force about a point and relationship to angular acceleration. Moment of inertia of systems of particles and rigid bodies. Rotational kinetic energy. Angular Momentum.

Waves

- Wave fundamentals**:** Definition of a wave. Types of wave Frames of reference, wave function $y(x,t) = f(x-vt)$, speed of wave, phase of wave.
- Periodic Waves. Definition of wavelength and period. Harmonic waves and ω-k notation, initial phase ϕ and phase differences. Difference between wave speed and particle speed. Particle velocity and acceleration. Wave speed on a string. Energy transport by a wave on a string.
- Principle of linear superposition. Reflection at free and fixed ends, reflections at interfaces. Resonant waves on strings and in open and closed pipes. Standing waves. Beats. Interference and coherence
- Waves in more than one dimension, circular and spherical waves, energy conservation in spherical waves. Huygens' Principle.

Optics:

- Idea of electromagnetic (em) waves. Speed of light in vacuum. Huygens ' Principle applied to reflection, refraction and diffraction. Laws of reflection. Diffuse and specular reflections.
- Images: Introduction to real and imaginary images and objects. Deviation introduced by reflection. Image formation in plane mirrors.
- Refraction in materials. Speed of light in a material. Snell's law. Deviation induced by refraction. Critical angle and total internal reflection. Optical fibres. Refraction in prisms. Minimum deviation in a prism.

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR PH 152 Quantum Physics and Electromagnetism		
Class Code: PH 152		Class Name: Quantum Physics and Electromagnetism	
Type: Compulsory, Elective	Level: 1	Credits: 20	Semester: 2
Class Coordinator: Dr N. Langford		**Tel:** 3077 **Email:** n.langford@strath.ac.uk	
Teaching Staff: Dr J. Jeffers			
Pre-requisites: Higher Physics and Mathematics or equivalents			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24		24	104	200

CLASS ASSESSMENT

Format: Continuous and Examination
1st Attempt: Students will be awarded the credit for the class by either (a) performance at an approved standard in Class Tests or (b) taking the Written Examination
Break down of assessment:
By (a) Class Test 85 %, Homework 15 %
By (b) Examination 70 %, Class Test 15 %, Homework 15 %
Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

A course designed to introduce students to quantum mechanics and electromagnetism. The course will highlight experimental observations that resulted in the development of quantum mechanics, such as the photoelectric effect and blackbody radiation. In terms of electromagnetism students will cover basic electrostatics such as Gauss's law and magnetostatics.

LEARNING OUTCOMES

1. Ability to define and apply Coulomb's Law to determine electrostatic force acting between charges.
2. Ability to determine electric field associated with charges.
3. Ability to describe and analyse motion of charges in electric fields.
4. Ability to find the electrostatic potential associated with a set of charges.
5. Know that capacitors store charge and how to analyse networks of capacitors.
6. Understand the difference between current and current density.
7. Be able to apply Ohm's Law and Kirchhoff's Rules to DC circuits.
8. Be able to determine the magnetic field for various systems and understand the motion of charged particles in a magnetic field.
9. Ability to determine force on a conductor and the torque on a current loop.
10. Understand photoelectric effect and determine stopping potential and work function.
11. Apply Bohr model of atom to obtain atomic energy levels and understand origin of spectral lines for atomic transitions.
12. Understand the origin of the Pauli Exclusion Principle and its consequences for atomic systems.
13. Understand wave-particle duality and apply Heisenberg's uncertainty principle.
14. Be able to determine nuclear binding energy.
15. Ability to explain difference between fusion and fission .
16. Ability to classify and distinguish between fundamental elementary particles.

SYLLABUS

Electromagnetism:

- Charge, electrostatic forces, Coulomb's Law. Electric field E, lines of force. Fields in conductors. Motion of free charges. Electric flux, Electric potential energy, electric potential V.
- Electric potential V for uniform electric fields and point charges. The electron volt. Equipotentials.
- Capacitance, series/parallel networks of capacitors, stored energy. Dielectrics, dielectric strength.
- DC Circuits: Electric current, current density. Resistivity, conductivity, temperature dependence, resistance, conductors, insulators. Ohm's Law. Electrical power and work. Conduction at an atomic level. Electromotive force, internal resistance. Kirchhoff’s Rules. Resistors in series and parallel, RC circuits. Instruments.
- Magnetism and Magnetic Effects: Magnetic field B, forces on charges and conductors. Force and torque on current loops; magnetic dipoles. Magnetic devices; mass spectrometer. Hall Effect. B for a long wire, solenoid, toroid, Forces between parallel wires.

Quantum Mechanics:

- Atomic & Quantum Physics: Blackbody radiation, light quanta and the photoelectric effect, atomic spectra, the Bohr model of the atom, lasers, electron diffraction, the wave equation and the Heisenberg uncertainty principle, Pauli exclusion principle.
- Nuclear Physics: Isotopes, binding energy and nuclear stability, radioactivity, carbon dating, nuclear reactions, fission and fusion, nuclear reactors.
- Elementary Particles: Forces of nature, quantum field theory, classification of particles. Properties of leptons, hadrons, baryons, fermions, bosons and quarks.

RECOMMENDED TEXT / READING

Jewett and Serway: Physics for Scientists and Engineers with Modern Physics

FACULTY OF SCIENCE CLASS DESCRIPTOR DEPARTMENT OF MATHEMATICS & STATISTICS			
Class Code: MM111		Class Title: Mathematics 1B	
Type: UG Elective	Level: 1	Credits: 20	Semester: 1
Class Coordinator: Prof I Osipov		Tel:	Email: i.w.stewart@strath.ac.uk
Teaching Staff: Prof I Stewart			
Pre-requisites: SQA Higher Mathematics (grade B) or equivalent			
Students: Chemical Engineering, Naval Arch & Marine Engineering, Physics			
Overlaps: MM110, MM113, MM115, MM116, MM117, MM101, MM103, MA101, MA102, MA108, MA11x			

CLASS DELIVERY (HOURS)

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24	0	36	92	200

CLASS ASSESSMENT

2 hour degree examination in January with August resit. Exemption from degree examination is possible based upon performance in class tests.

GENERAL AIMS

To give a basic understanding of the concepts and applications of mathematical functions, differentiation, integration and complex numbers.

LEARNING OUTCOMES

On completion of this class, the student should

- understand the concept of a mathematical function;
- be familiar with commonly occurring functions and their properties, and be able to manipulate and solve equations and inequalities involving them;
- know the factorial and binomial coefficient notation, and be able to use the binomial theorem;
- be able to differentiate functions, via combinations of the various differentiation rules;
- be able to locate and classify stationary points of a function of one variable;
- be able to integrate simple functions;
- be able to manipulate complex numbers in Cartesian, polar and exponential form;
- be able to use De Moivre's Theorem to find all zeros of a polynomial and obtain trigonometric identities.

SYLLABUS

Mathematical Foundations:
<u>Algebra</u> – mathematical notation, number sets and inequalities, basic operations (+,–,×,÷), modulus, factorial, indices, rules of precedence, use of brackets, expanding brackets, binomial expansion, simplifying algebraic expressions, factorisation, common denominators, cancelling common factors, proportionality, mathematical formulae and transposition, partial fractions.

<u>Functions</u> – basic concepts and notation, graphs, continuity and limits; composition of functions; inverses; linear and quadratic functions, completing the square; other commonly occurring functions (including polynomials, rational functions, exponentials, logarithms, hyperbolic functions, modulus); odd and even functions; periodic functions.
<u>Solving equations</u> – linear equations, quadratic equations, polynomial equations; simultaneous equations in two unknowns.
<u>Trigonometry</u> – definitions and graphs of sine, cosine and tangent; periodicity; radian measure;

definitions of sec, cosec and cot, and of inverse trigonometric functions; important trigonometric identities; solving trigonometric equations.

Introduction to Calculus:
Differentiation – definition of a derivative; notation; simple examples from first principles; graphical interpretation; stationary points; higher derivatives.
Standard derivatives – including x^a and trigonometric, exponential and natural log functions.
Rules of differentiation – linearity; product rule; quotient rule; chain rule.
Indefinite integration – reversing differentiation; standard integrals; linearity.
Definite integration – motivation: area under a curve; definition; the Fundamental Theorem of Calculus; finite and infinite limits.

Complex Numbers:
Algebra of complex numbers – motivation and definition of i; real and imaginary parts; arithmetic of complex numbers.
Polar and exponential forms – the Argand diagram; modulus and argument; polar form; Euler's formula; exponential form; products and quotients in exponential form.
De Moivre's Theorem – De Moivre's theorem; nth roots; solving polynomial equations; trigonometric identities.

Transferable Skills: See Level 1S spreadsheet for details.

RECOMMENDED TEXT / READING

** Croft, A. & Davison, R. *"Mathematics for Engineers, A Modern Interactive Approach"* 2nd Edition. (Pearson) ISBN: 013120193X.

FACULTY OF SCIENCE CLASS DESCRIPTOR DEPARTMENT OF MATHEMATICS & STATISTICS			
Class Code: MM112		Class Title: Mathematics 2B	
Type: UG Elective	Level: 1	Credits: 20	Semester: 2
Class Coordinator: Prof E Estrada		Tel: Email:	
Teaching Staff: Dr A. Sonnet; Prof N. Mottram; Dr G. Barrenechea			
Pre-requisites: MM111 or equivalent, MA111 or equivalent			
Students: Chemical Engineering, Naval Arch & Marine Engineering, Physics			
Overlaps: MM101, MM102, MM103, MM110, MM114, MM115, MM116, MM117, MA101, MA102, MA107, MA108, MA11x			

CLASS DELIVERY (HOURS)

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24	0	36	92	200

CLASS ASSESSMENT

2 hour degree examination in May/June with August resit. Exemption from degree examination is possible based upon performance in class tests.

GENERAL AIMS

To give a basic understanding of the concepts and applications of calculus, geometry, vectors, matrices and numerical methods.

LEARNING OUTCOMES

On completion of this class, the student should be
- able to differentiate functions defined either implicitly or parametrically;
- able to solve practical max/min problems;
- able to find definite and indefinite integrals using substitutions, partial fractions and integration by parts;
- able to use integration to calculate the area between two curves, volumes of solids of revolution, and lengths of planar curves;
- familiar with the equations of a straight line and a circle in 2 dimensions;
- familiar with the concept of a vector and the fundamental operations with vectors: addition, multiplication by a scalar, and scalar and vector products;
- able to find and use equations for lines and planes in 3 dimensions;
- able to carry out standard matrix operations;
- able to express systems of linear equations in matrix form, and to apply elementary row operations on the associated augmented matrix to find the solution of a given system;
- able to use the Trapezoidal/Simpson's Rule to approximate a definite integral;
- able to use Newton's method to find a root of a nonlinear equation (e.g. a polynomial or trig. equation).

SYLLABUS

Further Calculus:
Implicit differentiation – first derivatives and simple cases of second derivatives; derivatives of inverse trigonometric functions.
Parametric differentiation – first derivatives and simple cases of second derivatives.
Applications – graph sketching; optimisation problems; related rates of change; linear approximation and error analysis; simple Taylor and Maclaurin series.
Methods of integration – integration by substitution; integration by parts; integration using partial fractions; integrals of some trigonometric functions.
Applications – area between two curves; volumes of revolution about x and y axes; arc length of a plane curve.

Geometry and Vectors:
2-D geometry – Cartesian coordinates and polar coordinates; distance formula; equations of lines and circles; intersection of lines.
Vectors – motivation: quantities having magnitude and direction, e.g. force, velocity, displacement, etc; vectors as directed line segments; vector algebra; orthogonal unit vectors; representation of vectors as number triples; scalar and vector products, with applications.
3-D geometry – equation of a line through two points or through a point in a given direction; intersection of lines; equation of a plane through three points or through a point with a given normal vector; intersection of a line and a plane.

Matrices and Systems of Linear Equations:
Matrix algebra – definitions, notation, and some special matrices; multiplication by a constant; addition of matrices; matrix multiplication.
Matrix inverse – definition of the inverse of a square matrix, examples; the inverse of a 2×2 matrix; singular and non-singular matrices.
Linear equations – representation of a system of linear equations in matrix form.
Solution of systems of linear equations – Augmented matrix for n equations in n unknowns; reduction to triangular form using elementary row operations; unique solution, non-uniqueness and inconsistency.

Numerical Methods:
Numerical integration – Trapezoidal rule, Simpson's Rule.
Numerical solution of non-linear equations – Newton's method.

Transferable Skills: See Level 1S spreadsheet for details.

RECOMMENDED TEXT / READING

** Croft, A. & Davison, R. *"Mathematics for Engineers, A Modern Interactive Approach"* 2nd Edition. (Pearson) ISBN: 013120193X.

FACULTY OF SCIENCE
CLASS DESCRIPTOR

Class Code: PH 250		Class Name: Experimental Physics	
Type: Compulsory	Level: 2	Credits: 20	Semester: 1 and 2
Class Coordinator: Dr T. Han		**Tel:** 3267 **Email:** t.han@strath.ac.uk	
Teaching Staff: Dr T. Han			
Pre-requisites: PH 150 Experimental Physics, PH 151 Mechanics, Optics and Waves, PH 152 Quantum Physics and Electromagnetism or equivalent classes			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
10	0	80	20	90	200

CLASS ASSESSMENT

Continuous assessment

GENERAL AIMS

An extension of the first year class PH150 where students will undertake more complex experiments that are related to the taught components of the second year curriculum. Students will see the statistical origin for experimental uncertainties.

LEARNING OUTCOMES

By the end of the course students will be able to
1. Understand the operation of basic electronic components
2. Undertake detailed uncertainty analysis in relation to measurements made
3. Write a detailed lab report
4. Keep a laboratory notebook

SYLLABUS

Introduction to basic electronics
Introduction to uncertainty analysis
Assorted experiments related to lecture material delivered in 2nd year taught courses

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR		
Class Code: PH 251		**Class Name:** Mechanics, Optics and Waves	
Type: Compulsory	Level: 2	Credits: 20	Semester: 1
Class Coordinator: Dr T. Han		**Tel:** 3267 **Email:** t.han@strath.ac.uk	
Teaching Staff: Dr T. Ackemann, Dr D. McKee			
Pre-requisites: PH 151 Mechanics Optics and Waves, MM 111 Mathematics 1B, MM112 Mathematics 2B or Advanced Higher Physics and Mathematics or equivalent.			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24	0	0	128	200

CLASS ASSESSMENT

Format: Continuous and Examination
1st Attempt: Students will be awarded the credit for the class taking the Written Examination
Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

This class builds on the first year class PH151. Student will be introduced to special relativity, the vector treatment of rotational motion and the behaviour of systems when forced to oscillate. To extend their understanding of wave phenomena students will be introduced to the wave equation, Fresnel and Fraunhofer diffraction and the operation of lasers.

LEARNING OUTCOMES

By the end of the course a student shall;

- Be able to transform the motion of a body from one inertial frame of reference to another.
- Understand the difference between inertial and non-inertial frames of reference.
- Explain the relationship between conservative forces and potential energy and energy diagrams.
- Describe the motion of a system of particles by its centre of mass.
- Describe rotational dynamics in vector notation.
- Be able to quantify the motion of forced and damped harmonic oscillators.
- Understand key concepts associated with special relativity.
- Explain the difference between waves and photons.
- Understand the nature of different light sources.
- Analysis the imaging properties of simple and complex optical systems.
- Use the wave equation to describe the propagation of spherical and plane waves.
- Understand the difference between phase and group velocity.
- Describe diffraction and explain difference between Fraunhofer and Fresnel diffraction.
- Be able to use phase amplitude and complex amplitudes to describe diffraction and interference.
- Understand the difference between amplitude and wavefront splitting interference.
- Understand basic interactions between light and matter.
- Understand the basic operation of lasers.

SYLLABUS

Mechanics: Inertial reference frames, Relative velocities, Galilean transformation, Non uniform circular motion, Motion in resistive media, Non-inertial frames, Work-energy in 3D, Conservative forces and potential energy, Conservative forces and potential function, Energy diagrams,

Gravitational Potential energy, escape speed. Motion of Centre of Mass, Kinetic Energy of a system of particles, System of variable mass, Vector nature of Angular velocity, The torque vector, Angular Momentum, Rotational dynamics, Conservation of Angular Momentum, Spin and orbital Angular Momentum, Gravitation and the continuous distribution of mass, Pendulums, Damped oscillations, Forced oscillations; Special relativity. The Michelson-Morley experiment, Relativity of simultaneity, Time dilation, Length contraction, The relativistic Doppler effect, The twin paradox, The Lorentz Transformations, The addition of velocities, Momentum and energy.
Optics: The Nature Of Light; Historical Developments; Waves And Photons; The Electromagnetic Spectrum. Light Sources And Illumination: Radiometry And Photometry; Blackbody Radiation; Sources of Light. Geometrical Optics: Light Rays; Reflection And Refraction; Imaging properties of Lenses And Mirrors, linear and angular magnification; Optical Instruments: Camera; Projector; Eye; Compound Microscope; Telescopes;

Waves: Mathematical Description; Wave Equation; Plane Waves; Spherical Waves; Superposition of Waves; Phase And Group Velocities; Electromagnetic Waves. Diffraction: Fraunhofer And Fresnel Diffraction; Single Slit Diffraction; Huygens' Principle; Use Of Phase-Amplitude Diagrams (Phasors) And Complex Amplitudes; Circular Apertures; Rayleigh Criterion. Interference By Division Of Wavefront: Young's Double Slit Experiment And Variations; Diffraction Grating; Grating Resolving Power. Interference By Division Of Amplitude: Thin Film Interference; Newton's Rings; Thin Film Coatings - Antireflection And High Reflectance; Interferometers - Michelson, Mach-Zendar, Fabry-Perot; Applications Of Interferometers; Holography; Coherence. Light-Matter Interactions: Transitions, Light Absorption And Emission; Luminescence; Spontaneous And Stimulated Emission; Laser Operation; Laser Types And Parameters.

University of Strathclyde Science

FACULTY OF SCIENCE
CLASS DESCRIPTOR

Class Code: PH 252		**Class Name:** Quantum Physics and Electromagnetism	
Type: Compulsory	Level: 2	Credits: 20	Semester: 1
Class Coordinator: Dr T. Han		**Tel:** 3267 **Email:** t.han@strath.ac.uk	
Teaching Staff: Dr A. Arnold			
Pre-requisites: PH 152 Quantum Physics and Electromagnetism, MM111 Mathematics 1B, MM112 Mathematics 2B or Advanced Higher Physics and Mathematics or equivalent.			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24	0	0	128	200

CLASS ASSESSMENT

Format: Continuous and Examination
1st Attempt: Students will be awarded the credit for the class by taking the Written Examination
Break down of assessment:
Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

The class builds on the foundations established in PH152. Students will be introduced to the probabilistic nature of quantum mechanics. In addition students will develop a vector model of electromagnetism.

LEARNING OUTCOMES

By the end of the course a student shall;

- Understand why classical physics breaks down and the need for quantum physics
- Explain what is meant by a wavefunction and be aware that a wavefunction can be represented as a linear superposition of wavefunctions
- Discuss the physical significance of a normalised wavefunction and orthogonal wavefunctions as well as determine whether a wavefunction is normalised
- Understand and explain what is meant by the terms an observable and an operator.
- Relate position to momentum
- Be able to explain the terms expectation value, variance and uncertainty as applied to a wavefunction and for a given wavefunction determine the expectation value, variance and uncertainty in both real and momentum space.
- Explain the physical significance of the Schoedinger equation and apply this equation to specific potential energy distributions such as an infinite potential well, a potential step, a potential barrier and a harmonic potential
- Understand and be able to use vector calculus together with the grad, div and curl operators
- Use Gauss' law to determine electric fields from given charge distributions
- Understand AC theory with reference to inductors, capacitors and resistors and be able to analysis the performance of circuits containing these components.
- Use Ampere's and Biot-Savart's law to determine the magnetic induction for different shaped conductors
- Describe the operation of motors and generators in relation to Faraday's and Lenz's laws
- Understand the origin of the Maxwell Equations which lead to the theory of plane electromagnetic waves in a vacuum.

SYLLABUS

Quantum Physics: A review of classical physics outlining how classical physics breaks down. Planck's quantum hypothesis, Wave particle duality and Heisenberg uncertainty principle. Wave mechanics and its probability interpretation. Observables and operators, expectation values and uncertainty.
Electromagnetism: The class covers the vector treatment of electricity and magnetism building towards Maxwell's equations by the end of the class.
Vector calculus, the grad, div and curl operators, line, surface and volume integrals are introduced progressively when needed in construction of the electromagnetic theory. The course also covers motors and generators, and the distribution of electricity and utility of the 3-phase system. AC theory follows, covering inductors, capacitors, LRC circuits, resonance, transients and coupled circuits.
Finally the four Maxwell equations are developed from more elementary roots such as the Gauss and Faraday Laws, leading to the development of the theory of the plane electromagnetic wave in vacuum.

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR		
Department of Physics			
Class Code: PH 254		**Class Name:** Computational Physics	
Type: Compulsory	Level: 2	Credits: 20	Semester: 1 and 2
Class Coordinator: Dr T. Han		**Tel:** 3267 **Email:** t.han@strath.ac.uk	
Teaching Staff: Prof. G. L. Oppo			
Pre-requisites: PH 151 Mechanics, Optics and Waves, PH 152 Quantum Physics and Electromagnetism, MM111 Mathematics 1b, MM112 Mathematics 2b or Advanced Higher Physics and Mathematics or equivalent.			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	0	72	0	104	200

CLASS ASSESSMENT

Format: Continuous and computing lab – based examination
1st Attempt: 50 % continuous based on practical work, 50 % Examination.
Re-sit: Re-submission of laboratory work and re-sit lab-based exam

GENERAL AIMS

This course is designed to introduce students to the fundamentals of computer programming and the applications of computer programming, using Matlab, to solve physical problems.

LEARNING OUTCOMES

By the end of the course a student shall;

- Understand the basic constructs of programming including data types, decision making, loops, input and output of data.
- Be able to write simple programs in a selection of languages – Matlab, Labview and Fortran.
- Develop or use supplied routines to carry out specific computational tasks such as numerical integration, solving ODEs and PDEs, finding eigenvalues, interfacing equipment to computers.
- Have an understanding of curve fitting to data.

SYLLABUS

Data types – how data is stored and handled by computers, precision and rounding errors, simple and complex (arrays, structures, objects) data types.
Program structure – logical flow of a program; defining data types; decision making – if, if-else type statements; loops – if, while, do-while; functions; input and output of data. These will all be taught with reference to a variety of languages.
Programming tools – use of standard algorithms such as Runge-Kutta, cubic spline, integration and interpolation routines.

University of Strathclyde Science	**FACULTY OF SCIENCE** **CLASS DESCRIPTOR**

Class Code: **PH 258**		**Class Name:** Condensed Matter Physics	
Type: Compulsory	**Level:** 2	**Credits:** 10	**Semester:** 1
Class Coordinator: Dr T. Han		**Tel:**	**Email:** t.han@strath.ac.uk
Teaching Staff: Dr C Trager Cowan			
Pre-requisites: PH 152 Quantum Physics and Electromagnetism, MM 111 Mathematics 1b, MM111 Mathematics 2b or Advanced Higher Physics and Mathematics or equivalent.			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	12	0	0	64	100

CLASS ASSESSMENT

Format: Examination

1st Attempt: Students will be awarded the credit for the class by taking the Written Examination

Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

An introduction to solid state physics covering topics such as bonding in solids, through to the difference between conductors, insulators and semi-conductors.

LEARNING OUTCOMES

By the end of the course a student shall;

- Understand origin and nature of bonds in solids.
- Use key constructs to describe different types of crystal structure.
- Explain how crystal structure leads to band formation.
- Describe how bands affect properties of a crystal.
- Understand difference between conductor, insulator and semiconductor.
- Have a qualitative understanding of doping.

SYLLABUS

Bonding – necessary forces and types of bond; Crystal structure – Bravais lattice, basis, unit cell, types of unit cell, lattice types, Miller indices, reciprocal lattice, techniques for analyzing crystal structure; Consequences of crystal structure – band formation, conduction and valence bands, band gap, Fermi level, optical – absorption, emission, photoconductivity, electrical – insulators, conductors and semiconductors, and magnetic properties. Intrinsic and extrinsic materials. Bulk material properties – density, stress and strain, elastic and plastic behaviour, elastic moduli, thermal expansion. Heat flow – conduction, convection and radiation, specific and latent heat. Black body radiation, Stefan and Wien's law.

RECOMMENDED TEXT / READING

Recommended text(s):

DATE MODIFIED

25th June 2013 by N. Langford

University of Strathclyde Science	**FACULTY OF SCIENCE** **CLASS DESCRIPTOR**

Class Code: **PH 259**		**Class Name:** Gases and Liquids		
Type: Compulsory	**Level:** 2	**Credits:** 10		**Semester:** 1
Class Coordinator: Dr T. Han		**Tel:**	**Email:** t.han@strath.ac.uk	
Teaching Staff: Dr B W J McNeil				
Pre-requisites: PH 152 Quantum Physics and Electromagnetism, MM 111 Mathematics 1b, MM111 Mathematics 2b or Advanced Higher Physics and Mathematics or equivalent.				

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	12	0	0	64	100

CLASS ASSESSMENT

Format: Continuous and Examination

1st Attempt: Students will be awarded the credit for the class by taking the Written Examination

Break down of assessment:

Examination 100 %

Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

This course will introduce students to some of the key concepts associated with liquids and gases. Students will cover topics such as ideal and imperfect gases, Maxwellian distributions, hydrostatics and Bernoulli's equation.

LEARNING OUTCOMES

By the end of the course a student shall;

- Use the ideal gas law and extend to imperfect gases.
- Understand difference between isothermal and adiabatic processes.
- Explain the Carnot cycle and relate to heat engines.
- Be able to apply the laws of thermodynamics.
- Describe pressure in terms of molecular motion.
- Be aware of and be able to apply Maxwellian distribution functions.
- Understand the idea of mean free path and how it influences transport coefficients.
- Understand change of state
- Be aware of basis physics associated with hydrostatics
- Have a basic understanding of key concepts relating to fluid flow.
- Be able to tackle problems relating to Bernoulli's equation.

SYLLABUS

Gases: Ideal gas law, temperature and temperature scales, molecular interpretation of temperature, isothermal and adiabatic processes, work done by gas, Carnot cycle, heat engines, internal energy and degrees of freedom, heat capacities, laws of thermodynamics, entropy and disorder, free energies. Imperfect gases –Van der Waal's equation, changes of state, Maxwellian distribution functions, molecular flux, mean free path, transport coefficients of a gas – viscosity, diffusion, thermal conductivity,

Liquids: Hydrostatics – pressure as a function of depth, absolute and gauge pressure, Pascal's principle and applications, Archimedes' principle. Fluid dynamics – viscosity, fluid elements, flow line, streamline, ideal fluid. Mass and volume continuity equations, Bernoulli's equation and applications.

FACULTY OF SCIENCE
CLASS DESCRIPTOR

DEPARTMENT OF MATHEMATICS & STATISTICS

Class Code: MM211		Class Title: Mathematics 3B	
Type: UG Elective	Level: 2	Credits: 20	Semester: 1 and 2
Class Coordinator: Dr. C. Macdonald		**Tel:3658Email:** calum.a.macdonald@strath.ac.uk	
Teaching Staff: Dr. G. McKay			
Pre-requisites: MM111 and MM112, or MM113 and MM114, or equivalent			
Students: Chemical Engineering, Naval Arch & Marine Engineering, Physics			
Overlaps: MM213, MM215, MM217, MM201, MM202, ME209, MA200, MA201, MA206, MA208, MA211, MA212, MA215			

CLASS DELIVERY (HOURS)

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24	0	36	92	200

CLASS ASSESSMENT

2-hour degree examinations in January and May/June with August resit.

GENERAL AIMS

To develop the means of solving certain differential equations, to consider applications of Taylor and Maclaurin series, to generalize earlier ideas in calculus to deal with functions of several variables, to discuss in more detail matrices, determinants and functions of a complex variable, and to introduce vector calculus and eigenvalues/eigenvectors.

LEARNING OUTCOMES

On completion of this class, the student should be able to

- use tables of integrals;
- solve commonly occurring 1st and 2nd-order ordinary differential equations;
- understand the use of Taylor and Maclaurin series to approximate a given function;
- differentiate a function of several variables;
- find and classify stationary points of a function of two variables;
- perform double integrations over simple domains, in Cartesian or polar coordinates;
- manipulate elementary functions of a complex variable and solve second-order ordinary differential equations with constant coefficients;
- solve linear systems of algebraic equations and calculate the inverse of a matrix;
- compute the eigenvalues and eigenvectors of a matrix, and solve linear systems of constant-coefficient ordinary differential equations with simple associated eigenvalues;
- compute triple scalar and vector products, differentiate vector functions of one real variable, use the basic differential operators of vector calculus;
- relate the mathematics to appropriate applications.

SYLLABUS

Integration:
Use of integral tables and substitution to evaluate one-dimensional integrals.
Ordinary Differential Equations:
Methods of solution of important classes of ODEs (including first-order separable, linear and homogeneous ODEs, and second-order linear constant coefficient ODEs with standard forcing

functions); applications.

Partial Differentiation:
First and second derivatives, total differential, small errors, differentiation in a given direction, chain rule, implicit functions, stationary points. Indication of extension to functions of more than two variables.
Taylor and Maclaurin Series:
Notion of power series (briefly); statement of Taylor and Maclaurin theorems; applications.
Double Integration:
Interpretation of a double integral; evaluation; change of variable from Cartesian to polar coordinates; applications.
Complex Variables:
Revision of complex numbers; functions of a complex variable; use in solving second-order linear ODEs with more complicated forcing functions; other applications.
Matrices:
Revision; solution of linear systems of algebraic equations by elementary row operations; matrix inverse; determinants; eigenvalues and eigenvectors; diagonalization; applications.
Vectors:
Revision; triple products; vector functions; differentiation of vector functions; scalar and vector fields; grad, div, curl, Laplacian.
Linear Systems of Ordinary Differential Equations:
Solution of systems of ODEs by matrix methods.

Transferable Skills: See Level 2S spreadsheet for details.

RECOMMENDED TEXT / READING

* Jordan, D.W. & Smith, P. "Mathematical Techniques, An Introduction for the Engineering, Physical and *Mathematical Sciences"* (Oxford). D515 JOR, ISBN: 0198564619 .
* Kreyszig, E. *"Advanced Engineering Mathematics"* (Wiley). D510.2462 KRE, ISBN: 047133328X.
* Stroud, K.A. *"Engineering Mathematics"* (Macmillan). D510.2462 STR, ISBN: 0333620224.
* Kovach, L.D. *"Advanced Engineering Mathematics"* (Addison Wesley). D510.2462 KOV, ISBN: 0201103400.

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR

Class Code: PH 350		Class Name: Experimental Physics	
Type: Compulsory	Level: 3	Credits: 40	Semester: 1 and 2
Class Coordinator: Dr C. Trager-Cowan		**Tel:** 3465 **Email:** c.trager-cowan@strath.ac.uk	
Teaching Staff: Dr C. Trager-Cowan, Dr N. Lockerbie			
Pre-requisites: PH 250 Experimental Physics, PH 251 Mechanics, Optics and Waves, PH 252 Quantum Physics and Electromagnetism, PH 253 Properties of Matter			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	0	200	76	100	400

CLASS ASSESSMENT

Examination and Continuous assessment
12.5 % Class Test and 87.5 % continuous assessment
Re-submission of continuous assessment

GENERAL AIMS

This class extends the laboratory developed in PH150 and PH250. In this class the laboratory work is open ended with students able to fully explore the experiments in preparation for the final year project.

LEARNING OUTCOMES

By the end of the course students will be able to
1. Understand the operation of basic electronic components
2. Be able to build and characterise simple electronic systems
3. Undertake open ended laboratory work

SYLLABUS

The aim of the class is twofold - to describe the principles of electronic circuits which are widely used in physics laboratories showing how simple circuits can be designed and constructed in the laboratory and to introduce students to open-ended practical work in the laboratory conveying the basic skills of instrument handling and report-writing. Students are required to complete experiments selected from a range of topics that are covered in the 3rd year curriculum.
The electronics practical are supported by a series of lectures that cover: Analogue Electronics. Revision of previous work, input and output resistance, RC circuits, Laplace transform methods, the npn transistor and its use as a current source, an ac amplifier, and in a two stage amplifier. Digital Electronics. Combinational and sequential logic: logic gates with practical examples, flip-flop circuits, Boolean algebra, multiplexing, encoding and decoding, microprocessor systems.
Operational amplifiers, circuit analysis and applications as current source or amplifier. Transducers and their applications. A laboratory project involving the design and construction of an electronic circuit forms a part of the class.

FACULTY OF SCIENCE CLASS DESCRIPTOR Quantum Physics and Electromagnetism			
Class Code: PH 352		**Class Name:** Quantum Physics and Electromagnetism	
Type: Compulsory	Level: 3	Credits: 20	Semester: 1
Class Coordinator: Dr N. Langford		**Tel:** 3077 **Email:** n.langford@strath.ac.uk	
Teaching Staff: Prof S. M. Barnett, Prof G-L Oppo, Dr S. Virmani			
Pre-requisites: PH 252 Quantum Physics and Electromagnetism, MM 211 Mathematics 3B			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24	0	0	128	200

CLASS ASSESSMENT

Format: Examination
1st Attempt: Students will be awarded the credit for the class by performance at an approved standard in the Written Examination
Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

A course that builds on the material covered in PH252 extending a students understanding of quantum mechanics by introducing advanced concepts such as time independent perturbation theory and electromagnetism by exploring the wave like nature of electromagnetism as predicted by Maxwell's equations.

LEARNING OUTCOMES

By the end of the course a student shall;

- Determine the expectation value for a wavefunction
- Understand commutators and be able to derive specific relationships using commutators
- Explain the significance of raising and lowering operators and apply these operators to specific systems such as the harmonic oscillator
- Describe wavefunctions in terms of spherical harmonics
- Discuss the physical significance of the Stern-Gerlach experiment
- Understand spin and spin statistics. Explain the difference between Bosons and Fermions and discuss the significance of the Pauli principle and how it leads to the periodic table
- Understand the basic concepts of time independent and time dependent perturbation theory
- Be able describe a transverse electromagnetic (TEM) waves and explain the significance of the mode indices
- Be able to analysis the propagation of TEM waves in vacuum and dielectric materials
- Use the Poynting vector to describe energy flow
- Understand the concepts of radiation pressure and momentum
- Understand the significance of the complex propagation constant and use it to determine the skin-depth of a conducting material
- Explain the significance of the conservation of both electric and magnetic field at a boundary between non-conducting dielectrics.
- Use the boundary conditions to determine reflection and transmission coefficients with electric field perpendicular and parallel to the plane of incidence.
- Outline the origin of total internal reflection.
- Describe the propagation of electromagnetic waves in waveguide structures
- Determine the cut-off frequency for waveguide structures

- Explain the origin of radiation from moving charges and apply this concept to different types of dipole oscillator
- Be able to determine how antenna detect radiation.

SYLLABUS

Quantum Physics: Brief revision of quantum physics delivered in PH 252. Operators, expectation values and commutation relationships. Harmonic oscillator and raising and lowering operators, energy spectrum and probability densities. Angular momentum operators, spherical harmonics. Hydrogen atom and quantum numbers. Stern-Gerlach Experiment, electron spin. Identical particles – Bosons and Fermions, Pauli exclusion principle. Time-independent perturbation theory. Time-dependent quantum mechanics, Schrodinger and Heisenberg pictures, time-dependent perturbations and Fermi's Golden Rule.
Electromagnetism: Brief revision of electromagnetism delivered in PH 252. Transverse electromagnetic waves in free space and dielectrics. Dispersion and complex propagation constant. Attenuation and skin-depth in conducting media. Boundary conditions at interfaces – reflection and transmission coefficients, Snell's law and refraction. Total internal reflection. Waveguides and waveguide dispersion and cut-off. Plane waves using scalar and vector potentials. Faraday's law in a moving frame of reference. Poynting vector and energy flux for an em wave. Characteristic impedance, radiation pressure and momentum. Retarded potentials. Radiation from accelerated charges, short electric dipole and half-wave electric dipole. Radiated power. Antennas – dipole antenna, phased arrays, gain and antenna paramenters.

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR

Class Code: PH 355		**Class Name:** Physics Skills	
Type: Compulsory	Level: 3	Credits: 20	Semester: 1 and 2
Class Coordinator: Dr H J Fraser		**Tel:** 3420 **Email:** h.fraser@phys.strath.ac.uk	
Teaching Staff: Prof S. Kuhn, Dr H. Fraser, Dr S. Virmani			
Pre-requisites: PH 151, PH 152, PH 251, PH 252, PH 253, MM 111, MM 112, MM211.			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	12	0	64	100	200

CLASS ASSESSMENT

Format: Continuous and Examination
1st Attempt: 60 % Continuous Assessment, 40 % Examination
Re-sit: 50 % Examination, reattempt original examination, plus 50 % resubmitted written-only assignments from continually assessed part of course.

GENERAL AIMS

This class will develop a student's knowledge base and transferable skills in preparation for the project undertaken in 4th and 5th year of the course; focusing on oral, written and graphical presentations, literature and group-work skills, individual data analysis and interpretation skills, and basic grounding in physics problem solving

LEARNING OUTCOMES

By the end of the course a student shall;

- Be aware of the requirements for effective group / team work
- Be able to complete a literature survey
- Be aware of different referencing systems and aware of the pitfalls of web-based referencing
- Be able to prepare and deliver a poster presentation
- Develop and give an oral presentation using computer based presentation software
- Be able to undertake scientific analysis and dissemination of data at the forefront of Physics today
- Demonstrate problem solving skills as applied to material seen in the first three years of the course

SYLLABUS

Research Project preparation:- library skills; literature searches, electronic articles, researching a topic via the literature; assessing and delivering an oral presentation, poster presentations, brainstorming, understanding the structure and research remit of the Department of Physics, choosing and researching a BSc, MSci project. A literature survey will be undertaken between Nov – Jan in the students chosen preferential area of research for the following year, and a 15 minute oral presentation on the same subject area assessed during January exam diet. Given the nature of the group work and continual assessment, attendance at the lectures is compulsory and together with homework counts 5 % towards the final exam mark.

Problem solving: Problem based tutorials which address application of 1st and 2nd year physics to problems seen in both science and technology. Attendance at tutorials is compulsory, as is homework which must be submitted on a weekly basis. Participation and homework contribute 5 % to the final exam mark.

RECOMMENDED TEXT / READING

For Problem Based Learning: Benson University Physics (Wiley)

University of Strathclyde Science	**FACULTY OF SCIENCE** **CLASS DESCRIPTOR**

Class Code: PH 358		**Class Name:** Condensed Matter Physics	
Type: Compulsory	**Level:** 3	**Credits:** 10	**Semester:** 2
Class Coordinator: Dr N. Langford		**Tel:** 3077	**Email:** n.langford@strath.ac.uk
Teaching Staff: Prof. K. P. O'Donnell			
Pre-requisites: PH 252 Quantum Physics and Electromagnetism, PH 253 Properties of Matter, MM 211 Mathematics 3B			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	12	0	0	64	100

CLASS ASSESSMENT

Format: Continuous and Examination

1st Attempt: Students will be awarded the credit for the class by taking the Written Examination

Break down of assessment:

Examination 85 %, Homework 15 %

Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

A course that covers condensed matter physics introducing students to concepts such as the Fermi surface, superconductors, phonons and other forms of collective excitations.

LEARNING OUTCOMES

By the end of the course a student shall be able to;

- Understand why solids form crystals
- Explain the connection between atomic bonding and band theory
- Understand the concept and use of reciprocal lattices
- Explain electrical behaviour of different materials
- Show a quantitative understanding of semiconductor doping
- Describe the thermal properties of solids in terms of the phonon
- Describe optical processes in solids in a semi-classical model

SYLLABUS

Solids: Electrical properties of solids. Bonds and bands: metals, semiconductors and insulators. Reciprocal lattice and Brillouin zones. Bloch theorem and Kronig-Penney model, Nearly free electrons, Ziman and Feynmann (tight-binding) models of band structure. Dispersion relations, phase and group velocity. Fermi energy and density of states. Intrinsic and extrinsic semiconductors – electrons and holes. **Thermal properties** of solids– Einstein and Debye models of specific heat capacity, phonons. **Optical properties** of solids – photons, light absorption and emission processes, Einstein coefficients, oscillator strength and cross-section. Stimulated emission. **Materials Characterisation**: X-ray diffraction, Hall and Seebeck effects, spectroscopic techniques.

RECOMMENDED TEXT / READING

Recommended text(s):

Solids: Introduction to Solid State Physics by Charles Kittel

http://eu.wiley.com/WileyCDA/WileyTitle/productCd-EHEP000803.html

Solid State Physics by Ashcroft and Mermin

FACULTY OF SCIENCE

CLASS DESCRIPTOR

Class Code: **PH 359**		**Class Name:** Statistical Physics	
Type: Compulsory	**Level:** 3	**Credits:** 10	**Semester:** 2
Class Coordinator: Dr N. Langford		**Tel:** 3077 **Email:** n.langford@strath.ac.uk	
Teaching Staff: Dr B. McNeil			
Pre-requisites: PH 252 Quantum Physics and Electromagnetism, PH 259 Gases and Liquids, MM 211 Mathematics 3B			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	12	0	0	64	100

CLASS ASSESSMENT

Format: Continuous and Examination

1st Attempt: Students will be awarded the credit for the class by taking the Written Examination

Break down of assessment:

Examination 85 %, Homework 15 %

Re-sit: Re-working of 1st attempt examination Pass / Fail

GENERAL AIMS

A class that covers the fundamentals of thermodynamics through to an introduction to various distributions such as Maxwellian, Fermi-Dirac and Bose-Einstein.

LEARNING OUTCOMES

By the end of the course a student shall be able to

Solve problems relating to statistical mechanics based on the syllabus

Describe the difference between systems of interacting and non-interacting particles

SYLLABUS

Statistical Mechanics: Clausius Inequality, Definition and conceptualisation of Entropy, Central (or Fundamental) Equation of Thermodynamics, Introduction to Thermodynamic Potentials and the 3rd law of thermodynamics. Basic principles of statistical mechanics – microcanonical average, Boltzmann entropy, canonical & grand canonical ensembles, partition and grand partition functions. Applications of statistical mechanics –adiabatic cooling of solids, non-degenerate and degenerate systems, partition function for harmonic oscillators, density of states, Einstein and Debye theory of the heat capacity of solids, black body radiation Planck law. Perfect classical gas - derivation of Ideal gas laws, Maxwellian distribution functions. Perfect quantum gases: Bose-Einstein and Fermi-Dirac distributions, blackbody radiation, degenerate Fermi gas and free electron model of metals. Fermi energy, electronic heat capacity, breakdown of free electron model. Degenerate quantum gas: Bose-Einstein condensation.

RECOMMENDED TEXT / READING

Recommended text(s):

FACULTY OF SCIENCE
CLASS DESCRIPTOR

University of Strathclyde Science

DEPARTMENT OF MATHEMATICS & STATISTICS

Class Code: MM311		Class Title: Mathematics 4B	
Type: UG Elective	Level: 3	Credits: 20	Semester: 1 and 2
Class Coordinator: Dr P. Knight		Tel:	Email:
Teaching Staff:			
Pre-requisites: MM111/MM112 and MM211, or equivalent			
Students: Physics			
Overlaps: MA300, MA301			

CLASS DELIVERY (HOURS)

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24	0	48	80	200

CLASS ASSESSMENT

3-hour degree examination in May/June with August resit.

GENERAL AIMS

Statistics: To give a grounding in basic methods of data presentation and the use of standard numerical summaries. To present the laws of probability and the probability distributions most commonly used in the Physical Sciences.
Partial Differential Equations: To introduce Fourier series and partial differential equations, concentrating mainly on some linear equations of practical importance (one-dimensional wave equation, one-dimensional diffusion equation and two-dimensional Laplace equation).
Functions of a Complex Variable: To introduce some elementary complex analysis and its applications.
Integral Transforms: To introduce the Fourier transform and explain its physical interpretation.
Special Functions: To indicate the properties and applications of functions such as Legendre polynomials, Bessel functions and the gamma function.

LEARNING OUTCOMES

On completion of this class, the student should

- be able to construct and interpret bar charts, pie charts, histograms, stem and leaf plots and boxplots;
- be able to find the mean, median, standard deviation and semi-interquartile range of a data set and to make use of them appropriately in presenting data;
- be able to calculate probabilities relating to finite sample spaces using the laws of probability;
- be able to use and interpret the Binomial, Geometric, Poisson and Normal distributions;
- be able to test hypotheses and construct confidence intervals;
-
- know what a Fourier series is, and know how, and in what sense, it can represent a function, both periodic and non-periodic (on a finite interval);
- be able to obtain a Fourier series for a given function;
- be able to solve some simple partial differential equations using several techniques, particularly that of separation of variables;
- be able to apply Cauchy's Integral Theorem and the residue theorem to complex and real integrals;
- be able to derive simple Laurent expansions;
- know the definition and simple properties of the Fourier transform;
- be able to obtain a Fourier transform of a given function;
- know basic properties of Bessel functions, Legendre polynomials and the gamma function.

SYLLABUS

Statistics:
Presentation and summarisation of data: histograms, stem-and-leaf plots, box plots. Good and bad presentation. Introduction to Exploratory Data Analysis. Measures of location: mean, median, mode. Measures of spread: variance/standard deviation, range, quartiles and semi-interquartile range.
Probability Theory: Introduction. Origin of probability ideas. Assignment of probability. Basic laws: P(A or B), P(not A), P(A and B), P(A|B). Independence. Bayes' theorem.
Random Variables: General results. Discrete and continuous random variables. Expectation, variance, moments, quartiles. Mean and variance of linear combinations.
Some useful distributions and common applications: Bernoulli trials and the Binomial and Geometric distributions. Poisson process and the Poisson and negative exponential distributions. Measurement of errors and the Normal Distribution and Central Limit Theorem.
Other applications of the Normal Distribution: sampling distribution of the mean, approximation to the binomial, sums of random variables.
Elementary hypothesis testing and confidence limits.

Partial Differential Equations:
Periodic functions; trigonometric Fourier series; statement of convergence properties; exponential form. Odd and even functions; Fourier series for odd and even functions; Fourier series representation for a function defined on a finite interval; half-range sine and cosine series. Basic concepts for partial differential equations: order, linearity, direct integration, comparison with ODEs, substitution methods of solution, homogeneous, D'Alembert's solution of the wave equation, initial/boundary conditions, superposition. Derivation of wave equation and diffusion equation in one space dimension and of Laplace's equation in 2-D; indication of generalisation to 3-D. Solution by separation of variables in Cartesian co-ordinates; applications of Fourier series; brief mention of inhomogeneous equations.

Functions of a Complex Variable:
Derivative; Cauchy-Riemann equations; contour integration; Cauchy's integral formula; Taylor and Laurent series; residue integration method.

Integral transforms:
Complex, sine, cosine, Fourier transform; physical interpretation of Fourier transform.
Special Functions:
Legendre polynomials; Bessel functions; the gamma function.
Transferable Skills: See Level 3S spreadsheet for details.

RECOMMENDED TEXT / READING

* Chatfield, C. *"Statistics for Technology"* (Chapman and Hall). D519.5024 CHA, ISBN: 0-41225-340-2.
** Stephenson, G. *"Mathematical Methods for Science Students"*, (Longman) [Chapters 15 and 24].
D 510.245 STE, ISBN: 0582444160.
** Stephenson, G. *"Partial Differential Equations for Scientists and Engineers"* (Imperial College Press). D515.35302 STE, ISBN: 1-86094-024-2.
** Kreyszig, E. *"Advanced Engineering Mathematics"* (Wiley). D510.2462 KRE, ISBN: 047133328X.
** James, G. *"Advanced Engineering Mathematics"* (Addison-Wesley). D510.2462 JAM, ISBN: 0201596210.
** Wylie, C.R. & Barrett, L.C. *"Advanced Engineering Mathematics",* (McGraw Hill). D510.2462 WYL, ISBN: 0070722064.

FACULTY OF SCIENCE CLASS DESCRIPTOR			
Class Code: PH 450		**Class Name:** Physics Project	
Type: Compulsory	Level: 4	Credits: 40	Semester: 1 & 2
Class Coordinator: Prof. K. P. O'Donnell		**Tel:**	**Email:**
Teaching Staff: All Staff			
Pre-requisites: All physics classes from first three years of course.			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
0	0	400	0	0	400

CLASS ASSESSMENT

Format: Continuous
1st Attempt: Project report 50 %, Supervisor' Assessment 20 %, Project Oral 20 %, Project Talk 10 %
Re-sit: As above

GENERAL AIMS

The aim of the class is develop a student as an enquiring independent physicist by undertaking a project under the supervision of a member of staff of the department.

LEARNING OUTCOMES

Students will be able to carry out independent research work with suitable guidance.

SYLLABUS

A student will select a research project that will be directed by a member of staff in the department

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR		
Class Code: PH 451		**Class Name:** Physics Skills	
Type: Compulsory	Level: 4	Credits: 20	Semester: 1 & 2
Class Coordinator:		**Tel:** **Email:**	
Teaching Staff: Prof S. Kuhr, Prof. A Slight			
Pre-requisites: All Level 1 and Level 2 Physics Classes			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	24		0	152	200

CLASS ASSESSMENT

Format: Examination and continuous assessment
1st Attempt: 1st Attempt 75 % Examination (in two parts with one in of each diet of examinations), 25 % continuous assessment
Re-sit: 100 % Examination

GENERAL AIMS

The aim of the class is to further develop a physics student as a professional physicist. The class will introduce the students to key concepts in the commercialisation of research thereby introducing the students to the business world as well as further refine the problem solving skills of the students.

LEARNING OUTCOMES

On completion of this module, students should have:
Understanding of innovation, entrepreneurship and commercialisation and the skills required for success in these areas
Exposure to management principles and techniques relevant to technological industries
Development of understanding of cash flows and break even calculations
Experience of team working
Improved appreciation of career opportunities and roles for technology based students
confident to identify a previously unseen problem on any Physics topic covered in your education to date,
have improved your scientific analysis skills and problem solving skills,
able to identify potential solution to such unseen problems and know how to approach and tackle such problems, know how to write-up the problem, often starting with a diagram in a manner which makes it easy for you, your peers and the examiners to see how you have tackled the problem.

SYLLABUS

Training in the Management of all aspects of innovation, including patenting and other forms of IP protection, R&D Planning, product life cycle management, market research, production and selling. The class introduces the students to various management tools, including work breakdown structures, network diagrams, and cash flow tables. Project work concentrates on the production by a team of students of a business plan for the development of an innovative product (chosen by the team themselves), including the development of a formal cash flow plan and break even analysis for the project.
Problems will be taken from first two years physics courses

RECOMMENDED TEXT / READING

Either Benson University Physics or Jewett and Serway University Physics

FACULTY OF SCIENCE CLASS DESCRIPTOR			
Class Code: PH 452		**Class Name:** Topics in Physics	
Type: Optional	Level: 4	Credits: 20	Semester: 2
Class Coordinator: Dr A. W. Cross		**Tel:** 4614 **Email:** a.w.cross@strath.ac.uk	
Teaching Staff: Prof. R. Bingham, Dr A. W. Cross and Dr K. Ronald			
Pre-requisites: PH 352 Quantum Physics and Electromagnetism			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	12		0	140	200

CLASS ASSESSMENT

Format: Examination
1st Attempt: 100 % Examination
Re-sit: 100 % Examination

GENERAL AIMS

The aim of the class is to introduce students to state of the art developments in generation and use of charged particles in various forms such as free electron beams, plasmas and astrophysical plasmas.

LEARNING OUTCOMES

Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems

SYLLABUS

Discharges: Debye lengths, plasma frequencies, physics of particle transport in gases, physics of ionisation/particle emission, analysis of the Townsend avalanche, Paschens law, excitation in discharges, the role of metastables, relaxation scales, RF discharges, applications of discharges
Free Electron Physics:-electrons studied as free charged particles, Electron optics and electron microscopes, Free electron devices - electron accelerators and synchrotrons, Free electron radiation sources - Gyrotrons, Klystrons, Free-electron lasers, Intense electron beam physics.
Plasma Physics: basic plasma physics theory (particle orbit theory, fluid equations, ideal and magnetohydrodynamics, wave equations and kinetic theory). Physical interpretation of plasma phenomena illustrated with examples drawn from fusion plasmas.
Astrophysics: The history and geography of our galactic environment: stellar evolution - nuclear reactions and synthesis: role of weak interactions. Red giants, white dwarfs. Supernovae, neutron stars, black holes. Cosmology - the Big Bang and its physics.

RECOMMENDED TEXT / READING

A.M. Howatson, “An introduction to gas discharges” ; C. A. Brau, “Free-electron lasers”
P.S. Fargo, “Free-electron physics”; P.J. Goodhew “Electron microscopy and analysis”
S. Humphries, “Charged particle beams”
“The Physics of Plasmas”, T.J.M. Boyd and J.J. Sanderson, Cambridge University Press, 2003
“Plasma Physics – An Introductory Course”, Richard Dendy, Cambridge University Press, 1993
“Introduction to Plasma Physics and Controlled Fusion”, Volume 1,F.F. Chen, Plenum Press, 1984
“Plasma Physics”, R.A. Cairns, Blackie, 1985
“A Plasma Formulary for Physics, Technology and Astrophysics”, D. Diver, Wiley, 2001 " High Energy Astrophysics " by Malcolm Longair, Cambridge University Press KR Lang, Astrophysical Formulae 2nd Edition, Springer-Verlag.

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR		
Class Code: PH 453		**Class Name:** Topics in Solid State Physics	
Type: Optional	Level: 4	Credits: 20	Semester: 1
Class Coordinator: Prof R. W. Martin		**Tel:**	**Email:**
Teaching Staff: Prof R. W. Martin			
Pre-requisites: PH 352 Quantum Physics and Electromagnetism, PH 353 Properties of Matter			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	12		0	140	200

CLASS ASSESSMENT

Format: Examination
1st Attempt: 100 % Examination
Re-sit: 100 % Examination

GENERAL AIMS

The aim of the class is to track the development of the key concepts in solid state physics and how these concepts can be exploited to form functional optical and electronic devices

LEARNING OUTCOMES

On completion of this module, studentswill be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems

SYLLABUS

Chemistry and physics of crystalline, amorphous and semiconductor materials. Effects of impurities in such materials. Optical activity in crystalline and semiconductor materials. solving Schrödinger's equation for hydrogenic and multi-electron atoms, LS coupling, Born-Oppenheimer principle, Hund's rules, etc. Semiconductor statistics - electron and hole populations.
Electrical conduction - drift and diffusion of charge carriers. The p-n junction and related devices.
Photonics - the interaction of semiconductors with light.
Electronics - transistors, bipolar and unipolar. Power devices. Integration. Quantum wells and microstructured materials.

RECOMMENDED TEXT / READING

D.A. Neamen, Semiconductor Physics and Devices 3d Edition (McGraw-Hill, 2003)

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR

Class Code: PH 454		**Class Name:** Topics in Nanoscience		
Type: Optional	Level: 4	Credits:	20	Semester: 1
Class Coordinator: N Hunt		**Tel:**	**Email:**	
Teaching Staff: Prof. D. Birch, Dr Y. Chen				
Pre-requisites: PH 352 Quantum Physics and Electromagnetism, PH 353 Properties of Matter				

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	12	0	0	140	200

CLASS ASSESSMENT

Format: Examination
1st Attempt: 100 % Examination
Re-sit: 100 % Examination

GENERAL AIMS

The aim of this course is to introduce the subject of nanoscience. Specifically the course will address concepts relating to Nanoparticle production, characterisation and structure before progressing to the physics associated with molecular nanoscience, including intermolecular forces and the techniques used to investigate these forces.

LEARNING OUTCOMES

By the end of the course a student shall;
Have knowledge of the concepts and terminology relating to nanoparticles, quantum dots and nanostructures.
Show an appreciation of modern methods of production for nanoparticles.
Have knowledge of the chemical and physical characteristics of nanoparticles.
Demonstrate knowledge of the basic spectroscopy associated with nanoparticles, including Surface
Plasmon Resonances and fluorescence characteristics.
Have knowledge of how nanoparticle size and shape affect the physical, chemical and spectroscopic properties of a nanoparticle.
Be able to compare and contrast the properties of nanoparticles with those of other nanostructured materials such as nanorods, nanopyramids or multifacial particles.
Have knowledge of the definition of and basic physical and chemical properties of other forms of nano- materials such as non-metallic nanoparticles and 'soft' systems such as sol-gels, self assembled bio- nano materials and colloids.
Appreciate the applications for nanoparticles etc in modern science and technology, particularly in relation to physics, chemistry and medicine.
Show a basic knowledge of the issues relating to nonotoxicity and the ethical issues surrounding the use of nanoparticles in medicine.
Have knowledge of the physical basis of the key intermolecular interactions that relate to nanoscience, such as Hydrogen bonds, Van der Waals interactions and dipolar interactions.
Have knowledge of how the above intermolecular interactions affect nanoparticle formation, characterisation, functionalisation and application.
Have knowledge of the concept and physical principles governing nanostructuring in the liquid phase and its application to materials such as solvents, liquid crystals and room-temperature ionic liquids.
Have knowledge of the physical principles underpinning nanoparticle aggregation and explain how inter- particle effects contribute to their usefulness in applications such as Surface Enhanced

Raman Spectroscopy.

SYLLABUS

(A) Introduction to nanoscience – this part of the course will provide an overview of modern nanoscience. In particular it will cover the physical and chemical principles relating to nanoparticle production and their physical and chemical properties including basic spectroscopy such as visible light absorption, fluorescence and Surface Plasmon Resonance spectroscopy. The production and characteristics of other nanostructured materials and particles will be discussed including nanorods, nanopyramids and multifacial particles. An introduction to non-metallic and 'soft' nanomaterials will be given, including non-metallic nanoparticles, sol- gels, self-assembled bionanostructures and colloids. Applications of nanoparticles and nanomaterials in physics, chemistry and medicine will be covered along with issues relating to nanotoxicity and the ethics of medical nanoscience applications. (B) Molecular Nanoscience – this part of the course will cover the intermolecular and interparticle forces that underpin nanoscience and the experimental methods used to probe the structure and dynamics involved in nanomaterial physics and chemistry. In particular, the course will cover the physics and chemistry relating to Hydrogen bonding, Van der Waals interactions and dipolar interactions. Liquid phase nanostructuring will be discussed including applications to liquid crystals and room-temperature ionic liquids, as well as the role of nanostructuring in solvent-solute systems. The physics governing nanoparticle aggregation will be covered along with the significance for this in relation to surface enhancement phenomena. This part of the course will also provide an introduction to the experimental techniques used to measure the forces and dynamics that are important in nanoscience, these will include infrared absorption spectroscopy and time resolved methods across a range of timescales from stop-flow measurements to ultrafast spectroscopies.

FACULTY OF SCIENCE CLASS DESCRIPTOR			
Class Code: PH 455		**Class Name:** Topics in Photonics	
Type: Optional	Level: 4	Credits: 20	Semester: 1
Class Coordinator:		**Tel:** **Email:**	
Teaching Staff: Prof. E. Riis			
Pre-requisites: PH 352 Quantum Physics and Electromagnetism, PH 353 Properties of Matter			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
36	12	0	20	128	200

CLASS ASSESSMENT

Format: Continuous and Examination
1st Attempt: 85 % Examination and 15 % Continuous Assessment
Re-sit: 100 % Examination

GENERAL AIMS

The course provides an introduction to laser physics, laser optics and nonlinear optics as required for the work in many photonic laboratories

LEARNING OUTCOMES

Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems.

SYLLABUS

Laser Physics: Properties of laser radiation; Spontaneous and stimulated emission; Einstein A, B coefficients; Spectral line broadening; Population inversion; Multiple Level systems; Small signal gain; Amplification and line narrowing; Threshold condition; Gain saturation; Oscillating frequency; Spatial hole burning; Output coupling; Q-switching and methods of Q-switching; Amplification and saturation under pulsed operation.
Beam Propagation: Plane waves and paraxial rays; Ray transfer matrices; Multi-element and periodic optical systems; Cavity stability; Longitudinal modes; Gaussian beams; Complex beam parameter; Complex beam parameter and Ray transfer matrices; Optical resonators; Multiple mirror cavities; Dielectric mirrors; Polarization; Wave- plates; Jones matrices; Optical fibres.
Nonlinear optics: Linear wave equation; Classical electron oscillator; Dielectric susceptibility; Dispersion including group velocity; Nonlinear oscillator; Nonlinear polarization; Nonlinear wave equation; Coupled amplitude equations; Second order effects – second harmonic generation, phase matching, sum and difference frequency matching, parametric amplification and oscillation; Third order effects – optical Kerr effect, self-phase modulation, self-focusing, degenerate four wave mixing; Optical solitons; Mode-locking.

RECOMMENDED TEXT / READING

Recommended text(s): A. Yariv: Photonics: Optical Electronics in Modern Communications, Oxford
University Press (2007) other text books as suggested by lecturers.

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR

Class Code: PH 456		**Class Name:** Topics in Computational and Complex Systems in Physics	
Type: Optional	Level: 4	Credits: 20	Semester: 2
Class Coordinator: Dr B. Hourahine		**Tel:** 2325 **Email:** Benjamin.hourahine@strath.ac.uk	
Teaching Staff: Dr B. Hourahine, Prof. G-L Oppo			
Pre-requisites:			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
36	12	36	36	80	200

CLASS ASSESSMENT

Format: Examination and Continuous
1st Attempt: Examination 50%, continuous assessment 50 % (comprising 35 % laboratory assessment, 15 % essay)
Re-sit: 100 % Examination

GENERAL AIMS

The aim of this course is to introduce students to the ideas and concepts associated with complexity physics and to the use of computer simulations to demonstrate these processes

LEARNING OUTCOMES

By the end of the course a student shall;
1. Be aware of simple systems that exhibit nonlinear and complex behaviour.
2. Be able to analyse nonlinear systems and find stationary points
3. Possess the ability to analyse bifurcation diagrams and identify key features on these diagrams
4. Look at periodic solutions to nonlinear systems and recognise oscillations, and key features of these oscillations
5. Understand the origin of deterministic chaos and explain key features relating to chaos
6. Demonstrate understanding of the appropriate choice of method from the syllabus to address selected computational physics problems.
7. Be able to demonstrate an understanding of the algorithms described in the course.
8. Have demonstrated the ability to implement stable, efficient and numerically correct versions of these algorithms, with source code which is well documented.
9. Develop an ability to decide the reliability and usefulness of derived computational results.
10. Appreciate the physical significance of derived computational results.

SYLLABUS

Introduction: What are complex systems. Why is nonlinear physics is important. Predictability, nonlinearity and complexity. Bifurcations and universality.
Complex systems in 1D: Examples of 1D nonlinear models (ODEs): population dynamics, lasers etc. Stationary solutions (fixed points). Linear stability analysis. Bifurcation diagrams. Transcritical bifurcations. Vector fields. Bistability. Saddle-node bifurcations. Bistability as combination of saddle-node bifurcations
Complex systems and oscillations in 2D and 3D: Examples. Lasers with saturable absorbers. Eigenvalues and eigenvectors of a system of linear ODEs. Onset of oscillations. Harmonic and nonlinear oscillators, Fourier analysis. Evolution of perturbations near fixed points. Jacobian matrices. Hopf bifurcations. Stability of periodic orbits.
Discrete systems: Poincaré sections and maps. Stability of maps' fixed points. Flip bifurcation and period doubling. Period doubling cascade and deterministic chaos.
Deterministic chaos: Attractors and strange attractors. Properties and characterization of

deterministic chaos. The Lorenz system. The Rossler system. Lyapunov exponents. Fractal dimension. Manifolds.
Numerical modelling of dynamics: Hamiltonian systems, numerical integration of equations of motion, important symmetries, Verlet integration, correlations, the fluctuation dissipation theorem and property calculations
Stochastic methods: Random and pseudo-random numbers, Monte-Carlo sampling, integration and importance sampling. Random walks, Metropolis sampling, sampling statistical mechanics ensembles, interacting spins, critical phenomena and the Ising model. Time evolution and Kinetic Monte Carlo.
Partial differential equations: The Laplace and Poisson's equation on a grid, relaxation and over-relaxation, Green's function and Fourier solutions. Reaction-diffusion equations, Turing instabilities and pattern formation

RECOMMENDED TEXT / READING

Nonlinear Dynamics and Chaos by Steven Strogatz (Perseus Books, 2000)
An Introduction to Computational Physics by Tao Pang (Cambridge University Press, 2010)

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR

Class Code: PH 457		**Class Name:** Topics in Theoretical Physics	
Type: Optional	Level: 4	Credits: 20	Semester: 2
Class Coordinator:		**Tel:** **Email:**	
Teaching Staff: Prof. N. R. Badnell			
Pre-requisites:			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	12		0	140	200

CLASS ASSESSMENT

Format: Examination
1st Attempt: 100 % Examination
Re-sit: 100 % Examination

GENERAL AIMS

The aim of the class is to introduce students to the large scale structure of space-time

LEARNING OUTCOMES

Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems

SYLLABUS

Firstly, we develop the necessary mathematical concepts: 4-vectors, the metric tensor, covariant derivatives, connection coefficients and the Riemann curvature tensor. Secondly, we use them to derive Einstein's gravitational field equation and look at idealized cosmological solutions for the large-scale structure of the universe, including the standard model.
We conclude with a study of gravitational collapse and the properties of black holes.

RECOMMENDED TEXT / READING

***-Essential Relativity: Special, General, and Cosmological, W. Rindler (OUP, 2001 Edition: ISBN 0198508360 paperback)
***-(Schaum's outline of) Tensor Calculus, D. C. Kay (McGraw-Hill)
* -Gravitation, C.W. Misner, K.S. Thorne and J.A. Wheeler (Freemean).
* -Principles of Physical Cosmology, P.J.E. Peebles (Princeton).

FACULTY OF SCIENCE CLASS DESCRIPTOR			
Class Code: PH 458		**Class Name:** Topics in Quantum Physics	
Type: Optional	Level: 4	Credits: 20	Semester: 1
Class Coordinator:		**Tel:**	**Email:**
Teaching Staff: Dr D Oi, Dr G. R. M Robb			
Pre-requisites: PH 352 Quantum Physics and Electromagnetism,			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
36	12	0	15	137	200

CLASS ASSESSMENT

Format: Examination and Continuous assessment
1st Attempt: 85 % Examination and 15 % Continuous
Re-sit: 100 % Examination

GENERAL AIMS

The course provides an introduction to the basic concepts and theoretical ideas of quantum optics.

LEARNING OUTCOMES

Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems.

SYLLABUS

Classical electromagnetism, vector and scalar potential theory, linear and nonlinear media, nonlinear processes, optical coherence, quantum harmonic oscillator, quantisation of the electromagnetic field, states of single mode fields, nonclassical light. 2-level atoms and Jaynes-Cummings model. Micromasers and cavity QED. Density operators. Master equations. Decoherence. Quasi-probability representations. Fokker- Planck equation. Optical qubit. Optical generation of entanglement and Bell's inequality tests.

RECOMMENDED TEXT / READING

Recommended text(s): The Quantum Theory of Light, R. Loudon (Oxford Univ. Press) 3rd Edn. 2000. 0-
198-50176-5. Quantum Optics, Mark Fox, OUP. Methods in theoretical quantum optics, S. Barnett and P. Radmore, OUP.

University of Strathclyde Science	FACULTY OF SCIENCE CLASS DESCRIPTOR

Class Code: PH 459		**Class Name:** Topics in Atomic, Molecular and Nuclear Physics	
Type: Optional	Level: 4	Credits: 20	Semester: 2
Class Coordinator:		**Tel:** **Email:**	
Teaching Staff: Prof N R Badnell and Prof M Federov			
Pre-requisites: PH 352 Quantum Physics and Electromagnetism,			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	12		0	140	200

CLASS ASSESSMENT

Format: Examination
1st Attempt: 100 % Examination
Re-sit: 100 % Examination

GENERAL AIMS

This class aims to give a general overview and understanding of atomic and molecular physics and relate these to practical applications and related fields of study.

LEARNING OUTCOMES

Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems.

SYLLABUS

Atoms Hydrogen atom: wavefunction; spherical harmonics; associated Legendre functions; probability and radial distribution functions.
Angular momentum: quantum operators; commutation relations; l^2 and l; shift operators; states; matrix
elements, spin, composite system, Clebsch-Gordan series.
Atomic spectra and atomic structure: transition; selection rule; addition of angular momenta; fine structure; Lamb shift.
The Helium atom: spin eigenstates; singlets and triplets; Pauli exclusion principle; symmetric and anti- symmetric wavefunctions; transitions.
The alkali atoms: shell structure; screening; quantum defect; fine structure.
LS Coupling: Russell-Saunders coupling; jj coupling; intermediate coupling; selection rules; periodicity; term symbols; configuration interaction.
Atoms in external fields: Zeeman effect; Stark effect.
Atomic clusters: free-electron model, metal clusters and the Jellium model, magic number, size dependent excitation and emission.

Molecules; The quantum mechanics of bonding: Orbitals, hybridisation, σ-bonds, π-bonds, secondary bonds; Electronic states, HOMO, LUMO. The chemical zoo: All and more you ever wanted to know of chemistry; The important elements: H, C, N, O, metals; Water, alcohols, Polymers, Amino acids, Peptides, the peptidebond, primary/secondary/tertiary structure, DNA, Salts. Forces: Born-Oppenheimer approximation: nuclear vs. electronic, other examples; Bonds, harmonic approximation, normal modes; Anharmonicity: 3rd and 4th order, Morse potential, dissociation; Intermolecular forces, hydrogen bonds, ionic, Lennard-Jones. Kinetics:

Free energy; Potential energy surfaces; Curve crossing; Perturbation theory, Fermi's golden rule; Barriers, Boltzmann, Arrhenius; The simplest reaction: electron transfer, Marcus theory. Dynamics: Coherence vs. population; T1 and T2 times; Kubo theory; Landau-Teller theory. Techniques and methods: IR absorption and Raman scattering by vibrations; VIS absorption by electronic states, Franck-Condon principle; MD simulations.

Nuclear Physics: Definitions: N, Z, isotopes, isotones, isobars etc; mass of nuclei, mass defect, binding energy; nuclear
reactions, Q-values, centre of mass energy, half-life, activity, cross sections;
Nuclear decay: Introduction to alpha, beta and gamma decay, fission and fusion; decay chains;
Nuclear structure: Introduction to the liquid drop model, shell model, collective models; Rutherford scattering, electron scattering
Interaction of radiation with matter: Heavy particle: ionising collisions, Cerenkov radiation, range, Bethe
Bloch, Bragg peak; Electrons: Ionisation, Bremstrahhlung; Gamma rays: photoelectric effect, Compton scattering, pair production; Radiation detectors: gas ionisation (Geiger Muller), scintillators, semiconductors. Applications: carbon dating, fast high voltage switches; Glow in the dark watches, Radiation in medicine: Imaging techniques, cancer therapy

RECOMMENDED TEXT / READING

Atkins P and Friedman R, "Molecular Quantum Mechanics", Oxford, 2005. Foot C, "Atomic Physics", Oxford, 2004
Rodney Cotterill, "Biophysics: an introduction", Wiley, 2002
Atkins, "Physical Chemistry", Oxford.
Krane, "Introductory Nuclear Physics", Wiley
Lilley, "Nuclear Physics", Wiley

FACULTY OF SCIENCE
CLASS DESCRIPTOR

Class Code: PH550			**Class Name: Project**		
Type: Compulsory		**Level:** 5	**Credits:**	40	**Semester:** 1 & 2
Class Coordinator:	Prof. K. P. O'Donnell		**Tel:**	**Email:**	
Teaching Staff:	All staff				
Pre-requisites:	PH 450				

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
20				380	400

CLASS ASSESSMENT

Format: Continuous
1st Attempt: 1st Attempt: 100 % Continuous Assessment comprising written report 30 %, oral presentation 10 %, viva 30
% and supervisor mark 30 %
Re-sit: As above

GENERAL AIMS

This is the MPhys Project and is designed to follow on from the BSc project undertaken in 4th year and will allow students to further develop as independent learners

LEARNING OUTCOMES

By the end of the course a student shall;
- Be able to undertake a research project with minimal guidance
- Be able to present and defend their work in a variety of ways

SYLLABUS

Students gain experience of research techniques by performing an open-ended research project that continues the studies made in 4th year. The topic may be experimental, theoretical, or computation physics or a mixture of all three. The work is normally carried out in the research laboratories under the individual supervision of an experienced researcher.

RECOMMENDED TEXT / READING

Reading related to project area

DATE MODIFIED

University of Strathclyde Science	**FACULTY OF SCIENCE** **CLASS DESCRIPTOR**

Class Code: PH 552		**Class Name: Advanced Topics in Physics**	
Type: Optional	**Level:** 5	**Credits:** 20	**Semester:** 1
Class Coordinator: Prof Jaroszynski		**Tel:**	**Email:**
Teaching Staff: Prof Jaroszynsi, Prof P McKenna, Dr B McNeil			
Pre-requisites:			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	12		20	144	200

CLASS ASSESSMENT

Format: Examination
1st Attempt: 100 % examination
Re-sit: 100 % examination

GENERAL AIMS

The course provides an introduction to advanced applications of ultra high intensity laser

LEARNING OUTCOMES

Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems.

SYLLABUS

Theory of laser plasma interaction: plasma description, linear waves, non-linear effects, parametric interaction.
High power laser pulse interactions with dense targets: Overview of laser-solid interactions; energy absorption mechanism; ion acceleration; sheath acceleration and radiation pressure acceleration; hydrodynamics; shock waves; inertial fusion energy.
Micro-machining with femtosecond lasers. Laser-plasma wakefield accelerators.
Free-electron lasers.
Ultrafast optics, nonlinear optics. High harmonic generation.

RECOMMENDED TEXT / READING

Lasers by A. E. Siegman Stanford Press
Physics of Laser Plasma interactions W. L. Kruer, Westview Press

University of Strathclyde Science	**FACULTY OF SCIENCE** **CLASS DESCRIPTOR**

Class Code: PH 553		**Class Name: Advanced Topics in Solid State Physics**	
Type: Optional	**Level:** 5	**Credits:** 20	**Semester:** 2
Class Coordinator: Dr B Hourahine		**Tel:** 2325 **Email:** benjamin.hourahine@strath.ac.uk	
Teaching Staff: Dr B Hourahine			
Pre-requisites: PH 358 Solid State Physics or equivalent			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
30	10	0	60	100	200

CLASS ASSESSMENT

Format: Examination and assignment

1st Attempt: 70 % Examination, 30 % assignment

Re-sit: 100% Examination

GENERAL AIMS

The aim of this course is to introduce advanced concepts associated with the physics of nano-scale structures. This will be underpinned by exposure to relevant key concepts in modern condensed matter physics and optics. Modern computational methods to investigate these systems will then be introduced to illustrate methods of applying these concepts to realistic nanosystems.

LEARNING OUTCOMES

By the end of the course a student shall;

- Demonstrate an understanding of the density of states for the free and nearly electron models as a function of dimensionality.
- Appreciation of recent developments in systems with non-trivial topological properties
- Be able to qualitatively and quantitatively describe the characteristic features of carbon structures on the basis of simple LCAO models.
- Problem solving for examples of excitations in solids
- Appreciation of methods required to understand the many-particle nature of solids and nanostructures
- Understanding of the main categories of defects in semiconductor materials
- Ability to apply statistical physics to understand semiconductor alloy properties

Understanding of the interplay of light and structure for nanosystems

SYLLABUS

- Low dimensional systems: this section introduces systems including quantum wells, wires and dots, demonstrating the effects of confinement on the electronic structure of these structures. Some of the properties of the vast range of carbon nano-structures are then discussed using this understanding, in particular fullerenes, nanotubes and graphene. Dimensional reduction by magnetic fields will be discussed, starting from Landau levels and then the quantum hall effect, leading to an investigation of topological insulators.
- Semiconductors on the nanoscale – excitations, defects and alloys. This section discusses processes and structures present on the nanoscale in conventional semiconductor materials. Firstly transient deviation from the ideal crystal due to excitations are discussed. Secondly the properties and behaviour of native point and extended defects in semiconductors are examined. Finally, the nano-structure and possibilities for band-gap engineering of semiconductor alloys are investigated.
- Quantum mechanical models – the challenges of understanding and calculating the properties of systems of interacting particles are discussed (the Born-Oppenheimer approximation, Hartree and Hartree-Fock wavefunctions, screening and correlation of electrons, the Thomas-Fermi model,

density functional theory and the range of approximate functionals). Semi-empirical techniques for large scale modelling will then be developed as approximations to first principles methods

- Light and sub-wavelength structures – This section discusses the interaction of light with nanoscale matter. Rayleigh and Mie scattering of light from nano-particles are introduced, and the distinction between the near and far field discussed. Photonic analogues of crystals are then introduced, including a discussion effects such as the photonic band bap in these structures. This is followed by a discussion of collective excitation processes (plasmons and polaritons in particular) and the strong coupling regime between light and matter.

RECOMMENDED TEXT / READING

Solid State Physics, C. Kitel, Wiley 1996
The electronic structure and chemistry of solids, P. A. Cox, Oxford University Press 1987
The Solid State, H. M. Rosenberg, Oxford University Press 1988
Nanophotonics, P. N. Prasad, Wiley-Interscience 2004
Optical properties of Solids, M. Fox, Oxford 2010
Computational Physics, J. M. Thissen Cambridge University Press 2007

University of Strathclyde Science	**FACULTY OF SCIENCE** **CLASS DESCRIPTOR**

Class Code: PH 554		**Class Name: Advanced Topics in Nanoscience**	
Type: Optional	**Level:** 5	**Credits:** 20	**Semester:** 2
Class Coordinator: Dr O. J. Rolinski		**Tel:** **Email:** o.j.rolinski@strath.ac.uk	
Teaching Staff: Dr O. J. Rolinski and Dr C Trager-Cowan			
Pre-requisites:			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
48	24	0	0	128	200

CLASS ASSESSMENT

Format: Examination and continuous assessment
1st Attempt: 100 % examination
Re-sit: 100 % examination

GENERAL AIMS

The aim of this course is to introduce the advanced imaging and microscopy techniques associated with modern nanoscience. This will be underpinned by the physics required for a thorough understanding of these methods, including the Molecular Physics of absorption and fluorescence and the Optical Physics relating to microscopy and imaging in the visible and X-ray regions of the electromagnetic spectrum.

LEARNING OUTCOMES

By the end of the course a student shall be able to describe and discuss ;
the quantum mechanics relating to molecular electronic energy levels
the process of absorption of light by molecules
the process of fluorescence
the process of phosphorescence
that only specific structural components of large biomolecules fluoresce and comprehend the difference between natural biomolecule fluorescence and the use of artificial labels
the process of resonance energy transfer
the process of fluorescence quenching
the function of the instrumentation required for fluorescence measurements
the kinetics of excited molecular electronic energy levels
the use of FRET in nanoscale imaging and microscopy
the basic concepts of techniques such as confocal microscopy, scanning near field optical microscopy.
the applications of the above techniques to single molecule measurements.
the working principles and applications of scanning probe microscopy including atomic force microscopy and scanning tunnelling microscopy
the benefits associated with the use of X-ray wavelengths in imaging and spectroscopy
the physics associated with X-ray production for spectroscopy and imaging
the physics associated with X-ray wavelength optics
the relative merits of X-ray based techniques such as XAFS and XPS in nanoscience research

Applications of light scattering and emission methods for nanometrology
the molecular basics of optical medical sensing and imaging of metabolites
the working principles and applications o scanning electron and transmission electron microscopy
the choice of an appropriate technique for a given application.

SYLLABUS

(A) **Visible imaging methods** - This part of the course will reflect the progress in fluorescence spectroscopy in recent years. It will start from the experimental and quantum mechanical backgrounds and then will concentrate on the new applications with nm resolution. Detailed syllabus includes:

(i) Background: Measurement of fluorescence and phosphorescence, fluorescent molecules, basic characteristics of fluorescence. Quantum-mechanical fundamentals of fluorescence. Instrumentation for the steady-state and time-resolved measurements. Reconvolution methods. Excited state kinetics, solvation, fluorescence quenching, resonance energy transfer, molecular reorientations.

(ii) Fluorescence imaging techniques including resonance energy transfer (FRET) for selective detection of nM concentrations of analytes, determining the nm structure of macromolecules, fluorescence nano-tomography and its potential in bio- and medical structural sensing. Other visible light imaging techniques such as Single molecule spectroscopy, Confocal microscopy, Scanning near field optical microscopy (SNOM)

(B) **Nanometrology methods** – This part of the course will concentrate on the imaging and spectroscopic methods used in nanoscience and nanometrology that extend the techniques in part (A) and which allow measurement of the structure and topography of nanomaterials. This will include introductions to scanning probe microscopy, electron microscopy and the use of X-ray wavelengths for emission and fluorescence spectroscopy as well as in-situ methods based on light scattering, particle tracking and fluorescence. The physics associated with methods required for sample preparation will also be discussed.

(C) **Medical sensing methods** - This part of the course outlines the principles of nanomedicine in the context of skin and tissue and their molecular sub-assemblies and optical properties. Knowledge acquired in Parts A and B of the course are then used in examples of in-vitro cellular and in-vivo metabolic sensing e.g. metal ions, glucose, protein and fibrils as characteristics of chronic diseases such as diabetes, Alzheimer’s and Parkinson’s.

RECOMMENDED TEXT / READING

J.R. Lakowicz, "Principles of fluorescence spectroscopy", Plenum Press, New York 1999

FACULTY OF SCIENCE
CLASS DESCRIPTOR

Class Code: **PH 555**		**Class Name: Advanced Topics in Photonics: Modern experiments in Quantum Optics**	
Type: Optional	**Level:** 5	**Credits:** 20	**Semester:** 2
Class Coordinator: Prof S Kuhr		**Tel: 5712**	**Email:** stefan.kuhr@strath.ac.uk
Teaching Staff: Prof S Kuhr, Dr P Griffin			
Pre-requisites: none			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
36	12	0	20	132	200

CLASS ASSESSMENT

Format: Examination and Continuous Assessment
1st Attempt: 60 % examination and 40 % continuous assessment
Re-sit: 100 % examination

GENERAL AIMS

The course provides an introduction to phenomena and experimental techniques in modern atomic physics and quantum optics. Aside from theoretical basics, a particular focus will be on experiments and techniques, such as laser cooling and Bose-Einstein condensation, EPR-paradox, quantum teleportation, Schrödinger cats, quantum information and quantum cryptography.

LEARNING OUTCOMES

Students will be introduced to very modern experimental and theoretical developments in the field. In the accompanying tutorials, the students will in particular learn to read and understand research papers related to the subjects, aside from normal exercises.

SYLLABUS

Interaction of light with a two-level atom, optical pumping, nonlinear and sub-Doppler spectroscopy, Rabi oscillations, spontaneous emission, optical Bloch equations,
Quantized light-atom interaction, Cavity QED, non-destructive photon counting
Opto-mechanical effects, radiation pressure, Laser cooling, magneto-optical traps.
Ramsey interferometer and atomic clocks
Bose-Einstein condensation, degenerate Fermi gases, atom laser, matter-wave interferometry,
Optical lattices, Superfuid-to-Mott insulator transition
EPR-Experiments and Bell's inequalities, Schrödinger Cats
Foundations of quantum information, quantum bits and quantum gates,
Quantum computing with ion traps
Electromagnetically induced transparency and slow light

FACULTY OF SCIENCE
CLASS DESCRIPTOR

Class Code: **PH 556**		**Class Name:** **Advanced Topics in Complexity**	
Type: Optional	**Level:** 5	**Credits:** 20	**Semester:** 1
Class Coordinator: Dr F Papoff		**Tel: 3178**	**Email:** f.papoff@strath.ac.uk
Teaching Staff: Dr F Papoff			
Pre-requisites: PH 456 Topics in Computational and Complexity Physics			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
24	24	0	0	152	200

CLASS ASSESSMENT

Format: Examination and continuous assessment
1st Attempt: 60 % Examination 40 % continuous assessment
Re-sit: 100 % examination

GENERAL AIMS

The aim of the class is to extend a student's awareness of self-organization and complexity in Natural Sciences

LEARNING OUTCOMES

By the end of the course a student shall be able to Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems.

SYLLABUS

Synchronization
Nonlinear oscillator with external driving force, coupled nonlinear oscillators: networks of neurons, possible origin of Parkinson disease and epileptic seizures; arrays of lasers and coherence. Averaging and reduced models. Phase synchronization and complete synchronization. Synchronization of chaotic oscillators. Effect of noise.
Spatially Extended Nonlinear Systems
Formation of spatial structures, Linear Stability Analysis and dispersion relations. Diffusion, Turing instability and morphogenesis in biological systems. Diffraction and off-axis emission in nonlinear optical systems. Stationary and traveling waves, stationary patterns and patterns periodic in space and time.
Nonlinear Waves
Example of water waves, shock waves and gradient catastrophe. Solitons, solitonic waves and their applications to propagation of laser pulses in fibres and formation of super continuum. First order equations and method of the characteristics. Introduction to complexity.

RECOMMENDED TEXT / READING

Synchronization: a universal concept in nonlinear sciences, A.Pikovsky, M.Rosenblum , J.Kurths, Cambridge, University Press (2003) 1st paperback ed. Cambridge, UK ; New York : Cambridge University Press 2003
Pattern formation and dynamics in nonequilibrium systems, Michael Cross Henry Greenside, Cambridge

FACULTY OF SCIENCE
CLASS DESCRIPTOR

Class Code: PH 557		**Class Name:** Advanced Topics Theoretical Physics	
Type: Optional	**Level:** 5	**Credits:** 20	**Semester:** 2
Class Coordinator: Dr J Jeffers		**Tel:** **Email:** john.jeffers@strath.ac.uk	
Teaching Staff: Dr J Jeffers			
Pre-requisites:			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
36	12	0	0	152	200

CLASS ASSESSMENT

Format: Examination and continuous assessment
1st Attempt: 60 % Examination 40 % continuous assessment
Re-sit: 100 % examination

GENERAL AIMS

The class covers topics in advanced mechanics both classical and quantum by introducing students to the concepts of Lagrangians, Hamiltonians and more in depth study of fields.

LEARNING OUTCOMES

By the end of the course a student shall be able to Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems.

SYLLABUS

Synchronization
Nonlinear oscillator with external driving force, coupled nonlinear oscillatorble origin of Parkinson disease and epileptic seizures; arrays of lasers and coherence. Averaging and reduced models. Phase synchronization and complete synchronization. Synchronization of chaotic oscillators. Effect of noise.
Spatially Extended Nonlinear Systems
Formation of spatial structures, Linear Stability Analysis and dispersion relations. Diffusion, Turing instability and morphogenesis in biological systems. Diffraction and off-axis emission in nonlinear optical systems. Stationary and traveling waves, stationary patterns and (1) Review of Classical Mechanics
Newton's Laws, position and momentum, fields and forces, waves and the wave equation, electromagnetism, waves and the Lorentz force law, Green function techniques.

(2) Review of Quantum Mechanics
Schrodinger's equation, time-independent QM, measurement, evolution: Schrodinger and Heisenberg pictures, unitary evolution, mismatch between quantum and classical evolution.

(3) The Lagrangian
Motivation, generalised coordinates, the principle of least action, Euler-Lagrange equations.

(4) The Hamiltonian
Definition, Hamilton's equations, Poisson brackets and constants of motion, commutators

and the transition to quantum mechanics, canonical quantisation. (5) Fields Continuous systems, Lagrangian and Hamiltonian densities, scalar fields, vector fields.

RECOMMENDED TEXT / READING

FACULTY OF SCIENCE
CLASS DESCRIPTOR

Class Code: PH 558		**Class Name:** Advanced Topics in Quantum Physics	
Type: Optional	**Level:** 5	**Credits:** 20	**Semester:** 2
Class Coordinator: Dr D Oi		**Tel: 5712**	**Email:** daniel.oi@strath.ac.uk
Teaching Staff: Dr D Oi, Dr S. Virmani, Prof S. M. Barnett			
Pre-requisites: PH 458 Topics in Quantum Physics			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
36	12	0	15	137	200

CLASS ASSESSMENT

Format: Examination and continuous assessment
1st Attempt: 85 % Examination, 15 % assignments
Re-sit: 100 % examination

GENERAL AIMS

The course provides an introduction to the basic concepts and theoretical ideas of quantum information processing.

LEARNING OUTCOMES

Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems

SYLLABUS

Basic formalism of quantum theory, Hilbert spaces, tensor products, quantum measurement, quantum dynamics. Optimal measurement of quantum states for important cases. Basic protocols: quantum teleportation, quantum cryptography, non-locality. Basics of quantum algorithms: Deutsch-Jozsa, Simon, Grover, and Shor's factorization. Basics of information theory, data compression, noisy coding, entropy. Quantum error correction, decoherence avoidance. Quantum entanglement and LOCC conversion, Nielsen's theorem, separability. Models of quantum computation. Quantum simulators. Ideas behind quantum metrology, quantum control.

RECOMMENDED TEXT / READING

S. M. Barnett, `Quantum Information', OUP;
M. A. Nielsen and I. Chuang, `Quantum information and computation', CUP.

FACULTY OF SCIENCE
CLASS DESCRIPTOR

Class Code: PH 560		**Class Name: Advanced Topics in Electromagnetism and Plasma Physics**	
Type: Optional	**Level:** 5	**Credits:** 20	**Semester:** 1
Class Coordinator: Dr K. Ronald		**Tel: 5712 Email:** paul.mckenna@strath.ac.uk	
Teaching Staff: Dr K. Ronald, Dr B. Eliason			
Pre-requisites: none			

CLASS DELIVERY (HOURS):

LECTURES	TUTORIALS	LABORATORIES	ASSIGNMENTS	SELF STUDY	TOTAL
36	12	0	0	152	200

CLASS ASSESSMENT

Format: Examination
1st Attempt: 100 % examination
Re-sit: 100 % examination

GENERAL AIMS

The class introduces students to the primary methods for transmitting and manipulating electromagnetic waves and the interaction of these waves with plasmas.

LEARNING OUTCOMES

Students will be able to demonstrate knowledge of topics listed in syllabus and be able to apply that knowledge to related problems

SYLLABUS

The course will address primarily methods of transmitting (waveguides, antennae), storing (cavities) and manipulating EM radiation. It will look at both theoretical and practical consideration for a range of applications.

The solution for wave propagation in a smooth waveguide of arbitrary cross section will be considered and the general dispersion relations obtained for both TE & TM modes and for TEM configurations. This will lead to specific solutions for practical waveguides (Rectangular, Cylindrical, Co-Axial and Stripline). Resonators will be considered and the role of dielectric and conductive losses in defining ohmic Q will be compared to diffractive losses. The course will also cover practical considerations for the selection of waveguides and waveguiding systems and components.

The concepts used to define the performance of an antenna will be described (isotropes, gain & directivity compared to isotropes, radiation resistance etc).

The study of collective motions and oscillations in plasmas. The course will cover how charged particles interact via electric and magnetic forces, and how this modifies the propagation of electromagnetic waves. The course will also cover how electromagnetic waves are reflected and mode converted by a plasma layer, and how a plasma layer can work as a wave guide for certain types of waves.

The course will cover some elements from kinetic theory based on the Vlasov equation for a collisionless plasma. The interaction between particles and waves, such as collisionless damping of electrostatic waves, trapping of particles in waves, and new wave modes in magnetic fields. Some instabilities due to particle beams in plasmas will also be discussed.

RECOMMENDED TEXT / READING

'Elecromagnetic Fields and Waves' Lorrain Corson Lorrain 'Microwave Engineering' Pozar 'Foundations for Microwave Engineering' Collin 'Field and Wave Electromagnetism' Cheng 'Introduction to Plasma Physics and Controlled Fusion, Volume 1' F. F. Chen 'Introduction to Plasma Physics' R. J. Goldston and P. H. Rutherford 'Waves in Plasmas' T. H. Stix 'The Earth's Ionosphere' M. C. Kelley 'Linear and Nonlinear Waves' G. B. Whitham

APPENDX 3 – Faculty of Science Degree Award Algorithm

Principles

1. Given that the SCQF (which underpins the University's General Regulations) is based on "Levels of Study" rather than "Years of Study", the algorithm should reflect this by being composed from credit weighted means of marks over "Levels of Study" rather than "Years of Study".
2. It is the mark at the first attempt at any class that is used in the calculation.
3. For all degrees (Honours and Integrated Masters) classes at the two highest levels of study will be included; i.e. normally Levels 3 and 4 for Honours and Levels 4 and 5 for Integrated Masters. Exceptionally, where a curriculum for the award of an honours degree includes level 5 classes these shall be included in the algorithm as if they were Level 4 classes where this is to the benefit of the student.
4. All classes at each appropriate level in the students required curriculum shall be included in the calculation unless a class is assessed only on a Pass/Fail basis in which case it is omitted from the algorithm.
5. The weightings of the marks in the Composite Mark Algorithm shall reflect the credit value of the class and also the level of the class to reflect the general consensus that the marks at the higher level of study should have significantly more bearing on the final outcome.
6. Any exception form the Faculty Final Assessment Composite Mark Algorithm must be approved by the Faculty Board of Study.

The Composite Mark Algorithm

The Faculty Composite mark Algorithm shall be

$$C = \frac{\sum w_i c_i m_i}{\sum w_i c_i}$$

where *ci* is the credit value of the class, *mi* is the percentage mark gained in the class.

For Honours Degrees the sum is over all level 3 and level 4 classes in a students required curriculum, and *wi* = 1 for level 3 classes and 3 for level 4 classes. Where a curriculum for the award of an honours degree includes level 5 classes these shall be included in the algorithm as if they were Level 4 classes where this is to the benefit of the student.

For Integrated Masters the sum is over all level 4 and level 5 classes in a students required curriculum, and *wi* = 1 for level 4 classes and 3 for level 5 classes.
Alternatively, denoting the credit weighted average (CWA) mark for level 3, 4 and 5 classes by *L*3, *L*4 and *L*5 respectively, this can be calculated **for Honours** by

$$C = \frac{mL3 + 3nL4}{m + 3n}$$

where *m* and *n* are the numbers of credits at Level 3 and Level 4 respectively; and **for** Integrated Masters by

$$C = \frac{mL4 + 3nL5}{m + 3n}$$

where *m* and *n* are the numbers of credits at Level 4 and Level 5 respectively.

Where a curriculum contains the **same number** of credits (normally 120) at both levels included in the algorithm, the calculation is equivalent to

For Honours:	0.25*L3 + 0.75*L4
For Integrated Masters:	0.25*L4 + 0.75*L5.

APPENDIX 4 – Prize Information

Prizes and Rubric for their Award

Astronomical Society of Glasgow Prize (£50)
Offered annually by the Astronomical Society of Glasgow for award to the most distinguished student in the final examinations for a BSc Honours or MSci degree in Mathematics or Physics.

2Professor James Blyth Memorial Prize (£15 in books)
Founded in 1908 by students and friends as a tribute to the memory of Professor James Blyth MA LLD FRSE Professor of Natural Philosophy in the Glasgow and West of Scotland Technical College from 1880 to 1906. Awarded to a meritorious student in the first year class in Physics.

2Kelvin Prizes (two: £45 in books or instruments)
Founded in 1962 by Mrs Hilda M Beilby, daughter-in-law of a former Head of the Governors of the Royal Technical College, Sir George T. Beilby LLD DSc FRS, to commemorate the name of her grand-uncle, Lord Kelvin. One prize awarded to a meritorious student in the final year of an undergraduate course in the Department of Mathematics and the other to a meritorious student in the final year of an undergraduate course in the Department of Physics.

2Malcolm Kerr Prizes (six: £15)
Provided by an endowment arising under the terms of the Deed of Settlement of the late Malcolm Kerr, stationer in Glasgow. Four prizes awarded to meritorious students in the first year class in Physics, and two to meritorious students in the first year class in Biology.

Frank Leslie Prize (£50)
Founded in 2000 by the Department of Mathematics, in association with the Department of Physics, in commemoration of the late Professor Frank M Leslie DSc FRSE FRS, Professor in the Department of Mathematics from 1979 to 2000. Awarded to a meritorious student in the final year of the joint honours BSc course in Mathematics and Physics.

A. S. McLaren Prize in Physics (£20)
Founded in 1978 by the former School of Mathematics, Physics and Computer Science as a memorial to Mr A S McLaren, Lecturer and Senior Lecturer in the former Department of Natural Philosophy from 1946 to 1977. Awarded annually on the recommendation of the Head of the Department of Physics to the student who achieves the best performance in the second year Physics Laboratory.

2Professor James Muir Prize (£18)
Founded in 1939 under an endowment by students and friends to commemorate Professor James Muir MA DSc ARCST FIntsP Professor of Natural Philosophy in the Royal Technical College from 1906 to 1938. Awarded to a meritorious student in the final year of the course for a BSc or MSci degree in Physics.

Fred Stern Memorial Prize
Founded in 1978 by students and friends as a tribute to the memory of Dr Fred Stern, Lecturer in the Royal College of Science and Technology from 1957 to 1964, and in the University of Strathclyde from 1964 to his death in 1977. Awarded, on the nomination of the Head of the Department of Physics, to students in that Department who have exceptionally distinguished themselves, either by attainment or improvement. The prize money shall be used for a purpose proposed by the recipient, and agreed by the Head of Department, but this shall always include a suitable book. The amount of the prize shall be determined by the Head of Department, by reference to the accumulated value of the endowment at the time.

Richard Thornley Memorial Prize
Founded in 1987 to the memory of Dr F R Thornley, lecturer in the University of Strathclyde from 1976 to his death in 1987. Awarded, on the nomination of the Head of the Department of Physics, to a third or fourth year undergraduate in the Department of Physics for written work dealing with a specific problem in Physics or Applied Physics, whose solution has social, moral philosophical, cultural, or technological implications. The work will be judged on both the discussion of these implications and on the depth of scientific understanding.

APPENDIX 5 – John Anderson Campus Building Codes

On the John Anderson Campus the codes are:

TG	Thomas Graham (formerly as 'C')
JA	John Anderson (formerly as 'K')
AR	Architecture (formerly as 'F/G')
Col	Colville
Cur	Curran
GH	Graham Hills (formerly known as 'P')
L	Livingstone Tower
HD	Henry Dyer
McC	McCance
R	Royal College
S	Stenhouse
JW	James Weir (formerly known as 'M')
SB	Strathclyde Institute for Biomedical Sciences (SIBS)

APPENDIX 6 – Final Year Project Key Dates

Project Timetables

PH450

Taken in 4th year by MPhys and BSc Physics.
Optional for BSc Physics with Teaching and BSc Mathematics and Physics students

14th September 2015 Project booklet available to students
Students will receive project handbook with project request page.

15th September – 29th September 2015 Students choose projects
Students should visit supervisors and draw up a shortlist of 3 potential projects in order of preference from 1 to 3. Each project request must be signed and dated by both the student and the supervisor and submitted to the student office, JA8.31.

4pm 29th September 2015 Deadline for submission of Project choice form to JA8.31

1st October 2015 Official start of Projects
Project allocations announced at 12 noon through Myplace. Students who have been unsuccessful in getting their choice of project will receive an updated booklet for a second round.

16th October 2015 Literature review complete
Students submit literature survey and a risk assessment for project. The literature review will usually take the form of the Final Report's introductory chapter.

27th November 2015 Completed safety form to be returned to JA 8.31 by this date

18th January 2016 Progress report with aims of project to be returned by students to JA 8.31 by this date

23rd March & 30th March 2016 Project Talks 1-5 pm in parallel Sessions
Each student will be given a 15-minute slot. The expectation is that students will talk about their project for 10 minutes and then be questioned by the audience for 5 minutes.

25th April 2016 Project reports submitted
Project reports to be submitted as Word or PDF format through MyPlace and then passed through Turnitin for plagiarism detection. In preparing the report, please be aware that supervisors can advise on up to 10 pages of material, to help with the style of writing and content, but not to correct physics.

Week beginning 23rd May 2016 Viva week
Each viva will be about 35 minutes long, with 5 minutes for the student to outline their project work and 30 minutes of questions about project content.

Project Information for Continuing 5th Year Students

PH 550

Taken in 5th year by MPhys Physics students. The expectation is that students will continue with the project started in 4th year.

1st September 2015 Project booklet to students requiring new projects

11th September 2015 Deadline for submission of Project choice form to JA8.31

Week beginning 21st September 2015 Meeting with supervisor during Week 1.

23rd October 2015 Progress report to be returned by students to JA 8.31 by this date

2nd December 2015 Project Talks 1-5 pm in parallel sessions
Each student will be given a 15-minute slot. The expectation is that students will talk about their project for 10 minutes and then be questioned by the audience for 5 minutes.

14th December 2015 Deadline for draft project paper to supervisor for feedback before 21st December 2015

8th January 2016 Project papers submitted
Project papers to be submitted as PDF format through MyPlace and then passed through Turnitin for plagiarism detection.

Week beginning 18th January 2016 Vivas
Each viva will be about 35 minutes long, with 5 minutes for the student to outline their project work and 30 minutes of questions about project content.

Contacts

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Notes:

Timetable – Semester 1

	9:00am–10.00am	10.00am–11.00am	11.00am–12.00pm	12.00pm–1.00pm	1.00pm-2.00pm	2.00pm-3.00pm	3.00pm-4.00pm	4.00pm-5.00pm
Monday								
Tuesday								
Wednesday								
Thursday								
Friday								

Timetable – Semester 2

	9:00am–10.00am	10.00am–11.00am	11.00am–12.00pm	12.00pm–1.00pm	1.00pm-2.00pm	2.00pm-3.00pm	3.00pm-4.00pm	4.00pm-5.00pm
Monday								
Tuesday								
Wednesday								
Thursday								
Friday								