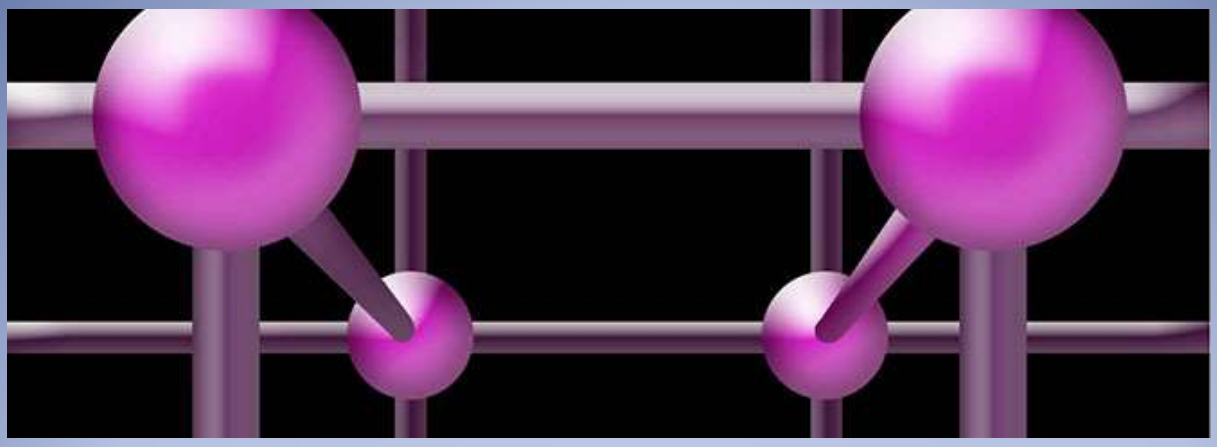
University of Glasgow | School of Physics & Astronomy



Postgraduate Taught Masters (MSc) handbook

Course Information Guide

MSc in Astrophysics; MSc in Physics: Advanced Material; MSc in Physics: Energy and Environment; MSc in Physics: Nuclear Technology; MSc in Quantum Technology; MSc in Sensors and Imaging Systems; MSc in Theoretical Physics.

Contents

1 Welcome statement from Head of School

As the Head of School of Physics and Astronomy, I would like to welcome you to your chosen MSc programme. The School prides itself in providing an excellent and supportive learning and teaching environment that is fully integrated with our research: in your lectures, laboratories and project work you will have the opportunity to interact with world-leading researchers working at the cutting edge of a wide range of fields of physics and astronomy, who are tackling some of the biggest contemporary challenges in science and technology.

All of our undergraduate degree programmes and most of our postgraduate taught masters programmes are accredited or recognised by the Institute of Physics and our teaching was highly commended in our most recent Periodic Subject Review by the Senate of the University. Our teaching has also attracted enthusiastic endorsement in recent years from our students in the National Student Survey and other surveys and barometers.

The School is firmly committed to supporting equally the careers and development of all its students and staff, as exemplified by our receipt of an Athena Swan Silver award for our support of women's careers. We value the diversity of our student body and recognise that this diversity improves the quality of our work by allowing students to bring a range of skills and viewpoints to inform and enhance their collective achievements. We therefore expect that all staff and students will work productively and professionally together in an atmosphere of mutual respect.

To support this, all our staff and graduate students undertake equality and diversity training, our lab guides include a code of conduct for students, supplementing the University policy https://www.gla.ac.uk/myglasgow/senateoffice/studentcodes/staff/studentconductstaff/, and we support the University's Dignity at Work and Study policy https://www.gla.ac.uk/myglasgow/humanresources/equalitydiversity/dignityworkstudyover/. You can be assured that any instances of bullying, harassment, or offensive language or behaviour will be both taken seriously by the School and treated with sensitivity. Points of support for students are your adviser of studies, your Class Head and Lab Head, and in addition the School has two appointed Equality and Diversity offices (currently Mrs Angela Eden and Prof Stephen McVitie), to whom students may speak in confidence.

Although many of our classes are large in number, our teaching staff are friendly and approachable; if you have any questions about your course please don't hesitate to speak to them. They will do their very best to help.

I hope that you enjoy your time with us in the School of Physics and Astronomy and I wish you success with your current and future studies.

Best wishes

Professor Martin Hendry

Head of School

2 Introduction and General Information

This Course Information Guide aims to provide specific information relevant to students enrolled on one of the MSc programmes offered by the School of Physics and Astronomy. Important information and updates throughout the year will be announced via the Physics and Astronomy MSc Moodle site: http://moodle2.gla.ac.uk/course/view.php?id=4318.

The University of Glasgow Calendar is the annual publication of University degree regulations and other information and regulations which cover fees, student codes, assessment and examinations. The Calendar is available on-line at http://www.gla.ac.uk/services/senateoffice/policies/calendar/.

2.1 Key personnel

MSc Convenor and Class Head	Dr Nicolas Labrosse	Nicolas.Labrosse@glasgow.ac.uk
MSc Project Co-ordinator	Dr Johannes Courtial	Johannes.Courtial@glasgow.ac.uk

2.2 Class representative

The University of Glasgow values students' views on the running of the courses. Within the School of Physics and Astronomy we hold two staff-student liaison committee meetings (one per semester). We invite MSc students to nominate themselves by emailing the MSc Convenor **before the end of the second week of teaching in Semester 1** to represent the Physics and Astronomy taught postgraduate students at these meetings. There will be one representative at these meetings. If more than one student volunteers, we will hold an election.

Find out how you can provide the University with feedback on your experience as a student at Glasgow: https://www.gla.ac.uk/myglasgow/senateoffice/qea/studentengagement/studentrepresentationmyclassreps/

2.3 Course credits

MSc students normally undertake a total of 180 course credits, of which at least 150 are at Masters level. 120 credits of lecture courses are normally taken over Semester 1 and/or Semester 2, and the 60-credit MSc Project is normally done over the Summer period.

All Taught Postgraduate students are required to take the Academic Writing Skills Programme – a writing diagnostic designed to allow you to get the most out of your academic writing. You will be invited to take part by e-mail.

2.4 Study mode

Our MSc programmes are open for registration on a full-time or part-time study mode. Part-time postgraduate students should be cognisant of the time commitment and attendance flexibility required. Part-time study mode brings in opportunities and challenges. If you want to know more about part-time study mode, speak to your Advisor of Studies.

2.5 University Session Dates

University session dates are set out at http://www.gla.ac.uk/services/senateoffice/sessiondates/.

3 Course Description

The MSc programmes intended learning outcomes, methods of content delivery, and range of assessment methods, are described in the appendix.

3.1 Course materials

The recommended course books are normally given at the start of teaching by lecturers. The Reading List tool of the University Library can also be used to find the list and location of recommended text books.

3.2 Degree award

The conditions of award of a Masters degree in Science are governed by the Generic Regulations for Taught Masters Degrees. To be awarded the MSc degree, you need:

i. a grade point average of 12 (equivalent to C3) or above in the taught courses, with at least 75% of these credits at grade D or above, and all credits at grade F or above
ii. a grade D or better in the 60-credit MSc project

Note that to progress to the MSc Project, students normally need to satisfy condition i) above.

Application of Discretion when determining the awards of Merit and Distinction on taught Masters degrees: in accordance with the Code of Assessment, the generic regulations for taught Masters degrees stipulate

that:

9.2 A candidate will be eligible for the award of Merit on achieving at the first attempt:

a) a grade point average of 15 (equivalent to B3) or above in the 180 or more credits completed on the programme, and

b) a grade point average of at least 14 (equivalent to C1) in the taught courses, and

c) a grade of at least C1 in the substantial independent work.

9.3 Where a candidate has satisfied the requirements set out at §9.2 (b) and (c), and their grade point average for the 180 or more credits completed on the programme at the first attempt falls within the range 14.1 to 14.9 the Board of Examiners shall have discretion to make the award with Merit.

9.4 A candidate will be eligible for the award of Distinction on achieving at the first attempt:

a) a grade point average of 18 (equivalent to A5) or above in the 180 or more credits completed on the programme, and

b) a grade point average of at least 17 (equivalent to B1) in the taught courses, and

c) a grade of at least B1 in the substantial independent work.

9.5 Where a candidate has satisfied the requirements set out at §9.4 (b) and (c), and their grade point average for the 180 or more credits completed on the programme at the first attempt falls within the range 17.1 to 17.9 the Board of Examiners shall have discretion to make the award with Distinction.

Where a candidate's overall GPA falls within one of the zones of discretion determined in regulations 9.3 and 9.5 of the generic regulations for taught masters degrees, the course grade profile of the candidate will be reviewed – taking account of course credit weighting - and if 50% or more of credit fall in the higher classification, the candidate's degree classification may be promoted. The grade achieved in the dissertation or other independent work will not be taken into account when considering course grade profile.

Specifically, the following rules will be used:

- If GPA $\geq$ 17.5 (14.5), and grade profile $\geq$ 50%, the student will be promoted to Distinction (Merit).

- If GPA < 17.5 (14.5), and grade profile $\geq$ 50%, the student will be promoted to Distinction (Merit) if there are no grades below C (D).

Personal circumstances/good cause claims are not a permitted criterion in the exercise of discretion for final awards.

3.3 How to get the best from your studies

Apart from the general advice to carefully think about study strategies, including turning up to lectures, tutorials, supervisions, doing your homework, keeping on top of new information, you can always get in touch with one of the key people listed in Section 2 of this document, or with your Advisor of Studies, or with your course lecturers, regarding any problem that you may have.

Note also that the University provides a high level of support to students on a range of topics (e.g. health, finance, careers, accommodation), and you can find out more at http://www.gla.ac.uk/studentlife/support/.

The Learning Enhancement & Academic Development Service (LEADS) offers a range of advisers in the student-facing side of LEADS, who provide in-course teaching, optional classes, and one-to-one appointments on a range of topics related to the subject-specific content of the University's degrees.

Students in Science & Engineering can make an appointment or come to a class with the Effective Learning Adviser for the College to talk about anything related to their academic work. You can receive tailored effective learning advice from the College Effective Learning Adviser: see http://www.gla.ac.uk/myglasgow/leads/students/writingstudyadvice/scienceengineering/.

4 Attendance and Adverse Circumstances

Sometimes, adverse circumstances prevent students to fulfil the course requirements. If you miss an examination or an assessment deadline, or if you believe your assessment performance has been affected by adverse circumstances, you should submit a Good Cause Claim, and this must be via MyCampus.

Submission of a Good Cause Claim is the mechanism that allows your circumstances to be considered by the Board of Examiners. Please note all Good Cause Claims must be submitted within one week of the date of the affected assessment.

Students should note that the University's Code of Assessment allows grades to be awarded only on the basis of demonstrated work. So, if you feel that some piece of assessed work has been affected by adverse circumstances, and if staff agree, then the only course of action available is for the grade for that piece of work to be set aside (in the case of continuously assessed work and Class Tests) or to allow a resit (in the case of Degree Exams) – marks cannot be adjusted.

To submit a Good Cause Claim on MyCampus:

1. Go to the 'Student Centre' and select My Good Cause from the Academics menu.
2. Select the relevant course(s).
3. Complete the report in MyCampus (there is provision for particularly sensitive information to be provided separately, outwith the system, but a claim report must still be entered into MyCampus).
4. Add supporting evidence by uploading documents. (Scanners are available on level 3 of the University Library.) It is the responsibility of the student to keep all original documentation and submit it to the Class Head on request.

If you encounter any difficulties with this process, please contact the Class Head and your Advisor of Studies immediately to let them know you have a problem with your Good Cause Claim.

What will happen to your Good Cause Claim?

The Course Administrator and/or Class Head will ensure that your claim is considered and this will be in accordance with the section of the Code of Assessment which covers incomplete assessment and good cause (paragraphs 16.45 to 16.53). The outcome of your claim will be posted into the Approval Information section on your Good Cause Claim in MyCampus. If it is accepted that your assessment was affected by good cause, the work in question will be set aside and you will (as far as is practicable) be given another opportunity to take the assessment with the affected attempt discounted.

For absences that are significant but for which a good cause claim is not being filed, students must complete a MyCampus absence report. A significant absence is defined to be:

- an absence of more than seven consecutive days during working periods
- an absence of any duration if it prevents a student from for example fulfilling any minimum requirement for the award of credit (e.g. missing attendance at one day of a two-day laboratory, but where the work was nonetheless submitted and therefore not involving a Good Cause claim).

All potentially significant absences should be reported as soon as is practical, by completing part 1 of the MyCampus absence report. Part 2 of the MyCampus absence report should be completed on return to university. The normal submission deadline for the completed absence report is 7 days after return to university. Documentary evidence is required when reporting any significant absence.

See also the Senate Office Absence Policy:
http://www.gla.ac.uk/services/senateoffice/policies/studentsupport/absencepolicy/

5 Plagiarism

The University of Glasgow's degrees and other academic awards are given in recognition of a student's personal achievement. Consequently, the University takes the issue of plagiarism very seriously. The University definition of plagiarism is:

"The incorporation of material without formal and proper acknowledgement (even with no deliberate intent to cheat) can constitute plagiarism. Work may be considered to be plagiarised if it consists of: a direct quotation; a close paraphrase; an unacknowledged summary of a source; direct copying or transcription".

Students are asked to make themselves familiar with what is meant by plagiarism and how to avoid it by reading the University of Glasgow Plagiarism website available from http://www.gla.ac.uk/plagiarism/. That website will help you understand what plagiarism is and how to avoid it through good academic practice. The following explanation is taken from that website, but again you are strongly encouraged to explore it and read in more details the University's advice on how to avoid plagiarism; what happens if you plagiarise; how to test yourself; where to seek help; and more advice based on frequently asked questions.

The important principle behind assessment is that it is your ideas and your ability to critically evaluate information that are being assessed, not anyone else's ideas or work. What this means is that any information or ideas which aren't yours must be acknowledged.

It is important you understand what plagiarism is, and how to avoid it, because the University doesn't distinguish between intentional and unintentional plagiarism, so a mistake, poor academic practice or submitting an early draft that you were intending to work on further will all be investigated in the same way and would all be considered plagiarism.

All of the following are against University rules:

- submitting work containing quotes or ideas taken from someone else's work, or similar wording to someone else's work without referencing that other work. Even incomplete acknowledgement or poor referencing can constitute plagiarism
- submitting work written by someone else, but presenting this as your own work
- inappropriate collaboration with others (collusion)

- submitting work which has been copied from somewhere else – this also includes where text has been replicated by retyping and
- submitting the same piece of coursework, or a substantial part of the same coursework more than once for the purpose of coursework assessment. This is the case even if this was all your own work initially (this is called 'auto-plagiarism' or 'self-plagiarism') as it could be deriving double credit for a single effort
- submitting work purchased from essay writing services

The number of companies offering essay-writing or proofreading services has increased. These external organisations can trick you into accidentally plagiarising by crossing the boundary from proofreading into rewriting and leading to you submitting work written by someone else.

The University strongly discourages the use of proofreading and essay-writing companies by students.

You are encouraged to report commercial essay-writing services publicity on University premises to the Senate Office. You should be extra vigilant when asking for assistance from anyone other than a member of University staff.

6 University Complaints Procedure

We hope you will be happy in your studies here.

If things are not going well, then please raise issues of any kind that are affecting your studies. Talk to the MSc Convenor, to teaching staff, or to your Adviser of Studies, as early as you can so that we can help.

The University is committed to providing an excellent educational experience for our students and high-quality services to all other service users of the University.

The University has a duty to maintain and enhance the quality of its provision and to provide an effective system for handling complaints. The University has a Complaints Procedure which allows complainants to raise matters of concern without fear of disadvantage and in the knowledge that privacy and confidentiality will be respected.

Anyone who has followed the University's Complaints Procedure and remains dissatisfied with the University's final response may seek Independent External Review of their complaint by contacting the Scottish Public Services Ombudsman. See http://www.gla.ac.uk/services/senateoffice/studentcodes/students/complaints/ for further guidance.

Remember that the Students' Representative Council Advice Centre is available to provide advice and assistance if you are considering making a complaint. (Tel: 0141 339 8541; e-mail: advice@src.gla.ac.uk)

7 School information

7.1 Out-of-hours access

A swipe card for out-of-hours admission to the Kelvin Building if desired can be obtained from Mr Peter Barbour, School Superintendent (Room 515b).

7.2 Student societies

The University of Glasgow Physics Society ("PhySoc") aims to promote an interest in all things physical. They organise events including a couple of "Beer and Donuts" nights, Christmas Ceilidh, Sport Tournaments, a guest lecture series, quotes competition, "women and cakes" coffee event, quiz nights and much more.

Glasgow University Astronomy Society ("astrosoc") is a student academic society at the University of Glasgow which promotes the science of astronomy through guest lectures and events, and also arranges social events both for astronomy students and for anyone else at Glasgow University who is interested in astronomy. They organise guest lectures and observing evenings throughout the academic year in addition to social events, including a Burns Supper.

8 Getting help and advice

The University of Glasgow hosts many student services, including counselling and study advice. If you need help and advice, you can

- Visit http://www.gla.ac.uk/students/
- If you are not sure what service you require or what is available to you, visit the Student Service Enquiry Team on Level 2 of the Fraser Building, who can help you select the correct service for your enquiry
- Talk to your Advisor of Studies.

8.1 Health and wellbeing

If you feel distressed, you should seek help from mental health support workers. The University supports students at its Counselling and Psychological Services. You can visit their web pages and contact them as follows:

Location: 67 Southpark Avenue, Glasgow G12 8LE
Telephone: +44 (0) 141 330 4528
Email: studentcounselling@glasgow.ac.uk

The UK's student mental health charity Student Minds also offers support and resources.

9 Finding your way on campus

See also http://www.gla.ac.uk/locations/

Appendix

1 Appendix: Course Component Details

Depending on which programme you are on, you will be expected to take a combination of compulsory and optional courses. You should refer to the programme specification documents, consult the course catalogue, and discuss with your Advisor of Studies to select your courses. The following contains information which is common across most programmes but it is not an exhaustive list of core / optional courses.

1.1 MSc Project (PHYS5021P)

All MSc students will select the MSc Project. This is a 60-credit project normally carried out in the summer period (June-August). This course provides students with an opportunity to carry out an extended, in-depth research project embedded within one of the School of Physics and Astronomy's internationally-leading research groups. Under some circumstances, this project may also be carried out in the premises of specific external partners.

By undertaking the MSc project, students will gain, within a first-class training environment, subject-specific and generic skills that will form an excellent foundation for a career of scientific leadership in academia and industry. The course aims are:

1) To provide advanced training and experience in the principles and practice of experimental, computational and/or theoretical (astro-)physics, using advanced instrumentation, methodology and software as appropriate, and in the critical analysis of experimental data.
2) To develop problem solving abilities, critical assessment and communication skills, to a level appropriate for a career of leadership in academia or industry
3) To employ these skills in preparing and writing a dissertation on an extended and demanding project.
4) To encourage students to work effectively, to develop a professional attitude to what they do and to take full responsibility for their own learning.

Progression criteria to the MSc project

The generic regulations for Taught Masters degrees state that before students can progress to the dissertation, they must achieve an overall GPA of at least 12.0 in the programme's taught courses, with at least 75% of the grades at or above 9 and no grades below 3 (on the 22-point scale). In practice, students are required to start work on the dissertation in the beginning of June before the relevant examination boards have met, i.e. before the course grades are published and the final GPA for the taught courses is confirmed. Some students will commence work on the dissertation but may subsequently be found to have not met the progression criteria. Masters degrees cannot be awarded where the progression criteria stated above are not met. Students will normally be asked to focus on resit examinations to improve their performance and meet the progression criteria: if successful, they will be allowed to carry out their MSc Project at a later time, normally immediately after confirmation that all progression criteria have been fully met. Students may exceptionally be allowed to progress to the MSc project if there is a reasonable prospect that they will meet

the progression criteria after taking up to two resit examinations in August. The decision is taken by the relevant Examination Board and is subsequently communicated to the student by the Course Convenor.

Intended Learning Outcomes

At the end of the course students should be able to:

1) Recover, evaluate and summarise the professional literature and material from other sources concerned with a chosen area of physics or astronomy
2) Prepare a written analysis of the current position in the chosen area, which should include a critical comparison of material from the sources he/she has identified and a summary of likely future developments.
3) Define, with the help of colleagues and taking into account the time available, a suitable area of work for a project and hence make a preliminary definition of goals to be achieved during the project
4) Make an appropriate safety assessment for the work proposed; with the help of colleagues, analyse what experimental/theoretical/computational methods might be necessary to achieve the goals of the project and hence decide how the project tasks should be organised
5) Perform the practical part of the investigation, taking due account of experimental errors of measurement and possible assumptions and approximations in analytical and computational work as appropriate
6) Revise the goals and strategies for completion of the project in the light of results achieved and difficulties encountered.
7) Write a report on an extended piece of project work, which should include a critical evaluation of the significance of the work and how it compares with work done in the same area, both within the local area and as reported in the general scientific literature
8) Prepare an abstract of the work performed of length about 250 words in the accepted scientific format.

Assessment

The MSc project is assessed by:

- an interim oral presentation demonstrating progress made in the project (10%). The oral presentation will be given in week 9 of the project period in front of academic staff and MSc students.
- the detailed project dissertation, submitted after completion of the project work (40%), i.e. after week 13 of the project period. The dissertation should be uploaded on the MSc Project Moodle site as a PDF document, and no hardcopy is required to be handed in.
- the student's performance during the project assessed by the project supervisors (50%).

Guidance on how to prepare for the MSc project report and oral presentation is given on the MSc Project Moodle site. Feedback on your performance will normally be given within 15 working days of the relevant assessment component.

How to choose your project?

A list of possible projects will be offered during Semester 1. However, students are strongly encouraged to approach academic staff members to discuss project ideas. Therefore, students should start thinking early on in the year about what particular area of research they would like to work on. A good starting point is to visit the School's research pages and read about the expertise and interests of members of staff. A list of MSc projects offered in the past can also be found on the MSc Project Moodle site to give an indication of potential research topics / supervisors. Feel free to approach staff members with specific requests related to the MSc project.

1.2 Students on the Quantum Technology MSc programme

These students are expected to take the following compulsory courses from the School of Physics & Astronomy:

1.2.1 Experimental Techniques in Quantum Optics (PHYS5056)

This is a 10-credit M-level course, normally taken in Semester 1. The scope of this course is to provide an introductory overview to some of the basic techniques that are commonly used in a quantum optics lab.

The course aims are to provide students with an opportunity to develop knowledge and understanding of the key physical principles underpinning widely used techniques in quantum optics. In particular students will cover practical sessions in the following areas:

1) generation of entangled photon pairs
2) single photon detection techniques and measurement of photon entanglement
3) ghost imaging
4) Hong-Ou-Mandel interferometry

Lectures will also involve home-reading of original scientific articles that will be assigned during the course. Time slots will then be devoted during each lecture to discuss these articles.

Following the lectures, a series of lab-based experiments will be carried out with the aim of investigating specific aspects of the technologies discussed during the lectures. These will be group-based projects (3-4 students max per project) with the expectation that each group will perform at least 2 out of 4 of the planned experiments.

Intended Learning Outcomes

By the end of this course students will be able to:

1) Describe how the basic elements of a quantum optics experiment work; photon pair generation and single photon detection
2) Describe the basic operating principle of a single photon avalanche diode
3) Describe the physical concepts underlying the Hon-Ou-Mandel interferometer
4) Describe the operating principle of ghost imaging and how to build a ghost imaging setup using both a quantum light source and a classical light source
5) Describe at least one approach to analysing the degree of entanglement between two photons
6) Demonstrate a quantum optics setup which utilises either entangled photon pairs, single photon detection techniques or ghost imaging

7) Describe how the basic elements of a quantum interferometer work, being able to explain the idea of shot noise squeezing.

Assessment

- Continuous assessment from the students writing up formal records of the 2 out of 4 practical exercises (50%). This will be examined via a short oral examination within the lab session, and looking at the student labbooks
- Dissertation on a research paper which has been introduced during the lecture module (25%)
- End of course oral examination to test knowledge (25%). This will be marked by academics.

1.2.2 Fundamentals of Sensing and Measurement (PHYS5044)

This course is described in Section 1.3.1 of this Appendix.

1.2.3 Advanced Data Analysis (PHYS5001)

This course is described in Section 1.4.2 of this Appendix.

1.3 Students on the Sensor and Imaging Systems MSc programme

Students on this programme should enrol onto Semester 2 classes in September once they've registered at the University of Edinburgh and will meet their personal tutor from Edinburgh at the start of Semester 2.

These students are expected to take the compulsory Semester 1 courses:

1.3.1 Fundamentals of Sensing and Measurement (PHYS5044)

This is a 20-credit M-level course, normally taken in Semester 1. Students will receive training in fundamental aspects of sensing and transduction across all modalities and the generalised concepts and parameters pertinent for transduction of physical phenomena into an electrical signal. The course will provide instruction in the characteristics of sensing and measurement across domains that will enable students to appraise and select appropriate task-specific sensing and imaging modalities and to be able to design and model high-level systems. The course aims are

1) To provide training in fundamental and general concepts in transduction and sensing
2) Familiarise the student with the salient characteristics of sensing across the main physical domains of electromagnetism (radio, optical), electrical, magnetic, ionising radiation, gravitational, biological, chemical
3) To develop understanding of transduction in electrical signals and signal conditioning
4) To provide understanding of the process of imaging with sensing
5) To provide training in solving problems associating with sensing and imaging

Intended Learning Outcomes

By the end of this course students will be able to:

2) Propose and assess a range of solutions to a sensing and imaging problem against pertinent criteria
3) Analyse and evaluate data provided by a range of sensors and imaging systems
4) Demonstrate an understanding of the fundamental limitations of a range of sensing and imaging techniques.
5) Demonstrate an understanding of the physical origins of phenomena to be measured

Assessment

- Written examination, comprising compulsory short questions and a choice of 1 from 2 long questions (70%)
- Written reports on one problem-based group project and individual project (20%)
- Oral presentation on problem-based project (5%)
- One individual assignment (5%)

1.3.2 Circuits & Systems (PHYS4003)

This is a 10-credit H-level course normally taken in Semester 1. The course aims are to provide students with an opportunity to develop knowledge and understanding of the key principles and applications of Circuits & Systems, and their relevance to current developments in physics.

Intended Learning Outcomes

By the end of the course students will

1. be able to demonstrate a knowledge and broad understanding of Circuits and Systems
2. be able to describe and analyse quantitatively processes, relationships and techniques relevant to the topics included in the course outline, applying these ideas and techniques to solve general classes of problems which may include straightforward unseen elements
3. be able to write down and, where appropriate, either prove or explain the underlying basis of physical laws relevant to the course topics, discussing their applications and appreciating their relation to the topics of other courses taken.

Assessment

Unseen examination in the main (April / May) exam diet.

1.3.3 Note on treatment of failed courses or missed assessments

The MSc in Sensor and Imaging Systems is delivered and awarded jointly by the Universities of Glasgow and Edinburgh. When students are enrolled on a specific course from either University, their studies are governed by the regulations of the relevant university. It is therefore important to make yourself fully aware of similarities and differences between the two universities. For example, when it comes to failed courses or missed assessments, students on the MSc in Sensor and Imaging Systems will be treated for Semester 1 courses under Glasgow rules, and for Semester 2 courses under Edinburgh rules. The Glasgow rules only are discussed in the rest of this document.

1.4 All other MSc students

In addition to programme-specific compulsory courses, all other MSc students are expected to take the following compulsory courses:

1.4.1 Research Skills (PHYS5015)

This is a 10-credit M-level course normally taught in Semester 1[1]. It provides students with an opportunity to develop generic scientific writing and presentation skills. The course aims are

1) To develop critical assessment and communication skills, to a level appropriate for a career of leadership in academia or industry
2) To employ these skills in preparing and delivering a written report and oral presentation on a chosen research topic
3) To encourage students to work effectively, to develop a professional attitude to what they do and to take full responsibility for their own learning.

Intended Learning Outcomes

At the end of the course students should be able to:

1) Recover, evaluate and summarise the professional literature and material from other sources concerned with a chosen research topic in physics or astronomy.
2) Prepare an oral presentation summarising the current position in the chosen research topic.
3) Prepare a written literature review on the current position in the chosen research topic, which should include a critical comparison of material from the sources he/she has identified and a summary of likely future developments.

Assessment

The assessment of the Research Skills course takes place normally in early January and is split equally between an oral presentation (20 minutes) and a detailed scientific review (approx. 2000 words) on a current research topic in physics or astronomy. Feedback on your performance will normally be given within 15 working days after the report submission deadline / oral presentation.

1.4.2 Advanced Data Analysis (PHYS5001)

This is a 10-credit M-level course, normally taught in Semester 2. This course provides a comprehensive introduction to the principles and practice of advanced data analysis, with particular focus on their application in physics and astronomy and on the growing use of Bayesian Inference methods in these fields. The course aims are

1) To acquire a working knowledge of advanced data analysis methods – i.e. to a level sufficient to permit their successful application to real data analysis problems, as would be encountered in students' own research projects.
2) To develop awareness of the current literature on advanced data analysis for the physical sciences, and the software available to support its application to real problems.

Intended Learning Outcomes

At the end of the course students should be able to:

[1] MSc students starting in January may choose to select the 20-credit M-level Physics Literature Project (PHYS5047P) course instead of Research Skills.

1) Describe qualitatively the theoretical foundations of the nature of probability, in the context of both a frequentist and Bayesian framework.
2) Define what is meant by a probability density function (pdf), and cumulative distribution function (cdf), as well as various descriptive statistics (e.g. mean, median, mode, moments, variance, covariance) used to characterize pdfs and cdfs.
3) Apply the principles of least squares and maximum likelihood to formulate and solve line and curve model fitting problems – using a matrix formulation where appropriate, and adapting the formulation to various cases and approximations (e.g. weighted least squares, correlated errors, non-linear problems).
4) Describe and apply the basic concepts of frequentist hypothesis testing, using the chi-squared goodness-of-fit test as an archetypal example.
5) Define in a Bayesian context the likelihood, prior and posterior distributions and their role in Bayesian inference and hypothesis testing, contrasting Bayesian and frequentist treatments of hypothesis testing.
6) Define the evidence and explain its role in Bayesian model selection, describing several numerical approximations to the evidence and their applicability.
7) Describe and apply data compression techniques for analysis of very large data sets, including singular value decomposition and principal component analysis.
8) Describe and apply efficient numerical techniques for generating random numbers and performing Monte Carlo simulations, including Markov Chain Monte Carlo methods for parameter estimation and model selection in problems of high dimensionality.

Assessment

Normally, assessment is split equally between practical exercises and homework assignments, and a final report on the mock data challenge. Feedback on your performance will normally be given within 15 working days of the final report submission.

1.5 Other courses

1.5.1 Glasgow University courses

In addition to the compulsory courses described above, all students are expected to choose from a range of core or elective courses within the University's Course Catalogue to satisfy the required number of credits and the programme requirements. Students can enrol on a range of courses offered by the School of Physics and Astronomy, as well as other Schools from the College of Science and Engineering, depending on their programme requirements, background experience, and objectives. This can be done via MyCampus. When in doubt, students should discuss their syllabus with their Advisor of Studies.

1.5.2 SUPA courses

If your individual timetable permits, you can choose from a range of SUPA (Scottish Universities Physics Alliance) postgraduate courses that can be taken by going to the (video-conferencing) SUPA room on level 2 in the Kelvin Building. Although they physically take place in various Scottish Physics departments, anyone can attend thanks to the video-conferencing facilities. Not that most of these courses cannot normally be taken into account in your syllabus towards the necessary 180 credits.

In order to be able to access relevant resources, students should visit the My.SUPA website (http://my.supa.ac.uk) and click the 'Request A My.SUPA Account' link at the top of the page. Once account details have been obtained, students need to register with SUPA for the SUPA courses that they are taking. Timetables can be obtained from that website as well.

1.6 Intended Learning Outcomes

The MSc programmes provide opportunities for students to develop and to demonstrate knowledge and understanding, skills, qualities and other graduate attributes as follows.

1.6.1 Knowledge and Understanding:

By the end of this programme students will be able to:

- Explain the fundamental theoretical, computational and experimental principles that underpin modern Physics, Engineering, and Technology;
- Explain the key physical principles of some elective topics relevant to research challenges in the chosen areas of study;
- Discuss current research themes in the chosen areas, explaining as appropriate the relevance of advanced mathematical, experimental, computational and data analysis methodology to their study.

1.6.2 Skills and Other Attributes:

By the end of this programme students will be able to:

Subject-specific/practical skills

- Programme straightforward and complex procedures in a high level computer language and use computers to solve physical problems;
- Plan and carry out computational modelling and investigations, using standard and complex or advanced programming or computational techniques, of complex physical systems or processes, demonstrating logic, initiative, planning and decision making skills in solving problems encountered;
- Plan and carry out experimental investigations, using standard and complex or advanced experimental equipment and apparatus, of complex physical systems or processes, demonstrating logic, initiative, planning and decision making skills in solving problems encountered;
- Analyse, interpret and critically evaluate practical data, simulations and models, make a quantitative evaluation of the errors inherent in the physical observables and draw valid conclusions from the results of practical investigations;
- Apply computer software to analyse data and to write scientific reports;
- Recover, evaluate and summarise the professional literature and material from other sources concerned with a chosen area of physics and prepare a written analysis of the current position in the chosen area, which should include a critical comparison of the material and a discussion of likely future developments;
- Plan the course of action required to achieve self-defined goals in an open-ended, extended physics project;
- Make appropriate safety assessments for experimental procedures.

Intellectual skills

- Describe and analyse quantitatively processes, relationships and techniques related to the areas covered in the contributory courses;
- Write down, and where appropriate either prove or discuss the underlying basis of, physical laws related to topics in these areas;
- Analyse critically, and solve using appropriate mathematical tools, advanced or complex problems, which may include unseen elements, related to topics included in the course component outlines;
- Demonstrate a critical awareness of the significance and importance of the topics, methods and techniques discussed in the lectures and their relationship to other concepts in courses which have been taken.

Transferable/key skills

- Give an oral account of practical work performed and conclusions drawn from it;
- Prepare a detailed written report on a practical investigation;
- Apply logical analysis to problem solving;
- Make a preliminary definition of goals to be achieved during open-ended project work and revise these goals and strategies for completion of the work in the light of results achieved and difficulties encountered;
- Write a report on an extended piece of project work, which should include a critical evaluation of the significance of the work, and how it compares with earlier work done in the same area;
- Prepare an abstract of practical or project work performed in the accepted scientific format;
- Prepare and present audio-visual presentations and posters summarizing the results of a project;
- Appreciate open problems typical of business situations;
- Interact positively with colleagues in a group context;
- Apply team-working skills to address a complex physics problem and contribute significantly to the work of a group tackling such a problem, combining their own work constructively with the work of others;
- Contribute to the management of a group engaged in project work;
- Combine with colleagues to prepare and deliver a presentation and report of group work.

1.7 Content delivery

Each MSc programme in Physics & Astronomy contains a combination of compulsory and elective (optional) lecture courses. Lecture courses are either 10 or 15 credits and comprise 18 or 27 contact hours respectively. Most Astronomy lecture courses are 15 credits whereas most Physics courses are 10 credits. In addition, students studying for the MSc in Sensor and Imaging Systems will take 20-credit courses that will include a range of contact hours. Courses are normally either at Masters level (M-level) or at Honours level (H-level). M-level courses are of a higher standard and provide a deeper level of knowledge.

The programmes will draw upon a wide range of approaches to learning and teaching:

Knowledge and understanding:

- Lectures and class tutorials
- Small group supervisions
- Practical and project work
- Private study

Intellectual skills:

- Lectures and class tutorials
- Small group supervisions
- Practical work, including IT laboratory
- Private study

Subject-specific/practical skills:

- Practical work, including IT laboratory
- Individual and group project work

Transferable/key skills:

- Extended theoretical project
- Small group supervisions

1.8 Assessment

The programmes will employ a wide range of assessment methods:

Knowledge and understanding:

- Written examinations
- Verbal and written reports of practical and IT work
- Multiple choice questions

Intellectual skills:

- Written examinations
- Verbal and written reports of practical and IT work
- Multiple choice questions

Subject-specific/practical skills:

- Verbal and written reports of practical and IT work
- Verbal, written and poster presentations of project work

Transferable/key skills:

- Verbal and written reports of practical and IT work
- Oral and written presentations of Group project work, and assessments by supervisors
- Written and poster presentations of project work, and assessment by supervisors

Students will be awarded separate results for each lecture, laboratory, workshop or project course on the University 22-point scale. Results for all contributing courses will be averaged, weighted by the appropriate number of course credits, in order to determine the overall result for each student's degree programme. The credit-weighted averaging of individual course grades will be calculated using numerical values (on the 22-pt scale) taken to one decimal place.

Extensive information about assessment, and a guide to understanding the marking system, are provided at http://www.gla.ac.uk/services/senateoffice/policies/assessment/codeofassessment/. In addition, students are strongly encouraged to refer to the definitive version of the Code of Assessment published in the University Calendar in Section 16 of the Fees and General Information Section (see link above).