MSc/Diploma in Applied and Modern Optics

Awarding Institution:	The University of Reading
Teaching Institution:	The University of Reading
Faculty of Science	Programme length: 12 months full time, also part-time options
For students entering in 2004	Date of specification: April 2002
Programme Director:	Dr John Macdonald, Department of Physics
Board of Studies:	Physics Postgraduate Board of Studies
Accreditation:	--
Web site:	http://www.rdg.ac.uk/physics/optics.htm

Summary of programme aims

The aim of the MSc course in Applied and Modern Optics is to equip graduates in the physical sciences with the skills, techniques, and basic knowledge of a well rounded and independent optical engineer with an intended career in the field of optics. It is the aim of the Diploma course to transfer the basic skills and techniques of an optical engineer to the students, but without requiring the standard of MSc students in the area of working under one's own initiative.

Transferable skills

Using Excel spreadsheets; experimental design and data handling; mathematical methods; experimental techniques; report planning and writing; presentation skills; managing a project.

Programme content

Students must take the three core modules PHMDA1, A2, A3 (50 credits) and a selection of the option modules (penultimate character in module code = B) to total a further 70 credits. The MSc then additionally involves a dissertation project worth 60 credits.

Module code	Module title	Credits	Level
PHMDA1	Introduction to waves and optics	20	M
PHMDA2	Introduction to optical design	20	M
PHMDA3	Support skills	10	M
PHMDB1	Advanced optical physics	10	M
PHMDB2	Optical information transport and processing	10	M
PHMDB3	Optoelectronic devices	20	M
PHMDB4	Imaging systems design	20	M
PHMDB5	Thermal imaging and remote-sensing optics	10	M
PHMDB6	Lasers	20	M
PHMDB7	Holography and interferometry	20	M
PHMDB8	Coherent and Fourier optics	10	M

Part-time and modular arrangements

All students have the modular flexibility described in the ‘Programme content’ section above. Part-time students may build up their modular credits towards a Diploma or MSc over an extended period. Students may also obtain a Certificate by successfully completing 60 credits. Individual modules may be studied as part of a Continuing Professional Development (CPD) programme.

Progression requirements

The pass mark for each module is 50%. It is not required to pass each module separately in order to qualify for a degree, provided the student’s overall credit-weighted average is greater than or equal to 50%, and provided that the following conditions are also met: (i) that no more than 20 credits are marked below 40%, and (ii) no module has a mark of less than 30%. A candidate who satisfies these requirements for at least 180 credits will be awarded the MSc. A candidate who satisfies these requirements for at least 120 credits but less than 180 credits will be awarded the Diploma; a candidate who satisfies these requirements for at least 60 credits but less than 120 credits will be awarded a Certificate. A candidate may elect to subject himself or herself to a single further assessment at any module that has been failed. In such a case the mark carried forward for that module will be 50% if the module is passed at the second attempt, or the higher mark of the two attempts if neither meets or exceeds 50%. Students will be counselled at stages during their progress through the degree regarding whether they should aim for the MSc, the Diploma, or the Certificate.

Summary of teaching and assessment

For full-time students teaching and learning proceeds by a mixture of lectures, directed reading, case studies, problem solving, computer-based assignments, labs, and tutorials. Web-based activities figure significantly.

For distance-learning part-time students there are no lectures, and web-based activity dominates (using the virtual learning environment Blackboard), including two-way electronic information flow, on-line resources, and discussion boards. Supervised hands-on experimental work is dealt with by summer schools.

Assessment takes three forms: formative, continuous, and summative. Formative assessment does not count towards the degree and is intended to provide information to both staff and students on progress. This is done by means of regular web-based tests for each module (weekly for full-time students). Continuous assessment is by means of reports submitted on lab experiments, computer-based assignments, and case studies. In order to maintain the self-contained nature of modules, every module contains some ‘practical’ work of this type -- there are no general-purpose ‘practical’ modules. The MSc dissertation also falls into the domain of continuous assessment. Summative assessment is by means of formal closed-book examinations for each module.

The pass mark for each module is 50%. It is not required to pass each module separately in order to qualify for a degree, provided the student’s overall credit-weighted average is greater than or equal to 50%, and provided that the following conditions are also met: (i) that no more than 20 credits are marked below 40%, and (ii) no module has a mark of less than 30%. A candidate who satisfies these requirements for at least 180 credits will be awarded the MSc. A candidate who satisfies these requirements for at least 120 credits but less than 180 credits will be awarded the Diploma; a candidate who satisfies these requirements for at least 60 credits but less than 120 credits will be awarded a Certificate. A candidate may elect to subject himself or herself to a single further assessment at any module that has been failed. In such a case the mark carried forward for that module will be 50% if the module is passed at the second attempt, or the higher mark of the two attempts if neither meets or exceeds 50%. Students will be counselled at stages during their progress through the degree regarding whether they should aim for the MSc, the Diploma, or the Certificate.

If the final overall credit-weighted average mark lies in the range 50% to 59%, then the degree will be awarded at the PASS level. If the mark lies in the range 60% to 69%, then the degree will be awarded as a PASS WITH MERIT. If the final overall credit-weighted average mark lies at 70% or above, and if <u>also</u> the dissertation module mark is 70% or above, then the degree will be awarded as a PASS WITH DISTINCTION.

Admission requirements
Entrants to this programme are normally required to have obtained an honours degree in a physical science or its equivalent.
Admissions Tutor: Dr John Macdonald, Department of Physics.

Support for students and their learning
University support for students and their learning falls into two categories. Learning support includes IT Services, which has several hundred computers and the University Library, which across its three sites holds over a million volumes, subscribes to around 4,000 current periodicals, has a range of electronic sources of information, and houses the Student Access to Independent Learning (S@IL) computer-based teaching and learning facilities. There are language laboratory facilities both for those students studying on a language degree and for those taking modules offered by the Institution-wide Language Programme. Student guidance and welfare support is provided by Programme Directors, the Careers Advisory Service, the University Counselling Service, the University Medical Centre, the University's Special Needs Advisor, Study Advisors, Hall Wardens, and the Students' Union.

As can be seen from the section on *Educational aims* below, the course requires a good deal of effort and commitment from its students, the reward being a very highly respected qualification at the end of it. Recognising these demands on the students, the staff who organise and teach on this course make very specific efforts to provide appropriate levels of student support, making sure they are available to answer students' questions and advise them on their progress. Also, the 10-credit core module PHMDA3 is entirely devoted to transferable skills that relate directly to the learning objectives of the course, and that are not directly examined, including mathematical and experimental methods and communication skills, and including a trial experiment that is taken through all the stages of planning, execution, and report-writing, with formative assessment and critical analysis throughout.

Career prospects
Optics has been a buoyant area for careers for the last 30 years, and there are signs of this increasing, rather than diminishing. The recent US National Research Council report *Harnessing Light – Optical Science and Engineering for the 21st Century* stresses the importance of optics as an enabling science with an expanding future, and the UK Engineering and Physical Sciences Research Council report *Research Landscape 2001/2002* features optics in 3 of its 11 funding programmes.

Recent graduates are working in a wide variety of optical areas: for example, a major holographic design project for the motor industry, thermal imaging, three-dimensional display-screen imaging, fibre sensing, and non-linear materials. The great majority of graduates stay in optics; those that move to other fields tend to enter the IT area. Also, each year some students go on to study for PhDs in Reading and elsewhere.

Opportunities for study abroad or for placements
Full-time MSc students carry out individual 4-month dissertation projects. Nearly all of these will be in sponsoring industrial and government laboratories. During this time they are normally paid by the sponsor. These placements are normally in the UK, although typically each year a couple are in continental Europe, and occasionally farther afield. Part-time students will normally arrange to work on a project at their employer's laboratory.

Educational aims of the programme
The aim of the MSc course in Applied and Modern Optics is to equip graduates in the physical sciences with the skills, techniques, and basic knowledge of a well rounded optical

engineer. This is a bold aim for a 12-month full-time course, and consequently the workload during the course is very considerable. It is our experience gained from student feedback that, in order to do himself or herself justice, the typical student will work harder during this year than during any year of an undergraduate course. However, the reward is the satisfaction of knowing that the final qualification is very highly respected within the optics community both in the UK and abroad. The staff involved with this course are committed to providing high-quality education and training in a supportive environment. It is in the students’ interests that we maintain the highest standards -- and we do -- but we also offer a correspondingly high level of support.

It is the aim of the Diploma course to transfer the basic skills and techniques of an optical engineer to the students, but without requiring the standard of MSc students in the area of working under one's own initiative.

Programme outcomes

Knowledge and understanding

Outcomes	**Teaching & learning methods and strategies**
Fundamentals of applied optics and optical physics: waves, rays, image formation, polarization, vision, optical propagation (see also modules PHMDA1, A2). The student should be able to describe the propagation of light through isotropic and non-isotropic media, to calculate the fundamental imaging properties of optical systems, and to recall the structure of the eye and account for its principal characteristics as an image-detecting device.	Mixture of lectures, directed reading, problem solving, computational assignments, tutorials, web-controlled resources and assignments, and lab experiments. For distance-learning students lectures and tutorials are replaced by web-based teaching and web discussion groups. *Assessment* Formative: web-based tests Continuous: reports on lab/comput'l assignments Summative: formal end-of-module examinations
Imaging systems and their applications (see also modules PHMDB4, B5). The students should be able to describe the aberrations of image-forming systems, to design simple optical systems, to explain the particular characteristics and design problems of thermal systems, and to discuss the principles and applications of remote-sensing systems.	Mixture of lectures, directed reading, problem solving, computational assignments, tutorials, web-controlled resources and assignments, and lab experiments. For distance-learning students lectures and tutorials are replaced by web-based teaching and web discussion groups. *Assessment* Formative: web-based tests Continuous: reports on lab/comput'l assignments
Optoelectronics and photonics (see also modules PHMDB1, B2, B3). The student should be able to describe the propagation of light through nonlinear materials, through multilayer thin-film stacks, and through optical fibres, to explain how fibres are used in optics communications and in optical sensors, to explain the structure and operation of common integrated optical devices, to use quantum mechanical ideas to account for the structure and operation of various semiconductor and optoelectronic devices, to list the various physical principles of optical modulators & deflectors and explain how they are used in real devices, and to give an account of the principles & practice of the detection of light.	Mixture of lectures, directed reading, problem solving, computational assignments, tutorials, web-controlled resources and assignments, and lab experiments. For distance-learning students lectures and tutorials are replaced by web-based teaching and web discussion groups. *Assessment* Formative: web-based tests Continuous: reports on lab/comput'l assignments
Principles and applications of lasers (see also modulePHMDB6). The student should be able to explain the principles of the design and operation of lasers (with a range of specific examples), to solve problems in the propagation of gaussian beams, and to discuss the application of lasers to various measurement and cutting tasks.	Mixture of lectures, directed reading, problem solving, computational assignments, tutorials, web-controlled resources and assignments, and lab experiments. For distance-learning students lectures and tutorials are replaced by web-based teaching and web discussion groups. *Assessment* Formative: web-based tests. Continuous: reports on lab/comput'l assignments
Coherent optics and its applications (see also modules PHMDB7, B8). The student should be able to distinguish between different types of coherence, to give an account of coherent image formation, and to discuss various applications of coherent light, particularly in interferometry and holography.	Mixture of lectures, directed reading, problem solving, computational assignments, tutorials, web-controlled resources and assignments, and lab experiments. For distance-learning students lectures and tutorials are replaced by web-based teaching and web discussion groups. *Assessment* Formative: web-based tests. Continuous: reports on lab/comput'l assignments

Intellectual skills

Outcomes	Teaching & learning methods and strategies
Planning of experiments (see also module PHMDA3, and parts of other modules). The student should be able to discuss critically the pros and cons of different designs of experiment and formulate strategies that are efficient and elegant.	Group problem-solving and discussions; case studies; trial experiment. For distance learners the groups make use of discussion boards. *Assessment* Formative: group reports.
Error analysis (see also module PHMDA3, and parts of other modules). The student should be able to deal effectively with uncertainties in experimental observations.	Computer-based learning and assignments; trial experiment. Feedback on formal reports. *Assessment* Formative: assignments. Continuous: reports on lab experiments and computational assignments.
Critical analysis (see also module PHMDA3 and parts of other modules). The student should be able to detect and explain weaknesses in experimental design and in formal reports, and suggest improvements.	Case studies; sessions on critical analysis of reports and experimental designs. Feedback on formal reports. *Assessment* Formative: assignments. Continuous: reports on lab experiments.
Principles of design (see also module PHMDB4). The student should be able to develop and explain a coherent and systematic approach to a design problem.	Optical design assignments and case studies, with discussion sessions on problems. *Assessment* Formative: problems. Continuous: report on optical system design case study.
Problem solving (see various modules). The student should be able effectively to organise resources and appropriate skills (including the skills and experience of others) to present a plausible strategy towards the solution of problems.	Problem assignments in various modules, including group working. *Assessment* Mixture of formative and continuous in various modules.
Managing a project (see dissertation module PHMDD1). The students should be able to plan a project of significant complexity, including the preparation of appropriate GANTT charts.	Lectures, notes, and explanatory examples. The experience of carrying a 4-month project. *Assessment* Continuous: dissertation.

Practical skills

Outcomes	Teaching & learning methods and strategies
Align and adjust sensitive optical systems (see also module PHMDA3 and others). The student should be able to adjust and align reflective, refractive, and diffractive components on an optical bench, to adjust arrange of interferometers, to adjust spatial filters, etc.	Hands-on introductory session. Support during lab experiments. *Assessment* Continuous: formal reports.
Cleaning and handling optical components (see also module PHMDA3 and others). The student should be able to handle and clean lenses and delicate mirrors appropriately.	Hands-on introductory session. Support during lab experiments. *Assessment* Formative: observation by supervisor.
Photographic and holographic processing (see also module PHMDA3 and others). The student should be able to process photographic and holographic films.	Hands on introductory session. Support during lab experiments. *Assessment* Continuous: formal reports.
Testing agreement between experiment and theory (see also module PHMDA3 and others). The student should be able to compare the results of two experiments and compare an experimental result with a theoretical result and make appropriate comments on their agreement or lack of it.	Computer-based learning and assignments; trial experiment. Feedback on formal reports. *Assessment* Formative: assignments. Continuous: reports on lab experiments and computational assignments.

Transferable skills

Outcomes	**Teaching & learning methods and strategies**
Spreadsheets The student should be able to use Excel to carry out basic calculations and operations, to plot graphs, to carry out linear regressions, to fit a theoretical equation to experimental data, and to calculate a frequency distribution.	Web-based interactive spreadsheet tuition focused on planning experiments and handling data and errors. *Assessment* Formative assessment only, via web tests and problems to be solved
Report writing The student should be able to plan and produce a professional quality formal report on an experiment or case study.	Documentation and lecture on report writing, plus critical analysis of trial report. *Assessment* Formative, via critical analysis of trial report. Continuous, indirectly via marking of formal reports of case studies, computational assignments, and lab experiments.
Team working The student should be able to reflect upon, consider, and summarise the views of his co-workers, divide tasks efficiently between them, and contribute to assignments as a team member.	Following an introduction to group working, parts of some modules require group working (4 to 8 students) for problem solving and information acquisition. Group chairmanship rotates. Also, students typically work in pairs in the lab. *Assessment* Groups are required to assess themselves, collectively and individually.
Seminar presentations The student should be able to plan and deliver a presentation to an audience on an aspect of his scientific work.	Documentation and interactive session on presentations. *Assessment* Continuous: student seminars on progress of the dissertation project.
Careers in optics The student should be able to outline various examples of career options and paths within the field of applied optics.	Presentations from past graduates with careers in optics. *Assessment* Formative: question and answer sessions and discussions.

Please note: This specification provides a concise summary of the main features of the programme and the learning outcomes that a typical student might reasonably expect to achieve and demonstrate if he or she takes full advantage of the learning opportunities that are provided. More detailed information on the learning outcomes, content and teaching, learning and assessment methods of each module can be found in module and programme handbooks.

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