VALIDITY

1. The information in this Programme Handbook should be read in conjunction with the General Regulations for Higher Awards of the University for Students Pursuing Programmes on a Modular Basis.

2. The information contained within this Programme Handbook is believed to be accurate at the time of production but the University and the Faculty cannot be held responsible for errors, omissions or changes which may have occurred.

3. The information in this Programme Handbook will be amplified during the course with the issue of additional material.

   This additional material shall be read as part of the overall Programme Guidelines and is considered to be part of the requirements of the Programme which the student is expected to satisfy.

4. The programme regulations governing performance requirements for the assignments, examinations and dissertation will be implemented within the scope of the General Regulations.
INTRODUCTION

This Handbook aims to describe the structure of the MSc programme in Medical Physics.

The course may be taken by:

(i) full-time students, home and overseas, over a period of one calendar year
(ii) persons already employed as hospital physicists (including trainee medical physicists) or in an approved, closely related occupation, who take the course as in-service training over two calendar years while still working at their place of employment;
(iii) some overseas students on a full-time basis over two calendar years, incorporating hospital training and/or additional research projects.

The MSc degree programme in Medical Physics was established in 1973 with the intention of meeting the needs of the Zuckerman Report on Hospital Scientific and Technical Services (1967/68) and has since kept apace with subsequent developments. The course was endorsed at the time by the Department of Health & Social Security as meeting the needs of the National Health Service with regards to content and attendance. It was also granted recognition by the Medical Research Council for the award of Advanced Course Studentships. In addition, support was received by Regional Health Authorities, particularly the South West Thames Regional Health Authority (SWTRHA) and South East Thames Regional Health Authority (SETRHA), through the provision of posts for the training of medical physicists. The MSc degree programme was substantially reviewed and updated during the academic year 2006/07, in preparation for the academic year 2007/08 and beyond.

The MP course is accredited by the Institute of Physics and Engineering in Medicine (IPEM), providing students with the knowledge base defined by the Institute as essential for the training of a professional graduate Medical Physicist. It encompasses an introduction to the life sciences and a broad appreciation of the application of physics to medicine.
CONTENT

SECTION A – WHO’S WHO IN THE MSc MEDICAL PHYSICS PROGRAMME……….5
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SECTION E - FULL MODULE DESCRIPTIONS…………………………………… 17
SECTION A – WHO’S WHO IN THE MSc MEDICAL PHYSICS PROGRAMME

The following staff members are central to the organisation and administration of the programme.

Professor David A. Bradley
Programme Director
Room 17BC03
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Ms Jan Poingdestre
MSc Medical Physics Programme Administrator
Room 4AA02
e-mail: j.poingdestre@surrey.ac.uk

External Examiner:
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National University of Ireland Galway
University Hospital Galway
Newcastle Road,
Galway
Ireland
Tel : +353-(0)91544311
Fax : +353-(0)91583017
Mob. : +353-(0)872756540
e-mail: wil.vanderputten@hse.ie

The course is taught by a number of specialists, some of whom are staff at the University of Surrey, while others are based in hospitals and other institutions.

University of Surrey
Faculty of Engineering & Physical Sciences
Mr K. Joyce, Health and Safety Advisor

Physics Department:
Dr D A Bacon
Prof DA Bradley
Dr D Faux
Mr K. Joyce
Prof BN Murdin
Prof A Nisbet **(joint University/RSCH appointment)
Dr Silvia Pani
Dr Z Podolyak
Prof P Regan
Dr J Scuffham (also Clinical Scientist, RSCH)
Prof NM Spyrou
Prof PM Walker

Centre for Vision, Speech and Signal Processing
Dr K Wells
Dr E Lewis

University of Surrey Library
Mrs E. Tramantza (Academic Liason Librarian and Learning Support)

External Lecturers:

Department of Health, Chief Scientific Advisor
Mr N Tomlinson

ECRI Europe
Mr A Deller
Essex County Hospital
Mr A J Porter

Health Protection Agency (Didcot, Oxfordshire)
Dr Elizabeth A. Ainsbury
Dr Simon D. Bouffler
Dr George Etherington
Dr Richard Haylock
Dr Azadeh Peyman
Dr Zenon Sienkiewicz

Guy’s & St Thomas’ Hospital
Dr JR Ballinger

Royal Berkshire Hospital
Professor M. Sperrin

Royal Free and University College Medical School:
Dr CA Mosse

Royal Marsden Hospital & Institute of Cancer Research:
Dr AD Hall
Dr S. Doran
Dr SA Sassi

Portsmouth Hospital
Dr M. Masoomi

Royal Surrey County Hospital:
Prof A Nisbet** (Head of Department of Medical Physics)
Professor Ken Young (Department of Medical Physics)
Professor David Dance (Department of Medical Physics)
Dr Tom Jordan (Department of Medical Physics)
Prof D Prasher (Department of Audiology)
Miss S Aldridge (Department of Medical Physics)
Mr P Hinton (Department of Medical Physics)
Mrs Debbie Peet (Department of Medical Physics)
Mr M Pryor (Department of Medical Physics)
Mr Hashir Aazh (Department of Audiology)
**joint University/Royal Surrey County Hospital appointment

St. Bartholomews and The Royal London Hospital
Dr JA Pickett

St. George’s Hospital:
Dr I Badr
Dr AJ Britten
Mrs P Moore

Visiting Professor
Professor Roger H. Clarke, CBE, BSc, MSc, PhD, DUniv, FRCR, FSRP
Lectures on ICRP Recommendations and ICRP 60
Emeritus member of the International Commission on Radiological Protection
Former UK Representative to the United Nations Scientific Committee on the Effects of Atomic Radiation
SECTION B - GENERAL INFORMATION REGARDING THE PROGRAMME

Course summary
The MSc programme in Medical Physics may be taken one-year full-time or on a two-year part-time basis and is designed to provide the student with the necessary knowledge base in the training of a professional graduate Medical Physicist. Some overseas students may do the course over two years to incorporate hospital training and/or additional research projects.

It is possible to make arrangements for those who wish to attend a specific part of the course in order to update knowledge or enhance their background.

The course is accredited by the Institute of Physics and Engineering in Medicine (IPEM).

Hospital Experience Module
Note that all costs associated with this are borne by students, including any travel costs and any accommodation costs associated with the Hospital Experience fortnight spent at centres not in commuting distance of the University of Surrey; no subsidy is available. The Programme Director will not assume any responsibility for issues concerning accommodation.

An extremely useful electronic information resource is the European Medical Imaging Technology e-Encyclopaedia for Lifelong Learning (EMITEL). Not immediately obvious from the title is that the resource actually offers extensive coverage of both the physics of imaging and therapy. The free resource is available at: www.EMITEL2.EU. Note that in accessing this, there is also an e-Dictionary, developed and loaded with 18 languages. The resource is highly recommended to you.
SECTION C - PROGRAMME AIMS AND OBJECTIVES

The MSc in Medical Physics is a multidisciplinary programme which is organised and administered by the Department of Physics, Faculty of Engineering & Physical Sciences, and involves other Faculties at the University of Surrey and a number of hospitals and institutions. Participating bodies include the Joint Department of Physics of the Royal Marsden Hospital and the Institute of Cancer Research; the Royal Surrey County Hospital, Guildford and St. George’s Hospital, London.

Students carry out practical work at these and other hospitals. In 1993 the MSc programme was first accredited by the IPEM for the training of physical scientists in Health Care. The programme also forms part of an integrated training scheme with hospital based consortia in Regional Areas. Those individuals selected for the training scheme are recruited through the National Health Service Clinical Scientist Recruitment Scheme.

Home, EU and overseas students attend the programme. The programme may be undertaken in one 'stage' over one year full-time or two years part-time and is divided into units of study called modules. The credit rating of a module is proportional to the total workload and one credit is nominally equivalent to 10 hours of work.

Educational aims of the programme

This programme is intended to:

- provide education and training of high quality in Medical Physics;
- stimulate and encourage a questioning and creative approach, thus developing their enthusiasm for Medical Physics and a capacity for independent judgement;
- facilitate personal development through the acquisition and use of transferable skills;
- provide students with a state-of-the-art knowledge of Medical Physics, preparing them for employment or further study and;
- produce postgraduates who are well-prepared for professional work in Medical Physics and related areas meeting the national needs for qualified postgraduates as identified by the relevant professional accrediting bodies.

The Department of Physics intends to provide students taking this programme with:

- opportunities to engage with a range of advanced concepts and applications, drawing upon the specialist expertise of the staff;
- an environment which is caring and supportive in both academic and pastoral aspects and which will have encompassed an appropriate range of teaching methods and broadened their learning experience.
Programme outcomes

On successful completion of the MSc programme, it is intended that students should be able to demonstrate:

a. Subject knowledge and skills, as follows:
   o a systematic understanding of Medical Physics in an academic and professional context, and a critical awareness of current problems and/or new insights, much of which is at, or informed by, the state of the art;
   o a comprehensive understanding of techniques applicable to research projects in Medical Physics;
   o familiarity with generic issues in management and safety and their application to Medical Physics in a professional context.

b. Core academic skills, as follows:
   o the ability to plan and execute under supervision, an experiment or investigation, analyse critically the results and draw valid conclusions. Students should be able to evaluate the level of uncertainty in their results, understand the significance of error analysis and be able to compare these results with expected outcomes, theoretical predictions or with published data. They should be able to evaluate the significance of their results in this context;
   o the ability to evaluate critically current research and advanced scholarship in the discipline;
   o the ability to deal with complex issues both systematically and creatively, make sound judgements in the absence of complete data, and communicate their conclusions clearly to specialist and non-specialist audiences.

c. Personal and key skills, as follows:
   o the ability to communicate complex scientific ideas, the conclusions of an experiment, investigation or project concisely, accurately and informatively;
   o the ability to manage their own learning and to make use of appropriate texts, research articles and other primary sources.
On successful completion of the PGDip, it is intended that students should be able to demonstrate:

d. Subject knowledge and skills, as follows:
   o An essential understanding of Medical Physics in an academic and professional context, and a basic awareness of current problems and/or new insights;
   o an essential understanding of techniques applicable to project work in Medical Physics;
   o familiarity with generic issues in management and safety and their application to Medical Physics in a professional context.

e. Core academic skills, as follows:
   o the ability to plan and execute under supervision, an experiment or investigation, to analyse the results at an essential level and draw valid conclusions. Students should be able to evaluate the level of uncertainty in their results, understand the significance of error analysis and be able to compare these results with expected outcomes. They should be able to evaluate the significance of their results in this context;
   o the ability to rationalise current research at an essential level;
   o the ability to deal with complex issues logically.

f. Personal and key skills, as follows:
   o the ability to communicate scientific ideas, the conclusions of an experiment or investigation concisely, accurately and informatively;
   o the ability to make use of appropriate texts, research articles and other primary sources.

Note that Module M1 Radiation Physics (15 Credits) and Module M4 Practical Aspects of Radiation Physics (15 credits) are compulsory modules for the award of the PGDip MP.

Reference points used to construct this specification:

- QAA Framework for higher education qualifications:
  
  *Follow links on UniS Medical Physics Home Page*

- Institute of Physics and Engineering in Medicine requirements;
  
  *Follow links on UniS Medical Physics Home Page*
SECTION D – CONTENT, PROGRAMME STRUCTURE AND PATTERN OF DELIVERY

COURSE CONTENT

The MSc course in Medical Physics comprises nine modules. Each is sub-divided into its various primary sections as shown. Contact hours, comprising lectures, tutorial, laboratory classes, seminars, demonstrations, hospital visits and hospital experience are also given. Full module descriptions are given in Section E to this Handbook.

Module PHY M032
Radiation Physics (30 hours of lectures)
Atomic and nuclear physics
Radiation physics

Module PHY M017
Radiation Biology (33 hours of lectures, 10 hours of tutorials/visits)
The cell
The cardiovascular and respiratory systems.
The nervous system
Anatomy
Cellular radiobiology
Acute and stochastic effects
Internal exposures
Epidemiology

Module PHY M007
Generic Skills and Methods; Health and Safety etc. (37 hours of lectures, labs, seminars and workshops)
The Nation’s Health and the Role of Medical Physics
Probability and Statistics
Computers in Medicine and associated student seminars
Communication and Research Skills Workshop, including literature reviews, research project plans, research proposals
Electrical Safety Aspects of Medical Physics
Safety of Medical Equipment

Module PHY M030
Practical Aspects of Radiation Physics (45 hours)
Radiation Labs (30 hours)
Radiation detection, dosimetry, radiobiology and radiation protection (15 hours)

Module PHY M009
Applications of Ionising Radiation Physics (38 hours of lectures, labs and hospital sessions)
X-rays and diagnostic radiology; MTF and ROC Analysis
Nuclear medicine
Radiotherapy and treatment planning

Module PHY M010
Applications of Non-Ionising Radiation Physics (32 hours of lectures)
NMR Spectroscopy, Imaging and Signal Analysis
Haemodynamics
Biodielectrics
Clinical Neurophysiology
Lasers in Medicine
UV Radiation and Blue Light
Module PHY M011
Hospital Experience (60 hours of hospital visits, demonstrations and hospital experience)
Royal Marsden Hospital visit and demonstrations
Royal Surrey County Hospital visits and demonstrations:
Use of Sources of Radiation, demonstrations;
X-Ray CT, demonstration;
Treatment Planning demonstration;
Radiotherapy Physics visit and demonstrations.
Health Protection Agency visit; Intakes of Radionuclides Group; EMF fields lab.
Hospital Experience (one week placement)

Module PHY M012
Ultrasonics and Audiology (35 hours of lectures, labs and hospital sessions)
Ultrasonics theory, instrumentation and practice
Audiology and audiological testing

Module PHY M031
Research Project and Dissertation

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**PATTERN OF DELIVERY**
**OUTLINE SCHEDULE OF ACTIVITIES FOR MSc MEDICAL PHYSICS PROGRAMME**

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<th>Hours/week</th>
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<td>Module PHY M032</td>
<td>Radiation Physics</td>
<td>15 weeks @ 2 hours of lectures/tutorials per week</td>
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<td>Module PHY M017</td>
<td>Radiation Biology</td>
<td>15 weeks @ 3 hours of lectures/tutorials/demonstrations per week and visit to Hunterian Museum</td>
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<td>Module PHY M007</td>
<td>Generic Skills - Computers in Medicine/Communication Skills/Electrical Safety</td>
<td>12 weeks @ 2 hours of lectures/tutorials per week</td>
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<td>Module PHY M030</td>
<td>Practical Aspects of Radiation Physics</td>
<td>5 weeks @ 2 hours of lectures per week</td>
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<td>Hour 6</td>
<td>Module PHY M007</td>
<td>Generic Skills - Probability and Statistics</td>
<td>3 weeks @ 3 hours of lectures per week</td>
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<td>Module PHY M030</td>
<td>Practical Aspects of Radiation Physics</td>
<td>8 weeks* @ 6 hours of labs per week</td>
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*This year the radiation labs begin with a preview/briefing in Wk 7; the first lab starts in week 8. Note that due to the large class size, individual student may find that their 'one week equivalent (five days)' of Hospital Experience may either be scheduled to take place during the Winter or Easter break.
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<th>Hours/week</th>
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### Spring Semester

#### Module PHY M009
Applications of Ionising Radiation Physics
12 weeks @ 3 hours of lectures per week

#### Module PHY M010
Applications of Non-Ionising Radiation Physics
5 weeks @ 7 hours of lectures per week

#### Module PHY M012
Ultrasonic**s and Audiometry
5 weeks @ 7 hours of lectures/labs per week

### Project Selection & Hospital Experience Report

<table>
<thead>
<tr>
<th>Hours</th>
<th>Easter***</th>
<th>Week 13</th>
<th>Week 14</th>
<th>Week 15</th>
<th>Weeks 16-25</th>
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<td>1-40</td>
<td>Exams</td>
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#### Module PHY M011
Hospital Experience*
1 week equivalent @ 40 hours/week

#### Exams

*Your Hospital Experience week may be scheduled to be either during the December/January break or Easter break period.
** The begin date for ultrasonics lectures is subject to change (with a view to bringing it forward).
*** The Easter break starts at the end of week 9 and lasts for four weeks.

### Occasional lectures/seminars/visits:
Please note that apart from the formally examinable/assessed material outlined above, there may also be occasional lectures/seminars/visits, the purpose of which will be to further enhance student knowledge of the vista of medical physics. Information from these events will not form part of the examined/assessed material.
Assessment

EXAMINATIONS

Across all MSc programmes offered by the Physics Department there are a grand total of 11 papers. MSc Medical Physics students take just five of these, as follows:

PHYM032 Radiation Physics
PHYM017: Radiation Biology
PHYM009: Applications of Ionising Radiation Physics
PHYM010: Applications of Non-Ionising Radiation Physics
PHYM012: Ultrasonics and Audiology

Examination papers PHYM014, PHYM017, PHYM009, and PHYM010 (duration 2 hours in each case) will each comprise of six questions, of which four must be attempted; each question is equivalent to 25% of the full marks available on a given paper. Examination paper PHYM012 (duration of 1.5 hours) will comprise five questions of which three must be attempted; each question is equivalent to 25% of the full marks available on the paper.

Each of the examination papers PHYM014, PHYM017, PHYM009, and PHYM010 will be given a mark out of 100. PHYM012 will be given a mark out of 75.

As soon as agreed provisional marks become available they will be given to Students. These marks are subject to change, pending ratification by the Examinations Board in September and subject to confirmation by the Student Progress and Conferment Executive (SPACE) and Senate.

COURSEWORK

This will consist of essays, seminars and laboratory reports assigned by individual lecturers on the course. For the topic areas ‘Probability and Statistics’ and ‘Radiation Detection, Dosimetry, Radiobiology and Radiation Protection’, in each case there will be a 1-hour Multiple-Choice Test, each to be undertaken in the last timetabled 1-hour lecture slot for delivery of that material. Coursework in the form of lab reports, seminars and essays will also form part of the assessment and each will be marked out of 20. See below for the schedule of coursework submission dates. Instructions will be issued for each coursework element, concerning content, length and form.

Practical Work/Practical Experience

Students take courses of practical and laboratory work, demonstrations and visits associated with particular lecture courses.

Students also gain practical experience by placement for a period of one week (equivalent) in an approved department of a hospital or similar institution during the Winter/Spring Semester breaks. Students present to the University a report on their hospital experience and this will be assessed as part of the examination for award of the degree. **On No Account Should Prior Arrangements For Leave Be Made That May Conflict With Such Arrangements.**

Clinical scientist trainees will also present to the University a report based on one week of their activities during their Winter/Spring hospital work, to be assessed as part of the examination for the award of the degree.

Each student will be expected to keep a laboratory notebook in which to record their experimental work throughout the course. Each student will also be expected to keep a laboratory notebook in which to record data and other pertinent information obtained during the course of their dissertation project.

It is noted that some laboratory classes and demonstrations may take a form which cannot be marked fairly and no attempt will be made to allocate a mark for these.
COURSEWORK AND DEADLINES

<table>
<thead>
<tr>
<th>COURSEWORK</th>
<th>SUBMISSION/ DELIVERY DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module PHY M007</td>
<td></td>
</tr>
<tr>
<td>Essay ‘The Nation’s Health and Medical Physics’/ Communication Skills</td>
<td>9am 8 November 2010</td>
</tr>
<tr>
<td>Test in Probability and Statistics</td>
<td>Last lecture period dedicated to the topic area TBC</td>
</tr>
<tr>
<td>Computers in Medicine Seminars</td>
<td>During Autumn Semester TBC</td>
</tr>
<tr>
<td>Essay on Safety Aspects of Medical Physics</td>
<td>9am 6 December 2010</td>
</tr>
<tr>
<td>Module PHY M030</td>
<td></td>
</tr>
<tr>
<td>Two Radiation Laboratory Reports</td>
<td>9am Monday 31 January 2010</td>
</tr>
<tr>
<td>Test: Radiation Detection, Dosimetry, Radiobiology and Radiation Protection</td>
<td>Last lecture period dedicated to the topic area TBC</td>
</tr>
<tr>
<td>Module PHY M011</td>
<td></td>
</tr>
<tr>
<td>Report/Essay (Part 1 IPEM Trainees) on Hospital Experience</td>
<td>9am Monday 6 June 2011</td>
</tr>
<tr>
<td>Module PHY M012</td>
<td></td>
</tr>
<tr>
<td>Ultrasound Laboratory Report</td>
<td>9am Monday 23 May 2011</td>
</tr>
</tbody>
</table>

**Dissertation**
A research project on some aspect of medical physics is carried out either at a hospital, at the University or sometimes at both. The dissertation work is carried out during three months in the summer.

The Course Director with the Course Administrator will compile a list of proposed dissertation topics which will be circulated some time in March and arrange for students to choose a suitable topic in consultation with potential supervisors, including lecturers on the course in the Department and University and those in collaborating hospitals and other research institutions. A document will be issued to the students giving advice about writing the dissertation and its presentation. This document also includes guidance on referencing.

**Hospital Experience**
The Hospital Experience takes place over a period of one week, either during the Winter (December) or Spring Semester break. A list from about 50 hospitals willing to take students will be given to the students during the first half of the Spring Semester. Placement of students will be discussed with the Course Director before final decisions are made. These hospitals have been selected carefully because of their expertise in medical physics and are geographically distributed over the UK. Students are encouraged to select their placements, without considering restraints of location as their main priority. Accommodation can, in general, be arranged at the hospitals, although this does not apply to the majority of the London hospitals. Students are expected to pay for all accommodation and travel expenses and should budget accordingly.

It is likely that while at the hospital the student will be associated with one particular project or task. However, it will be his or her prime responsibility to become acquainted with the other areas of medical physics pursued at the hospital, the structure of the department and its role in the hospital.
A summary of the hospital experience will be written as a report. Each student may be requested to relate his/her experience in a short verbal presentation to other members of the class.

The hospital supervisor gives a mark out of 20 for the student's overall performance during the hospital experience period. An academic member of staff gives a mark out of 20 for the student's written report on the hospital experience.

**Overall Assessment**  Each module is credit-weighted, the weighting given to a module being directly proportional to its credit–weighting, as follows:

The following weighting will be given in the final assessment:

(a) 5 examination papers : 4.25
(b) coursework on module 2 : 0.5
(c) coursework on module 3 : 1
(d) coursework on module 4 : 1
(e) coursework component of module 8: 0.25
(d) report/essay hospital experience : 1
(e) dissertation : 4

Total: 12

**Disclosure of marks**
There is full disclosure of marks on an individual, confidential basis. These may be obtained from the Course Director.

**Student Prizes and Sponsorship**
The following prizes are awarded on an annual basis:

*Mayneord Prize* - A prize in memory of Professor Valentine Mayneord will be awarded to the student with the best overall performance on the recommendation of the Examinations Board. Professor Mayneord was one of the pioneers of medical physics, who had a long association with the Department and encouraged the growth of teaching and research in the field.

*BNES Prize* - A prize donated by the British Nuclear Energy Society for the best dissertation undertaken in the area of nuclear and/or radiation physics.
SECTION E - FULL MODULE DESCRIPTIONS, 2010/11

Module PHY M032
Title: Radiation Physics

<table>
<thead>
<tr>
<th>Module Provider:</th>
<th>Physics</th>
<th>Module Code:</th>
<th>PHYM014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level:</td>
<td>M</td>
<td>Number of Credits:</td>
<td>15</td>
</tr>
<tr>
<td>Module Co-ordinator:</td>
<td>Dr Z Podolyak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Module Availability
Autumn Semester

Assessment Pattern

<table>
<thead>
<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed book examination</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Part-time Students: Same as for full time students

Qualifying Condition(s)

Pre-requisite/Co-requisites
None

Module Overview
Lectures provide a detailed and systematic overview of atomic and nuclear physics and the interaction of radiation with matter, plus introductory material describing detector operation and dosimetry.

Module Aims
To provide the student with a detailed understanding of the structure of matter, radioactivity, types of radiation and the mechanisms by which radiation interacts with matter.
To provide the student with the comprehensive understanding of radiation counting, spectroscopy equipment, dosimetry measurements.

Learning Outcomes
After completing this module, the student should be able to:-

Module Specific Skills:-
- Systematic understanding of the fundamental processes involved with the interaction of X- and gamma-ray photons, charged particles and neutrons with matter;
- Critical analysis and self-directed problem solving of the practical aspects of handling radioactive substances and the ability to extract qualitative and quantitative information about the emitted radiations.

Discipline Specific Skills:
- Application of statistical analysis techniques to specialised radiometric data through appropriate software tools.
- Application of skills in an experimental context for the measurement for various radiation emissions in terms of both dosimetry and spectroscopy.
- Perform a detailed investigation of radiation sources and their interactions in media.

Personal and Key Skills:
- Critically analyse and summarise data;
- Provide concise and accurate reporting of findings, including limitations resulting from an appreciation of equipment capability and the availability of calibration standards.
Module Content

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Title</th>
<th>Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Z Podolyak</td>
<td><strong>Radiation Physics</strong>&lt;br&gt;Interactions of radiation with matter, photons, neutrons and charged particles. Attenuation coefficients and the Mixture Rule. Concept of neutron flux and cross-section; the neutron spectrum. The interaction of electrons (and other charged particles) with matter; elastic and inelastic processes, bremsstrahlung and radiative yield, energy dependence. Measurement of radioactivity and standards.&lt;br&gt;Introduction to radiation detectors, describing the basic function and operation of semiconductor, scintillator and gas detectors, counting statistics, dead time and energy resolution.</td>
<td>9</td>
</tr>
<tr>
<td>Prof P H Regan</td>
<td><strong>Introductory dosimetry</strong>&lt;br&gt;Introduction to dosimetry measurements, air ionisation chambers, use of absolute standards, calculation of exposure, absorbed dose, and dose rate.</td>
<td>3</td>
</tr>
</tbody>
</table>

**Methods of Teaching/Learning:**
The principle teaching approach is by formal lecture.

**Selected Texts/Journals**

**Methods of Assessment**
This module is assessed in Paper I which will consist of 6 questions of which 4 must be attempted. Full marks for a question will be equivalent to 25 % of the total marks available in assessment of this module.
**Module PHYM017**  
**Title: Radiation Biology**

<table>
<thead>
<tr>
<th>Module Provider:</th>
<th>Physics</th>
<th>Module Code:</th>
<th>PHYM017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level:</td>
<td>M</td>
<td>Number of Credits:</td>
<td>15</td>
</tr>
<tr>
<td>Module Co-ordinator:</td>
<td>Prof. Andy Nisbet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Module Availability**  
Autumn Semester

**Assessment Pattern**

<table>
<thead>
<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed book examination</td>
<td>100 %</td>
</tr>
<tr>
<td>Part-time Students:</td>
<td>Same as for full time students</td>
</tr>
</tbody>
</table>

**Pre-requisite/Co-requisites**
None

**Module Overview**
This course starts with an overview of human biology, followed by a discussion of the nature of the interaction of ionising radiation with biological systems. The course emphasises the effects at the cellular level and the impact that this has on the individual and across the population. The behaviour and effects of ingested and inhaled radionuclides are also covered.

**Module Aims**
To provide an understanding of the human body and the effect of ionising radiation on it.

**Learning Outcomes**
After completing this module, the student should be able to:

- **Module Specific Skills:**
  - Critical analysis of basic molecular cell and tissue structure and function and description of the principles of anatomy

- **Discipline Specific Skills:**
  - Describe the control systems of the human body
  - Application of radiation knowledge to understand basic radiobiology and genetics

- **Personal and Key Skills:**
  - Appreciate science underpinning radiological protection standards
<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Title</th>
<th>Lecture Hours</th>
<th>Lab Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. A Nisbet</td>
<td>Human Biology; the cell, the cardiovascular and respiratory systems, the nervous system and anatomy.</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>Dr S Bouffler</td>
<td>Primary events in the cell; deposition of energy from low and high LET radiations; molecular events; DNA damage and repair; cellular radiosensitivity; dose-rate and LET dependence; molecular genetics of radiation cancer, human variation in radiation sensitivity.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dr E A Ainsbury</td>
<td>Acute (non-stochastic) effects after whole and partial body irradiation; damage to red bone marrow, gut epithelium, gonads, optic lens and developing brain of the foetus.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dr G Etherington</td>
<td>Radionuclides in man; the behaviour of radionuclides in the body including isotopes of tritium, caesium, strontium, iodine, radium and plutonium; ICRP biokinetic and dosimetric models; dose calculations; doses to the embryo and foetus.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dr R Haylock</td>
<td>Concepts of epidemiological studies</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dr Z Sienkiewicz</td>
<td>Possible biological effects, acute effects on behaviour and the nervous system, reproduction and development and cancer related effects.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Dr A Peyman</td>
<td>Dosimetry, practical measurements and theoretical modelling, instrumentation, antennas.</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Methods of Teaching/Learning**

**Selected Texts/Journals**

4. “Radiobiology for the Radiologist”, Hall, E.J., Lippincott Co (3rd Edn or later)
5. “Molecular Biology of the Cell”, Alberts B.,
9. “Publication 72 - Age-dependent doses to members of the public from intake of radionuclides”, ICRP, Pergamon Press.
Methods of Assessment
This module is assessed in Paper 4 which will consist of 6 questions. Students answer 4 questions from the 6. Full marks for a question will be equivalent to 100 % of the total marks available in assessment of this module.
Module PHY M007
Title: Generic Skills and Methods; Health and Safety Etc

Module Provider (AoU): Physics  Module Code: PHYM007
Level: M  Number of Credits: 15
Module Co-ordinator: Prof DA Bradley

Module Availability
Autumn and Spring Semesters

Assessment Pattern

<table>
<thead>
<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Test and coursework</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Part-time Students: Same as for full time students

Qualifying Condition(s)

None

Module Overview
An introduction to the use of computers in medicine, laboratory peripherals and simple interfacing. Basic ideas in probability and statistics will also be covered with a view towards valid interpretation of an inference from data. The applications used to illustrate these ideas will be drawn from content relevant to the course. A half-day communication skills workshop will address the need for the science professional to communicate in an effective manner, in accord with the accepted norms.

Also provided will be comparison of types of medical imaging that allows both differing and complementary characteristics to be compared in relation to the state of formal imaging theory. Methods of image display and hard copy output are considered, together with factors affecting visual perception.

Safety is of paramount importance in the hospital situation and students will also be expected to understand a wide variety of safety procedures, in particular in regard to electrical safety.

Module Aims
To provide each student with programming skills and the knowledge to enable them to effect typical laboratory interfacing tasks. To convey an essential understanding of the principles of probability and statistics and how they can be applied to practical problems. To create an appreciation of the basic ideas engendering effective communication skills. To provide an overview of the electrical hazards that can arise when equipment is connected to patients and review the ways in which the risks to both patients and operators can be minimised. To provide an overview of the imaging process as related to medical equipment and methodology.

Learning Outcomes
After completing this module, the student should be able to:

Module Specific Skills:
- design and implement simple programmes in C and understand the principles involved in interfacing to peripheral equipment;
- apply probability distribution theory and statistical inference to sets of data;
- perform calculations for random and systematic errors, curve fitting, hypothesis and significance tests and apply these techniques to a variety of problems;
- be aware of the duties and responsibilities of a clinical scientist and other health professions, to ensure both professional safety at work and also that of the patient;
- understand the similarities between imaging techniques and the relative advantages of different approaches to underpin more detailed courses in this programme;
- represent and defend a piece of work at a seminar.

**Discipline Specific Skills**
- demonstrate familiarity with the techniques of statistical analysis; test for significance, confidence limits etc;
- be conversant with data manipulation, and the techniques of image formation and display;

**Personal and Key Skills:**
- solve problems in a systematic manner;
- possess IT skills.
- ability to evaluate the risks involved in a particular application.

### Module Content

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Title</th>
<th>Lecture Hours</th>
<th>Lab/Workshop/seminars Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mr N. Tomlinson</td>
<td>The Nations Health and the Role of Medical Physics</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Prof BN Murdin</td>
<td>Probability and Statistics</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Dr D. Faux (DF)</td>
<td>Probability, conditional probability, Bayes’ rule, independence, random variables, expectation, some standard distributions. Statistics: samples and populations, estimation, significance tests, some applications</td>
<td>2 (DF)</td>
<td>3 hrs lab (DF) 8 hrs seminar (KW/EL)</td>
</tr>
<tr>
<td>Dr K. Wells (KW)</td>
<td>Computers in Medicine</td>
<td>3</td>
<td>3 hrs workshop (ET)</td>
</tr>
<tr>
<td>Dr E. Lewis (EL)</td>
<td>To provide an overview of the application of computers in medicine and a specific understanding of the role of computers in imaging applications.</td>
<td>3 (DAB)</td>
<td></td>
</tr>
<tr>
<td>Dr Silvia Pani (SP)</td>
<td>Communication Skills</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Prof DA Bradley (DAB)</td>
<td>Electrical Safety Aspects of Medical Physics</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Mrs Evi Tramanza (ET)</td>
<td>An outline of electrostatic, and current electricity macroshock and microshock hazards. National and International standards. Risk analysis. Examples of hazards taken from current publications.</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Mr A Deller</td>
<td>Safety of Medical Equipment</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Mr K. Joyce</td>
<td></td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
Methods of Teaching/Learning
The module is taught by lecturers from the School of Electronics & Physical Sciences, industry and hospital professionals.

Selected Texts/Journals
Each lecturer recommends his/her own set of reference books. The current list is as follows:

(i) Essential Reading
Statistics for Technology, C Chatfield, 3rd Edn, Chapman & Hall, 1983
Practical Statistics for Medical Research, DG Altman, Chapman & Hall, 1991
Medical Technology, D W Hill & R Summers, Chapman & Hall, 1994
Imaging Systems for Medical Diagnostics, Ed E Krestel, Siemens, Berlin, 1990

(ii) Supplementary Reading
A Handbook of Public Speaking for Scientists & Engineers, P. Kenny, Adam Hilger, 1982
Practical Statistics for Medical Research, DG Altman, Chapman & Hall, 1991
PACS, Basic Principles and Applications, HK Huang, 1999
PACS & Imaging Informatics, Basic Principles and Applications, HK Huang 2004

Methods of Assessment
There is one test on Probability and Statistics, seminars by each student (for the section Computers in Medicine). There are two pieces of writing (one each for sections Communication Skills and Electrical Safety Aspects of Medical Physics). The marks are equally divided among the four individual components of the assessment with 25% of the available marks assigned to each item.
Module PHY M030
Title: Practical Aspects of Radiation Physics

Module Provider: Physics
Module Code: PHYM030
Level: M
Number of Credits: 15
Module Co-ordinator: Prof DA Bradley

Module Availability
Autumn Semester

Assessment Pattern

<table>
<thead>
<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coursework</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Part-time Students: Same as for full time students
Qualifying Condition(s)

Pre-requisite/Co-requisites
None

Module Overview
To provide the student with underpinning knowledge and practical experience in handling radioactive substances, radiation counting and dosimetry.

Module Aims
To familiarise the student with the use of radioactive substances in a variety of practical situations, radiation counting and spectroscopy equipment employing standard radiation experimental techniques. Effects of radiation on biological systems are developed into effects on humans and reasons for the quantification of risks. Concepts, quantities and practical methods of measuring radiation dose are considered, including methods for evaluating dose from radioisotopes taken into the body. The module includes consideration of a selection of legal, administrative and practical radiation protection issues within a hospital environment.

Learning Outcomes
After completing this module, the student should be able to:

Module Specific Skills:
- explain the biological effects and safe application of techniques using ionising radiation in human medicine;
- make detailed calculations of radiation exposure and relate these to practical applications.
- appreciate the practical aspects of handling radioactive substances and to gain some knowledge as to how to extract information from the radiations emitted on the qualitative and quantitative basis.

Discipline Specific Skills:
- select an appropriate means of measurement for the various radiation emissions in terms of both dosimetry and spectroscopy;
- to carry through a detailed investigation of radiation sources and their interactions in media;
- exhibit familiarity with the possibilities offered by complex digital hardware.

Personal and Key Skills:
- maintain a laboratory diary at a level appropriate of a professional scientist;
- analyse and summarise data;
- provide concise and accurate reporting of findings, including limitations resulting from an appreciation of equipment capability and the availability of calibration standards.
<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Title</th>
<th>Lecture Hours</th>
<th>Lab Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr K Wells</td>
<td>Ionising Radiation Detection</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Essentials of how radiation detectors work. Pulse counting and deadtime, counting statistics and energy resolution. Solid state detectors: Ge, Si; ionisation detectors; gas detectors: Proportional counters MWPCs and G-M tubes. Classification and definition of scintillators: organic vs inorganic; the scintillation mechanism of NaI (TI); photomultiplier tubes; scintillation counters and their uses.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof DA Bradley</td>
<td>Dosimetry</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Starting by considering particle fields and interactions in absorbing media, a review of dosimetric methods includes reference to absolute and operational methods with emphasis on air ionisation methods. Exposure and subsequent calculation of absorbed dose in various tissue types is described. Methods of calculating doses and dose-rates from radioactive sources are described. Models for calculating doses from radioisotopes taken into the body are described and sources of data listed.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mr AJ Porter</td>
<td>Radiation Protection in Practice</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current legislation and guidance enforced in the UK Shielding and design requirements for diagnostic X-ray rooms, nuclear medicine facilities and radiotherapy treatment rooms. Radiation dose limits Appreciation of radiation doses received by different occupations within a hospital. Discussion of techniques for achieving dose reduction to patients and staff.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof DA Bradley</td>
<td>Radiation Physics Laboratories</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>Prof P Walker (+ technical staff and demonstrators)</td>
<td>The students undertake experiments in pairs and it is expected that one experiment is completed per day. Experiments involve the use of sealed and unsealed radiation sources and some include techniques for separating radionuclides and for radio-labelling of biological materials eg. Red-blood cell labelling. Introduction to standard laboratory methods such as detector calibration are encompassed as are radiation dosimetry applications. The students must keep a bound laboratory notebook for recording experimental procedures and data.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Methods of Teaching/Learning
The module is led by academic staff of the Physics Department, supported by technical staff and demonstrators in the case of laboratories.

### Selected Texts/Journals
Each lecturer recommends his/her own set of reference material. The current list is as follows:

**Supplementary References**

- The Ionising Radiation Regulations (IRR 99) Regulations
- Handbook of Chemistry and Physics, Edn 60, Weast, CRC Press, 1980
- Table of Isotopes, Edn 8: Shirley, Wiley, 1996
- Radiation Detection and Measurement, G F Knoll; Wiley & Sons, 1999
- Introductory Nuclear Physics, Krane, Wiley, 1988
Methods of Assessment
There are two lab reports for the Radiation Physics Lab. In addition there is a 1 hour duration multiple choice question (MCQ) paper based on the underpinning lecture material. The marks are distributed among the two lab reports (33 % each) and the MCQ paper (34 %).
Module PHY M009
Title: Applications of Ionising Radiation Physics

<table>
<thead>
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<th>Module Provider:</th>
<th>Physics</th>
<th>Module Code:</th>
<th>PHYM009</th>
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<tr>
<td>Level:</td>
<td>M</td>
<td>Number of Credits:</td>
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</tr>
<tr>
<td>Module Co-ordinator:</td>
<td>Prof DA Bradley</td>
<td></td>
<td></td>
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</table>

Module Availability
Spring Semester

Assessment Pattern

<table>
<thead>
<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed book examination</td>
<td>100 %</td>
</tr>
<tr>
<td>Part-time Students:</td>
<td>Same as for full time students</td>
</tr>
<tr>
<td>Qualifying Condition(s)</td>
<td></td>
</tr>
</tbody>
</table>

Pre-requisite/Co-requisites
None

Module Overview
Ionising radiation is widely used for diagnostic and therapeutic purposes. The bulk of hospital physicists work with ionising radiation and hence the topic is fundamental for anyone entering the profession. An introduction is given to imaging systems: X-radiography, gamma cameras, X-ray computed tomography, single photon computer tomography (SPECT) and positron emission tomography (PET). An overview is given of radiotherapy techniques and the biological processes concomitant with this modality, together with discussion of isodose curves and variation with incident radiation energy.

Module Aims
To achieve an understanding of medical X-ray and gamma ray imaging technology in terms of equipment components and their performance and to relate this to the needs of diagnostic medical imaging. To give the student a broad overview of the techniques used in-vivo and in-vitro nuclear medicine studies. To provide an overview of the use of radiopharmaceuticals in nuclear medicine. To establish a basic appreciation of the operational aspects of radiotherapy treatment units and accessories, the radiation beams available and their interaction with tissues, together with clinical implications. An appreciation of quality management, its aims and application to imaging and radiotherapy.

Learning Outcomes
After completing this module, the student should be able to:

Module Specific Skills:
- describe the physical principles and key technologies which determine the performance of medical X-ray imaging systems;
- describe the quality assurance cycle required for diagnostic X-ray and nuclear medicine equipment and to be familiar with test equipment commonly used for the most important measurements undertaken by physicists in an imaging department;
- describe the operation of treatment units and the radiation beams available together with their interactions in tissues and the clinical implications;
- describe details of the quality management system required in its application to radiotherapy facilities.

Discipline Specific Skills:
- use this knowledge when taking up posts within the Health Service and other related fields.
**Personal and Key Skills:**
- ability to use physics techniques in a multidisciplinary context;
- ability to evaluate the risks involved in a particular application.

### Module Content

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Title</th>
<th>Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr K. Wells</td>
<td><strong>X-rays, γ-rays, MTF and ROC Analysis</strong></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Mathematical formulation of the imaging system: linear operator, principle of superposition, impulse response function, stationarity, line spread function, edge spread function, convolution integral, MTF. Usefulness of MTF, modulation input and output, test objects, measure of performance, cascade MTFs. Perception of detail, visual acuity, resolution criteria. Existence of observer, decision criteria, confidence thresholds, conditional probabilities, types of decision. Construction of the ROC curve and principle of ROC analysis.</td>
<td></td>
</tr>
<tr>
<td>Dr AJ Britten (4h)</td>
<td><strong>X-ray Imaging and analysis</strong></td>
<td>12</td>
</tr>
<tr>
<td>Dr SA Sassi (2h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The X-ray tube construction and operational needs.</td>
<td></td>
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<tr>
<td></td>
<td>X-ray scatter in diagnostic imaging and scatter reduction methods.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>X-ray film, intensifying screens and film-screen imaging performance.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Non-film imaging: Image intensifiers and video X-ray images.</td>
<td></td>
</tr>
<tr>
<td>Mr M. Pryor (4h)</td>
<td><strong>Introduction to quality management systems.</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>The quality assurance or life cycle of x-ray equipment. The role of the physicist, radiographer and engineer. Types of x-ray equipment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radiation safety and performance measurements on diagnostic and fluoroscopic equipment. Test equipment for the physicist.</td>
<td></td>
</tr>
<tr>
<td>Prof K. Young</td>
<td><strong>The NHS Breast Screening Programme - organisation, facts and figures. Risk/benefit analysis in mammography. The profile of quality assurance and the role of the physicist. Elements of the mammographic imaging system: dedicated X-ray sets, films, intensifying screens and film processing systems. Use of various anode and filter materials to tailor the X-ray spectrum to individual patients. Effects of film processing on image quality and patient dose. Stereotactic biopsy systems and special procedures. Introduction to digital imaging modalities and their applications in mammography.</strong></td>
<td></td>
</tr>
<tr>
<td>Prof D. Dance (2h)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dr M Masoomi (6h)</td>
<td><strong>Nuclear Medicine</strong></td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Types of radionuclides used in medicine and methods of production. 'In vivo' and sample measurement techniques. Radionuclide imaging, design and QA of cameras and other imaging systems. Gamma-ray emission tomography and positron tomography. Dynamic studies. Whole body counting. Saturation analysis. Clinical applications of radionuclide techniques, tumour localisation and uptake, organ function, absorption studies.</td>
<td></td>
</tr>
</tbody>
</table>
metabolic investigations. Comparison of radionuclide and other tests. Gamma probe; design and clinical application. Introduction to PET imaging. PET instrumentation; coincident events, scintillators, block detectors, 2D versus 3D, PET radioisotopes. Clinical application of PET.

Dr J. Ballinger (4h)

Radionuclides - review of decay modes and production methods. Preparation of radiopharmaceuticals - Pharmacopoeial requirements. Overview of radiopharmaceuticals - labelling methodologies. Diagnostic radiopharmaceuticals - selection of radionuclide, localisation mechanisms, clinical applications, protein and peptide based radiopharmaceuticals Therapeutic radiopharmaceuticals - selection of radionuclide, relevance of dosimetry studies, clinical applications

In vitro studies

Dr AD Hall (2h)

Molecular Imaging

Prof A Nisbet and relevant RSCH staff

Radiotherapy and Treatment Planning


Methods of Teaching/Learning

The module is taught by lecturers from both the Department of Physics and from hospitals.

Selected Texts/Journals

(i) Essential Reading

Radiation Oncology Physics. Ed. E.B. Podgorsak, IAEA, 2005
Physical Aspects of Brachytherapy, Godden TJ, Adam Hilger 1988
The Essential Physics of Medical Imaging, Ed J T Bushberg, Williams & Wilkins, 1994
(ii) Supplementary Reading

Screen Film Mammography. G T Barnes & G D Frey. Medical Physics Publishing
Film Processing in Medical Imaging A G Haus. Medical Physics Publishing
QA Guideline for Medical Physics Services NHS BSP Pub 33, 2nd Edn, 2005
IPEM Rep. 89. The Commissioning & Routine Testing of Mammographic X-ray Systems, 2005
Consolidated Guidance on Standards for the NHS Breast Screening Programme NHS BSP Pub 60, 2005
European Standard EN ISO 9001, European Committee for Standardisation, Brussels, 2000
ICRU Report 50, Prescribing, Recording and Reporting Photon Beam Therapy, 1993
BJR Suppl. 25, Central Axis Depth Dose Data for use in Radiotherapy, BIR, 1996
P. Michael Conn (Series Volume Editor) Publisher: Academic Press Publication Date: 10 July 2004
A variety of review articles covering the field are available in the scientific literature, including: Molecular Imaging Perspectives, J R Soc Interface, 2005 (published online) Paul J Cassidy and George K Radda

Methods of Assessment

This module is assessed in Paper 7 which will consist of 6 questions. Students answer 4 questions from the 6. Full marks for a question will be equivalent to 25 % of the total marks available in assessment of this module.
Module PHY M010
Title: Applications of Non-Ionising Radiation Physics

Module Provider: Physics  Module Code: PHYM010
Level: M  Number of Credits: 15
Module Co-ordinator: Prof DA Bradley

Module Availability
Spring Semester

Assessment Pattern

<table>
<thead>
<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed-book examination</td>
<td>100 %</td>
</tr>
</tbody>
</table>

Part-time Students: Same as for full time students

Qualifying Condition(s)

Pre-requisite/Co-requisites
None

Module Overview
Delivers material on the basic principles of medical NMR. Discusses basic biochemical parameters that affect the flow of blood in vivo and fundamental fluid mechanics equations and the way that they can be applied to the human circulatory system. Discusses clinical measurement of blood pressure, flow and volume. Examines theoretical aspects and simple models explaining the behavioural response of biological cells to external electromagnetic fields. Gives an overview of methods for investigation of nervous system function. Looks at the physics and technology of laser systems, UV and blue light and the interaction of these radiations with biological materials and their applications in medicine, together with an appreciation of the hazards involved and protective measures.

Module Aims
To introduce students to the basic areas of analogue and digital electronics as might be encountered in medical instrumentation etc. To provide the student with the theoretical skills necessary to understand the physics behind the operation of nuclear magnetic resonance and its imaging applications. To introduce the application of fluid mechanics in the study of blood flow and clinical measurement of haemodynamic variables. To introduce background theory and application of biodielectric materials and equipment. To provide an overview of methods for investigation of the nervous system. To provide a basic introduction to the principles of lasers and UV and blue light in medicine.

Learning Outcomes
After completing this module, the student should be able to:

Module Specific Skills:
- describe the generation of a free-induction-decay and radiant and spin echoes and their utilisation for magnetic resonance imaging;
- describe the concept of k-space and solve problems relating to Fourier techniques for image generation;
- describe various types of laser and UV equipment and the appropriate safety measures;
- apply hydrodynamics to the problem of liquids and solute transport;
- describe the essentials of theoretical models on biological cell structures and the response to external EM fields and practical consequences.
### Discipline Specific Skills
- ability to use physics techniques in a variety of multidisciplinary contexts;
- provide an evaluation of risk;
- develop familiarity with the possibilities offered by complex digital hardware, including image processing.

### Personal and Key Skills:
- solve problems in a systematic manner;
- have general awareness of safety issues in the workplace and elsewhere.

### Module Content

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Title</th>
<th>Lecture Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr S Doran</td>
<td><strong>Introduction to NMR Spectroscopy, Imaging and Signal Analysis</strong>&lt;br&gt;A microscopic (energy level) approach to NMR; a macroscopic (magnetisation vector) approach; relaxation; the Bloch equations; chemical shift; CW &amp; pulsed NMR; $T_2^*$ relaxation.&lt;br&gt;MRI fundamentals: the slice, frequency and phase direction; the spin-echo imaging method; image contrast; components of an MRI system.&lt;br&gt;Signal representation in the time and frequency domains; complex numbers and oscillating systems; Fourier series; Fourier transforms; properties of Fourier transforms; convolution. The generalised imaging system and concepts of modulation transfer function.</td>
<td>14</td>
</tr>
<tr>
<td>Dr J Pickett</td>
<td><strong>Haemodynamics</strong>&lt;br&gt;The circulatory system. The nature of blood. Whole blood viscosity, plasma viscosity, red cell deformability and aggregation. Flow characterisation, blood flow calculations, Viscometers. Blood pressure measurement, blood flow measurement, microvascular assessments.</td>
<td>5</td>
</tr>
<tr>
<td>Dr A Peyman</td>
<td><strong>Biodielectrics</strong>&lt;br&gt;Typical bioelectric waveforms generated by various organs of different animals; static and time dependent Electromagnetic (EM) fields; basic mathematical formulae governing their interaction with matter; fundamental parameters characterizing the biological cell response to time dependent external EM fields; latest models and theoretical aspect of cell structure; frequency dependent nature of sensation threshold of current injected into the body for impedance measurements; bipolar and tetrapolar configuration used to measure the true impedance; measurement of body fat and water contents using electrical impedance (EI) and (NIR) methods; EI Epigastrography using the state-of-the art machine constructed in 1997; brief reference to calculation of various parameters associated with EIE traces and power analysis of the stomach motility.</td>
<td>5</td>
</tr>
<tr>
<td>Mrs P Moore</td>
<td><strong>Clinical Neurophysiology</strong>&lt;br&gt;The neuron as the building block. Axonal transmission. Synaptic transmission. Nerve conduction velocity testing. Basic Needle EMG Evoked Response testing with special reference to BAER in infants. EEG with special references</td>
<td>2</td>
</tr>
</tbody>
</table>
Dr CA Mosse

Lasers in Medicine
The course offers a brief review of basic laser physics and an introduction to the biophysical processes involved in the interaction of laser light and biological tissues. The photothermal, photochemical, photomechanical and photoablative effects of laser light are considered with reference to the underlying physical principles behind the therapeutic and diagnostic uses of laser light. Basic laser safety is introduced and simple mathematical models used to describe the laser ablation and coagulation of soft tissues.

Prof M Sperrin

UV Radiation and Blue Light
Introduction - including brief history.
Subdividing the UV spectrum - UVA, -B, -C.
Effects of UVR on humans - including effects on skin and eye and photosensitivity.
Sources of UVR - including lamps used in medicine & medical applications; radiation protection surveys.
Other sources of UVR - sunbeds, uses in offices, industry, research, sunlight.
The course covers the properties, sources, hazards and uses of ultraviolet radiation, mainly in medicine but also in everyday life where of interest from a non-ionising radiation protection viewpoint. There is particular emphasis on making correct measurements.

Methods of Teaching/Learning
The module is taught by lecturers from the School of Electronics & Physical Sciences and clinical and medical physics departments in hospitals.

Selected Texts/Journals
Each lecturer recommends his/her own set of reference books. The current list is as follows:
(i) Essential Reading
The Physics of Medical Imaging, Ed S Webb, IoPP, 2002
NMR Imaging in Biomedicine, Peter Morris, OUP, Clarendon Press 1986
Signal Processing First, McClellan, Schafer and Yoder, Pearson, 2003
Quantum Description of High-Resolution NMR in Liquids, Morris Goldman, Clarendon, 1988
Principles of Nuclear Magnetic Resonance Microscopy, PT Callaghan, Clarendon, 1991
Introduction to Communication Systems, FG Stremler, 3rd Edn, Addison Wesley, 1990
Digital Signal Processing, JG Proakis and DG Manolakis, Macmillan, 1992
An Introduction to Cardiovascular Physiology. JR Levick, Butterworth Heinemann, 1991
Medical instrumentation application and design. JG Webster, Houghton Mifflin, 1992
(ii) Supplementary Reading
The Oregon Medical Laser Center web site, in particular:
http://www.omlc.ogi.edu/classroom/ece532/class1/index.html
Filter Design for Signal Processing, D Miroslav, DV Tosić and BL Evans, Prentice Hall ISBN 201 361302

Methods of Assessment
This module is assessed in Paper 8 which will consist of 6 questions. Students answer 4 questions from the 6. Full marks for a question will be equivalent to 25 % of the total marks available in assessment of this module.
Module PHY M011
Title: Hospital Experience

<table>
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<tr>
<th>Module Provider:</th>
<th>Physics</th>
<th>Module Code:</th>
<th>PHYM011</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level:</td>
<td>M</td>
<td>Number of Credits:</td>
<td>15</td>
</tr>
<tr>
<td>Module Co-ordinator:</td>
<td>Prof DA Bradley</td>
<td></td>
<td></td>
</tr>
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</table>

Module Availability
Autumn Semester

Assessment Pattern

<table>
<thead>
<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coursework and hospital experience assessment</td>
<td>100 %</td>
</tr>
<tr>
<td>Part-time Students:</td>
<td>At least equivalent to that for full time students</td>
</tr>
</tbody>
</table>

Qualifying Condition(s)

Pre-requisite/Co-requisites
None

Module Overview

Hospital experience and placements, the latter being of 1 week duration, are arranged for all non Health Service students. The hospital experience and placements are arranged to give students a broad overview of medical physics in the Health Service and cover the main areas of radiotherapy, nuclear medicine, diagnostic radiography and clinical measurements. The placements are arranged by staff carrying out their normal duties; students should be sensitive to all situations and if required be prepared to withdraw for an appropriate length of time at short notice. In addition students will be expected to dress appropriately when on hospital premises. For Health Service students the hospital acquaintanceships will be taken to provide the full range of insight into practical hospital physics.

Module Aims
To address the important aspect of management, both of scientific and routine services. Provide an appreciation of the wide range of ionising radiation sources encountered by medical physicists and their application in the clinical setting. Provide an overview of a range of medical physics applications in clinical practice, including practical experience in some radiotherapy, diagnostic radiology and nuclear medicine related techniques and non-ionising sources. To experience how the theory of science and technology is applied in practice, appreciating also the procedures in place and in practice for ensuring the safety of staff, patients and hospital visitors.

Learning Outcomes
After completing this module, the student should be able to:

Module Specific Skills:
- have an awareness of the many facets of safety and management so that they can work safely and appropriately in both the hospital environment and other large organisations involved with applications of science;
- understand some of the practical aspects of the application of science and technology in a hospital.

Discipline Specific Skills:
- have practical experience and understanding of how nuclear medicine techniques work in the laboratory and clinical setting;
- have practical experience and understanding of how imaging techniques work in the clinical setting;
• have practical experience and understanding of radiotherapy techniques;
• have an appreciation of the management of a medical physics department.

**Personal and Key Skills:**
• confidence in presenting, in a short period of time, scientific material which they have researched and to respond to questions that may arise during presentations;
• development of professional awareness.

### Module Content

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Title</th>
<th>Experiential Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinated by Prof A. Nisbet</td>
<td>November Visit to Royal Surrey County Hospital (Semester 1)</td>
<td>4</td>
</tr>
<tr>
<td>Coordinated by Prof A. Nisbet</td>
<td>Use of Sources of Radiation (2 hours approx)</td>
<td></td>
</tr>
<tr>
<td>TBA</td>
<td>Visit to Hunterian Museum (in association with Anatomy and Pathology Lectures by Prof Nisbet)</td>
<td>8</td>
</tr>
<tr>
<td>Mr M Pryor</td>
<td>X-ray CT (Semester 1 or 2)</td>
<td>2</td>
</tr>
<tr>
<td>Coordinated by Prof A. Nisbet</td>
<td>Treatment Planning Demonstrations (Semester 1 or 2)</td>
<td>2</td>
</tr>
<tr>
<td>Dr AD Hall/ Dr Sassi</td>
<td>Royal Marsden Hospital Seminar (Semester 2)</td>
<td>3</td>
</tr>
<tr>
<td>Hospital Supervisor</td>
<td>One week placement (over Winter and Spring break periods)</td>
<td>40</td>
</tr>
</tbody>
</table>

### Methods of Teaching/Learning

The individual components of the module are led/supervised by senior members of the various Hospital Medical Physics Departments involved. The learning is experiential.
Selected Texts/Journals
Each lead person recommends his/her own set of reference material. The current list is as follows:

Supplementary References
The Ionising Radiations Regulations (1999) SI 3232
Work with Ionising Radiation. Approved Code of Practice, HSE, 2000
The Ionising Radiation (Medical Exposure) Regulations 2000 No.1059
Medical and Dental Guidance Notes. P. Allisy-Roberts IPEM, 2002
Radioactive Substances Act 1993,
ARSAC Licence Regulations
Lessons Learned from Accidental Exposures in Radiotherapy, IAEA Safety Report Series No. 17, IAEA (Vienna), 2000
Applying Radiation Safety Standards in Radiotherapy, IAEA Safety Report Series No. 38, IAEA (Vienna), 2006
The Physics of Medical Imaging, Ed S Webb, IoPP, 2002
Medical CT & Ultrasound: Current Technology & Applications, Goldman & Fowlkes
AAPM, 1995
Basic Science of Nuclear Medicine, 2nd Ed., Parker, Smith, Taylor, Churchill Livingstone, 1984
Practical Nuclear Medicine, 2nd Edn, PF Sharp, HG Gemmell, FW Smith, OUP, 1998
Medical laser safety in the United Kingdom, R. J. Parsons, Lasers in Medical Science, 4, 177-179, (1989)
Medical CT and Ultrasound ‘Current Technology and Applications’
AAPM Summer School June 95, Editors: Goldman LW and Fowlkes, JB
Advanced Medical Publishing 1995

Methods of Assessment
The first six components of this module are not assessed. The experience gained in these visits and demonstrations is intended to provide an enriching experience, the value of which feeds into the quality of the students’ ‘two week placement report’ for full time students and the report that replaces this for part 1 IPEM trainees. The report is to be delivered by the end of week 13 of the Spring Semester and is assessed in combination with the Hospital Supervisor’s evaluation of student involvement in the learning opportunity. The report attracts a full mark equivalent to 50% of the total marks available while the supervisor’s report provides the remaining 50% of the total marks available.
Module PHY M012
Title: Ultrasonics and Audiology

<table>
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<tr>
<th>Module Provider:</th>
<th>Physics</th>
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<tbody>
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<td>Module Code:</td>
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<tr>
<td>Level:</td>
<td>M</td>
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<td>Number of Credits:</td>
<td>15</td>
</tr>
<tr>
<td>Module Co-ordinator:</td>
<td>Dr Silvia Pani</td>
</tr>
</tbody>
</table>

Module Availability
Spring Semester

Assessment Pattern

<table>
<thead>
<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed book examination and coursework</td>
<td>100 %</td>
</tr>
<tr>
<td>Part-time Students:</td>
<td>Same as for full time students</td>
</tr>
</tbody>
</table>

Qualifying Condition(s)

Pre-requisite/Co-requisites
None

Module Overview
This module provides an introduction to imaging techniques that do not involve ionising radiation, an area in which there have been a number of major developments in the last decade. The module is designed to give students knowledge of the basic physics that underpins ultrasound, together with details of common imaging strategies. The module also covers topics relating to audiometry and audiology, including an overview of the physiological and acoustic processes involved in the production and perception of speech sounds.

Module Aims
To introduce the uses of ultrasound in medicine and to outline the physical principles involved. To identify limitations and explore practical solutions within the context of the applications. The module also aims to provide a basic understanding of the physical and subjective principles of audiometry and their interrelations, also providing some practical experience in audiometric procedures and calibration.

Learning Outcomes
After completing this module, the student should be able to:

- manipulate the wave equation (in relation to acoustics) and analyse sound propagation in various systems, including propagation across boundaries;
- describe the acoustics of speech production and the structure and function of the ear;
- describe the physical and subjective principles of audiometry and their interrelations and to have practical ability in audiometry procedures and calibration.

Module Specific Skills:
- describe the fundamental processes involved with the interaction of ultrasound with matter;
- explain the biological applications of techniques using ultrasound and audiometric procedures.

Discipline Specific Skills:
- use this knowledge when taking up posts within the Health Service and other related fields;

Personal and Key Skills:
- ability to use physics techniques in a multidisciplinary context.
## Module Content

<table>
<thead>
<tr>
<th>Lecturer</th>
<th>Title</th>
<th>Lecture Hours</th>
<th>Lab Hours</th>
</tr>
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<tbody>
<tr>
<td>Prof M Sperrin</td>
<td><strong>Ultrasonics theory, instrumentation and practice</strong>&lt;br&gt;Nature of ultrasound, ultrasonic wave parameters, linear wave propagation, speed, compressibility, impedance, pressure, phase, intensity, power, reflection, refraction, scattering, absorption, attenuation; Piezoelectric effect, single element transducer, pulse shape, measurement of acoustic field, pulse repetition frequency, pulse repetition period, wave front, beam shapes, near field, far field, focusing; ultrasound imaging, Doppler, quality assurance, artifacts (Imaging and Doppler); Interaction of ultrasound with tissue, possible biological effects; Measurement of the acoustic output parameters.&lt;br&gt;Production and assessment of Ultrasound scans. Probe design. Interaction of ultrasound with tissue. Resolution. Digitisation and signal processing. Synthetic aperture techniques. Harmonic imaging. Measurement errors. Quality assurance &amp; phantoms.&lt;br&gt;The Doppler equation. Uses of Doppler. Indexes of wave shape and applications. Frequency analysis techniques. Pulse Doppler. Colour representation of blood flow. Artifacts. Ultrasonic therapies, including lithotripsy and hyperthermia.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Dr S Pani</td>
<td><strong>LABS:</strong>&lt;br&gt;1. Determination of the sound speed, acoustic impedance, reflection coefficients and attenuation of materials using pulse-echo ultrasound.&lt;br&gt;2. Measurement of fluid flow using a simple portable diagnostic Doppler ultrasound system of the kind frequently met in medical practice.&lt;br&gt;3. Plotting the acoustic field radiated by an ultrasound transducer using a state-of-the-art pvdf needle probe hydrophone.&lt;br&gt;4. Investigation of acoustic streaming and banding and cavitation in high-intensity acoustic fields.&lt;br&gt;5. Measurement of the power output of therapy-level transducers using a tethered float radiometer.</td>
<td></td>
<td>15</td>
</tr>
<tr>
<td>Dr R A Bacon</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prof Prasher</td>
<td><strong>Audiometry &amp; audiological testing</strong>&lt;br&gt;As most students will have no knowledge of acoustic measurement a significant portion of the course is devoted to the measurement of sound pressure level both in general and with special reference to its measurement in artificial ears and hence the standardisation of audiometric zero. Basic Anatomy and Physiology of the auditory system. Subjective aspects of hearing and threshold measurement. Sound level meters. Types of audiometry and audiometers. Design and calibration of audiometers. Procedures for audiometry.</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

### Methods of Teaching/Learning

The module is taught by external lecturers from the clinical, manufacturing and national standards professions.
**Selected Texts/Journals**
Each lecturer recommends his/her own set of reference books. The current list is as follows:

**Essential Reading**
- Fundamentals of Acoustics, Kinsler L E et al., Wiley & Sons Ltd, New York, 1982
- Output Measurements for Medical Ultrasound, RC Preston (Ed) Springer-Verlag 1991
- Physics & Instrum. of Diagnostic Medical Ultrasound, Fish P, Wiley 1999
- Ultrasonic Physics & Instrumentation, Hedrick, Hykes & Strachman, Elsevier, 1995
- Essentials of Ultrasound Physics, JA Zagzebski, Elsevier, 1996
- The Safe Use of Ultrasound in Medical Diagnosis, G ter Haar & FA Duck, BMUS 2000
- Essentials of Ultrasound Physics, James A. Zagzebski, Mosby-Year Book Inc., 1996
- Output Measurements for Medical Ultrasound, Roy C Preston, Springer-Verlag, 1991
- Paediatric Audiology 0-5 years, 2nd Edn, 1993. McCormick B (Ed), Whurr Publishers,
- The Handbook of Clinical Audiology, J Katz. 5th Edn, Lipincott, Williams & Wilkins 2002
- Diseases of the Ear, Mawson & Wright, 6th Edn, Edward Arnold, 1997
- A Synopsis of Otolaryngology, R Gray & M Hawthorne, 5th Edn, Butterworth Heinemann, 1992

**Methods of Assessment**
This module is assessed by coursework and examination. The coursework consists of one lab report for module sub-section ‘Ultrasoics, instrumentation and practice’ and full marks for this will be equivalent to 25% of the total marks available in assessment of this module. The examined component appears in Paper 5 which will consist of 5 questions. Students answer 3 questions from the 5. Full marks for a question will be equivalent to 25 % of the total marks available in assessment of this module.
Module PHY M013
Title: Research Project and Dissertation

<table>
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<th>Module Provider:</th>
<th>Physics</th>
<th>Module Code:</th>
<th>PHYM013</th>
</tr>
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<tbody>
<tr>
<td>Level:</td>
<td>M</td>
<td>Number of Credits:</td>
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</tr>
<tr>
<td>Module Co-ordinator:</td>
<td>Prof DA Bradley</td>
<td></td>
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Module Availability
Summer

Assessment Pattern

<table>
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<tr>
<th>Unit(s) of Assessment</th>
<th>Weighting Towards Module Mark( %)</th>
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</thead>
<tbody>
<tr>
<td>Coursework</td>
<td>Dissertation (100%), including marks allocated for work carried out during the project).</td>
</tr>
<tr>
<td>Part-time Students:</td>
<td>Same as for full time students</td>
</tr>
</tbody>
</table>

Qualifying Condition(s)

Pre-requisite/Co-requisites
None

Module Overview
All students undertake a project; for both full-time and part-time students the project topic is decided after the Easter vacation. Full-time students are assigned a supervisor from the Faculty soon after the Easter period. Part-time students undertaking a project outside of the Faculty are allocated a supervisor from within the School and an external supervisor. The latter is usually a Medical Physicist within the Health service approved by the Faculty. The internal supervisor meets with the external supervisor and the student to agree a project and possible work-plan. Contact is maintained throughout the project by e-mail etc. with possible site visits by the internal supervisor.

The work is assessed as follows:

Oral presentation and bibliography
Students are expected to present a brief ‘mid-project’ talk (5-10 minutes duration) to the Medical Physics Group, one month after the project has begun, and also on the same day to submit a bibliography for the project. The purpose of the bibliography and presentation is to identify progress in the project and to receive comments from the Group which may be incorporated into the project plan.

Dissertation
A dissertation of no more than 10,000 words (approximately 40 pages excluding full page diagrams, tables, references and appendices) must be written on the project and handed in, in accord with the procedures laid down in Section E of the Course Handbook. Supervisors will give guidance on the layout of the project report and the first draft of the material where appropriate.

Module Aims
This module provides the research component of the MSc programme. Hence it is the component that establishes the programme at Masters level.

Learning Outcomes
As demonstrated in the dissertation and preliminary exercises, the student should be able to: perform a literature search; give a scientific presentation, work in the context of a research group, keep a professional log book, write a scientific report.
Time-management; report writing; keeping a research notebook; oral and written presentation, IT skills and communication.

**Methods of Assessment**

| Evaluation of the mid-project talk and associated bibliography and the subsequent dissertation. |