DEGREES UNDER CONSIDERATION

BA  Part II Natural Sciences: Experimental and Theoretical Physics  Y160
BA  Part II Natural Sciences: General (Special Subject Physics)  Y160
MSci Part III Natural Sciences: Experimental and Theoretical Physics  Y160

INTRODUCTION

The purpose of the visit was to consider the application for accreditation of degree courses taught wholly or partly within the Department of Physics at the University of Cambridge. The primary aim of the Institute of Physics accreditation process is to provide an independent and rigorous assessment of physics degree courses, and thus assess whether or not the course provides a suitable educational base for the subsequent award of Chartered Physicist (CPhys) status. Accreditation is conducted on a rolling-review basis and is performed by a team of assessors who scrutinize the required paperwork and visit an applying department for one day. Accreditation is granted for a maximum of five years and works on a pass or fail basis with no system of grading.
The team of assessors met members of the academic staff during the morning session and later met with a group of undergraduate students from a variety of degree programmes. The visiting team toured the Department to observe the facilities.

**DEPARTMENTAL MANAGEMENT**

The organisational structure of the department was found to be fine and the interaction with the college system was good. The Head of Department has responsibility of the running of the department and all Committees report to the Head. The Teaching Committee oversees all teaching matters and receives student input through the Staff-Student Committee. Major changes to the physics courses have to be approved by the Management and Strategic Committees of the Natural Science Tripos and by the University’s Education Committee. External Examiners reports are dealt with appropriately and there is a good feedback system in place.

The Staff-Student Committee seems to work well and the students provided examples of its effectiveness. The visiting team was impressed to note that student questionnaires are used in its deliberations and that all reports are reviewed and moderated by the student representatives. The minutes of the meetings are available on the website.

**PROGRAMME & CURRICULUM**

The department offers 3-year BSc degrees and an extended 4-year MSci degree.

The visiting team was happy with the general coverage of the core curriculum in most courses. It was noted that the there were minor omissions in the General (Special Subject Physics) but that these are compensated for by material in the curriculum of the other sciences included in their programme. The department is currently in the middle of restructuring the courses in order to offer the students more choice in later years but it was clear that the core would still be covered. The visiting team was happy to accredit the courses with the proviso that the department keep the Institute of Physics fully updated of the changes made to the final years of the course.
The mathematics coverage was praised by the students as being designed for physics and applicable to the problems they were doing in their physics modules.

Students have supervisions each week in groups of two with a tutor who will go through problem sheets. The students were full of praise for the system and the visiting team believe that the system of great benefit to the students. The supervisions can be conducted by post doctoral students. The visiting team initially had some doubts that this would be adequate but the students indicated that post doctoral students were just as good as academic staff and also had the advantage of recent knowledge of the problems that the students could have. The Director of Studies will assist students if they find that their supervisions are not working well for whatever reason.

The degree programmes are well structured and appropriate to the range of abilities within the student profile and there are distinct conceptual and educational differences between the BSc and MSci programmes. All the degree programmes provide an acceptable coverage of essential physics and offer the opportunity to learn and practise a broad range of graduate skills. The team did note the absence of teamwork within the programmes. This had been raised at the previous accreditation visit and the team was disappointed to note that no changes had been made. Team working skills are highly desired by employers and the visiting team believe this omission is a weakness in the Cambridge physics provision.

LABORATORY & PROJECT WORK

Laboratories are adequate and supported by technicians, graduated demonstrators and academic staff. The experiments are interesting but much of the equipment is old and the students mentioned that in the first year that they could appear uninviting. The visiting team hope that funding will become available to update the laboratories as the uninviting aspect may well be putting off potential students continuing with physics. Health and safety is taken seriously with a mandatory presentation before each practical course.

Students expressed concern with the unevenness of treatment from demonstrators and much of the problem appeared to be with understanding demonstrators who did not have English as their first language. The department is aware of this and the Head of class is always available should students require further help but the students did not always realise this at the time and can be reluctant to contact them.
The visiting team suggested that the department should encourage the students to approach the head of class if required.

Projects were interesting and of comparable standard with elsewhere. The students found project work very useful and enjoyable despite being stressful at times. The students commented that although you do not always get your first choice the number of prospective projects available usually means that an appropriate project can be located and if not the option is available to come up with their own idea.

**SUPPORT FACILITIES**

Library and PC provision is largely provided by the colleges but well supported by departmental provision. The assessors saw the ample provision of computers in the department and the students indicated that college facilities are excellent. The students have access to online journals and the larger science library can be used if necessary although the students were of the opinion that this was rarely needed. Lecturers are also helpful in providing students with copies of papers for their project work.

**STUDENT WELFARE**

The students commented that in the first few years the department could come across as unfriendly as there was little social interaction. The visiting team felt that this was inevitable given the size of the department and the tripos system and noted that the department was aware of the situation and was taking steps to alleviate this.

There is a university careers service but the students seemed to know little about it and those that did were not of the opinion that it was much use. This could well be due to the students met by the visiting team having a good idea as to what they intended to do for a career.

The main support networks are associated with the colleges and it is clear that this works well and to the benefit of the students.
CONCLUSION

The physics degrees at the University of Cambridge are of a high standard and the students are clearly content with their choice of degree. The college system is highly beneficial to the students’ learning experience and ensures their wellbeing. The Institute of Physics is pleased to accredit the courses for the full five years.

ACCREDITATION RESULT

The degrees listed below are accredited with immediate effect and are set a Review Date of 30-May-2009.

ACCREDITED

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APPENDIX

The Physics Degree
Institute of Physics

The Physics Degree

Graduate Skills Base
Core of Physics

Updated: January 2003
THE PHYSICS DEGREE

This document details the skills and achievements that graduates of accredited courses should have. The Institute appreciates that there is a wide range of degrees including single, dual and joint degrees; this document only relates to the physics component of each degree. This document should be read in conjunction with the QAA benchmark statement for Physics, astronomy and astrophysics. The Institute considers the benchmark statement as definitive and nothing in this document is incompatible with the statement.

1 Courses should provide a positive experience of Physics and should encourage the student to foster and maintain an intellectual curiosity in the discipline. The Graduate Skills Base and the Core of Physics against which courses will be measured are presented below.

2 Furthermore, all courses should seek to satisfy the following objectives:
   • impart a secure knowledge of the fundamental elements of Physics
   • nurture confidence in the use of appropriate mathematical techniques
   • promote oral and written communication skills
   • teach the effective use of information technology & computing facilities for the treatment and presentation of experimental data
   • provide an awareness of safety procedures and environmental issues
   • develop and strengthen problem solving abilities

3 BSc programmes may contain project work or a dissertation. It is expected that MPhys/MSci programmes will incorporate project work and may be organised to allow students to work both individually or in groups. The objectives of such project work ought to include most of the following:
   • investigation of a physics-based or physics-related problem
   • planning, management and operation of an experiment or investigation
   • development of information retrieval skills
   • informed use of data analysis methods
   • establishment of co-operative working practices with colleagues
   • adoption of a reporting structure for the dissemination of information.

All accredited courses must fulfil section C of the Graduate Skills Base.
GRADUATE SKILLS BASE

A. PHYSICS SKILLS*

Students should learn:

1. How to formulate and tackle problems in physics. For example, they should learn how to identify the appropriate physical principles, how to use special and limiting cases and order-of-magnitude estimates to guide their thinking about a problem and how to present the solution making their assumptions and approximations explicit;

2. How to plan, execute and report the results of an experiment or investigation. They should be able to use appropriate methods to analyse their data and to evaluate the level of its uncertainty. They should also be able to relate any conclusions they make to current theories of the physics involved.

3. How to use mathematics to describe the physical world. They should have an understanding of mathematical modelling and of the role of approximation. They should be able to compare critically the results of model calculations with those from experiment and observation.

B. TRANSFERABLE SKILLS*

A Physics degree should enhance

- Problem-solving skills

Physics degree programmes involve students in solving problems with well-defined solutions. They will also gain experience in tackling open-ended problems. Students should develop their ability to formulate problems in precise terms and to identify key issues. They should develop the confidence to try different approaches in order to make progress on challenging problems.

- Investigative Skills

Students will have opportunities to develop their skills of independent investigation. Students will generally have experience of using textbooks, and other available literature, of searching databases and of interacting with colleagues to extract important information.

- Communications skills

Physics and the mathematics used in physics deal with surprising ideas and difficult concepts; good communications is essential. A physics degree should develop students’ ability to listen carefully, to read demanding texts, and to present complex information in a clear and concise manner.
• Analytical skills

Physics helps students learn the need to pay attention to detail and to develop their ability to manipulate precise and intricate ideas, to construct logical arguments and to use technical language correctly.

• IT skills

During their studies, students will develop their computing and IT skills in a variety of ways, including their ability to use appropriate software such as programming languages and packages.

• Personal skills

Students should develop their ability to work independently, to use their initiative, to organise themselves to meet deadlines, and to interact constructively with other people.

C. EXPERIMENTAL SKILLS

The Institute of Physics believes that all graduates should have some appreciation of physics as an experimental science. Physics is inherently a subject relating hypothesis and prediction to the real world, and thus coping with the complexities of the real forms an important part of the education and training of a physicist. To this end all graduates of an accredited degree should:

• have a serious appreciation of the elements of experiment and observation, including some involvement in planning, data acquisition and analysis, and a real appreciation of the meaning of uncertainties in experimental or observational measurements.

• Be able to determine, understand and analyse the uncertainties (both systematic and random) of observation in any measurement.

• Acquire some appreciation of the way regulatory issues will influence scientific experimentation and observation, such as health and safety issues in relation to the areas in which they work, and in planning an investigation.

For many courses, experimental work will be a vital and challenging part and will provide students with the skills necessary to plan an investigation and collect and analyse data. These required skills may be taught through a conventional laboratory course, by computer simulation, by paper exercises with appropriate data, or by case studies using real experimental data from a published source. Other methods may be used provided they meet the above objectives.

*Physics skills and Transferable skills are taken directly from the benchmark statement for Physics, astronomy and astrophysics which is available at http://www.qaa.ac.uk
The **Core of Physics** relates to single-honours degrees at the BSc level. Minor-major combinations and joint-honours degrees will naturally have a reduced Physics content which **will be complemented by another discipline but** should normally cover the core material.

The **Core of Physics** contains a set of headings under which appear examples of material which should normally be covered. The actual arrangement of material under the designated headings could be debated *ad infinitum*; consequently, the arrangement of material in a given curriculum is not a critical issue. This particular arrangement is given as one example.

As such, this **Core of Physics** should **not be read as a syllabus** and a traditional arrangement of the curriculum is not a requirement nor is a traditional teaching approach.

It is more appropriate to read it as a core of **concepts** which should be familiar to a graduate of an accredited course. This is not a list of what should fill every degree; rather it is a list of what would normally not be omitted *i.e.* it stipulates a minimum content. It is, in essence, that material which almost every member of the academic staff will be able to teach or tutor comfortably.

Physics is a hierarchical discipline, therefore, before some of the topics identified below can be treated in adequate depth there is a tradition of prerequisite material which must be covered.

A degree eligible for accreditation should have engendered a familiarity with the following five fields of Physics, to include an appreciation of the limitation of the physical theories, to be able to apply the fundamental principles to particular areas and to include some awareness of how they have developed over time:

- electromagnetism
- wave phenomena
- classical and quantum mechanics
- statistical physics and thermodynamics
- properties of matter

The salient elements of these fields of Physics are presented in the **Core of Physics** which follows.
CORE OF PHYSICS

Electromagnetism


Wave Phenomena


Fourier methods and applications.

Classical Mechanics and Quantum Mechanics


**Statistical Physics and Thermodynamics**


**Properties of Matter**

Microscopic descriptions of solids, liquids and gases. Reference to plasma. Changes of state. Bonding. Inter-atomic forces.


Moduli of elasticity (Young’s, shear and bulk). Coefficients of expansion. Thermal and electrical conductivities. Superconductivity. Electron theory of solids to include the band structure of a semiconductor. An understanding of the p-n junction. Phonons.