VICTORIA UNIVERSITY OF WELLINGTON
ACADEMIC PROGRAMME REVIEW

PHYSICS

SELF REVIEW

September 2007

VOLUME I

Contents

Chapter 1

Introduction

The physics group in the School of Chemical and Physical sciences welcomes this review. This is the first review of the physics teaching programme since 1993.

The physics group is relatively small but very active, and enjoys an excellent research reputation which is reflected in the quality of its teaching programmes. We conduct excellent research across a wide range of physics disciplines, including solid state physics, soft matter physics, geophysics, electrodynamics and optics, quantum theory, and astrophysics, and covering both theoretical and experimental aspects. In many areas our research success is linked to the presence of the MacDiarmid Institute for Advanced Materials and Nanotechnology which has been hosted by and closely linked to the School since 2003. The physics group also has an active outreach programme that includes teacher liaison, school visits, and the maintenance and continual updating of a website of physics demonstrations.

In recent years we have seen a steady increase both in the number of students taking 100 level physics, and in the numbers enrolling in the physics major of the BSc degree. That this is in contrast with a national trend of decreasing physics enrolments reflects extremely well on the physics programme at VUW, although the national trend must continue to be seen as a concern. Furthermore, we continue to have a major concern over the decreasing preparedness of students in mathematics. We also face significant challenges as the new Bachelor of Engineering is progressively implemented over 2007-2010.

Chapter 2

Overview

The physics programmes under review are the responsibility of the School of Chemical and Physical Sciences (SCPS). SCPS was formed in 1997 by the amalgamation of the previously separate Departments of Chemistry and Physics. Prior to this the structure of the physics programmes was the responsibility of the Department of Physics. Since the formation of SCPS the physics group has continued to operate with a significant degree of academic autonomy in the administration of the physics programmes.

This chapter presents a brief introduction to the Physics Group and its key concerns for this review. The following chapter presents the academic programmes of the Physics Group.

2.1 Physics

The physics group teaches a Physics major for the BSc and BSc(Honours) degrees, and also has joint responsibility with the School of Mathematics, Statistics and Computer Science (SMSCS) for BSc and BSc(Honours) majors in Electronic and Computer Systems (Engineering). We also offer MSc and PhD degrees in Physics, and make substantial contributions to the BScTech, BIT and BE degrees. Our curriculum is similar to those of other NZ universities, with core and some elective material taught in the initial 2 years and an emphasis that reflects our research strengths at the advanced levels, particularly at 400 level. This emphasis is in the areas of condensed matter physics, astrophysics and geophysics, but also with a growing contribution in electronic and computer systems. Three non-core courses are also taught at 100 level, with two of these (PHYS 131 and 132) of interest to non-physics specialists, and PHYS 130 providing physics at an introductory level catering in particular to Architecture students. A introductory course (PHYS134) is also taught in the summer trimester.

The physics group currently has 12.4 permanent academic positions, with another 2 contracted fixed-term positions through the MacDiarmid Institute. These 2 contract positions end in June 2008, although with the recent refunding of the MacDiarmid Institute it is hoped that new or re-appointments will follow. We have also recently received the resignation of 1 permanent staff member who will leave at the end of October 2007, and indication of the impending retirement of another staff member in mid-2008. The development of the Bachelor of Engineering may well also see the transfer of 2 or 3 academic staff members into a new School of Engineering. We therefore face, in the near future, significant uncertainty in the level of staffing.

Over the past 3 years, against a back-drop of falling student numbers in physics at other New Zealand universities, we have seen a significant increase in both numbers of students taking physics courses, and in numbers in the Physics major of the BSc. Over the next few years this increase may be continued by the development of the BE, which requires 100 level physics for two of its majors, and which will draw upon existing 200 and 300 level electronics courses for part of its 200 and 300 level structure. However, whilst so far the physics group has had considerable input into the development of the BE, it is likely that this input will diminish with the establishment of a separate School of Engineering. The implications of this both for student numbers and for the future of the Electronic and Computer Systems major in the BSc need careful consideration.

Our overall numbers also remain vulnerable to changes in the requirements of other disciplines, in particular of the Architecture Intermediate (1st year).

The strength of the physics research of the school has led to increasing graduate student numbers which, while essential for maintaining the research output, is placing a severe strain on laboratory and study space.

2.2 The Self-Review Process

The physics group used the guidelines prepared by the Office of the Assistant Vice-Chancellor (Academic) to structure this document. A sub-committee of the group was established to formulate the initial draft of the document. The draft was then made available to all physics staff for comment and input 2 weeks before the final draft was submitted. The Head of School performed an editing role.

Chapter 3

Physics Programmes

The undergraduate programmes either in physics or to which physics makes a significant contribution to a joint programme are:

- the Bachelor of Science (BSc) with a major in Physics
- the Bachelor of Science (BSc) with a major in Electronic and Computer Systems
- the Bachelor of Science and Technology (BScTech) with specializations in Advanced Materials and Electronics and Instrumentation
- the Bachelor of Information Technology (BIT)
- the Bachelor of Engineering (BE) with majors in Electronic Engineering and Computer Systems Engineering

The graduate programmes offered, jointly offered or to which a significant contribution is made are:

- the Graduate Diploma in Science with specialisation in Physics
- the Graduate Diploma in Science with specialisation in Electronics
- the BSc (Honours) in Physics
- the BSc (Honours) in Electronic and Computer Systems Engineering
- the BSc (Honours) in Geophysics
- the Masters degree (MSc) in Physics
- the Masters degree (MSc) in Electronic and Computer Systems Engineering
- the Doctor of Philosophy degree in Physics
- the Doctor of Philosophy degree in Electronic and Computer Systems Engineering

The programmes in physics have existed at VUW since it became an independent university in 1960. The Electronic and Computation Systems (ELCO) major was introduced in 1996 and is co-taught with the School of Mathematics, Statistics and Computer Science (SMSCS). The Honours, Masters and Doctorate programmes in Electronic and Computer Systems Engineering were subsequently introduced in 2006 and are also co-taught with SMSCS. The BScTech was introduced in 1998 and the Advanced Materials major is co-taught with the Chemistry group within SCPS. The introduction of the BE in 2007, currently co-taught by staff in SCPS and SMSCS, but with a separate School of Engineering likely to be established as early as 2008, has already had significant implications for some of the undergraduate programmes. The BIT will be phased out from 2008, as will be the Electronics and Instrumentation major of the BScTech.

Because of the changing landscape associated with courses in electronics and technology due to the initiation of the BE, this chapter concentrates on the programmes (BSc, BSc(Hons), MSc and PhD) in Physics. The implications for the physics group, and the programmes in Electronic and Computer Systems, from the development of the BE are discussed in Chapter 9 on Future Challenges.

3.1 Strategy

From the point of view of the BSc and BSc(Hons) degrees in physics the overall goal of the physics programme is to produce students who, not only have a solid background in the core areas of physics, but also have been exposed to wider aspects of physics including astrophysics, geophysics, environmental physics and electronics. Such graduates will be able to not only pursue careers in high level physics research, but also be active in contributing to the public understanding of science, and in training the next generation of scientists.

We are also cognisant of the fact that many students take courses in physics through interest but with no intention of majoring in the subject. To this end the physics offering includes two courses (PHYS131 and PHYS132) at 100 level which give an introduction to applications of physics in two of the most common areas of interest. Additionally, subject to satisfying course prerequisites, all courses at all levels are open to students not majoring in physics. We thus aim to contribute to the general understanding of important physical principles and applications by students who do not aim to be specialists in the subject.

The SCPS Strategic Plan for 2003-2005 and the Operational Plan 2006-2008 both mention teaching and learning goals. Two of these are itemised below with comments on the manner in which the physics group, in particular, has made progress towards achieving these.

"The School of Chemical and Physical Sciences will foster a culture of quality research, teaching and learning in a stimulating and collegial environment.
This will be achieved by:

- *Being a nationally and internationally recognised high profile School, concerned with the delivery of high quality teaching programmes in chemistry, physics, electronics, materials science and technology. The teaching programmes will be broad based and informed by research…"*

SCPS Strategic Plan 2003-2005

The success that had been achieved by the physics group in both rounds of the Performance Based Research Fund (PBRF), and the enhanced national, and international recognition of SCPS through its hosting of the MacDiarmid Institute, has helped us to move a long way to the achievement of this goal. We have also made a concerted effort within our teaching programmes to improve the engagement of students with physics and with the school as a physical environment in which they feel comfortable. We believe that the quality of our programmes is illustrated by the success achieved by our graduates.

"Student retention. It is our goal that by 2015 the School of Chemical and Physical Sciences will be the leading institution for the study of chemistry, physics, and particular areas of technology/engineering in New Zealand. Achieving this will require a large number of excellent students which means we will have to do an excellent job of recruiting and retaining students at all levels. Note that improving retention is often more cost effective than improving recruiting. One more student in a stage one course helps, but a student retained right through to a Ph.D. takes a great many courses. Thus the issue of student retention in the School of Chemical and Physical Sciences encompasses students at all levels in the school. This includes retention during first year courses in chemistry, physics, and technology, retention from first year courses into second and third year courses, and so on up to retention of our senior undergraduate students into postgraduate levels."

SCPS Operational Plan 2006-2008

As is discussed below we have put significant resources into retention of existing students. Through this we have seen a rise in retention rates of Physics majors from 100 to 200 level and this is now beginning to feed through into 300 and 400 level. Some work still needs to be done in encouraging students to remain and pursue postgraduate study. We have also actively pursued an expansive outreach programme since 2001 and maintain wide links with the community of secondary school physics teachers. We believe that partly through this activity we are now starting to see a change in attitude among secondary school students who now see VUW as "the" place to study science and physics in particular.

Specific strategies that have been carried out as a means of fostering both a general growth in student numbers and in retention of physics majors are:

- The use of our best and most experienced lecturers in the core 100 level physics courses. This includes the high profile Prof. Callaghan in PHYS114 and Dr Turner, who has won several teaching awards, in PHYS115.
- Restructuring of the core 100 level laboratory classes to improve student engagement by the use of Guided Enquiry as a means of teaching for at least some of the laboratories.
- Provision of study and common room space for undergraduate students.
- Institution of additional help for, specifically, 100 level students by running a physics Help Desk.
- Being proactive in running and supporting an extensive SCPS outreach programme, including a dedicated staff member to facilitate the programme and involvement from all physics staff members.

The University has approved core attributes for its graduates of leadership, creative and critical thinking, and communication. All physics courses offered in SCPS aim to develop critical thinking and communication, and use assignments, laboratory work, term tests and examinations to this purpose. Indeed, the critical thinking skills of physics graduates are highly regarded by employers across a wide range of disciplines. Creative thinking is more relevant in research and is encouraged in the Physics (Honours) programme by the inclusion of two research project papers. Within the undergraduate degree our courses do encourage students to tackle problems using a repertoire of resources including information from lectures, textbooks and the Internet. Especially in courses at 300-level and higher, problems are set which require thinking outside the actual course lecture notes. Leadership skills are fostered in some tutorials, where groups are encouraged to solve problems together.

3.2 Learning Outcomes

As was detailed above our overall goal is to produce students, both physics majors and non-majors, who have an appreciation and understanding of the subject which will be of value to them in their future careers. An indication of our success is given by the following small selection of achievements by our students. A more complete list is included at the end of this Chapter.

- Elizabeth Campkin (BSc 2006) is now a qualified physics teacher, teaching in Wellington

- Elizabeth Connor (BSc(Hons) 2005) has completed a postgraduate course in science writing at Imperial College, London and is now working as a science writer/journalist
- Martijn Jasperse (BSc 2006) received an Honours Scholarship from the University of Melbourne
- Jade Mackay (current PhD student) won a Bright Futures Top Achiever Doctoral Scholarship
- Daniel Pringle (MSc 1999, PhD 2005) was appointed to a Postdoctoral Fellowship in the Arctic Regional Supercomputing Centre, University of Alaska, Fairbanks

3.3 Student Numbers in Physics

The number of students registered in physics courses for 2002–2007, divided by level, is shown in Fig. 3.1.

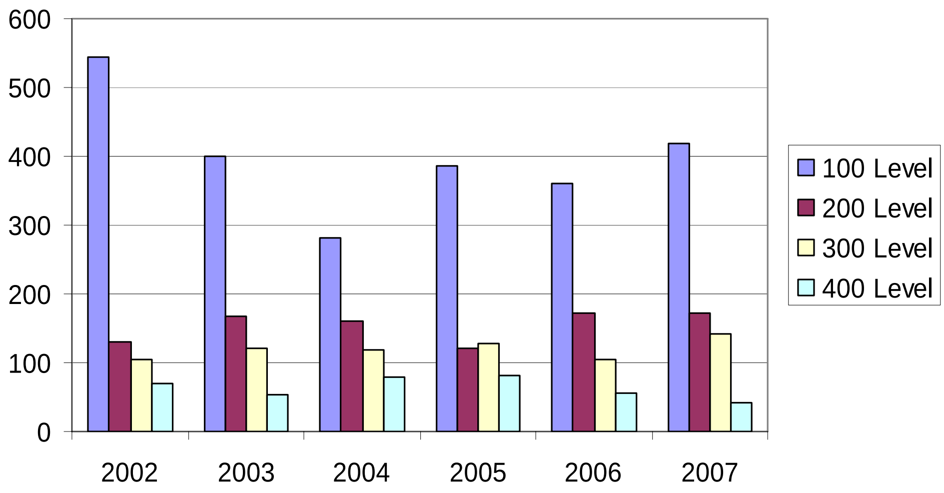

Figure 3.1: Course enrolments by level for all physics courses, 2002-2007. Note that 100 level numbers for 2007 are incomplete as PHYS134 does not run until the 3rd trimester.

The data shown indicate the degree to which physics is susceptible to changes in the requirements of other disciplines. Set against a general decline of 100 level students from 2002-2004, the low in 2004 reflects a year in which the first year requirements for Architecture were changed so that the majority of Architecture students did not enrol in PHYS130. Similarly, the rebound in 100 level numbers in 2005 resulted in part from another change in the Architecture Intermediate which re-established the requirement for some training in physics. Continuing discussion within the Faculty of Architecture and Design around the restructuring of their degree programme means that physics numbers remain vulnerable to such changes. Likewise, while the number of Physics (Honours) students has remained basically stable, the decline in overall 400 level numbers largely reflects reduced numbers of Geophysics (Honours) students (PHYS441 and PHYS447) and changing patterns of enrolment in the BScTech and BIT (PHYS420-423).

Notwithstanding this, since 2004 100 level numbers have seen a steady increase and this has also been reflected in the increase in numbers of students both beginning and continuing with a major in physics as shown in Fig. 3.2.

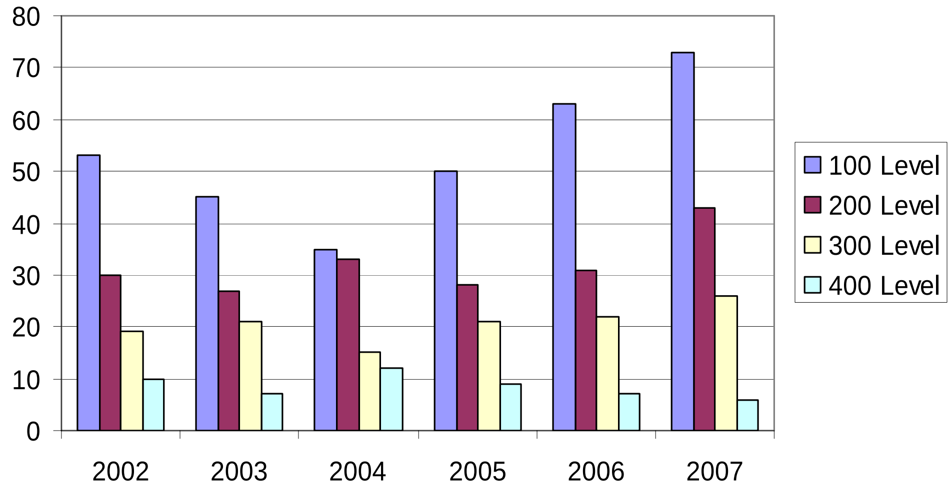

Figure 3.2: Physics major numbers by level, 2002-2007.

Fig. 3.2 shows a steady growth in students majoring in physics at undergraduate level. This is attributed to two main factors. The first of these is the higher level of exposure that science in general, and physics in particular, at VUW has due to, for example, excellent PBRF ratings and the high visibility of the MacDiarmid Institute. Additionally, as is discussed later, since 2005 the physics group has injected considerable resources into support structures for students at 100 level and into schools outreach. We have also made changes at 100 level to enhance the student learning experience. This has significantly improved the retention rates of students from 100 to 200 level within physics with a consequent flow-on effect from 200 to 300 level. It is of some concern that a similar rise in retention has yet to be seen at 400 level. However, the increase in 300 level class sizes in 2007, including an increase in the number of students achieving A- to A+ grades, may see this begin to appear in 2008. Grade distributions and pass rates in courses are discussed in detail in Chapter 4.

Since 2001 the physics group has been proactive in running and supporting an extensive outreach programme. This initially started with a programme of school visits which saw primarily year 7 and 8 students visit the school for half a day to participate in laboratory activities in physics and chemistry. The initial success of this scheme has seen it broadened so that in both mid-year and end-of -year non-teaching periods we host a total of 20-30 school groups. The mid-year sessions now concentrate on year 12 and 13 students, with the end-of -year sessions being targeted at the younger students. Similarly, for many years SCPS has hosted a physics teachers day during which physics teachers from the lower North Island visit for a programme of activities, share concerns with the physics group, and interchange ideas. We have in recent years also run a Scholarship day for Year 13 students considering doing the NCEA Physics Scholarship examination. Although the contribution to the increase in base numbers in physics cannot be quantified, we have a general feeling that the goodwill towards SCPS created by these, and other similar, activities is a contributing factor to our student growth.

Postgraduate numbers over the period 2002-2007 are shown in Fig. 3.3. Note that, due to "postgraduate holding", PhD numbers for 2007 do not show the complete total of active students. Numbers for 2006 and 2007 also include students enrolled in courses in the Electronic and Computer Systems Engineering postgraduate programme for which physics holds responsibility. Over this period there has been a small but steady rise in the number of

PhD students in physics, however, the most notable feature is a significant rise in the number of MSc students. The sharp rise in 2006 and 2007 is due not only to the inclusion of ECSE MSc students but also reflects an almost doubling of MSc students in physics itself.

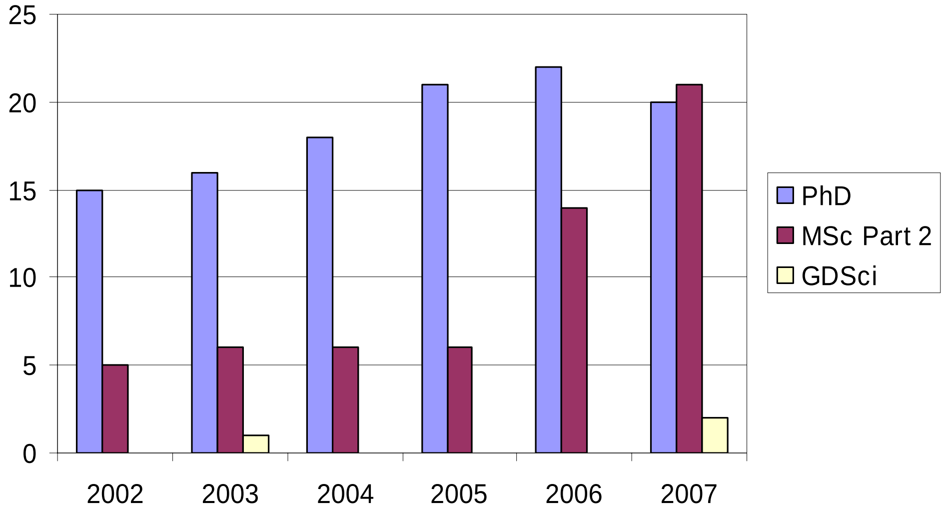

Figure 3.3: Physics postgraduate numbers, 2002-2007. PhD numbers for 2007 are incomplete due to students in the "postgraduate holding" category.

Over this period we have also seen a significant number of good students accept postgraduate offers from better funded overseas universities, rather than remaining in SCPS. We believe that the increase in postgraduate numbers would have been more substantial over this period had there been a greater availability of postgraduate scholarships for these able students. This issue has been raised several times with the University Senior Management Team and there has been an increase in the number of studentships offered. Nevertheless, our position remains that we would like to see automatic postgraduate scholarships offered to all students obtaining a First Class Honours degree.

3.4 Programme Management Processes

3.4.1 Structure

Each course within the physics programme has a designated co-ordinator who is usually either the sole lecturer, or one of the lecturers in the course. The course co-ordinator has overall responsibility for the course, including producing the course outline, notes and laboratory manual, co-ordinating the teaching within the course, maintenance and development of the laboratory experiments associated with the course, production of test and examination papers, management of the marking of these, and compilation of the final results.

At the 200, 300 and 400 levels there are, in addition, overall level co-ordinators. In 2007 these were Dr Ingham (200 level), Prof. Etchegoin (300) and Prof. Lekner (400). At 200 and 300 level the main responsibility associated with this is the organisation of the laboratory timetable across the year level. The 400 level co-ordinator sets the timetable for the Honours courses and manages the allocation, supervision and marking of the PHYS490 and PHYS491 research projects. At all three levels the overall co-ordinator also convenes examiners meetings covering all the courses at that level.

MSc and PhD students fall under the management of the Physics Graduate Co-ordinator (Prof. Kaiser).

3.4.2 Allocation of Teaching

Allocation of teaching duties is part of the annual physics workload allocation process, and is the responsibility of the Deputy Head of School, Dr Ingham. Each staff member is canvassed for their preferences for teaching in the following year, and duties are assigned so as to balance workloads over the physics group. More details of this workload allocation system are given in Chapter 5 and Appendix I.

Central to the allocation of physics teaching is the philosophy that all members of staff should be able to teach in any course at 100, 200 and 300 level. Within these levels the only exceptions to this are the 300 level electronics courses which require a more specialised knowledge. In general, within the limits of staff preferences and taking into account absences on Research and Study Leave, it is endeavoured to change teaching allocations in each course every 4-5 years. This ensures that a fresh approach to each course is maintained and that staff do not become stale with teaching the same material.

At 400 level, where courses are more advanced, as far as possible teaching allocations fit the research interests of staff.

3.4.3 Course Entry Standards/Criteria

Entry to our standard 100 level courses is based largely on student achievement in NCEA in physics and mathematics (as detailed in Chapter 7). Where possible individual students are specifically advised which courses are appropriate for their particular background and planned programme. Unfortunately the University's drive for automation of the first year enrolment procedure means that many students do not receive this advice. Ultimately enrolment in the physics undergraduate programmes is not restricted once a student has gained entry to the University.

3.5 Teaching and Learning Methods

The undergraduate programme in physics is taught through a combination of lectures, tutorials and laboratory classes. At 100 level lecture material is supported by weekly assignments which are marked and returned together with model answers. Laboratory work involves 10 weeks of experiments and is assessed on the basis of the log book that students are required to keep. At 200 and 300 level the number of assignments varies somewhat from course to course. Formal laboratory reports and the ability to keep a satisfactory laboratory log book are also assessed. Details by course may be found in Table 3.1.

Individual teaching styles vary, from the traditional chalk on blackboard or pen on whiteboard lectures, through use of overhead projectors, to full Powerpoint style presentations. Tutorials are timetabled as whole class tutorials. These may be run as problem solving sessions where problems paralleling that week’s assignment questions are solved; sessions where students, or groups of students, are asked to make presentations; or as is discussed below making use of interactive "clickers" to encourage student participation.

Course	Title	Points	Teaching Methods	Assessment
PHYS114	Physics 1A	18	36L, 12T, 30 hrs	55E, 20L,20T, 5A
PHYS115	Physics 1B	18	36L, 12T, 30 hrs	60E, 20L, 15T, 5A
PHYS130	Introductory Physics	18	36L, 12T, 18 hrs	70T, 20L, 10A
PHYS131	Energy and the Environment	18	36L, 12T, 20 hrs	55E, 20L, 15T, 10A
PHYS132	Introductory Astronomy	18	36L	65E, 15T, 20A
PHYS134	From Newton….an Introduction to Physics	18	54 hrs	50T, 30L, 20A
PHYS209	Physics of the Earth and Planets	11	24L, 12T, 12 hrs	60E, 20L, 15T, 5A
PHYS214	Physics 2A: Relativity, Quantum and Particle Physics	22	48L, 12T, 21 hrs	60E, 20L, 15T, 5A
PHYS215	Physics 2B: Electromagnetism, Optical and Thermal Physics	22	48L, 12T, 24 hrs	60E, 20L, 15T, 5A
PHYS217/ TECH203	Computerised Data Acquisition and Analysis	15	24L, 24 hrs	40E, 30L, 20T, 10O
PHYS234	Digital Electronics	11	16L, 4T, 33 hrs	50T, 50L
PHYS235	Analogue Electronics	11	16L, 4T, 33 hrs	50T, 45L, 5A
PHYS304	Electromagnetism	15	24L, 6T, 16 hrs	60E, 20L, 15T, 5A
PHYS305	Thermal Physics	15	24L, 6T, 16 hrs	60E, 20L, 15T, 5A
PHYS307	Quantum Physics	15	24L, 6T, 16 hrs	60E, 20L, 15T, 5A
PHYS309	Solid State and Nuclear Physics	15	24L, 6T, 16 hrs	60E, 20L, 15T, 5A
PHYS339	Experimental Techniques	15	16L, 24 hrs	45E. 40L, 15T
PHYS340	Microprocessor and Interface Electronics	15	24L/T, 24 hrs	33L, 34T, 33A
PHYS341	Analogue Electronics and Instrumentation	15	24L/T, 20 hrs	55E, 35L, 10A
PHYS342	Advanced Digital Electronics	15	21L, 8T,	20L, 40T, 40A
PHYS411-447	Physics Honours	15	24L/T	70-80E, 20-30A
PHYS490	Research Project A	15	150 hrs	100L
PHYS491	Research Project B	15	150 hrs	100L

Table 3.1: Teaching methods and assessment in physics courses. Lectures (L) and tutorials (T) are 50 minutes long. The number of hours represents the number of hours of laboratory work associated with the course. In different courses this is divided into 2, 3 or 4 hour laboratory sessions. Assessment is shown as % on final university examination (E), internal tests (T), laboratory (L), assignments and projects (A) and oral presentations (O).

The importance of assignments is emphasised by credit towards the final course grade being given for them in nearly all courses. Laboratory report writing is emphasised at 200 and 300 level as part of the goal that physics graduates should have communication skills in science. Satisfactory completion of the assignment and laboratory component is a course requirement in all courses.

3.5.1 New Developments

Since around 2001 the physics group has initiated several new approaches to teaching at 100 level which have been well received by students and are, no doubt, partially responsible for the increase in retention rate discussed above. We have also endeavoured to create an environment for students, within the Laby Building, which is welcoming and presents a "home away from home" to the student. This has included the establishment of a small undergraduate common room equipped with a small kitchen and a number of computers.

The appointment of Dr Lukefahr in 2004 was specifically aimed at providing additional support at 100 level through both evolutionary changes to laboratory classes, the development of new lecture demonstrations, and targeting specific help for weaker students. We have also employed on contract an experienced Secondary School physics teacher (John Hannah) to aid in this, and to help promote interactions with local schools. These appointments have led to a series of developments which reflect new pedagogy and adopt or adapt new teaching techniques. However, one of the central difficulties with such active learning approaches to teaching is that they are very time-consuming for staff and in many cases require expensive equipment.

- The introductory course PHYS134 was introduced in the summer trimester of 2005/6. Unlike PHYS131 which had previously been offered over the summer trimester as a general interest course in physics, PHYS134 was intended as the first "bridging" course for new students that had been offered in physics. The course represented a new philosophy of teaching within the physics group in that it is taught through the mechanism of *WorkShop Physics* (also referred to as Guided Enquiry) in which Dr Lukefahr is trained. This technique was developed partly at Dickinson College in Pennsylvania. In it students develop their own understanding of physics through carefully constructed, guided enquiry-based activities that are mostly centred in the lab. PHYS134 uses this technique to take students through the development of theories of light, bringing in a variety of aspects of introductory physics along the way. The success of Guided Enquiry in PHYS134 has subsequently led us to a process of evolution whereby some of the laboratory classes in PHYS114 and PHYS115, as well as in PHYS130 and PHYS131, are now presented in this style. Feedback from the students indicates that they tend to prefer this type of laboratory class to the more traditional style of following a series of instructions from a manual. Guided Enquiry appears to be particularly successful as a learning tool when the demonstrators are actively prepared to encourage group discussion, and to this end special training has been given to the student demonstrators in PHYS114 and PHYS115. The essential idea is that demonstrators are given a rough outline of a set of questions and discussion topics (a script) designed to initiate conversations about the physics between the demonstrator and the students. The conversations tend to diverge from the script, which is a desirable outcome. More generally, demonstrators are now expected to be better prepared and are not allowed to stand at the back of the room. They must circulate continuously. Examples of both a Guided Enquiry laboratory and a scripted discussion for demonstrators are given in Appendix G.

- We have also since 2003 significantly overhauled and added to our bank of physics demonstrations. The use of these, primarily in 100 level teaching, has been significantly increased despite the difficulties engendered by lecturing in theatres relatively remote from the Laby Building.

- We have adopted some of the *peer instruction* techniques pioneered by Eric Mazur at Harvard University for use in our tutorial classes and less frequently in lectures. These teaching techniques involve asking a series of carefully designed questions often in conjunction with demonstrations and/or example problems. Students respond to the questions with electronic devices similar to remote controls. This allows either anonymous or marked responses and again involves the students actively in the development of their understanding of the material. The techniques and technology have been adopted by universities around the world including other New Zealand universities. A wealth of education research any many institutions over many years has shown this technique to be remarkably effective when used well. Feedback from internal surveys of the students at 100 level indicates that it is a positive development.

- The extension of the Physics help desk as is discussed below.

Following Dr Lukefahr's experiences in the United States, and with the active encouragement of Dr Turner as programme director, we have also promoted a Physics Club. One of the founding members of the club was Professor Alan Macdiarmid. It offers students interested in physics a range of fun and interesting social activities including Game Nights featuring foosball tables, twister, sausages, and ice cream made using liquid nitrogen. There are astronomy nights on campus and off campus, movie nights, bowling nights, and a range of other events that bring together students from stage one through postgraduate. Many of the club members are not physics majors; the only requirement for membership being an interest in physics.

2007 has also seen the introduction of the SCPS Colloquia, a series of evening talks aimed at introducing the physics and chemistry research areas in SCPS to undergraduate students at 200 level and above. As well as providing useful scientific teaching, it is hoped that the talks will encourage undergraduate students to consider going on to a graduate degree, and to ensure that they are aware that exciting opportunities for this exist in SCPS. The talks assume a basic understanding of physics or chemistry, but no specific knowledge of the research field. The seminars run approximately every two weeks during term time, and thus far feedback and attendance have been very positive.

3.5.2 Undergraduate Student Advice

Within SCPS programme advice for undergraduate students is provided by Gillian Turner who, as Programme Director, is identified as the point of contact for enrolling students. Dr Turner aims to see all 200 and 300 level physics major students before the start of each academic year to advise them on the most appropriate selection of courses for the stage of their study that they are at. As mentioned above, the automated enrolment procedure makes this impractical at 100 level. However, many such students do independently seek advice before enrolling and also during the academic year. Academic advice is also provided by Student Advisors and the Associate dean of Students within the Faculty of Science.

3.5.3 Demonstrating and Tutoring assistance for students

While lecturers are responsible for the planning of experiments within a course, actual demonstrating in the laboratories is generally done by senior undergraduate and postgraduate students. For PHYS114 and PHYS115 a specific laboratory manager/demonstrator is employed who co-ordinates the marking of the laboratory classes and contributes heavily to the running of the laboratory classes.

It is physics policy at 200 and 300 level, even when demonstrators are involved in the laboratory, that the lecturer for the course should be present for the first 20-30 minutes of the each lab classes to assist students in getting started. Pressure of time means that, in practice, individual lecturers do this to differing degrees. In some courses (e.g. the 200 and 300 level electronics courses) there is significant lecturer input into demonstrating over and above this. In all 200 and 300 level laboratory courses except PHYS214 and PHYS215 marking of laboratory reports is the responsibility of the lecturer. In PHYS214and PHYS215 marking is done by the demonstrators.

A highly successful Physics Help Desk has been run since 2002. This presently operates for some 7-9 hours per week (depending on demand). The Help Desk is staffed primarily by postgraduate students with supporting academic staff input and is believed to have been a significant factor in the increased retention of students. Additional Equity and Awhina (see Chapter 8) tutorials are also available to students.

3.5.4 Student Workloads

Anticipated student workloads are indicated in the Course Outline handed out at the start of each course. We use as a guideline the principle that to obtain an average pass in a course, the average student should require 10 hours of work per point value. For example, an 18-point course with 3 lectures and 1 tutorial per week for 12 weeks, and 30 hours of laboratory work has 78 hours of contact time. The remaining non-contact time would be spent studying lecture notes and textbooks, reviewing marked assignments and model answers, working on laboratory reports and weekly assignments. Although no up to-date information exists on how the actual time spent by students on individual courses relates to point value, the Science Faculty, as part of a review of the BSc degree, is presently organising surveys to collect new data relating to this.

3.5.5 Links with other programmes at VUW

Other BSc majors at Victoria University that require at least one physics course are Electronic and Computer Systems and Geophysics.

Degrees other than the BSc that require at least one physics course are the Bachelor of Science and Technology (Advanced Materials), the Bachelor of Engineering (Electronic Engineering and Computer Systems Engineering), and the Bachelor of Building Science (BBSc). The Bachelor of Architecture (BArch) requires 18 points of either Physics or Mathematics for students who have not studied these at year 13.

3.6 BSc in Physics

The Bachelor of Science is the primary undergraduate degree in the Science Faculty, with a broad selection of courses available for crediting towards the degree. As was outlined above, we believe that a major in Physics should both cover the core areas of physics and allow students to broaden their physics knowledge through a choice of elective courses in other areas of physics. To this end our major in physics is taught to international standards. For example, at 100 level the standard is set largely by a combination of the handful of international essentially equivalent university-level text-books, and a firm collegial belief of the physics academics that this material is at the correct level. Similarly standard internationally recognised texts are also used as the basis for teaching at 200 and 300 level.

At 100 level the two core courses, PHYS114 and PHYS115, cover mechanics, optics, fluids, thermal physics, electricity, magnetism, electromagnetism and quantum physics. We also require MATH113 (Calculus) and MATH114 (Algebra and Discrete Mathematics). Although not a formal requirement of the physics major, PHYS131 (Energy and the Environment) and PHYS132 (Introductory Astronomy) are available to students wishing to learn about applications of physics.

There are also two core courses at 200 level. PHYS214 gives an introduction to both formal quantum mechanics and to the areas of particle and nuclear physics and special relativity. PHYS215 presents both classical thermodynamics and an introduction to statistical mechanics, as well as further material in physical optics, electromagnetism and some ac circuit theory. A further mathematics course, MATH206 (Calculus 2), is also a core requirement. In addition to the core students have two choose 2 out of 4 elective courses covering earth and planetary physics (PHYS209), digital (PHYS234) and analogue (PHYS235) electronics, and computer acquisition and analysis of data (PHYS217). This elective component is important in broadening the students' knowledge of physics.

At 300 level there are four core courses in the Physics major. These are PHYS304 (Electromagnetism), PHYS305 (Thermal Physics), PHYS307 (Quantum Physics) and PHYS309 (Solid State and Nuclear Physics). Additionally students have to choose one out of the three courses PHYS339 (Experimental Techniques), PHYS340 (Microprocessor and Interface Electronics) and PHYS341(Analogue Electronics and Instrumentation). However, with the permission of the Programme Director (Dr Turner) substitution of other relevant courses is permitted. The most common of these are MATH301 (Calculus 3) and MATH322 (Applied Mathematics).

Further details of the requirements for the Physics major of the BSc are to be found in the attached Undergraduate Prospectus for Physics (Appendix C1).

The workload for the BSc degree is a minimum of 360 points, which usually takes three years of study, with a student attending university during trimesters one and two each year. Each trimester is twelve weeks long, followed by an examination period. Workloads are designed to total about 40–50 hours a week during the trimester.

3.7 Graduate Programmes

3.7.1 Graduate Diploma in Science

This is a one-year programme of coursework at 200 level and above for students who already have a Bachelors degree. It requires at least 72 points from courses at 300 level or above, and a total of 116 points. The Diploma can optionally be endorsed with a particular subject or specialisation, chosen from a wide range. The options within the physics offering are Physics and Electronics. The Graduate Diploma is intended for graduate students who want to extend their Bachelors degree by specialising and focusing more on one area of application, but who not be suitably prepared for Honours. It is aimed at adding value to a basic Bachelors degree. The GDSci in Physics has infrequent enrolments (~ 1-2 per year).

3.7.2 BSc(Honours)/MSc Part 1 in Physics

Honours is intended to extend and deepen students' understanding and knowledge in physics, and/or to prepare them for research at the MSc and PhD level. The physics course for BSc(Honours), or MSc Part 1, consists of 120 points, typically made up of eight 15-point courses in an approved combination. Subject to availability, courses are chosen from the list given in Table 3.2, with the exception that all students have to complete the two research project papers PHYS490 and PHYS491. Substitution of up to two courses from another discipline (e.g. chemistry, geophysics, mathematics) is also permitted with the approval of the Honours co-ordinator (Professor Lekner).

The absence of a required core, other than the two projects, allows access to Honours to students with a variety of interests ranging from the more traditional areas of physics (as taught in PHYS411-PHYS417), through electronics/instrumentation (PHYS420-PHYS423) to solid earth geophysics (PHYS441 and PHYS447).

Course	Title
PHYS411	Quantum Mechanics
PHYS412	Theoretical Physics
PHYS413	Condensed Matter Physics A
PHYS414	Condensed Matter Physics B
PHYS415	Electromagnetism
PHYS416	Relativity and Electrodynamics
PHYS417	Astrophysics
PHYS420	Signal Processing A
PHYS421	Signal Processing B
PHYS422	Instrumentation
PHYS423	Electronics
PHYS440	Directed Individual Study
PHYS441	Origin and Evolution of the Solid Earth
PHYS447	Introduction to Geomagnetism
PHYS460	Directed Individual Study
PHYS490	Research Project A
PHYS491	Research Project B

Table 3.2: Honours courses in physics

The Honours degree as a whole is, however, intended to be a single course based on a coherent programme of study and not merely the aggregation of a specified number of unrelated courses. Thus, although marks/grades are aggregated, the final assessment of the Class of Honours to be awarded is based on the overall performance in the programme as a whole and through assessment of the candidate's quality of mind and command of the subject.

Students who take the Honours courses as the MSc Part 1 then do MSc Part 2 the following year, obtain the MSc degree with a class of Honours. However, the physics group normally prefers that students do exactly the same two years' work in physics by obtaining a BSc(Hons) degree in the first year, and then enrolling in MSc Part 2 to complete an MSc degree.

3.7.3 MSc Part 2

MSc in Physics students may enter the MSc in Physics at Part 1 for a two-year MSc following a BSc, or at Part 2 for a one-year MSc following a BSc (Hons), usually provided the class of honours degree is II(2) or better. The MSc Part 2 requires 120 points by thesis. Recent MSc theses are listed in Appendix H.

3.7.4 Doctor of Philosophy

The PhD in Physics is awarded for a research thesis, usually with no requirement for course work, the culmination of a period of 2–5 years full-time study. Students will either have completed a master's degree before being accepted into the PhD programme, or be given provisional entry on the basis of the BSc(Hons). The Graduate Studies Coordinator for Physics (Professor Kaiser) advises prospective students about possible supervisors. Once a topic has been agreed with a supervisor, the student is assigned a second supervisor. University guidelines on six-monthly reporting are followed. Recent PhD theses are listed in Appendix H.

Graduate students at PhD level are required to give a seminar once a year, reporting on their research to date, and are strongly encouraged to attend all other physics seminars within SCPS.

3.8 Student Information

A selection, ordered by the highest VUW degree achieved by the student, of some of our graduate destinations is given below.

PhD:

- Graham Appleby (PhD 2006) - obtained an Alexander von Humboldt postdoctoral fellowship at Darmstadt Germany
- Ryan Cormier (PhD 2004) is now at the Medical School, University of Ottawa
- Simon Granville (BSc(Hons) 2003, PhD 2007) is currently a postdoctoral fellow at EPFL, Lausanne

- Bridget Ingham (PhD 2005) has had Post-Doctoral Fellowships at Imperial College, London (2005-6) and Stanford University (2006-7). She has just accepted a permanent position at IRL in Wellington.
- Annette Koo (PhD 2006) is currently a postdoctoral fellow at University of Monash
- Alexander Khrapitchev (PhD 2005) is currently a postdoctoral fellow at the University of Oxford
- Erwan Hemery (PhD 2007) is currently working for the NZ Electricity Commission
- Rosario Lopez-Gonzalez (PhD 2005) is currently a postdoctoral fellow at the University of Pennsylvania
- Antoine Lutti (PhD 2006) is currently a postdoctoral fellow at University College London
- Daniel Pringle (PhD 2005) is currently a postdoctoral fellow at University of Alaska Fairbanks
- David Stewart (PhD 2006) has had a Post-Doctoral Fellowship at IRL, and is now a Post-Doctoral Fellow at Oak Ridge National Lab, USA
- Peter Zoontjens (PhD expected 2007) has just accepted a Post-Doctoral Fellowship at RMIT in Melbourne

MSc

- Tim Benseman (BSc(Hons) 2003, MSc 2004) has completed a PhD at Cavendish Laboratory the University of Cambridge, UK and is now employed there as a postdoctoral fellow
- Damien Martin (MSc 2003) is now a PhD student at University of California (Davis) working in the area of gravitation and cosmology
- David Williamson (BSc(Hons) 2006, MSc expected 2007) has accepted a scholarship to study for a PhD at St. Mary's University, Halifax, Nova Scotia

BSc(Honours)

- Joanna Atkins (BSc(Hons) 2003) is now a PhD student at Columbia University, New York
- Daniel Bayliss (BSc(Hons) 2004) is now a PhD student at Australian National University
- Elizabeth Connor (BSc(Hons) 2005) has completed a postgraduate course in science writing at imperial college, London and is now working as a science writer/journalist
- Michael Dalley (BSc(Hons) 2005) is now a PhD student at University of Queensland
- Swee Goh (BSc(Hons) 2004) is now a PhD student at the Cavendish Laboratory, University of Cambridge, UK
- Sam Flewett (BSc(Hons) 2005) is now a PhD student at the University of Melbourne
- Grant Kennedy (BSc(Hons) 2005) is now a PhD student at Australian National University
- James Reid (BSc(Hons) 2003) is now a PhD student at Australian National University
- Dmitri Schebarchov, Nat Lund and Nicola Winch (all BSc(Hons) 2006) are doing MSc's at VUW
- Halvar Trodahl (BSc(Hons) 2005) is now a PhD student at Harvard University, USA

BSc

- Elizabeth Campkin (BSc 2006) has completed a teaching diploma and is now teaching physics in Wellington

- Martijn Jasperse (BSc 2006) received an Honours Scholarship from the University of Melbourne
- Samuel Palmer (BSc 2006) is completing a Graduate Diploma in Secondary Teaching
- Jamie Wallace (BSc 2007) is now in pilot training in the RNZ Air Force

Chapter 4

Student Profile

Appendix K contains a number of tables with data provided by Central Student Administration. These include:
Table J.1 - Physics enrolments by course for 2000-2007.
Table J.2 - Physics enrolments by gender, residency and ethnicity for 2000-2007.
Table J.3 - Physics course grade distributions for 2000-2007.
Table J.4 - Physics major numbers by level for 2002-2007.
In the following sections we have attempted to summarize some of this data and discus any interesting trends.

4.1 First Year Analysis

Tables 4.1 and 4.2 summarise first year enrolments in physics. Table 4.1 shows enrolments in the two core courses for the BSc Physics (PHYS114 and PHYS115) by year divided by sex, domesticity and ethnicity. The same division for the non-core courses PHYS130, PHYS131, PHYS132 and PHYS134 are shown in Table 4.2. Note that in Table 4.2 the data for 2007 are incomplete as enrolments for the third trimester course PHYS134 do not finalise until December.

	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
Enrolled (RE)	207	220	266	223	134	173	189	233
Male (%)	82.6	81.4	75.9	77.1	88.1	76.7	81.5	77.3
Female (%)	17.4	18.6	24.1	22.9	11.9	23.3	18.5	22.7
Domestic (%)	94.2	95.9	92.1	87.4	85.8	86.7	94.2	94.8
International (%)	5.8	4.1	7.9	12.6	14.2	13.3	5.8	5.2
NZ European (%)	69.1	69.5	75.1	72.9	75.9	77.2	82.6	75.3
NZ Maori(%)	1.4	3.2	4.5	4.6	3.1	1.9	4.8	4.7
Pacific Island (%)	3.9	2.9	2.3	1.8	3.1	0.0	3.6	6.5
Asian (%)	23.7	20.0	17.4	17.0	17.9	16.0	5.4	11.2
Other/undeclared (%)	1.9	4.5	0.7	3.7	0.0	4.9	3.6	2.3

Table 4.1: Total first year enrolments in PHYS114/PHYS115 by sex, domesticity and ethnicity.

The tables re-emphasise the points made in Chapter 3.3. Prior to 2004 numbers in core 100 level cores were relatively stable (the large numbers in 2002 were a surprise and remain unexplained). Similar observations apply to the numbers in the non-core 100 level courses although 2003 may have indicated the start of a decline in these numbers. The large drops in 2004 resulted from changes in the requirements for the Architecture Intermediate. The recovery in non-core course numbers in 2005 resulted from a return of these students to PHYS130, but not to PHYS131 which until then had been a popular choice for these students, while the growth in the core courses since 2004 appears to reflect a genuine increase in students attracted to physics. This is also illustrated by the rise in the number of Physics majors shown in Fig. 3.2. Total numbers in the non-core courses were also boosted from 2005 by the introduction of PHYS134 in the third trimester.

	2000	2001	2002	2003	2004	2005	2006	2007
Enrolled (RE)	217	225	279	178	148	212	171	187
Male (%)	60.8	68.4	66.1	65.7	72.3	67.8	68.0	67.5
Female (%)	39.2	31.6	33.9	34.3	27.7	32.2	32.0	22.5
Domestic (%)	97.7	95.1	93.1	88.2	86.5	87.7	84.5	91.4
International (%)	2.3	4.9	6.9	11.8	13.5	12.3	15.5	8.6
NZ European (%)	75.6	74.2	65.4	68.0	69.7	71.6	63.6	71.7
NZ Maori(%)	6.5	5.8	12.1	4.1	5.5	4.9	8.5	7.2
Pacific Island (%)	3.2	3.6	3.7	2.3	3.4	4.9	2.4	4.6
Asian (%)	12.4	10.7	14.3	19.8	17.2	13.2	21.2	10.5
Other/undeclared (%)	2.3	5.8	4.5	5.8	4.2	5.2	4.3	6.0

Table 4.2: Total first year enrolments in PHYS130-PHYS134 by sex, domesticity and ethnicity.

Ratios of male:female and domestic:international students have essentially remained constant in both sets of courses. The same is largely true of the ethnic mixture, suggesting that physics as a discipline has not been unduly affected by the nationally reported decline in the number of overseas students, particularly from China. The higher proportion of females in the non-core courses results partly from the Architecture Intermediate and partly from the more applied nature of PHYS131 and PHYS132.

4.2 Grade Distributions

Shown in Tables 4.3 and 4.4 respectively are grade distributions by year for the core 100 level courses and the non-core 100 level courses. The Q grade, awarded to students not completing course requirements, was discontinued in 2006, from which time students who would previously have been awarded a Q were graded D or E. The K grade, introduced at this time for students who achieved a passing mark (≥ 50%) but did not complete course requirements has not yet been awarded in a physics course and is therefore not included in the tables.

		2000	2001	2002	2003	2004	2005	2006
100 level core	A	13.6	16.2	17.7	15.2	13.4	22.0	21.1
	B	39.3	30.1	33.1	30.0	37.3	32.9	30.1
	C	31.1	26.4	22.6	34.1	24.6	27.7	26.5
	D	8.7	9.7	10.9	8.0	7.5	4.6	7.4
	E	2.9	5.6	3.4	3.6	6.7	4.6	14.8
	Q	4.4	12.0	11.7	8.5	9.7	7.5	-

Table 4.3: Grade distributions by percentage, 2002-2006, for 100 level core physics courses. Note that the Q grade was discontinued from 2006.

The main feature of the grade distribution in the 100 level core physics cores is that since 2005 there has been a rise in the percentage of students achieving A+/A/A- grades. Given the changing, and relatively small, numbers in the courses some variability is not unexpected. As there has been no conscious change in the expected standard a possible reason for this other than natural variability is that 2005, the first year of this increase, was also the year in which the number of Physics majors at 100 level first showed a significant jump. The rise in A grades may therefore be a reflection of an increase in the number of better qualified students choosing to study physics at VUW. As is shown in Fig. 4.1 below, in periods of both falling (2002-2004) and rising (2004-2006) enrolments in the core 100 level courses the percentage of students failing (D/E/Q) has remained essentially constant at approximately 20%.

		2002	2003	2004	2005	2006
100 level	A	21.5	32.0	29.7	31.1	25.1
non-core	B	35.1	27.0	24.3	34.4	42.7
	C	19.4	14.0	23.6	11.8	17.0
	D	3.2	7.3	6.1	3.8	2.9
	E	2.2	5.1	2.7	2.4	12.2
	Q	18.6	14.6	13.5	16.0	-

Table 4.4: Grade distributions by percentage, 2002-2006, for 100 level non-core physics courses. Note that the Q grade was discontinued from 2006.

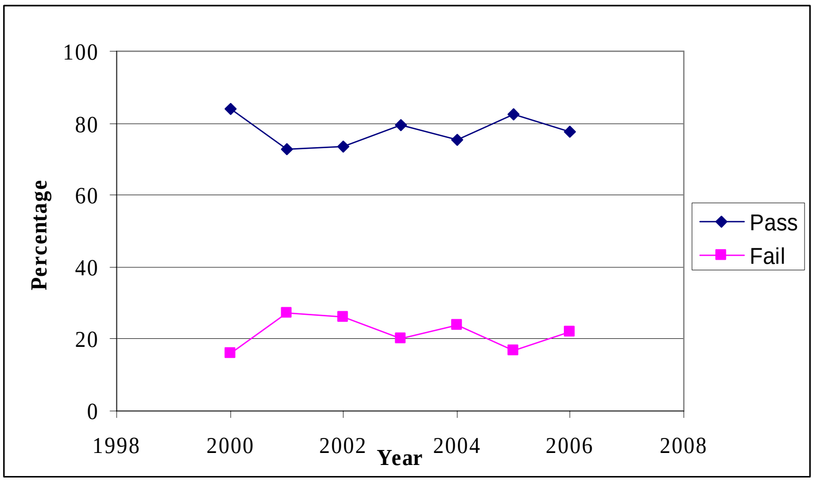

Figure 4.1: Pass/Fail rates for 100-level core courses

In the non-core 100 level courses the grade distribution is more biased towards the higher grades and, although prior to 2006 the percentage of students awarded Q was relatively high, the percentage of students completing course requirements but failing (D/E) is relatively small. The higher number of non-completing students in these courses is consistent with the higher number of students with limited physics/science background who are unfamiliar with the requirements of laboratory work.

Grade distributions for 200 and 300 level courses are shown in Table 4.5. At both 200 and 300 level a single student will typically complete 4 or 5 physics courses in a given year. This means that an additional small number of good/weak students achieving consistently high/low grades can cause relatively large variations in the percentages at these levels. Bearing this in mind Table 4.5 does not indicate any significant trends in grade distributions.

		2000	2001	2002	2003	2004	2005	2006
200 level	A	26.6	28.1	31.3	31.0	21.9	30.8	29.5
	B	31.7	28.1	32.1	32.7	36.3	30.0	34.9
	C	25.2	22.2	21.4	21.4	22.5	24.2	18.6
	D	5.8	3.7	5.3	3.6	8.1	4.2	7.0
	E	3.6	5.2	2.3	3.0	4.4	1.7	9.3
	Q	7.2	12.6	6.9	7.7	6.9	9.1	-
300 level	A	21.0	23.8	21.2	30.6	37.3	43.0	35.0
	B	45.0	36.6	29.8	34.7	33.1	25.0	29.1
	C	21.0	21.8	17.3	23.1	14.4	19.5	13.6
	D	5.0	7.9	11.5	2.5	5.9	3.9	10.7
	E	2.0	5.0	9.6	2.5	2.5	0.0	12.6
	Q	6.0	5.0	10.6	6.6	7.6	7.0	-

Table 4.5: Grade distributions by percentage, 2002-2006, for 200 and 300 level physics courses. Note that the Q grade was discontinued from 2006.

Overall pass rates at 200 level, as shown in Fig. 4.2, have remained relatively constant at about 85%. Much greater variation in the overall pass rate at 300 level is shown in Fig. 4.3.

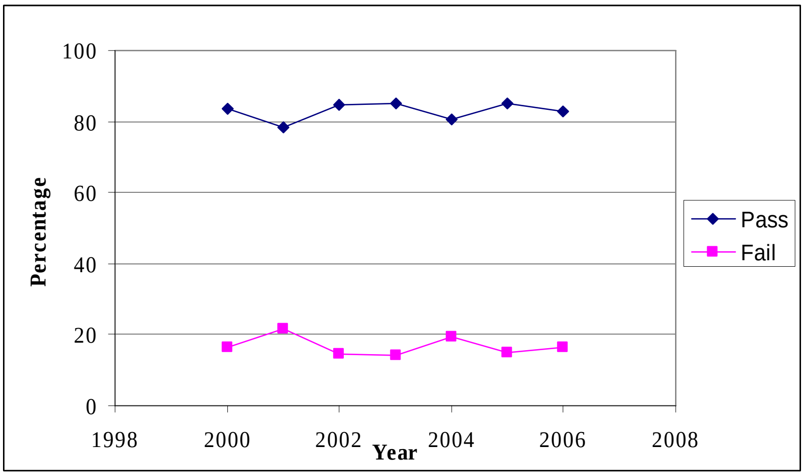

Figure 4.2: Pass/Fail rates for 200-level courses

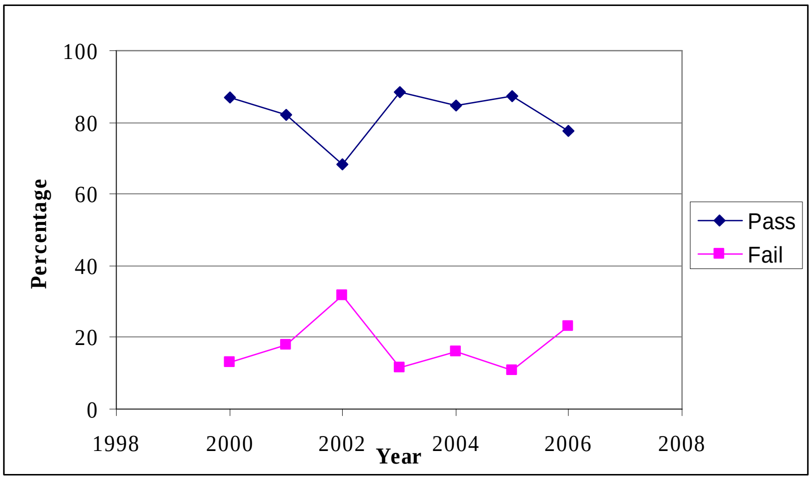

Figure 4.3: Pass/Fail rates for 300-level courses

4.3 Majors

The rise in Physics majors at 100-300 level was noted in Chapter 3.3 and numbers for all levels are listed in Table 4.6 below.

	2002	2003	2004	2005	2006	2007
100 level	53	45	35	50	63	73
200 level	30	27	33	28	31	43
300 level	19	21	15	21	22	26
400 level	10	7	12	9	7	6

Table 4.6: Physics major numbers by level, 2002-2007.

As was discussed earlier we believe that this rise in major numbers results from the enhanced perception of VUW as the place to study physics and from the effort that has been put into attracting and retaining students.

4.4 Degree Completions

Table 4.7 below lists the number of students completing their qualification at each of the BSC, BSc(Hons), MSc and PhD level for the years 2001-2006.

	2001	2002	2003	2004	2005	2006
BSc Physics major	7	8	10	9	10	11
BSc(Hons) Physics	3	6	4	6	5	5
MSc Physics	0	1	3	2	2	1
PhD Physics	1	3	2	1	4	4

Table 4.7: Degree completions, 2001-2006.

Tables 4.6 and 4.7 show that of the students enrolled as a physics major at 300 level (Table 4.6) only approximately 50% complete their qualification in a given year. Although this partly reflects a number of students who have to retake courses at 300 level, more significant is the fact that many students are enrolled in double majors and/or double degrees and consequently spread their study at any given level over a number of years. Although not shown in Table 4.7, the rise in MSc and PhD numbers since 2003 (Fig. 3.3) is reflected in the fact that completions of these degrees by mid-2007 already surpass the 2006 figures.

4.5 Graduate Destinations

As is suggested by the table above a significant fraction of BSc graduates who major in physics remain at VUW for further study. An additional small number pursue further study elsewhere. Few of the remainder are captured by the Graduate Destination surveys carried out by the Careers Office and therefore information on them comes largely from personal knowledge of individual staff members. In recent years it appears that an increasing number have entered the teaching profession.

The majority of BSc(Hons) graduates pursue further study at either MSc or PhD level. Many of these are listed in Chapter 3.8. It is clear from this that out graduates are able to achieve places at many of the top universities in the world.

Following postgraduate study at MSc and PhD level our graduates take a variety of positions including not only in universities and government research laboratories, but also in industry.

Chapter 5

Staff Profile

This chapter presents an overview of the physics staff. Each member of staff has prepared a brief statement focused on their teaching philosophy. Short curriculum vitae of all staff appear in Appendix J. Also included in this chapter is an overview of physics research and a statement of how the distribution of work amongst staff is managed.

5.1 Summary Curricula Vitae

Paul Callaghan

Paul Callaghan took his first degree in Physics at Victoria University of Wellington. He then did a DPhil degree at Oxford University, working in low temperature physics. On his return to New Zealand in 1974 he took up a lecturing position at Massey University where he began researching the applications of magnetic resonance to the study of soft matter. He was made Professor of Physics at Massey University in 1984, and in 2001 was appointed Alan MacDiarmid Professor of Physical Sciences at Victoria University of Wellington. He also heads the multi-university MacDiarmid Institute for Advanced Materials and Nanotechnology. His research interests lie in developing Nuclear Magnetic Resonance (NMR) methodologies for the study of molecular dynamics and molecular organization in complex fluids, soft matter and porous materials. He teaches half of PHYS114 and particularly enjoys teaching first year classes. He teaches a large proportion of PHYS411 in which students are also encouraged to assist in presenting course material to the class. He also contributes to the teaching of PHYS414.

Paul is Past President of the Academy Council of the Royal Society of New Zealand. He has published around 230 articles in scientific journals as well as a book on magnetic resonance. He is a founding director of "magritek", a small spin-off company based in Wellington, which sells NMR instruments. He is a regular public speaker on science matters and talks with Kim Hill every month on her Saturday Morning radio show.

In 2001 Paul became the 36th New Zealander to be made a Fellow of the Royal Society of London. He was awarded the Rutherford medal in 2005, in 2006 was appointed a Principal Companion of the New Zealand Order of Merit and in 2007 was recognised by a KEA/NZTE World Class New Zealander award and the Sir Peter Blake Medal.

Dale Carnegie

DC's first degrees were in theoretical physics and applied mathematics, before concentrating first on applied physics, and then electronics, mechatronics and signal processing. His research interests are now in the area of mechatronics, specifically the autonomous control of mobile robotic vehicles. In order to better equip students with the material and knowledge required to undertake employment or postgraduate study in mechatronics, he coordinates and lectures in two advanced mechatronic engineering papers ECSE425 (Advanced Mechatronic Engineering I: Hardware and Control) and ECSE430 (Advanced Mechatronic Engineering II: Intelligence and Design). ECSE425 concentrates on the hardware of microcontrollers, sensors, actuators, motor drivers and control, whilst ECSE430 adds the robotics, artificial intelligence, and industrial design material to create adaptive and attractive final products.

Background material to these courses, as well as general embedded control systems and instrumentation is provided in PHYS340 (Microprocessor and Interface Electronics) that DC also coordinates. Additionally, as digital technology continues to become smaller and faster, and as such has a profound impact on electronics and intelligent systems, DC also lectures and coordinates PHYS342 (Advanced Digital Electronics). All of DC's courses strongly encourage active student participation during the lectures, and all papers have a substantial practical laboratory content with an emphasis on dealing with real-world applications.

Andy Edgar

AE's research interests lie in materials science and solid-state spectroscopy, with current funded research being in the area of radiation imaging and dosimetry. He has part-taught the only course specifically relevant to this area, PHYS309 " Solid State and Nuclear Physics", but also the more general PHYS413 "Condensed Matter Physics A." In both cases he has illustrated the lecture material with personal experience. With qualifications in electronics as well as physics, he had until recently been heavily involved in presenting the electronics and signal processing courses, and brought his personal design experience to the teaching of these courses. With the advent of new electronics engineering staff however, his teaching portfolio now has a greater emphasis on physics. Until 2004 AE had been the 300 level physics and electronics laboratory coordinator. He introduced many of the experiments there, together with a library of video introductions to the experiments. Practical lecture demonstrations are a favourite theme, but the School is no longer well set up to support these. Tutorials based on group problem solving with pairs or triples of students working on whiteboards with overall coordination by AE are a favoured way of consolidating understanding of the material and establishing intra-class and class-lecturer dialogue.

Pablo Etchegoin

PGE's interest are in experimental ultra-sensitive laser spectroscopy techniques with emphasis on surface enhanced fluorescence and Raman scattering. These interests impact on the teaching side directly; on the advanced experimental techniques course (PHYS339) and electromagnetism at Honours level (PHYS416). Several aspects of PHYS339 have been upgraded in the last 3 years to adapt them to more modern experimental tools used (particularly) in spectroscopy. The largest number of modifications were done on the teaching and experimental demonstrations of Fourier transforms and series. The course has now an up-to-date modern overview of Fourier transforms for applications in experimental physics, together with an introduction to modern computational tools like Matlab (which is not known or used by all the students at 300 level). PHYS416 on the other hand, has been oriented towards current research areas in the fields of electromagnetic calculations and radiation problems in nanophotonics. The course has now incorporated modern computational tools for this task (like FemLab), and several examples come directly from some of the interest of PGE in surface plasmon resonances.

Gideon Gouws

My research interest is in the development of sensors and sensor systems for a variety of applications. These include ultrasonic, magnetic and RF sensors for environmental monitoring or the measurement of material structure and properties. The fundamentals of these devices has been integrated into undergraduate teaching (Phys 217), where the students also gain exposure with software packages to interface with these systems. The modeling and control of various electromechanical systems in Phys 422 also allow frequent reference to research examples.

Shaun Hendy

SH's research interests lie in theoretical and computational materials science, particularly in the application of these techniques to nanoscience and nanotechnology. His teaching in PHYS 412, PHYS 413 and TECH 101 is directly related to and informed by these interests. For instance, in TECH 101 he gives six lectures on nanotechnology which draw heavily on his research. He has also developed a nine lecture course as part of PHYS 412 on the theory and simulation of simple liquids which introduces students to advanced aspects of statistical mechanics not covered elsewhere in the curriculum. This course has led to a number of students pursuing graduate studies in this area. SH's joint position at Industrial Research Limited (IRL) frequently allows him to relate classroom material to practical examples in industrial applications. For instance, in TECH 101 and PHYS 412 he uses several examples from IRL's microfluidics programme. SH is also able to offer summer work at IRL to 2-3 advanced undergraduates every year.

Malcolm Ingham

MI is a geophysicist and environmental physicist with interests in electromagnetic induction in the Earth, geomagnetism, hydrology and the physics of sea ice. These interests feed, or have fed, directly into teaching in PHYS131, PHYS209, PHYS441 and PHYS447. The associated involvement in instrumentation and data analysis are also relevant to the electronics and signal processing courses. MI has a firm belief in lecture material being strongly supported by practical experience in the laboratory and has been proactive in upgrading existing experiments and introducing new ones in PHYS209 and PHYS235, and in introducing significant computer based assignments in PHYS420 and PHYS421. He was also responsible for the initial course design, including the laboratory component, of TECH102 which in 2008 will finally be superseded by ENGR101. Prior to the existence of Blackboard he was also the architect of the website for PHYS131 when it was taught as a distance course over the summer trimester.

Alan Kaiser

Alan has introduced several topics from his research into his lectures, for example using carbon nanotubes and conducting plastics (two of his current research interests) as examples of novel conducting materials in his course on the electronic properties of materials in PHYS413 Condensed Matter Physics A. In all his courses, he likes to help students understand theoretical ideas and equations by relating them to real life phenomena. The behaviour of materials of very small dimensions (nanoscience) provides nice examples of some of the strange aspects of quantum theory and their measurable consequences. He also enjoys using simple physical concepts to help understand the remarkable properties of the planets and their moons in his first year astronomy course.

John Lekner

John Lekner is a theoretical physicist, with interests in quantum theory, electromagnetism, statistical mechanics, and more recently in acoustics and in fluid flow. He enjoys teaching along with readings in the history of science, and occasionally combines these interests in a publication, such as in "Young Einstein and the beginnings of quantum mechanics" (2007). His research in parallel with David Beaglehole, interpreting his ellipsometric measurements, led to many papers, and a book entitled "Theory of reflection of electromagnetic and particle waves" (1987). John coordinates the Physics Honours Programme, and has supervised about thirty Honours projects (eleven since 2001). Each is a research-level project, planned by the supervisor. For the students this is their first experience of research, and substantial mentoring is needed in methodology, theoretical and mathematical techniques, and scientific ethics. John's approach is always to give the students as much freedom as possible (consistent with at least some of the project goals being achieved), so that they experience the joy of discovery and are able to exercise as much initiative as they have.

Howard Lukefahr

Howard Lukefahr is interested in the use of guided enquiry teaching techniques and the use of culturally relevant context material to enhance science education and increase participation in study of science by all segments of society. He is involved in physics education resource development, science communication, and public science. In the SCPS physics labs, HL is modernizing laboratory exercises in calculus-based stage one courses and service courses. This includes building guided enquiry components into existing lab exercises and tutorials where appropriate, development of new laboratory exercises on topics such as superconductivity and radioactivity, and new approaches to training of demonstrators to facilitate the interactive guided enquiry approach to laboratory instruction. HL has recently developed 50% of the lectures and 40% of the lab exercises for the new engineering course (ENGR101). HL is the principal developer of the New Zealand Physics Teachers' Resource Bank at www.physics.school.nz, a now popular website used by about 2000 unique visitors a month from all over the world to enhance intermediate, secondary and tertiary science education. A principle component of the Resource Bank is the unique Te Reo Maori Physics Education Project which seeks to increase participation in the study of science by Maori and Pacific Island students through collaborative production of multimedia resources that feature Maori pupils doing, enjoying, and explaining physics experiments to their peers. This project is directed by Liz Richardson and has had external funding. HL is a principal investigator in this project. HL's involvement in science communication and public science includes developing VIP science courses for well known New Zealanders through the Royal Society and multiple science-related radio programs with Radio New Zealand.

Ben Ruck

BR is involved in teaching courses ranging from introductory level physics (PHYS 130 "Introductory Physics", and PHYS 131 "Energy and the Environment") to honours level courses in quantum mechanics and condensed matter physics. He enjoys all of them, and finds the student contact during lab classes particularly refreshing. His research is in condensed matter physics, in particular the growth and study of thin films of rare-earth or transition metal nitrides with interesting electronic and magnetic properties. This research directly informs the teaching of the honours level courses, and he also feels it is important to convey a sense of the nature of physics research to students at all levels. BR is a strong believer in the value of physics education, not only for the relevance to the real world, but also for the unparalleled opportunity it provides to practice problem solving skills.

Denis Sullivan

DJS's initial research training was in low energy experimental physics (at ANU), and over the course of time at VUW he gradually evolved into an astrophysicist, who regularly carries out optical astronomical observations as a key part of his research. In addition to the simple curiosity of a physicist's mind, an underlying driver for this transformation was an interest in instrumentation, electronics and data analysis techniques, if only because it is an effective way to understand the various processes and their limitations. These interests and expertise have fed directly into the various courses he has taught over the years. Currently, and for the past few years his teaching has involved PHYS 114 (100-level mainstream entry; lecturing and course/laboratory coordination), PHYS 132 (Introductory Astronomy; lecturing and course/laboratory coordination), PHYS 417 (Astrophysics; sole lecturer), PHYS 421 (Discrete Signal Processing; lecturing), PHYS 490/491 (Research Project supervision).

His research-informed teaching philosophy can be simply explained. First and foremost he is a physicist, so all aspects of his teaching are influenced by the desire to communicate an understanding of the physical world via a hierarchy of mathematical models, along with a parallel ``physical understanding''. As an active astrophysicist and astronomer, his specific research interests are liberally sprinkled as relevant examples (but not the only ones he uses!) in the courses he teaches. So, such things as Newtonian motion in a gravitational field, Fourier analysis of photometric time-series data, or the exotic extensions to ``everyday'' physics that are required to understand the modern world of astrophysics (eg white dwarf stars, gravitational microlensing, black holes, etc), make regular appearances. He is absolutely convinced his astrophysics research activity enriches and enhances his credibility as a university teacher, but he is also adamant that these interests do not unreasonably bias his delivery.

This review document is also an appropriate place to acknowledge the contribution the Department of Physics and Astronomy at the University of Canterbury has made to VUW astrophysics research. Over a period of 30 years they have allocated "free" telescope time at their Mt John Observatory, Lake Tekapo, for research undertaken by VUW staff and students (primarily DJS). Access to this facility continues in terms of one metre telescope time and via the research programme pursued by the MOA collaboration. Although DJS's research has involved observational work on various telescopes around the globe, it is fair to say that a viable research programme of the kind that he developed at VUW would not have been possible without access to the domestic telescope time provided at Mt John. This research has directly contributed to all levels of teaching undertaken by DJS.

Jeff Tallon

Jeff Tallon has a dual appointment at Industrial Research Ltd (IRL) where he is "Distinguished Scientist" and at SCPS Victoria University where he is Professor of Physics. His main research interests are in high-temperature superconductors (HTS), nanotechnology, strongly-correlated organic-inorganic materials and bio-nanotechnology. With colleagues at IRL he discovered a number of HTS materials and developed processes to enhance their properties. The physics of these materials is still not understood and is regarded as one of the key outstanding unresolved problems in Physics. He is internationally known for his discoveries and insights into these materials and has worked for 20 years developing a fundamental understanding of their highly unusual properties and generic phase behaviour. His patents are licensed to Massachusetts-based American Superconductor Corporation, the leading manufacturer of HTS wires and products. This relationship and associated intellectual property led to the establishment of HTS-110 Ltd a New Zealand company developing high-level HTS products for the international market such as high-field magnets for research and minerals processing, components for generators, NMR instruments, various defence applications and heavy-duty (7,000 Amp) current leads for accelerators such as the Large Hadron Collider. This is a 21st century technology that will eventually revolutionise almost every societal sector: health, transportation, energy, ICT, minerals and research. Jeff teaches a course in superconductivity for TECH101 and teaches solid state physics at 3rd year and honours level drawing on his extensive research experience in this area. He finds that teaching directly in his field of research adds a currency and relevance that advances a subject beyond the mere theoretical and makes it more immediate to students. This is helped also by his involvement in turning research discoveries into a business. He is a frequent public speaker at professional groups, service groups and schools. He has published around 250 papers, was past Deputy Chair of the Marsden Fund, is a recipient of the Rutherford Medal, a Fellow of the Royal Society of New Zealand and an Honorary Fellow of the Institute of Practising Engineers of New Zealand.

Paul Teal

Paul Teal's research is in statistical signal processing. His particular focus is in Blind Source Separation using techniques such as Independent Component Analysis and Non-negative Matrix Factorisation. Other areas of signal processing he researches are Bayesian estimation, machine learning, array processing and communications theory. Areas of application of these techniques include foetal heartbeat detection and heart rate tracking, seizure detection, acoustic holography, nonlinear modelling, mobile radio channel prediction, radioisotope identification and sonar signal processing. His industrial experience provides many real life applications to enliven his lecturing in signal processing and electronics.

Gillian Turner

GMT teaches a range of undergraduate physics courses, 400 level courses in geophysics, and is the undergraduate programme director and course advisor for physics. GMT’s undergraduate teaching focuses on capturing students’ interest in the physical world, in challenging students of all abilities and encouraging the development of good study habits, while at the same time laying a sound foundation in both classical and modern physics. GMT works on the principle that teaching and learning should be a two-way, interactive process: students need to be motivated to engage in their learning, they should be encouraged to participate actively in all aspects of their studies: lectures, tutorials, assignment work, laboratory work. GMT has won VUW awards for innovation and excellence in teaching. Beyond teaching, GMT was instrumental in setting up the SCPS outreach programme; for several years she has been involved in the organization and judging of the Wellington Science Fair for Year 7-13 students, in the Royal Society’s *Realise the Dream* event, and in writing intermediate and secondary level educational resources.

5.2 Research

SCPS hosts New Zealand's largest Centre of Research Excellence, and draws both prestige and valuable income from that partnership. The MacDiarmid Institute, with its focus on Materials Sciences, also serves to unify the disciplines of Chemistry and Physics (together with their associated technologies) which form the academic culture of the School. We equally value physics research activity that is not part of the Centre, and seek to ensure a broad research culture in a collegial atmosphere. We value and seek to maximize all student enrolments in our entire programme.

Research in physics covers a broad spectrum including solid state physics, soft matter physics, geophysics, electrodynamics and optics, quantum theory, astrophysics, and, more recently, in association with the developments in engineering, mechatronics and signal processing. The breadth of research covered is both a strength and a weakness. Whilst the breadth of research means that we are versatile, adaptable and diversified, and it allows us to focus at higher levels on research led teaching, it also means that many of us tend to work in isolation or in very small groups. This is certainly the case in areas falling outside the structure of the MacDiarmid Institute, but is also the case in some research areas within the Institute. In all areas of physics research we have extensive links with researchers outside VUW, both nationally and internationally.

The physics group has an outstanding research record, as evidenced by its top rating in the initial Performance Based Research Funding assessment, and by maintaining its overall PBRF score in the second round while being the only physics group in New Zealand where actual staff numbers included in the exercise increased. Another indication of excellence is the number of FRST and Marsden Fund awards obtained by members of the group.

5.3 Staff Workload

Allocation of teaching duties is part of the annual physics workload allocation process, and is the responsibility of the Deputy Head of School. Each staff member is canvassed for their preferences for teaching in the following year, and duties are assigned so as to balance workloads over the physics group.

Points are allocated to each course on the basis of the number of lectures and tutorials and the estimated staff input into the laboratory classes and administration of the course. Level administration and student advice given by the programme director also have point values allocated. Details of the point values used are given in Appendix I. The total point value across the physics programme is then divided by the number of full time equivalent staff (FTE) available to do the teaching. This takes into account, for example, staff on Research and Study Leave, and uses the basic premise that a full time position is rated as 0.8 FTE teaching and a base 0.2 FTE for research. Staff who have external research support are given additional teaching relief of a fraction of FTE. No explicit allowance is made for graduate supervision as it is accepted that this aspect of teaching comes under the research component of the FTE (plus any additional teaching relief due to research income).

The physics group has used this system for approximately 20 years. Total workloads are calculated and balanced across the group, as shown in Appendix I. The aim is to have all staff with points that are within a relative error of plus or minus 20% of the average points load. Recent appointees have reduced workloads over three years from their appointment date. Difficulties in this system arise from the quantised nature of courses (i.e. the undesirability of fragment teaching in a course into too many parts) and in giving suitable workloads to fractional staff.

Year	No of teaching FTE	Average load (points)
2003	6.8	187
2004	9.5	136
2005	11.2	121
2006	10.7	123
2007	10.8	123

Table 5.1: Average points load for a full time member of staff, 2003-2007.

The average teaching workloads over the last 5 years, expressed in terms of contact hours (a basis of 1 point per lecture/tutorial), are shown in Table 5.1. Also shown is the teaching FTE for each year allowing for Research and Study Leave absences. It is clear from this that the advent of the MacDiarmid Institute, which over 2003 and 2004 resulted in the employment of new staff, has been a major factor in reducing teaching loads by approximately 1/3. Contract staff, funded primarily through overheads from external research grants, are also used in some teaching activities, notably in supervising the core 100 level laboratory classes.

An additional factor in our workloads, which is not included in the above, is marking of assignments, laboratory reports, tests and exams. At 200 and 300 level, with the exception of 214 and 215 laboratory reports which are marked by demonstrators, all marking is done by the course lecturers. In the core 100 level courses laboratory marking is done by demonstrators and the laboratory supervisor, while marking of exams is shared around academic staff as a means of evening out discrepancies in teaching loads.

Chapter 6

Learning Environment

This chapter addresses a number of key issues in the support of physics students at all levels.

6.1 Laboratory Facilities

Laboratory space available for teaching of undergraduate physics has gradually shrunk over the last 15 years as greater demands for research space within the Laby Building have caused internal structural reorganisation of the laboratories. We currently have 5 teaching laboratories of which two (LB201 and LB202) are dedicated to the laboratory components of the core 100 level courses. One adjacent laboratory (LB203) is used for the other 100 level courses and also by PHYS217/TECH203. LB214 is a dedicated electronics laboratory serving PHYS234, PHYS235, PHYS340, PHYS341 and PHYS342. Pressure of space is greatest in LB215 which houses the PHYS214, PHYS215, PHYS209 and the 300 level laboratory classes.

At 100 level equipment has been, and continues to be, significantly upgraded through the University's annual CAPEX round. The same has been true of equipment for the electronics laboratory which has also, in the last two years, benefited from the injection of capital into the BE programme. In all of the above multiple sets of equipment are available to accommodate large laboratory classes. However, in the main 200 and 300 level laboratory courses both space and equipment limit the number of students to 8 per laboratory class. In an environment of increasing enrolment this may ultimately cause pressure on the timetabling of laboratory classes. Equipment for some laboratory experiments at these levels is also purpose build and, in some cases, is now in need of upgrade.

Technical support for the teaching laboratories is excellent with 2 dedicated technical positions.

6.2 Computing Facilities

Physics PhD and most MSc students have access to dedicated modern pcs either in research laboratories or in shared offices. A small number of MSc students and Honours students only have access to shared pcs in the graduate room LB415. Undergraduate students have 2 leased pc's available to them in the undergraduate common room (see 6.5) and also make general use of computers available in the teaching laboratories. They also have access to computers through the University provision of computer rooms around the campus. Apart from computers in the teaching laboratories all of these machines are provided through the University leasing arrangement with Dell and are replaced every 3 years.

Computers in the teaching laboratories LB201, 202 and 203 are all leased through the University arrangement with Dell. They are therefore modern pcs as are those in the electronics laboratory (LB214) which were purchased by SCPS using a specific grant in support of the development of engineering. Computers in the joint 200/300 level laboratory

(LB215) are often tied to particular experiments using dedicated software which is not necessarily easily transferable to new machines. Replacement of these machines therefore often has implications for upgrade or replacement of software and therefore represents an on-going problem.

Standard software on the laboratory computers includes Word and Excel, while machines in LB203 and 214 also run Matlab and LabVIEW.

SCPS has its own dedicated computer support position (Scott Forbes) and is therefore, in most instances, not reliant on Information Technology Services (ITS) for specialist desktop support.

All of the above computing facilities relate largely to the Windows operating system. In addition a small number of individual staff members use either Macintosh or Linux/Unix operating systems. Linux/Unix, in particular, is not supported by ITS and this continues to be a source of discontent among some staff. It has been suggested that in not exposing senior physics students, and those interested in pursuing research careers in particular, to an operating system (Unix/Linux) that is widely used in other areas, and is more suited for a range of computing applications, we are somewhat remiss. Without dedicated support from ITS this would be difficult to achieve.

6.3 Web-based Support

The University has now for a number of years promoted the use of *Blackboard* as a base for course web sites. Many of the undergraduate courses now have such sites which are used largely for posting notes (either in written or Powerpoint form) and assignments. There are presently no physics courses that use the more advanced features of *Blackboard* such as discussion forums and testing. This is possibly largely because of the overheads in staff time that are required to maintain such features.

6.4 Library Facilities

The University Library is our main resource. Its electronic access to journals is much improved, for example with the addition of PROLA (Physical Review Online Access). For those staff who are members of the MacDiarmid Institute, the online access is augmented by other university libraries, notably Canterbury.

In addition, we have about 1200 physics and mathematics texts in Laby 408 on uncontrolled loan (many donated by former staff, a large number from the National Library), with more valuable books on controlled loan in Laby 411. These are a useful resource for rapid browsing and borrowing.

The New Scientist (very popular) is held in the common room (Laby 407); back copies of other journals are held in Laby 416 and 411.

The laboratories have some reference books: about 60 texts in the electronics laboratory (Laby 214), another 60 second and third year texts in the 200-300 lab (Laby 215) and a few elementary texts in the undergraduate common room, Laby 214A.

6.5 Graduate Student Space

Physics graduate students at PhD level either have dedicated space within their research laboratory or a desk in a shared office. MSc and Honours students occupy shared space in LB415 which also houses several computers for their use. This space is also used by Chemistry students at these levels and increasing graduate student numbers in SCPS as a whole is putting considerable pressure on it. Graduate students from Honours level upwards share the staff common room facilities.

6.6 Undergraduate Student Space

Somewhat unusually within the University, since 2002 physics has provided an undergraduate common room. This provides a small amount of working space and two computers connected to the University network, as well as tea and coffee making facilities, a fridge and a sandwich maker. This room is situated adjacent to the 200/300 level laboratory and is particular popular with physics students at these levels. Additional carousels for individual work are located in the corridor outside the teaching laboratories.

6.7 Help Desk

As mentioned in Chapter 3.5.2 an undergraduate help desk aimed at students in all the 100 level courses is run in both the first and second trimesters.

6.8 University Support Services

VUW has a range of Student Services available, including an excellent Student Learning Support Service for assisting students who need extra tutoring. The Student Counselling Service is also available for students in trouble and Disability Support Services provide a number of resources and special provisions for students with temporary or permanent impairments, injuries, or chronic illnesses.

6.9 Additional Support for Maori and Pacific Nations Students

The Faculty of Science runs an extensive mentoring system for Maori and Pacific Nations students. This is discussed further in Chapter 8.

6.10 General Environment

A significant effort has been made over the last 5 years to improve the working environment for undergraduate students. We believe that this helped to give students a much greater sense of belonging to the school rather than it simply being a place that they visit for laboratory classes.

Chapter 7

Quality Assurance

7.1 Entry to First Year Courses

The physics group has introduced the following guidelines to assure that students are taking courses appropriate to their backgrounds in physics and mathematics.

Prior to 2004, students in their final year of high school would typically sit Bursary examinations. Under this system students were advised into either PHYS114 or PHYS130 according to their marks in Bursary physics and mathematics with calculus. In general marks of 55% in both physics and calculus were used as the lower limit for entry into PHYS114. A small number of students with excellent marks (>85%) in both these exams were offered the option of direct entry into PHYS214 instead of PHYS114. Most such students then took PHYS115 in the second trimester. These requirements were not absolutely rigid and the overriding principle was that students should be enrolled in the course most appropriate for them.

The introduction of the NCEA has necessitated a review of our requirements for entry to physics courses. Year 13 physics is now split into study of 5 achievement standards - wave systems (4 credits), mechanical systems (6), modern physics (3), electrical systems (6), and practical physics (5) - each of which is assessed independently and carries the number of credits shown. The first 4 of these standards are assessed by external examination, the fifth is internally assessed. Students are awarded each standard at one of three levels - achieved, merit and excellence. The mathematics syllabus is similarly split into achievement standards both in calculus and in statistics.

The national requirement for entry to university is that a student should have gained 14 credits in each of two subject areas together with a further 14 credits from at most two different domains of the NCEA framework. This is judged to be the equivalent of 3 C grades in the former Bursary examination. After considerable discussion we have developed the following guidelines for entry into physics:

(1) Entry to the core 100 level physics courses (PHYS114 and PHYS115):
- ≥ 14 credits at NCEA level 3 physics; and
- ≥ 14 credits at NCEA level 3 mathematics with calculus

Equivalent qualifications from overseas are also accepted.

(2) Entry to the introductory courses (PHYS130 and PHYS134):
- some familiarity with level 1 NCEA general science and mathematics.

(3) Direct entry to PHYS214:
- excellent results across all externally assessed units at NCEA level 3 in both physics and mathematics with calculus, and after discussion with the physics programme director.

Note that thus far we have not used the NCEA Scholarship examination as a criterion for direct entry into PHYS214. This is partly because results of this examination become available too late to be of use, and partly because of a poor correlation between level 3 results and Scholarship results.

In the 3 years since the introduction of NCEA we have found that the single biggest problem has been a significant move amongst students away from mathematics with calculus in favour of mathematics with statistics. Additionally, although the NCEA system gives greater transparency in terms of the details of which parts of physics a student is comfortable with, there is some evidence both that some schools are not entering students for all the standards, and that, equally, some students are not attempting some standards. This is discussed further in Chapter 9.

7.2 Quality Assurance

7.2.1 Internal Reviews

Each year after the conclusion of teaching the physics group holds a one day meeting of academic staff devoted solely to a review of the year's teaching programme. At each level (100 to 400), each course co-ordinator gives a brief review of their course raising issues of concern. This is followed by a general discussion of the teaching at that level which addresses issues such as adjustments in course content, changes to the laboratory experiments etc. The meeting is minuted and the minutes are subsequently circulated to staff. Minutes of the meetings for 2005, 2005 and 2006 are included in Appendix L.

7.2.2 External Review of Honours

The Physics Honours programme is reviewed annually by an external examiner. We invite an academic from another university in New Zealand (for example Professor Geoff Austin of Auckland University in 2005), or a visiting overseas academic (for example Dr Suzanne Fielding of the University of Manchester in 2006) to review our 400-level courses.

The external examiner is supplied with course information and with all of the examination papers for the current year, and asked to assess the course content, and the level at which it is taught. The examiner normally comments on the comprehensiveness of the Honours course as a whole, and on how appropriate it is to the local research environment.

The examiner meets with the staff (collectively), to question staff about particular courses, and to make suggestions. The report is further discussed in a staff meeting, and when possible the suggestions made are implemented. For example, Professor Austin suggested that we allow more time to our students in the final examination, and we have (after discussion) increased the time allowed from two to three hours, in all honours courses. At other times it is not practicable to implement the implicit suggestion, as for example Dr Fielding's comment on the absence of traditional fluid mechanics (we do teach aspects of fluids in PHYS412, such as Monte-Carlo and molecular dynamics simulation techniques).

Overall, we have had very favourable reviews.

7.2.3 Course Assessment Quality Assurance

Final grades for each course are agreed upon, either at a meeting of the group of lecturers teaching the course, or by the lecturer in consultation with at least one other colleague, taking into account any formulae for assessment in the course information given out at the beginning of a course. Table 7.1 shows the correspondence of marks to letter grades used in physics. This is the same as that recommended by the Victoria University assessment handbook.

	Percentage	Letter Grade
Pass:	85% or higher	A+
	80-84%	A
	75-79%	A-
	70-74%	B+
	65-69%	B
	60-64%	B-
	55-59%	C+
	50-54%	C
Fail:	40-49%	D
	below 40%	E

Table 7.1: Equivalence of marks and letter grades used in physics.

The marking of tests and exams is done only by academic staff, to assure quality and consistency
of grading.

7.2.4 Evidence of Quality

As teaching is research led, the strength of research in the physics group in SCPS is an important indicated of quality. The results attained by the physics group in the Performance Based research Fund (PBRF) evaluation is one testimony to this quality. In the initial round of the PBRF the group was rated the top physics group in New Zealand with an overall score of 5.1. In the 2006 round the physics group maintained this overall score whilst dropping to 2nd in physics rankings behind Auckland. However, it should be noted that this result was achieved despite a substntial increase in the number of eligible staff due largely to the addition of several postdoctoral fellows (who have track records too short to score highly in the PBRF assessment). This was in contrast to the other universities where the number of eligible physics staff fell (except for Otago). The continuing standard of physics research in to condensed matter and nanotechnology is also testified by the 2007 refunding of the MacDiarmid Institute for a further 6 years, and by the number of FRST and Marsden awards obtained by members of the physics group.

7.2.5 Course Evaluations

Staff have been invited to briefly review the courses they currently teach, and the resourcing of these courses.

PHYS114: Physics 1A (2007: Sullivan & Callaghan)

Evaluation of course: This course is the School's entry level to our calculus-based physics teaching, and is taught in the first trimester. When combined with the second trimester course (PHYS 115), this represents our ``mainstream" 100-level offering, which functions both as preparation for progression in physics, and a university-level introduction to mathematical physics for those students pursuing other courses. The current division of material between 114 and 115 does not follow the typical textbook progression and has been in place for about 10 years now. The division follows a rearrangement we made to accommodate the large range of student backgrounds and abilities we typically have entering the course.

In 114 we teach introductory mechanics, followed by oscillations, waves and quantum theory, while in 115 we teach thermodynamics and kinetic theory followed by electricity and magnetism topics. This arrangement allows particularly well-prepared entry-level students to go directly into PHYS 214 (which includes material on special relativity and nuclear and particle physics), and then they can complete their first year physics studies with 115 (material not well covered in the NCEA prescriptions). A recent innovation in 114 has been to start the lectures with some relatively simple geometrical optics material (to offset the "seen this stuff before" syndrome) and then start mechanics ``beginning" with kinematical concepts, and the essential ideas of calculus. This has led to a "squeeze" on the lecture time available for a reasonable coverage of rotational motion in 114, so some of these material (eg rolling motion) has been exported to 115.

To be perfectly blunt, satisfying all the diverse needs of the students entering PHYS 114 has been, and will continue to be, a difficult task. We could probably improve things by streaming students into two parallel courses, as we did in the Department of Physics up until about 15 years ago. However, this would result in 3 entry level physics streams, and the typical numbers of students now enrolling in 114 (about 120-130) make this option untenable given our staff numbers. For an academic unit with an important PBRF research focus, our current staff numbers only justify the current level of streaming: PHYS 130 (Introductory Physics) and PHYS 114.

Evaluation of course resources: Given that 114 is our mainstream entry level course, and it is therefore a crucial base for our primary goal of delivering teaching and research activities in physics, the physics group have always employed significant sources in this area. Largely funded by teaching replacement money from the MacDiarmid Institute, we have been able to employ specialist teaching expertise in recent years in the form of Howard Lukefahr, Frank Cook and John Hannah to assist us in the quality of delivery of our first year courses. Undoubtedly, overall course quality has improved, with increased emphasis on individual student help, regular lecture demonstrations, improved laboratory supervision, and (for the first time this year) the introduction and use of electronic real-time question and answer sessions (``clickers").

PHYS115: Physics 1B (2007: Turner & Lekner)

Evaluation of course: This is the second half of the core physics programme at Stage 1. It is assumed that students entering PHYS115 have studied physics to NCEA level 3 or equivalent, have a background in mathematics that includes elementary calculus, trigonometry, vectors etc., and are familiar with the material covered in PHYS114. PHYS115 currently includes physical optics, elementary kinetic theory and thermodynamics, electricity and magnetism. Until recently geometrical optics was also covered in PHYS115, but for the past two years this has been moved to the beginning of PHYS114 to provide an introduction that does not required calculus, replacing the more advanced rotational dynamics which has been moved to the beginning of PHYS115. The course comprises 36 lectures, 12 tutorials and 10 laboratories. Assignments, based on lecture material, are set weekly, marked (by graduate students), and returned with feedback on students' progress. Laboratory experiments are related to lecture topics, though it is not possible to always run experiments concurrently with relevant lectures, due to equipment limitations. A "Helpdesk" is offered for students seeking advice on course material or assignment questions. Students' final grades are calculated from a final 3 hour exam (60%), laboratory (20%), in-term test (15%) and assignments (5%). The assignment contribution is sufficient to provide an incentive to work throughout the term, but small enough that students who seek help e.g. from staff, Helpdesk, other students do not gain an unfair advantage. In 2006 and 2007 PHYS115 has been taught by Prof. Lekner and Dr Turner, with Dr Lukefahr and Mr Cook supervising the laboratory. Dr Lukefahr has also been popular in the 'clicker' tutorial sessions that he has run.

Evaluation of course resources: PHYS114 and 115 are resource-hungry courses in terms of academic staff and sub-lecturer (markers, demonstrators, helpdesk tutors) time. This allocation of resources is seen to be an investment, as the retention of students into Stage 2 and 3 has increased significantly in the past few years. Laboratory experiments and equipment are gradually being upgraded as time and funds become available.

PHYS130: Introductory Physics (2007: Ruck & Lukefahr)
Evaluation of course: PHYS130 teaches physics at an introductory level aimed at students with little or no background in physics or mathematics. The course covers a range of core topics with close reference to the role of physics in shaping our lives. In 2007 the course was taught jointly by Dr. Ruck and Mr. Hannah, with dual responsibility taken for the laboratory. At present many of the enrolled students are Architecture or Building Science majors, and efforts are made to accommodate the needs and interests of this large group. The course comprises 36 lectures, 12 tutorials, and 8 2-hour laboratories. The assessment is based on two in-class terms tests (35% each), the weekly assignments (10%), laboratory work (10%), and a laboratory test (10%).

Evaluation of course resources: PHYS130 requires significant laboratory resources, including substantial lecturer presence, laboratory demonstrators (senior students), and David Stead who coordinates the laboratory equipment. In addition senior students are employed to mark the weekly assignments, and students are encouraged to attend the physics help-desk sessions. Course material is posted on blackboard, and copies of the course text (Paul Hewitt, Conceptual Physics) are available in the library. Students have also been encouraged to use the services of Colin Walker in the Student Advisory Service for help with mathematical aspects of their learning. Lecture demonstrations are essential in this course, and while progress has been made in improving the available equipment there are still many relevant demonstration for which equipment is either unavailable or beyond its useful lifetime.

PHYS131: Energy and the Environment (2007: Ruck & Lukefahr)
Evaluation of course: PHYS131 deals with a range of highly relevant topics in physics, with a strong emphasis on the role of scientific understanding in informing decision making across a broad range of societal issues. Thus the course introduces underlying physical concepts before treating topics such as human use and production of energy, global warming, environmental hazards, and nuclear energy and radiation. The material is divided into modules, with roughly one module covered per week. PHYS131 requires a much lower level

of mathematical proficiency than the core physics courses (PHYS114 and 115). Students from a broad range of backgrounds enrol, including Physics majors, Earth Science students, and a few Arts, Law, and Commerce majors. With the focus on topical material it is believed that this course has the potential to grow significantly in student numbers. Thus, efforts have been made recently to attract students from the Environmental Studies major, who should find the material both relevant and stimulating. The course comprises 36 lectures, 12 tutorials, and 10 2-hour laboratories. The assessment is based on an in-class terms tests (15%), the weekly assignments (10%), laboratory work (20%), and a 3 hour final exam (55%). In 2007 the course was taught by Dr. Ben Ruck, Mr. John Hannah, and Dr. Howard Lukefahr (12 lectures each). 2007 also saw the use of a guest lecturer (Alison Jappinen) who presented case studies during two of the regular tutorial slots.

Evaluation of course resources: The considerations detailed above for PHYS130 also apply to PHYS131. For this course there is no specific textbook, although there is a set of course notes and numerous useful books available in the library.

PHYS132: Introductory Astronomy (2007: Sullivan, Lekner & Pereira)
Evaluation of course: This course develops a range of topics in astronomy and astrophysics at a largely descriptive and non-mathematical level. In spite of this, the course is taught by physicists and the material aims to develop a physical understanding of various topics in astronomy. The course is taught in the second semester using 3 lecturers such that the 36 lectures are divided into 12 lectures segments. The first lecture block (usually DJS) covers material on elementary spherical astronomy, stellar systematics, elementary stellar structure and evolution, telescopes, extrasolar planets, and the end result of stellar evolution (white dwarfs, neutron stars and black holes). These lectures conclude with material on the evolution of scientific ideas, focussing on the concept of the black hole.

The second lecture block presented by JL deals with Solar Physics. It begins with historical and modern measurements of the distance to the Sun, and the determination of the radius and mass of the Sun. The surface temperature of the Sun is determined from the solar constant, the distance to the Sun, and the Stefan-Boltzmann “blackbody” radiation law. Solar spectra are discussed, as evidence for the composition of the outer layers. Next, nuclear reactions in the core, the source of our energy, are covered, followed by discussion of the internal structure, with estimates of the pressure and temperature in the core. Finally, the JL part of the course covers sunspots and related phenomena: early observations, rotation of the Sun, sunspot structure, sunspot cycle, magnetic properties, and the solar dynamo.

The final lecture block (GP in 2006 and 2007, but usually ABK) covers in detail the physical properties of the solar system planets, using the excellent visual material provided by the various space probes. Other topics include the Big Bang and associated cosmological ideas, and the possibility of life elsewhere in the universe.

A parallel ``laboratory'' course provides 5 projects for the students to undertake (4 reports required) largely away from the university, but with assistance from the course coordinator and a number of demonstrator ``help desk'' sessions. These projects include (1) a visit to the Planetarium at Carter Observatory for a special (DJS-run) session, (2) Observation of sunset/sunrise times and postions throughout the course, (3) use of a small astronomical telescope, and (4) measurement of the sidereal/solar time difference (a project adopted from a similar University of Canterbury project). The fundamental aim of the project work is to introduce students to some of the practical aspects of astronomy observational work and simple spherical astronomy principles. This project work is assessed via submitted reports, contributing a total of 20% to the overall mark. A one hour in-term test counts 15%, and the final three hour exam 65%.

Any qualified physicist should be able to teach most/all of the material in this course, but having a research-active astronomer as the course coordinator and one of the lecturers gives it a university-level respectability and authenticity. For example, DJS's research involving extrasolar planets (gravitational microlensing and transits) and pulsating white dwarf stars are covered in his lectures. His astronomer's observational experience also enters the course. The School will probably need to modify this course (primarily the project work), or even terminate it, when DJS eventually "moves on". Since this course is not part of the core physics offering, it is germane to discuss student enrolment. This year the initial enrolment was about 34, but this has decayed to about 24. With these numbers, one might seriously question its viability. This situation approximately represents the recent history. A possible "solution" is to adopt a strategy we had in the past -- alternate PHYS132 with the parallel "interest" course PHYS131 (which also has relatively low enrolment numbers). However, 132 is not particularly demanding on resources.

Evaluation of course resources: The main resource requirement for this course is the input for 36 lectures (always provided by three different staff members). This is followed by the requirements for the project work, which have been provided by DJS, assisted by some help-desk support, and access to a computer program (Cybersky) on several computers, the Planetarium, and a 20 inch Celesteron telescope. The only significant expenditure on equipment for this course has been the purchase (more then 15 years ago) of two 20 inch Celestron telescopes. One can fairly say that the School has substantially gained from this course, with little input in the way of physical resources.

PHYS134: From Newton to Einstein and Beyond: an Introduction to Physics (2006/7: Lukefahr)

Evaluation of course: Physics 134 is a unique course in that it is taught entirely in Guided Enquiry mode in which students complete exercises in a laboratory environment. These exercises ask students leading questions and guide them through a process in which they develop and also articulate their understanding of physics. The pedagogy is based partly on the *WorkShop Physics* model developed in the US. The process is effective, with drop out rates very low even in the summer trimester, and student evaluations that are almost uniformly very positive. The topics include optics, waves, electromagnetism, mechanics, and applied mathematics. All of these topics are developed with the history of our understanding of light as the central connecting theme. While the course is successful in many ways, enrolments have not been as large as was initially hoped. Moreover, this course, like the other 13x courses, does not fully prepare students arriving with only fifth form science for Phys 114 and 115.

Evaluation of course resources: In terms of equipment the course is fully resourced and no additional expenses are anticipated. Like nearly all guided enquiry approaches, this course is very time-intensive. The course meets 15-18 hours per week for activities which are more intensive for the instructor than either traditional labs or traditional lectures. However, with the course materials now very well developed, this is feasible.

PHYS209: Physics of the Earth and Planets (2007: Ingham& Turner)
Evaluation of course: This is an 11 point elective course at 200 level in the Physics major and a core course in the Geophysics major. It is taught in two parts. The first of these starts with Kepler's Laws and orbital dynamics, including tidal forces, before looking at the physics of planetary temperatures, atmospheres, surfaces and the internal structure of planetary bodies in the Solar System. The second part of the course focuses on the Earth and provides an introduction to global geophysics. It develops a knowledge of the internal structure of the Earth through treatment of the moment of inertia, body-waver seismology, the Adams-Williams equation, the thermal profile of the Earth and the geomagnetic field. The course includes six 2-hour experiments. Four of these are computer based - two dealing with orbital dynamics, one with measurement of the rotation rate of Mercury, and one in which an Excel spreadsheet calculation is used to determine the internal density structure of the Earth by solving the Adams-Williamson equation. The remaining two experiments deal with measurement of the moment of inertia of a composite sphere and a model seismic refraction experiment.

Evaluation of course resources: The lecturers are responsible for all the assessment which includes weekly assignments and the marking of laboratory reports, term test and final exam. Laboratory demonstrating is done by one of the lecturers. Because of the difficulty in finding a single text which covers both the planetary and geophysics parts of the course, the teaching materials include a comprehensive book of notes. Assignments and assignment answers are made available through the Blackboard system. The course has become increasingly popular over the last few years but, although most of the material in it is very general, there are probably only 3 or 4 members of staff who would feel completely comfortable teaching it.

PHYS214: Physics 2A: Relativity, Quantum and Particle Physics (2007: Kaiser & Pereira)
Evaluation of course: One of our core Physics second year courses, the course presents the students with many topics that are unfamiliar and challenging to understand, for example Special Relativity, Quantum Mechanics, Nuclear and Particle Physics and General Relativity. On the one hand, the novelty of the ideas enhances the interest of the course, particularly for gifted students (several of whom enter directly into this second year course in their first year at university). On the other hand, some students find the new concepts difficult to master. It is desirable for students to do Special Relativity as early as possible (before the Special Relativity labs) to give them time to absorb the ideas. We have made assignment marks a small part of the overall course assessment - this has encouraged students to spend more time on the assignments that with the tutorials are helpful for understanding the new concepts.

Evaluation of course resources: Two lecturers share 48 lectures and 12 tutorials during the Trimester. There is a lecture or tutorial every day of the week and hence it is a highly intensive course for both student and lecturers. Each week an Assignment is set, which the course lecturer marks. In addition students undertake seven Lab classes of 3 hours in duration, covering topics from Special Relativity, Quantum applications/phenomenon and Nuclear and Particle physics. Lab demonstrators are in charge of these Lab sessions, and are usually either post-graduate students or Honours Level students. In addition, Course Lecturers generally attend for 10 -30 mins during the early part of the Lab sessions to answer questions and check students' understanding of the experiments. We need to ensure that demonstrators have a thorough knowledge of the Labs they are supervising, as some demonstrators do not do enough preparation before the laboratories. Most equipment is working well, although in 2007 we had a problem with one of the computers which controlled one of the pieces of equipment. The number of students doing the course increased significantly this year, which of course put pressure on the teaching resources. Copies of alternative textbooks for the course have been made available in the Library to assist students with understanding the course, and summary lecture notes are placed in Blackboard along with assignments and answers.

PHYS215: Physics 2B: Electromagnetism, Optics and Thermal Physics (2007: Etchegoin & Ruck)

Evaluation of course: PHYS215 forms the second part of the core 200 level physics offering. It is divided into two main sections. The first section, taught by Dr. Ben Ruck, covers topics in electric circuits (approx. 8 lectures, 2 tutorials) and a broad coverage of optics including the nature of light, geometrical optics, the interaction of light with matter, and interference (16 lectures, 6 tutorials). The second section, taught by Prof. Pablo Etchegoin teaches the thermodynamics component of PHYS215 (24 lectures, 6 tutorials) aiming at a unified view of thermodynamic principles from three different points of view: classical (phenomenological), microscopic, and kinetic. A very long time is dedicated to the explanation and principles of one of the most important (and difficult) concepts in basic physics training: the entropy and its ramifications in other areas (like information theory). The average student going through PHYS215 acquires an in-depth basic understanding of the concept of entropy in its many manifestations and from several different points of view. The course serves also the purpose of preparing the students for a more advanced statistical thermodynamics course at 300 level. The students complete 8 3-hour laboratory sessions, and submit a detailed write-up of 4 of these. Assessment is based on laboratory work (20%), assignments (5%), a terms test (15%), and a 3 hour final exam (60%).

Evaluation of course resources: The scope of this course and its core nature ensure a high demand on resources. Senior student demonstrators are employed in the laboratory classes, and the lecturers attend to give advice and to personally touch base with the students. Peter Coard plays an essential role overseeing the laboratory equipment. Given the class size and scope of laboratory equipment it is not always possible to ensure temporal correspondence between material being covered in lectures and that in the laboratory. The broad range of topics in this course means that there is no course textbook, but numerous titles from the library are suggested in the course outline. Material from the course, including lecture notes and assignments, are posted on blackboard.

PHYS217: Computerised Data Acquisition and Analysis (2007: Gouws & Teal)

Evaluation of course: The course provides an introduction to the use of computerised systems in data acquisition and analysis for scientific and technological applications. It comprises 22 lectures and tutorials and 11 laboratory sessions. It is presented as two largely independent parts, with the first part focussing on data acquisition and covering topics such as the basic principles of operations of A-to-D converters, errors in A-to-D systems, static and dynamic properties of sensors ands transducers and, time varying signals and spectral analysis. The second part focuses on data analysis, including sources and types of errors, probability density functions and distribution tests. For both these sections, the use a industry standard software packages are an integral part of the course. Data acquisition is performed in the laboratory using LabVIEW and associated hardware, while the data analysis laboratories are based on Matlab. The effective presentation of scientific data in both written reports and oral presentations also form an integral part of the course.

Evaluation of course resources: The laboratories are well equipped with a suite of PC's and the necessary hardware. However, the need to renew licences for LabVIEW and Matlab on an annual basis makes the course expensive to run.

PHYS234: Digital Electronics (2007: Gouws)
Evaluation of course: This course serves as a practical introduction to digital electronics. It comprises approximately 20 lectures and tutorials and 11 laboratory sessions and covers topics from Boolean algebra, combinational and sequential logic, characteristics of logic families, sequential design and an introduction to programmable logic devices. The laboratory sessions are an integral part of the course and exposes most of the students for the first time to basic electronic construction techniques and fault finding. A significant sequential design project forms a capstone laboratory.

Evaluation of course resources: The textbook, "Digital Systems: Principles and Applications" by R.J. Tocci et al has been in use for a number of years, but is updated regularly by the publishers. It covers all material well. The laboratory is well equipped with nearly all-new experimentation, the exception being the student design stations. The availability of a good laboratory demonstrator is essential, as the labs require constant student attention.

PHYS235: Analogue Electronics (2007: Ingham)
Evaluation of course: This is presently an 11 point elective course in the Physics major. It is also a core course in the Electronic and Computer Systems major, and from 2008 will also be largely co-taught as ELEN201 as part of the Batchelor of Engineering. It is likely that this will ultimately lead to an increase in the point value. The course is designed with a practical approach in which 11 3-hour experiments accompany the 16 lectures. Lectures cover circuit theorems and analysis, diodes, ac circuits, RC and RL filters, transistors (BJT and MOSFET), and operational amplifiers. In 2007, in anticipation of co-teaching with the BE degree in 2008, the practical part of the course included for the first time a design exercise in which students both designed (using Protel) and populated a printed circuit board.

Evaluation of course resources: The lecturer is responsible for all the assessment which includes assignment marking and the marking of laboratory, log books and the design exercise. Because of the specialised nature of the course, laboratory demonstrating is done by a graduate electronics/BScTech student supported by the lecturer. Peter Coard does an excellent job of technical support for the course. Recent updating of equipment in the electronics laboratory means that the course is adequately resourced. However, space may become an issue in 2008 with the need to schedule additional laboratory classes to accommodate ELEN201. This will also lead to a heavier marking load on the lecturer. The number of staff who are able and comfortable with teaching the course is relatively small. However, this should increase with anticipated Engineering appointments.

PHYS304: Electromagnetism (2007: Edgar)
Evaluation of course: This is a 15 point core 3rd year course in electromagnetism taught with the analytical tools of vector calculus. A brief review of vector calculus is first given, before starting with electrostatics, including methods of solving Laplace's equation and linear dielectrics. Magnetism and the description of magnetised material are then covered, including the magnetic vector potential and electromagnetic induction. The four Maxwell relations are teased out during the development, together with the constitutive relations for linear dielectrics and magnetic materials, and the various strands are brought together in the final

topic which is Maxwell's equations and the description of plane electromagnetic waves. The course covers the first seven chapters of the text by Griffiths and leads on to Phys 416 "Electrodynamics". The lectures are supported by four 4-hour experiments based on field laws, magnetic susceptibility, the skin effect, and transmission lines. Lectures are also supported by tutorials where students solve preset (not assignment) questions in small groups, coordinated by the lecturer.

Evaluation of course resources: The lecturer is responsible for all the assessment which includes fortnightly assignment marking and the marking of laboratory reports and log books. Laboratory demonstrating is mainly done by graduate students, but aided by a pre-recorded video outline and periodic brief visits by the lecturer. The course is generally adequately resourced, though the marking load on the lecturer is quite high when there are 20+ students in the class. Teaching materials (assignments, tutorials, answers to both, course outline, lab scripts, lectures [retrospectively]) are made available through the Blackboard system. This is a popular course amongst staff and essentially all staff can teach it. The library supports the course through provision of multiple copies of the textbook but a subjective view is that it is not widely used by the class.

PHYS305: Thermal Physics (2007: Edgar)
Evaluation of course: Phys 305 is a 15 point third-year core course in statistical mechanics, taught using the text by Kittel and Kroemer. It begins with the basic ideas of temperature, entropy and thermal equilibrium before introducing the partition function, Helmholtz free energy and the Boltzmann factor. The Classical, Fermi-Dirac and Bose Einstein distributions are developed, and applied to Fermi and Bose gases. The material is illustrated with examples drawn from astrophysics, solid state physics and chemical physics. Thermal diffusivity is a supplementary topic. The lectures are supported by two 8-hour experiments on thermal diffusivity, and magnetic susceptibility (or the Planck distribution). The course is a general requirement for Honours but not a specific prerequisite for any 400 level course.

Evaluation of course resources: The lecturer is responsible for all the assessment which includes fortnightly assignment marking and the marking of laboratory reports and log books. Laboratory demonstrating is mainly done by graduate students, but aided by a pre-recorded video outline and periodic brief visits by the lecturer. The course is generally adequately resourced, though the marking load on the lecturer is quite high when there are 20+ students in the class. Teaching materials (assignments, tutorials, answers to both, course outline, lab scripts, lectures [retrospectively]) are made available through the Blackboard system. This is a popular course amongst staff and essentially all staff can teach it. The library supports the course through provision of multiple copies of the textbook but a subjective view is that it is not widely used by the class.

PHYS307: Quantum Physics (2007: Lekner)
Evaluation of course: this is the first serious course in quantum theory that students get. It covers the principles of non-relativistic quantum mechanics, based mainly on the Schroedinger equation and elementary operator (Dirac) algebra. The students are introduced to the motion of particles in one and three-dimensional quantum wells, and to angular momentum and spin. There are applications to the vibrations and rotations of molecules, atomic spectra, and elementary nuclear theory. The course is taught in 23 lectures, six tutorials, and four four-hour laboratory sessions. JL has rewritten all the laboratory notes, and designed assignments which parallel the course and the laboratory work.

Evaluation of course resources: The lecturer (who is also the course coordinator) is responsible for marking the laboratory reports and six assignments, as well as for laboratory supervision. The marking and supervision load is quite heavy when the class is large; in 2007 the initial enrolment was 26, of whom 24 completed. Increased enrolment is a mixed blessing: a substantial proportion of the students are unable to cope with the concepts and the mathematics; in 2007 there were 4 A+, but 6 E grades!

PHYS309: Solid State and Nuclear Physics (2007: Pereira & Tallon)
Evaluation of course: Students in this course are presented with topics on Solid State Physics and Nuclear Physics, an extension and advance of concepts from PHYS214. The standard of the course is relatively general, with not too much mathematics but much more conceptually driven. The course has been taught by two lecturers over the last four years and this is because it really encompasses two different themes. The course focuses on applications of solid state and nuclear physics and hence tends to get many Physics and Technology students. In my opinion, most students are quite happy with the structure and content of the course as well as the amount of work involved - 24 lectures and 6 tutorials. In addition students undertake four, four-hour Laboratory classes which in 2007 were supervised by post-graduate students, due to large class size, but previously were supervised by the Course lectures. The Laboratories fit quite nicely with the Lecture Course content, although some students might think they are a bit long. However, that is the nature of physics experiments - for good results, one needs to be patient.

Evaluation of course resources: There are no major problems with the course resources. For some of the Nuclear Physics Labs some of the sources might be getting a bit old and hence their activity is a bit low. These might need to be replaced in the next year or so.

PHYS339: Experimental Techniques (2007: Etchegoin)
Evaluation of course: PGE's interests are in experimental ultra-sensitive laser spectroscopy techniques with emphasis on surface enhanced fluorescence and Raman scattering. These interests have a direct impact on the teaching side of the "advanced experimental techniques" course (PHYS339). Several aspects of PHYS339 have been upgraded in the last 3 years to adapt them to more modern experimental tools used (particularly) in spectroscopy. The largest numbers of modifications were done on the teaching and experimental demonstrations of Fourier transforms and series. The course has now an up-to-date modern overview of Fourier transforms for applications in experimental physics, together with an introduction to modern computational tools like Matlab (which is not known or used by all the students at level 300). The experiments have also been renovated by the acquisition of new instruments in the 2006 CAPEX round.

PHYS340: Microprocessor and Interface Electronics (2007: Carnegie)
Evaluation of course: Evaluation of Course: PHYS340 builds on the material presented in 2nd year digital and analogue electronics and introduces the microprocessor such that software and hardware coexist to solve a particular real-world problem. The inputs to the microprocessor such as sensors, memory devices, signal conditioning, analogue-to-digital conversion are presented as well as the outputs, particularly displays and actuators. PHYS340 must cater for students from a variety of backgrounds, from those who have only done the minimum prerequisite electronics to those who have additional background material for example PHYS217, Computerised Data Acquisition and Analysis. The course is delivered in the first trimester and comprises 22 lectures and 27 hours of assigned laboratory

assessment and is worth 15 points. The assessment is internal, and cumulates in a final project dealing with the PID control of a DC motor using a microcontroller's PWM outputs.

Evaluation of Course Resources: The course is solely lectured by Dale Carnegie who is also the course administrator, with postgraduates assisting with laboratory demonstration. Most of the laboratory equipment was specified by Carnegie, and designed and fabricated by the School's Electronics Technician Johnny McClymont. Scott Forbes deals with the computer resources required for the course to function, including the networking of the computers in the LB214 laboratory and the installation and maintenance of the appropriate software. The laboratory and test equipment is maintained by Peter Coard.

PHYS341: Analogue Electronics and Instrumentation (2007: Teal)
Evaluation of course: This is one of the three core ELCO 3 year subjects, of which two are required for that major. This course develops further the understanding and skills gained in PHYS235. Power supplies, diodes bipolar junction transistors and field effect transistors are treated in some depth, with examples of power amplifiers and differential amplifiers. This enables students to have a deeper understanding of the issues and limitations involved in the use of operational amplifiers, especially at high frequencies. The various forms and configurations of negative amplifier feedback are also studied. The Laplace transform is used as the basic for advanced circuit theory and analysis, including transient and steady state frequency response. Throughout the focus is on understanding and the ability to design circuits which take account of device limitations. The course comprises 24 lectures, several tutorials, and ten laboratory sessions, the last three of which are a design exercise. There are several assignments throughout the course.

Evaluation of course resources: At present the course is taught solely by Paul Teal. There are however several staff in the school who are capable of teaching it. The laboratory sessions are supervised by a graduate student. Most of the technology students will have taken this course and so there is not usually a shortage of suitable students. The class size may increase considerably when this course is adapted and taught as ELEN301, but this should not present any difficulties.

PHYS342: Advanced Digital Electronics (2007: Carnegie)
Evaluation of Course: PHYS342 builds on the material presented in 2nd year digital electronics paper and significantly introduces the Field Programmable Gate Array such that extremely large digital circuits can be implemented on a single chip. Programming of this chip is performed using VHDL although the students are also presented with other options for chip configuration including the use of state diagrams. The lectures include material on IC fabrication and processing, nMOS and CMOS technology, circuit characterisation, memory arrays, reliability and testing. The course is delivered in the second trimester and comprises 21 lectures and 24 hours of assigned laboratory assessment and is worth 15 points. The assessment is 50% internal, 50% external examination.

Evaluation of Course Resources: The course is solely lectured by Dale Carnegie who is also the course administrator, with postgraduates assisting with laboratory demonstration. The laboratory requirements include a PC and power supply that is standard to any electronics laboratory. Carnegie arranged for the specialised software and development boards to be donated by Xilinx Inc. Scott Forbes deals with the computer resources required for the course to function, including the networking of the computers in the LB214 laboratory and the installation and maintenance of the appropriate software. The laboratory and test equipment is maintained by Peter Coard.

PHYS411: Quantum Mechanics (2007: Callaghan & Ruck)
Evaluation of course: PHYS411 builds on the 300-level quantum mechanics course PHYS307. However the 400 level course is based more extensively on a vector space description using Dirac notation. Some background in linear algebra is assumed, but a short course in vector spaces and linear operators is provided at the start of the course, as well as an introduction to Group Theory and Group Representations. The course has a strong emphasis on symmetry and the importance of irreducible representations in quantum mechanics. Topics covered include: the relationship of wave mechanics to vector spaces, the Dirac delta function, ket and bra space, observables, measurement, expectation values, completeness. A canonical example is provided by the Spin-1/2 state and Stern-Gerlach boxes. The course covers eigenvalue equations, the Hamiltonian and evolution operators, (stationary) perturbation theory. Schrödinger and Heisenberg pictures, and conservation laws. Following the introduction to unitary displacement operators in the active and passive view there is a large emphasis on angular momentum, Lie-algebra for generators of rotation group. SU(2) symmetry and generalised rotation operators. Some methods for handling dynamical behaviour for stationary and time dependent Hamiltonians are covered. Students are introduced to product representations, Clebsch-Gordon coefficients and angular momentum coupling, with examples from atomic physics, nuclear magnetic resonance and hadron (SU(n)) symmetries. The course also covers the density matrix, ensemble averages, state evolution and quantum coherence.

An important part of PHYS411 is the emphasis on philosophical issues. State reduction, non-locality, entanglement, hidden variables and Bell's theorem are all touched on in overview, without too much detail, but with the aim of building awareness of these issues.

Evaluation of Course Resources: The course is taught by Professor Callaghan and Dr Ruck jointly, using extensive printed notes written by the coordinator Professor Callaghan, supplemented by readings and articles. Students are expected to present part of the material themselves in 15 minute sessions on at least two occasions for each student. They are given around 1 week to prepare. 4 assignments are marked in which students work through a set of problems. These subsequently form the basis of a tutorial in which model answers are provided. A feature of the finals examination is the opportunity to answer an essay question in which students are expected to show physical insight without the need for detailed mathematical treatment.

PHYS412: Theoretical Physics (2007: Pereira & Hendy)
Evaluation of course: Students in this course are presented with topics which, in principle, involve aspects of Theoretical Physics. Given there are only 18 lectures in the course, it is clear an exhaustive study of theoretical physics is out of the question and rather students are presented with topics which draw from the lecturers' areas of expertise. I don't believe there is any problem with this, although I believe any Theoretical Physics course should mention or have reference to Computational Physics, as nowadays it is difficult to solve any theoretical model without some computational input. I'm not suggesting a computational physics course, but rather students should be enlightened as to the fact that "real" physical problems are most of the time solved numerically.

The Course over the last few years has focused on aspects of statistical physics and fluid mechanics and has been taught by two lecturers - Gerald Pereira and Shaun Hendy. In the first half of the course we consider simple statistical models which exhibit phase transitions such as real gas/liquid systems and magnetic phase transitions. We introduce the "mean-field technique" for solving these models and then introduce an "exactly solved system" - the Ising model to compare to mean field results. As is known, the Ising model in 2 or 3-dimensions cannot be solved exactly, so we show introduce the Monte Carlo technique for a computational solution. This only takes one lecture, and in an Assignment question students are asked to write a small code for the 2-dimensional Ising model (In the past most students have really enjoyed this, although some found it quite difficult and I let them off doing this simulation.) Students are alerted to the limitations of mean-field theory and the in the second part of the course the role of fluctuations is discussed with particular reference to simple liquids. Density functional theory is also introduced to students as well as the Molecular Dynamics technique.

Evaluation of course resources: If students are going to complete a computer simulation as an Assignment question they require access to a computer. For most students, who usually have a mathematical bent, this is not a problem as Maths and Computer Science give students a Linux account. They can then use that account to write and run their code. If students do not have access to MCS machines, then this is a problem. In the past, I have given some students a lend of my laptop, which runs FORTRAN or Matlab. As has been mentioned in previous Physics end-of-year meetings it is desirable for our students to have much better computational abilities. If this is so, we should provide them with a computer account and access.

PHYS413: Condensed Matter Physics A (2007: Hendy & Kaiser)
Evaluation of Course: This is a first semester foundation course in solid state physics, which also serves as a preliminary for the associated second semester course Phys 414 “Condensed Matter Physics B”. The background knowledge required for Phys 413 is that of 300 level quantum mechanics. Phys 413 is primarily concerned with establishing descriptions of the periodic nature of crystalline materials, and the implications for the propagation of electromagnetic waves, atomic vibrations, and especially electrons in solids. As is standard at 400 level, the course consists of 18 lectures, 6 tutorials and 6 assignments. Tutorials are designed to closely support the assignment questions, and to encourage group discussion and problem solving.

Evaluation of Course Resources: Currently the course is taught by two lecturers. The department is well served by its expertise in Condensed Matter physics research so there are unlikely to be difficulties in staffing this course in the near future. The course site on Blackboard is a repository for course information, lecture notes, assignments, notices, and model answers to assignments and tutorials. The texts (Ashcroft and Mermin, and Kittel) are available on Closed Reserve in the main library. Generally resources for the course are satisfactory.

PHYS414: Condensed Matter Physics B (2007: Callaghan, Tallon & Ruck)
Evaluation of course: PHYS414 covers material in condensed matter physics from the perspective of several applied topics. The topics are closely related to the course lecturers’ fields of research, but there is an emphasis on covering fundamental concepts within this framework. At present the material covers aspects of polymer physics, interacting electrons and magnetism, and superconductivity. Assessment consists of three marked assignments

(20%) and the 3 hour final exam (80%). In 2007 the course was taught by Dr. Ben Ruck, Prof. Jeff Tallon, and Prof. Paul Callaghan (6 lectures each).

Evaluation of course resources: As for the associated course PHYS413, this course is well served by the presence of several staff members in SCPS whose research is in condensed matter physics. As a result the material in this course often has close linkages with honours projects on offer (PHYS490, 491). The recommended readings for the course are available in the VUW library.

PHYS415: Electromagnetism (2007: Pereira & Lekner)
Evaluation of course: This Honours course continues on from PHYS304. The first part, taught by GP, covers static and dynamic solutions of Maxwell's equations, including electromagnetic waves in confined geometries (waveguides). The second part, taught by JL, introduces radiating systems: dipole radiation, and the linear antenna. It also covers the scattering of light by small dielectric and metallic spheres.

Evaluation of course resources: Assignments are used to teach applications and details of the lecture material; they amount to 20% of the total mark.

PHYS416: Relativity and Electrodynamics (2007: Lekner & Etchegoin)
Evaluation of course: The first part, taught by JL, covers Einstein's theory of special relativity, the dynamics of relativistic particles, including scattering and threshold energies of reactions, and the relativistic formulation of Maxwell's equations, including Lorentz transformation of fields. The second part, taught by PGE, specializes in topics oriented towards current research areas in the fields of electromagnetic calculations and radiation problems in nanophotonics. The course has now incorporated modern computational tools for this task (like FemLab), and several examples come directly from some of PGE's research interests in surface plasmon resonances and nano-optics.

Evaluation of course resources: Assignments are used to teach applications and details of the lecture material; they amount to 20% of the total mark.

PHYS417: Astrophysics (2007; Sullivan)
Evaluation of course: This Honours-level course is offered in the second trimester and covers a selection of modern topics in astrophysics. About 10 years ago, the Physics Honours programme was reorganised into one trimester courses, and this facilitated the development of particular courses that more closely matched a staff member's interests and expertise. PHYS417 is one such course. Topics include stellar structure, with a focus on the mechanical structure of white dwarf stars (including the important changes brought about by the relativistic behaviour of the degenerate electron gas), some nuclear and particle astrophysics theory, and largely observational general relativity. The basic philosophy employed in teaching the course is to develop an understanding of the underlying physics used to explain some of the intriguing phenomenona inhabiting the world of astrophysics.

DJS's research activities include using pulsating white dwarfs as vehicles to study a variety of things (including neutrino creation in hot dense plasmas) and gravitational microlensing as a tool to search for extrasolar planets. Thus, material in the course aims to develop the physics behind these endeavours. Although no general computational theory is covered, the students are introduced to a number of software programs, in the knowledge that all advanced physics research requires significant computing at some stage or other. A genuine effort is made to combine the specific research interests of the lecturer with the important general goal of providing the students with a broad background in some advanced physics topics. The lectures on general relativity do not attempt to completely develop the subject from first principles (this is would take many more lectures, and in any case a course, or courses, in this vein are offered by Matt Visser in Mathematics). Instead a physical approach is adopted, along with a treatment that largely avoids being "bogged down" in 4 dimensional tensor analysis, so that important applications such as the trajectories of particles in the spherically symmetric gravitational Schwarzschild field can be derived, understood, and applied to key situations such as the bending of light near a massive object (as is required to understand gravitational microlensing.

Evaluation of course resources: The (up to) 24 lectures are delivered entirely by DJS, and students are given 3 detailed assignments, which count the (now standard) 20% towards the final mark. Probably, when DJS "goes" this course will be retired.

PHYS420: Signal Processing A (also taught as TECH420 and ECSE420, 2007: Ingham & Teal)
Evaluation of course: This course is a 15 point 400 level course which deals with signal processing of signals that are continuous in time. It is a final year option for BSc (Hons) and BScTech students. Topics covered include Fourier Series, the Fourier Transorm, linear systems including filters, spectral analysis, properties of random signals and variables, modulation, and signal to noise enhancement.

Evaluation of course resources: There are 24 lectures in the course, and associated tutorials as appropriate. Assignments include computer exercises. There are no major course resourcing issues.

PHYS421: Signal Processing B (also taught as TECH421 and ECSE421, 2007: Ingham & Sullivan)
Evaluation of course: This course is a 15 point 400 level course which deals with signal processing of signals that are discrete in time. It is a final year option for BSc (Hons) and BScTech students. Topics covered include convolution in the discrete time domain and the design of filter kernels, recursive filtering, the DFT and FFT and their use in spectral anlysis.

Evaluation of course resources: There are 24 lectures in the course, and associated tutorials as appropriate. Assignments include computer exercises. There are no major course resourcing issues.

PHYS422: Instrumentation (also taught as TECH422 and ECSE422, 2007: Gouws)
Evaluation of course: The course studies dynamic systems encountered in a variety of instrumentation and mechatronic systems. Course materials includes the properties of electrical, mechanical, thermal systems and the modeling of such systems, the control of dynamic systems using feedback and the design of PID control systems using mainly Root Locus techniques. Throughout the course, extensive use is made of Matlab and Simulink as an aid in modelling. A laboratory project is run in parallel with the lectures in which a dynamic system is analysed, modeled and a controller designed.

Evaluation of course resources: The textbook “Control System Engineering” by Norman S. Nise has been successfully used for the last two years. Matlab/Simulink licences require annual renewal.

PHYS423: Electronics (also taught as TECH423 and ECSE423, 2007: Teal & Edgar)
Evaluation of course: This course is a 15 point 400 level course which was originally intended to be advanced analogue electronics, but it is a course in transition with the new engineering offering. It is a final year option for BSc (Hons) and BScTech students. The intention at present is to use this course to present radio frequency electronics as a basis for understanding wireless and broadcast technologies in the analogue and digital domains. In 2007 the topics included active and passive filters, oscillators, phase-locked loops, high frequency amplification, transmission lines, and antennae.

Evaluation of course resources: There are 24 lectures in the course, six tutorials, and 6 assignments, but no laboratories. There are no major course resourcing issues for PHYS423 other than the very limited number of staff who can teach it. One minor one is that it is difficult to find an appropriate text for the diversity of topics which are taught.

PHYS441: Origin and Evolution of the Solid Earth (also taught as GPHS441, 2007: Smith [SGEES}, Ingham & Turner)
Evaluation of course: This course is a 15 point 400 level course in both the Physics and Geophysics Honours programmes. The course covers three main aspects of solid earth geophysics: (i) the shape of the Earth and gravitation - this includes precession of the equinoxes, nutations, the geoid, tidal deformation, isostasy, post-glacial rebound; (ii) heat transfer within the Earth - covering conduction, convection, the thermal profile of the Earth and the energy budget for the core and how this impacts on the likely development of the Earth; (iii) geochronology - covering the origin of the elements, theory of radioactive decay, age equation, use of isochrons, K-Ar, Ar-Ar, and Rb-Sr methods, radioactive series, Pb isotopes, results from terrestrial and lunar rocks and meteorites, age of the Earth.

Evaluation of course resources: There are 24 lectures/tutorials in the course, and 4 assignments. There are no major course resourcing issues.

PHYS447: Introduction to Geomagnetism (also taught as GPHS447, 2007: Ingham)
Evaluation of course: This course is a 15 point 400 level course in both the Physics and Geophysics Honours programmes. The course gives an introduction to the main areas of geomagnetism - physical and mathematical descriptions of the geomagnetic field, time variations in the field, past behaviour of the field (including secular variation, polarity reversals and transitions) and the use of palaeomagnetism and rock magnetism in their study, magnetohydrodynamics and generation of the geomagnetic field.

Evaluation of course resources: There are 24 lectures/tutorials in the course, and 4 assignments. There are no major course resourcing issues.

PHYS490: Research Project A
PHYS491: Research Project B
Evaluation of course: Each is a research-level project, planned by the supervisor. For the student this is the first experience of research, and substantial mentoring is needed in experimental methodology, theoretical and mathematical techniques, and scientific ethics. Our approach is always to give the students as much freedom as possible (consistent with at least some of the project goals being achieved), in the choice of project and its

implementation, so that they experience the joy of discovery and are able to exercise as much initiative as they have.

Evaluation of course resources: The Research Projects are coordinated by John Lekner, with all physics staff being encouraged to submit research topics at the beginning of terms 1 and 2. These are circulated to students, who then choose the topic that interest them most, subject to the supervisor being willing to take them on. In term 1 the students give a practise talk, and then a final talk, which counts for 10% of the total mark. In term 2 only the final talk is given. The project reports are read and marked by the supervisor and two co-examiners. A staff meeting is held each term to discuss the results. Thus all of the available physics staff play a role.

PHYS440: Directed Individual Study
PHYS460: Directed Individual Study

These are occasionally used to fill a particular need. For example, this year an Honours student asked to be taught Relativistic Quantum Theory, and John Lekner agreed to write the lecture notes in the form of (up to now) about twenty tutorial/problem sheets. In this case there are no lectures, but rather meetings between the student and JL.

Chapter 8

Treaty Obligations

8.1 Te Ropu Awhina Putaiao

Awhina is the comprehensive mentoring support system for Maori and Pacific Nations students enrolled in 100 and 200 level science, architecture and design courses. Awhina also supports non Maori and Pacific Nations students who wish to be included. Graduate and postgraduate Maori and Pacific Nations students (and other interested students) are encouraged to become involved as mentors to these students and help them get their university studies off to a good start. Some mentors are also tutors and demonstrators for undergraduate science courses while others act as role models for Maori and Pacific Nations' secondary school students. Whanau support has been extended into the University and the wider community through career mentors and community mentors. Within each faculty there are academic staff who can be contacted for support. Awhina also has many support staff. The outreach programme has mentors who visit Bishop Viard, Poriura and Mana Colleges and teach various subjects to pupils.

More details may be found at the URL: http://www.vuw.ac.nz/science/Awhina/about.html

8.2 Te Reo Physics Project

Since 2004, staff from the MacDiarmid Institute and the School of Chemical and Physical Sciences (SCPS) have worked on an exciting and unique project, directed at increasing Maori and Pacific participation in the study of science in general and physics in particular. The project involves collaboration with teachers and pupils at Kura to develop multimedia physics education resources featuring Maori pupils at the Kura and Te Ropu Awhina Putaiao students at Victoria University doing, enjoying, and explaining physics to their peers. This on-going project has generated national and international interest and may be used as a model by First Nations' peoples in Canada. Phase 1 of the project was funded by Te Puni Kokiri , the MacDiarmid Institute, SCPS, and the VUW Faculty of Science (Equity area) and is managed by Liz Richardson , Deputy Dean (Equity). The resources are posted on the popular New Zealand Physics Teachers' Resource Bank, www.physics.school.nz, developed and maintained by MacDiarmid and SPCS staff.

Chapter 9

Future Challenges

As part of the self-review process we have taken the opportunity to identify those issues which we see as most important for the maintenance and future development of physics as a successful discipline within the Faculty of Science at VUW. These are dealt with in the order of (1) issues arising from developments external to SCPS, (2) issues that are internal to SCPS; and (3) issues dealing specifically with physics teaching.

9.1 Bachelor of Engineering

Members of the physics group have had significant involvement with the planning and introduction of the Bachelor of Engineering (BE) at VUW in 2007. A small focus group has been active in the general planning of the BE programme and in particular the design of the Electronic Engineering and Computer Systems Engineering majors of the new degree. Current physics courses form an important component of the BE programme, as PHYS114 and PHYS115 are compulsory 100 level courses for the above two streams, while the core engineering course ENGR 101 is currently jointly presented by SCPS and SMSCS. In addition, several existing 200 and 300 levels physics-based electronics courses will be co-taught with the corresponding engineering courses as will be detailed below. Physics staff members thus make a substantial teaching contribution to engineering courses with Ingham and Lukefahr currently teaching in ENGR101 while several staff members (Ingham, Teal, Carnegie, Edgar and Gouws) will be involved in teaching 200 – 400 engineering courses over the next few years.

In terms of student numbers the new degree (with ~100 first year enrolments in total in 2007) has already been partly responsible for increased numbers in PHYS114 and PHYS115. It is anticipated that there will be further growth in 2008 and beyond. While these impacts are initially beneficial to physics, the long term implications of the BE for 200 and 300 level physics are less clear.

In 2008 the existing courses PHYS217 (Computerised Data Acquisition and Analysis), PHYS234 (Digital Electronics) and PHYS235 (Analogue Electronics) will be at least partly co-taught by physics staff as 200 level BE courses. In 2009 similar 300 level co-taught courses will come on-stream. Such developments should initially be favourable for physics. However, it is possible, over time, that the majority of students in these courses will be BE students rather than the traditional make-up of PHYS and ELCO majors. With the anticipated establishment of a new School of Engineering in 2008 or 2009, and the employment of specific engineering staff, in the longer term it is likely that there will be a move for the BE courses to be taught specifically by engineering staff and the input of SCPS into these courses may decrease. This may potentially bring the existence of PHYS217, PHYS234 and PHYS235 (and similar PHYS300 level courses) as separate entities into question.

Physics needs to be proactive in ensuring that a relevant, modern and varied physics programme remains when Engineering splits away from SCPS and SMSCS. Electronics and other strands of physics should remain an integral part of our offering and the electronics courses offered to physics students should be appropriate for the education of a physics student.

9.2 Vulnerability to changing requirements

As has been stated earlier, enrolments in the non-continuing 100 level courses, which make a substantial contribution to overall EFTS numbers in physics, are susceptible to changing requirements in some of the degrees that these courses service. The most significant such requirement is that for Architecture 100 level students who have not studied physics at school to take PHYS130 or PHYS114. Such vulnerability impacts not only on the viability of the specific courses but also on that of the entire physics programme as a substantial reduction in EFTS numbers will compromise the financial status of physics (and SCPS) as a whole. There is no easy solution to this problem, as programmes such as Architecture have to themselves satisfy the requirements for professional recognition.

The physics group is therefore conscious of the need to maintain and develop physics courses which are relevant and of interest to students in other disciplines. This includes tailoring the 200 level electronics courses to a degree so that, while maintaining their relevance to physics majors, they are suitable for the BE programme. It is also of high importance to physics that PHYS131 (Energy and the Environment) should be recognised for the significant contribution that it can make to the Environmental Studies programme.

9.3 Promotion and funding of postgraduate study

It has been noted earlier that PhD numbers in physics over the years 2002-2007 have shown only a small growth compared to undergraduate numbers. Although this could be regarded as anomalous in a school which has had such significant success in research, it partly reflects the fact that many of our top BSc(Hons) students (as shown in Chapter 3.8) are successful in obtaining prestigious overseas scholarships, while we attract fewer postgraduates from overseas and other New Zealand universities. Nevertheless, it remains a challenge for us to further increase our postgraduate numbers.

There are several obstacles which we perceive to achieving increased numbers. For internal students other than the very top students a significant issue is the present manner in which University scholarships are awarded. The reliance on grade point average for ranking of students means that students who obtain a 1st class BSc(Hons) degree but do not achieve A+ or A grades in all their 400 level courses, have little chance of securing a scholarship. The outlook is even bleaker for students obtaining a 2.1 at BSc(Hons), some of whom may in fact be very well suited to a research degree. Attracting postgraduate students from overseas also faces the barrier of securing funding for them.

Potential solutions to these problems include a significant increase in the amount of money that VUW puts into MSc and PhD scholarships. However, we would therefore very much like to see modifications to the University system whereby scholarships are awarded. These might include an increase in the number of targeted scholarships (i.e. those awarded to specific projects) rather than general scholarships for unspecified projects. We would also welcome a move to see potential supervisors have an increased input into student selection rather than reliance on grade point averages.

9.4 Proposed changes to the BSc

The Faculty of Science is presently considering a proposal to restructure the BSc degree. This has arisen partly out of a concern that there is no generic structure to a BSc major and that, as a consequence, majors in different disciplines require vastly different numbers of points within the discipline. A decision on whether the present recommendations will be adopted will be taken before the end of 2007.

The number of points required for a physics major is at present not significantly different from what would be instituted if the proposals are accepted. However, the proposal to standardise courses to 15 points at 100 level and either 15 or 20 points at 200 and 300 level, would necessitate considerable reorganisation of material. If the proposals are adopted they would be implemented gradually over the time frame 2009-2011. It is imperative that physics should be ready to capitalize on any new structure to maximise any possible benefits.

9.5 Staffing

A number of present physics staff are approaching what is normally regarded as retirement age. We have also recently had the resignation of a younger member of staff, and the establishment of a School of Engineering may see the transfer of up to three others. As a result, over the next few years new appointments will be required. These will, of course, be subject to the University scrutiny in terms of budgetary and EFTS sustainability.

The physics group itself will need to decide on the areas of specialization that new appointments will have. For a relatively small physics group, the question of a diverse range of research interests versus a more narrow focus (as exemplified and specifically funded by the MacDiarmid Institute) is an interesting issue. On the one hand, a limited and apparently associated group of research activities may appear to be a better option for obtaining external funding. It is also likely to lead to a more collegial research environment with more overlapping interest in the different research activities and seminars, etc. However, on the other hand, the resultant narrower base of interests and expertise leads to significant difficulties when considering the variety of advanced courses a physics unit should be offering. As was discussed in Chapter 7, there are already a number of courses that are poorly supported in terms of the number of staff who would feel comfortable teaching in them. These include elective courses at a range of levels in astronomy/astrophysics, geophysics/environmental physics and electronics.

9.6 Accommodation

Shortage of space is already an important issue within SCPS as a whole and is already having noticeable impact on our ability to operate at maximum efficiency. Over the last 10 years in being required to respond to financial pressures we have seen physics laboratory space decrease by approximately 50%. With the growth in physics, both in undergraduate student numbers and due to expansion in research activity with the establishment of the MacDiarmid Institute, there are now serious space issues to be faced. These range from personal space for research students, through research laboratory space and staff office space, to space in teaching laboratories. In the longer term some of these issues may be resolved by the construction by 2011 of the Laby extension and the adjacent Science and Engineering Innovation Centre.

The University has recently reached agreement with the Postgraduate Students Association on the space requirements for postgraduate students. While students working in the major physics research laboratories are catered for in this context, we have significant problems in meeting our obligations for many MSc students who do not have dedicated space or computing facilities available to them.

The increased number of students majoring in physics is beginning to put a significant strain on the teaching laboratories. This is most noticeable at 200 and 300 level, where the two year levels share a teaching laboratory (LB215), and in the electronics area (LB214).

LB215 is used by PHYS214, PHYS305, PHYS307 and PHYS339 simultaneously in the first trimester and by PHYS209, PHYS215, PHYS304 and PHYS309 in the second trimester. When, for example, laboratory classes in PHYS209 and PHYS215 are full (note availability of equipment means that these classes are limited to 8 students each per laboratory class) there is very little space in the 200 level part of the laboratory. Given the complexities of managing a university-wide timetable which minimises clashes, further increases in the number of students will require increasingly creative organisation of laboratory times. This may include evening laboratories with the attendant issues of staff workloads and problems of finding demonstrators. In 2005 a solution was trialled of moving some of the 300 level experiments into research laboratories. However, student feedback suggested that this was not popular as students felt that they were then isolated from their peer group during the laboratory. All 300 level experiments have since been returned to LB215.

In the case of the electronics laboratory (LB214), with the necessary addition of extra laboratory classes to accommodate BE students in the Electronic and Computer Systems Engineering streams, the draft timetable for 2008 already has the teaching laboratory fully occupied from 9-5 Monday to Friday inclusive. Although the creation of new laboratory teaching space for the BE in the Cotton Building may alleviate this in the long term, there is no short-term plan if numbers in the electronics courses/BE increase more rapidly than expected.

9.7 Student Preparation

It is clear that the increased number of students at 100 level includes many who are less well prepared in physics and/or mathematics than has been the case in the past. In particular, with increased options available in NCEA more students are entering university without our recommended minimum achievement in calculus. Problems that result from this lack of preparation are now starting to flow on into 200 and 300 level. Some of these, and the current practice of dealing with them, the typical observed results, and some possible alternative solutions to them, are listed in Table 9.1 below.

Each of the suggested possible solutions is not itself without problems and would, additionally, require significant changes to be made to our course structure. Introducing a summer trimester course in mathematics specifically for physics would have the problem that many students needing such a course do in fact not recognise this need until they formally start their first trimester at VUW. Achieving enrolments of the appropriate students would therefore be an issue. Some attempt has already been made to hold targeted sessions on calculus at the start of PHYS114. This has been done in timetabled laboratory slots and has been accompanied by some reorganisation of lecture material at the start of the course to delay the onset of the use of calculus until this has been done. However, without a large reorganisation and reduction of material in PHYS114, and also PHYS115, this at best a stop-gap measure.

Originally designed as a bridging course for students starting university, PHYS134 has also suffered from the conflicting needs of students to prepare themselves better for their first year, and to be in employment over the summer. In reality few of the students enrolling in the course continue on with physics. It is questionable whether any altered bridging course would be any more successful in attracting the students who would benefit from it most.

Problem & current practice	**Present result**	**Possible solution**
Lack of calculus A student does MATH103 (Introductory Calculus) in 2/3 of the 1st year. If successful this leads on to MATH113 (Calculus I) in 2nd year and MATH206 (Calculus II) in 3rd year.	Students have no/little calculus until the end of their 1st year and struggle to understand the use of calculus in PHYS114 and PHYS115. The students' mathematics is always 1 year behind physics.	Introduce MATH103 or equivalent in the summer trimester. Alternatively teach some calculus at the beginning of PHYS114.
Lack of physics (a) A student does PHYS134 in the summer trimester (often with MATH104 (Introductory Algebra and Discrete Mathematics)), or (b) PHYS130/PHYS131 and MATH103/MATH104 in the 1st year.	(a) Although PHYS134 provides a stimulating introduction to physics it leaves many gaps. There is also no introduction to calculus. (b) Provides a good preparation for PHYS114 and PHYS115 but the student takes an extra year.	A summer trimester bridging course which retains some elements of Guided Enquiry but also contains more traditional physics material and an introduction to the necessary mathematics.
200 and 300 level The physics major includes PHYS304, 305, 307, 309 and MATH206.	With increased help available to pass PHYS114 and PHYS115 (typically with B or C grades) an increasing number of students also pass PHYS214 and PHYS215 (often at the 2nd attempt) but then find that they are not up to the rigorous theoretical physics required at 300 level.	Introduce a non-continuing Physical Sciences major that requires 60-72 300 level points in a combination of say 3 subjects (e.g. PHYS, CHEM, MATH). Use PHYS342 (Special Topic) to introduce an applied physics or, for example, an environmental physics course at 300 level.

Table 9.1: Problems, results and possible solutions arising from lack of preparation of students.

If the trend of an increased number of poorly prepared students continues, it may be that we will have to seriously reconsider how we structure our 100 level teaching. At present PHYS114 and PHYS115 are divided according to material rather than difficulty. This is in contrast to, for example, chemistry which has a first trimester 100 level course which is more of an introductory nature and leads into a more advanced second trimester paper.

The possibility of introducing a more general major within the BSc in, as suggested, Physical Sciences, would allow some students, who presently hit a block in the more advanced physics courses, to successfully complete their degree. The existence of the special topic at 300 level allows us some flexibility in designing alternative courses that might suit this group of students. Any such change, however, would need to fit with the present proposals to change the structure of the BSc (see below). Entry to BSc(Hons) in PHYS, CHEM or MATH would continue to be via their respective BSc majors. The Physical Sciences major would be intended for students ending their studies at BSc level, or continuing to a Graduate Diploma in Science.

9.8 Workload expectations

In Chapter 3.5.4 it was noted that although the standard University workload model is that each point of a course equates to 10 hours of work, there are no recent data on workloads across the Science Faculty. Within physics it is important that we ensure standardisation across our courses so that different courses do not place different expectations on students with regard to either workload or standards.

Since 2005 we have standardised the assessment in the majority of courses (see Table 3.1) both at individual year levels and between year levels. However, some work remains to be done on standardising how, in particular the internal component of, that assessment is achieved. For example, the frequency and number of marked assignments, the number of marked laboratory reports etc. It is also of concern that we have no data on the amount of individual work that students put into each course by way of private study.