**Internal Academic Review 2005-2006**
**Department of Physics, Engineering Physics and Astronomy**
**Internal Academic Review Committee Report to Senate**

The Internal Academic Review (IAR) of the Department of Physics, Engineering Physics and Astronomy is now complete. The Internal Academic Review Committee (IARC) has taken into consideration all of the submissions related to the IAR of the Department of Physics, Engineering Physics and Astronomy and respectfully submits the following report. The IARC Report to Senate is intended to supplement the findings of the attached Review Team Report and to provide a mechanism for the Head of the Department, the Dean of the Faculty of Arts and Science and the Dean of the Faculty of Applied Science to jointly report on the progress in addressing the Review Team recommendations (please see the "Outcomes" section of this report).

**Summary of the Internal Academic Review of the Department of Physics, Engineering Physics and Astronomy**

The Department of Physics, Engineering Physics and Astronomy offers high quality, laboratory-intensive undergraduate and graduate programs to excellent students taught by a faculty complement comprised of innovative teachers and productive researchers. The Senate Internal Academic Review Committee (IARC) agrees with reviewers that a dedicated core of technical and administrative staff does an impressive job of supporting the work of faculty and students. The IARC would be remiss if it did not highlight the Department's exemplary record of service and outreach as well as the research accomplishments across the spectrum in the department: and to note, in particular, those Queen's researchers associated with the world-renowned Sudbury Neutrino Observatory.

The IARC joins reviewers with their praise for the quality of the critical self-assessment completed by the Department and its willingness to immediately take steps to address many of its challenges whether self-identified or identified by reviewers. The Department and the Faculties of Arts and Science and Applied Science are encouraged to continue addressing the most pressing issues such as a review of graduate programs, expanding technical resources and redesigning the web page, and to develop plans and approaches to deal with longer-term concerns such as space, low female enrolment and coordination of funding and teaching resources between the Faculties supporting the Engineering Physics program.

The IARC commends the Department and all participants for a comprehensive and thoughtful Internal Academic Review and wishes the Department and Faculty continued success in addressing the recommendations outlined in the following Review Team report:

**Outcomes of the Internal Academic Review of the Department of Physics, Engineering Physics and Astronomy**

*Joint response submitted by the Dean of the Faculty of Arts and Science, Dean of the Faculty of Applied Science and the Head of the Department of Physics, Engineering Physics and Astronomy*

*The Internal Academic Review Team, in conjunction with the External Consultants, highlight that the Department of Physics, Engineering Physics and Astronomy offers high-quality laboratory-intensive undergraduate and graduate programs to excellent students taught by a faculty complement comprised of innovative teachers and productive researchers. Of note is the fact that the Engineering Physics program is only one of two of the ten engineering programs that received full six-year accreditation by the Canadian Engineering Accreditation Board in 2006.*

The Faculty of Arts and Science recognizes the importance of addressing and supporting issues such as securing resources to supply faculty complement in needed areas, review of undergraduate and graduate programs, expanding technical resources and redesigning the web page, developing plans and approaches to deal with ongoing concerns such as space, low female enrolment, and the coordination of funding and teaching resources between Faculties supporting the Engineering Physics program.

It is important to note that the Faculty of Applied Science has no direct financial authority to address program concerns with resource implications. The Faculty of Applied Science supports engineering activities in the Department by reviewing a declared engineering budget established by the Faculty of Arts and Science through a memorandum of understanding with the Faculty of Applied Science. The declared budget allocation is built upon the resource allocation model created by the Faculty of Applied Science for other engineering programs at the University. It is sensitive to enrolment changes in the Engineering Physics program and to the relative enrolment balance between programs offered by the Department. Outside of the base operating budget, the Faculty of Applied Science provides equipment and curriculum development funding to the Department from Faculty endowments.

Research and Teaching:

*The Internal Academic Review Team emphasizes the significance of the Department's exemplary record of service and outreach as well as research accomplishments across the spectrum in the Department, in particular those Queen's researchers associated with*

*the world-renowned Sudbury Neutrino Observatory. The Internal Academic Review Team also recognizes the teaching excellence in the Department, but is mindful of the reliance on adjunct teaching.*

The Faculty of Arts and Science recognizes the significance of the excellent research and teaching profile in the Department, and is committed to its support and enhancement through seeking ways to refurbish and expand space, and to supply faculty complement in needed areas, such as particle astrophysics. In recognition of the importance of this area, the Faculty of Arts and Science has just released a full-time tenure-track position in nuclear particle astrophysics to replace a recently departed faculty member.

With respect to teaching, both the Faculties of Arts and Science and Applied Science recognize that the Department is reliant on adjunct teaching, and that every effort should be made to provide resources for more tenure-track teaching, especially in first-year courses, which is the norm in engineering departments.

Space:

*The Internal Academic Review Team recommends that the Department of Physics work with the Faculty of Arts and Science to find resources to renovate existing space and for creating new space that will be suitable for research and graduate students. The IART also recommends that the Department should seek advice from the Office of Advancement to identify fundraising opportunities to pay for the required renovations and expansion.*

The Faculty of Arts and Science is committed to seeking resources for space requirements in the Department. Funding for the renovation for the SNO research space in Stirling Hall, as well as funds to complete the laboratory for a recently arrived CRC I faculty member, provided by the Faculty of Arts and Science, are two recent examples of support in this area.

Both the Faculty of Arts and Science and Applied Science are actively involved in facilitating linkages between the Department and the Office of Advancement in order to secure financial support from external sources for the Department.

*Follow-up on these recommendations and issues will take place during annual budget and staffing meetings between the Dean of the Faculty of Arts and Science, the Dean of the Faculty of Applied Science and the Vice-Principal (Academic)*

**Attachment:**

Review Team Report

**Report of the Internal Academic Review Team**
**for the**
**Department of Physics, Engineering Physics and Astronomy**

March 27, 2006

**Committee Members:**
Mr. Tom Hunter, Department of Chemistry (Staff)
Dr. Terry Krupa, School of Rehabilitation Therapy (Faculty)
Dr. Susan Lederman, Department of Psychology (Faculty)
Dr. Jim Lee, Department of Geological Sciences & Geological Engineering (Faculty)
Dr. Kim McAuley, Department of Chemical Engineering (Faculty) (Chair)
Ms Amber Simpson, School of Computing (Graduate student)

## 1. Executive Summary

This report presents an assessment of the quality and suitability of the endeavours of the Physics Department at Queen's University. In preparing this assessment, we have considered: undergraduate and graduate programs, teaching methodologies and outcomes, research funding levels and accomplishments, and service and outreach activities. Our conclusions and recommendations are based on information obtained from: the External Reviewers' Report prepared by Drs. Michael Plischke and Stewart Smith; the Self-Study Document prepared by the Physics Department; a tour of Stirling Hall where the Physics Department is housed; Departmental websites, and meetings with the Department Head, faculty, support staff, and graduate and undergraduate students.

Our committee agrees with the assessment provided by the external reviewers. We commend the Physics Department on its research accomplishments, its high-quality students, its dedicated support staff, and its ability to attract and retain talented academic staff. The main areas of concern flagged by our Committee and the External Reviewers are: inadequate space for research and graduate students, deficiencies in undergraduate and graduate curriculum and teaching methods, and the need for judicious replacement of retiring academic staff. Further details about our assessment of the Physics Department and its academic programs are provided in Sections 2 and 3 below, followed by a list of recommendations in Section 4.

Kim McAuley

## 2. Commendations

We commend the Physics Department on the strengths and accomplishments in teaching and research and service that are described below.

### 2.1 Teaching

The Department of Physics expresses commitment to the ongoing development of educational practices and methodologies. Particular strengths in the Department include: faculty who are committed to education and invested in ensuring the excellence of graduating students; several faculty who have been recognized by nominations for teaching awards; a group of adjunct faculty who are recognized as talented teachers; and technical staff who support learning in laboratory-intensive Physics and Engineering Physics undergraduate programs. There is also considerable evidence that faculty and support staff in the Physics department strongly support the students' education by maintaining high levels of interest and by ensuring accessibility. Students are very appreciative of the round-the-clock access to the teaching and learning facilities in Stirling Hall.

Students are routinely included in governance and decision-making within the Department, through annual meetings with the Department Head, and membership on the Appointments Committee and the Promotion Renewal and Tenure Committee.

The Department has done a good job of maintaining a healthy number of support staff so that they can offer high-quality laboratory and project courses that promote hands-on discovery-based learning for students.

The Engineering Physics undergraduate program is a challenging program of the highest quality. This program, which attracts a large number of outstanding students, requires that a substantial number of faculty positions be held by Professional Engineers. The Department has done a good job of hiring engineers who can ensure the success of Engineering Physics program, and of upgrading laboratory equipment used by Engineering Physics students.

A large proportion of Master's students pursue Ph.D. programs at Queen's or at other universities, indicating that their Master's studies were positive and worthwhile.

### 2.2 Research

All tenure-stream faculty members are engaged in research and hold NSERC Discovery grants. The Department supports faculty members who take on significant service jobs by providing reduced teaching loads, thereby enabling continued research productivity for faculty engaged in service. The department also benefits from ongoing high-caliber research by Professors Emeriti. One senior faculty member and two Professors Emeriti are Fellows of the Royal Society.

The Department has done an excellent job of hiring junior faculty members, many of whom hold Premier's Research Excellence Awards or Tier II Canada Research Chairs. Despite space constraints in Stirling Hall, the Department has done a good (but somewhat slow) job in preparing labs to house the impressive research equipment acquired by recent hires.

The Particle Physics research group and the associated Sudbury Neutrino Observatory (SNO) experiments are world-class. The infrastructure at SNOLab and the talent and energy of its researchers holds great promise for impressive research results in the future.

2.3 Service and Outreach

The Physics Department operates an excellent local astronomical observatory, providing opportunities for Queen's students, school groups, and members of the Kingston community to observe the night sky. The department also runs the Cave public lecture program, which enables the Department to bring distinguished international physicists to speak to the broader Queen's community.

In recent years, members of the Physics Department have taken on important roles on the Applied Science Operations Committee and as Deans in the Faculty of Arts & Science and the School of Graduate Studies. Faculty members have also served on external scientific advisory boards, NSERC Grant Selection Committees and on the Board of the Canadian Astronomical Society.

The departmental website is comprehensive, well organized, and easy to navigate with several useful links. There are links to current colloquia and talks, departmental news, and employment opportunities. All faculty and staff members have their own web page, as do research associates, graduate students, and even teaching assistants. Additional links for tutors, alumni, and visitors are also useful and a good idea. The website contains a direct link to the Queen's Observatory, which contains recently updated information about upcoming Open Houses, and is a useful link to maintain for outreach purposes. The SNO web page (Subatomic Physics and Particle Astrophysics Research Group) is well designed and comprehensive, highlighting the various and numerous achievements by the SNO group, with further information on graduate studies for students as well as contact names.

## 3. Concerns

A number of concerns were flagged by the Department in its Self-Study document, by the External Reviewers, and by our Review Committee. These concerns are described below, and recommendations to address them are provided in Section 4.

3.1 Teaching

The need for direct attention to pedagogical practices was identified in the Department's Self-Study report. Exit poll results reveal that, over the past five years, PHYS and ENPH undergraduate students gave low ratings (compared to both the Arts & Science and Applied Science averages) for the following questions: Class participation was actively encouraged;

Queen's contributed to speaking skills; Queen's contributed to leadership skills; Queen's contributed to self-confidence; Queen's contributed to sensitivity to ethical issues; Queen's contributed to awareness of the rights and responsibilities of citizenship. Undergraduate students that we met desired more opportunities to enhance their knowledge and experience about Physics and how it relates to the world around them. They suggested that more of the seminars from invited speakers could be aimed at, and advertised to, undergraduate students.

USAT scores from the past five years (Appendix W of Self-Study) indicate that the average score in Physics undergraduate courses was consistently below the Arts & Science mean and the Queen's mean for the key questions: overall this is an excellent course, and overall, this instructor is an effective instructor.

The number of undergraduate students in Arts & Science Physics undergraduate programs is low, and has been decreasing with time. The data on p. CC-4 of the Self-Study indicate that most students who start their degree in a Physics concentration do not complete a Physics degree. The Department is concerned about deficiencies in the curriculum offered to Arts & Science undergraduates (i.e., lack of instruction in numerical methods, applied statistics and computer-based tools) and about the outdated equipment used in Arts & Science undergraduate laboratory courses. There are also concerns that students entering first-year Physics courses have less background in mathematics and physics than they had in the past, due to recent changes in the Ontario high-school curriculum.

The Department is concerned that the percentage of women in undergraduate programs is low (30% in Arts & Science Physics programs and 12 to 16 % in Engineering Physics) and has not been increasing in recent years.

Degree completion times for Master's and Ph.D. degrees are undesirably long (Tables 8, 10 and 13 in Appendix BB of Self-Study).

The Department currently has a small number of Master's and Ph.D. students (an average of 2.2 per faculty member in 2005). The Head has indicated that the Department has the intellectual capacity and desire to take on additional graduate students, particularly since new funding from the Province will be available for graduate-student support, but the department does not have the required space to house additional graduate students. The Department also has concerns about the limited number of high quality of applicants who apply to its graduate programs.

Availability of graduate-level courses is a serious concern, particularly for Master's and Ph.D. students who have completed their undergraduate degrees at Queen's, and who have taken the undergraduate version of double-numbered courses. The Department relies too heavily on double-numbered courses; graduate courses that are double-numbered with third-year courses are of particular concern.

The Department relies too heavily on Adjunct Faculty (36% of courses in 2004/05) particularly for large-enrolment first-year courses.

The Engineering Physics undergraduate program has four options, all of which require accreditation from the Canadian Engineering Accreditation Board. Successful program accreditation depends on a weakest-link analysis, in which difficulties with any one option jeopardizes accreditation of other stronger options. Current enrollments in two of the four options continue to be low (i.e., only three students selecting the Materials option and one student selecting the Computing option in the Mar. 6, 2006 preregistration data supplied by the Faculty of Applied Science, as contrasted with 30 students selecting the Mechanical option).

Recent changes by the University to scheduling of laboratory and project courses have made it difficult for undergraduate students to obtain the assistance that they need from departmental technical staff.

3.2 Research

Space is the Department's most pressing concern. The quality and quantity of available space are inadequate to meet research needs of new and existing faculty and to permit an expansion in the number of graduate students. Temperature control problems make it difficult for people to work in Stirling Hall during summer months.

As highlighted by the external reviewers and the Department itself, the Particle Astrophysics research group suffers from "a lack of theoretical support". It will be important for the department to hire in this area, to enable collaboration between this group and other research groups in the department and to ensure that sufficient graduate courses are available for students doing research in this area.

Inadequate access to machine shop services is an area of concern, particularly for researchers doing experimental work. Difficulties associated with the machine shop contribute to strained relationship with the Chemistry Department, since researchers in the two Departments compete to obtain services from a single machinist. The Physics Department is also concerned that current mechanisms are inadequate for tracking and prioritizing work done in the machine and electronics shops.

3.3 Outreach, Service and Websites

A general comment about the departmental website is that, while comprehensive, it is not particularly eye-catching, especially for prospective students. The quality and quantity of material on the pages of faculty members varies significantly. Many personal home pages are underutilized, with no photograph or other personal or professional information, except for contact details. Despite very low female/male student ratios in the department, there is nothing on the website to promote the department to women or to even indicate that the department (through its programs, social activities, etc.) is particularly welcoming to women. Most of the research group home pages are also rather plain. Although spectacular images from the Hubble Space Telescope and various NASA missions have been widely publicized in recent years, the Astronomy Research Group page is perhaps the most disappointing, with no images on it whatsoever, just text. The absence of attractive graphic materials is also a problem for the Condensed Matter Physics & Optics, and Engineering & Applied Physics pages. Given the exciting research occurring in the various fields of physics and astronomy, there is considerable

potential to transform the departmental website and associated links into something that would be visually attractive, informative, and appealing to all users.

## 4. Recommended Actions

1. The Physics Department should work with the Dean of Arts and Science to develop plans for renovating existing space and for creating new space that will be suitable for expansion of research activity and the number of graduate students. The Department should also seek advice from the Office of Advancement to identify fundraising opportunities to pay for the required renovations and expansion.

2. The Physics Department and individual faculty members should consider using the resources of the Queen's Teaching and Learning Centre to assist with the development of sound and practical instructional methods. Several examples of instructional practices that might be more thoroughly integrated into the curriculum include: more planned opportunities for student discussion, focusing discussions on physics problems that are yet to be resolved, and developing the "real world" relevance of physics problems under study.

3. The Physics Department should review and upgrade its website, paying particular attention to making the discipline appealing to potential female students, which should make the website more attractive to potential undergraduate and graduate students of both sexes, and to alumni and other potential donors interested in supporting the future goals of the Department. It would be helpful to include undergraduate students in website design and testing, and in other outreach activities aimed at showing the socially relevant side of Physics.

4. The Physics Department should undertake a comprehensive review of its graduate program, including course offerings, recruiting methods and factors that contribute to long degree-completion times. The department should investigate partnering with other institutions to offer graduate-level courses (e.g., RMC or Guelph and Waterloo, who offer graduate-level courses by video link).

5. The Department should undertake a review of its Arts and Science Physics undergraduate programs and curriculum. Perhaps some of the first-year Applied Science computing modules taken by Engineering Physics students could be made available to Arts and Science Physics students.

6. The Physics Department should undertake a review of its Engineering Physics undergraduate program to determine whether it should continue to offer four options. Renaming and refocusing the Materials option to emphasize nanotechnology may help to attract more students.

7. The Department should develop a plan to reduce its reliance on Adjunct teaching.

8. With assistance from the Chemistry Department, the Physics Department should undertake a review of the operation of its machine and electronics shops. The Departments should determine whether sufficient income from shop services could be generated to warrant hiring an additional full-time or part-time machinist or an apprentice.

9. The University should give priority to scheduling of upper-year physics laboratory courses at times that meet the instructional needs of students, and that will not result in limited access to technicians.

10. Future hiring of faculty members should be focused in the following areas:
    - A particle theorist who can contribute toward the research efforts and graduate teaching of the Particle Astrophysics research groups.
    - A condensed matter physicist who can contribute to core Physics research and teaching.
    - Applied physicists with engineering credentials who can help to maintain accreditation of the Engineering Physics undergraduate program.

    Efforts should be made to identify qualified female candidates who could fill these positions. Because the pool of available female candidates for faculty positions is small, the Department should also seek women when hiring technical support staff, in an effort to provide more role models for female students.