Physics Program Review (Year 1)
(Dr. Erik Brekke, Dr. Michael Olson)

The Physics Discipline has experienced a significant resurgence in momentum over the past two years. The addition of two new courses (Advanced Physics Laboratory and Optics & Atomic Physics) and the establishment of a student-faculty collaborative research program in atomic physics have significantly increased the quality of the physics curriculum and generated enhanced opportunities for student-faculty collaboration. Thus, our "five-year" vision for the Physics Discipline at St. Norbert College seeks to build upon the momentum gained over the last two years by continuing to improve the quality of the physics program, making a sustained contribution to the College and greater community, and recruiting and retaining a greater number of physics students.

Improving the quality of the physics program: The Physics Discipline seeks to improve the quality of the physics program by increasing the continuity of instruction and student-faculty interaction in areas of faculty expertise. To enhance the continuity of instruction, the discipline hopes to begin offering certain intermediate (200-level) physics courses, currently taught on a two-year rotation, on a yearly basis. This change would allow for a smoother transition to 300 and 400 level courses and allow these courses to be taught with greater rigor. We continue to increase the opportunities for student involvement, particularly in on campus research opportunities. In addition, we hope to introduce specialized advanced-level courses, on a rotating basis, in areas of faculty specialization that are not currently offered at SNC. These could include, but are not limited to, condensed matter physics and nuclear/particle physics.

Making a sustained contribution to the College and greater community: The Physics Discipline hopes to, in the future, make a greater sustained contribution to the College through a continued presence within the Core Curriculum throughout the academic year with courses such as "Physics and the Arts" and "Introductory Astronomy". The discipline also seeks to contribute to the training of future teachers through specialized courses for students in the Teacher-Education Program. We also hope to engage in more service-learning activities outside of the College (i.e. science education and outreach programs) in area schools, ideally in collaboration with students and faculty in Teacher Education.

Recruiting and retaining a greater number of physics students: The discipline feels that by having a continuous presence within the Core Curriculum, it will raise the visibility of the Physics program by introducing prospective first-year majors to the discipline through high-interest courses such as Introductory Astronomy and Physics and the Arts. The discipline also seeks to strengthen its collaboration with other disciplines, including the possibility of team-taught, interdisciplinary courses and research projects. It is also felt that increasing the number of in-house research opportunities and additional course offerings (as described above) will enhance the recruitment and retention of physics students.

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1 Under current staffing, these courses can only be offered intermittently either during the J-term or summer session.
2 The physics major may be completed in three years, such that first-year students exposed to Physics through the core curriculum may begin the major in the fall of their second year and still graduate within four years.
It should be noted that, while some of the above initiatives may be addressed immediately with only two full-time faculty members, the complete fulfillment of our “five-year” vision would be greatly enhanced by the hiring of an additional full-time faculty member in Physics. This would allow the discipline to further improve the quality of the Physics program, while simultaneously making a sustained contribution to the greater academic community, both inside and outside of the College.

Upon completion of the physics program, students should have developed the knowledge and skills necessary for success in future careers or graduate schools. In particular, our graduates should possess: a broad knowledge base, problem solving skills, the ability to think creatively, excellent oral and written communication skills, and experience with research methods. Some of these skills will be developed progressively through a number of courses, while others will be especially sharpened through a particular course or activity.

*A broad knowledge base covering the basic fields of physics will be developed gradually.* The introductory physics sequence and modern physics provide an essential overview of all realms of physics, with our intermediate and advanced courses (Electronics, Classical Mechanics, Electricity & Magnetism, Thermal, Optics & Atomic, and Quantum Mechanics) then allowing much deeper understanding of a particular subject.

*The development of problem solving skills is one of our primary outcomes,* with students having the ability to quickly relate known information to possible methods and attain meaningful solutions. This concept is introduced in the introductory sequence, and cultivated throughout our curriculum, particularly in group problem sessions in introductory level classes and in ‘theory labs’ within the upper level classes. This allows students to gradually mature in their problem-solving abilities while developing the self-confidence to exercise their intellectual creativity in applying what they have learned to new problems and systems.

*Creative thinking and the ability to explore new options and methods is an essential aspect of physics,* and these skills are likewise gradually developed through all of our physics classes. In particular, our upper level laboratory classes help students transition away from the rote following of instructions to the planning of new methods of attacking problems and attaining experimental data.

*The ability to collaborate with others and communicate ideas effectively is essential to the success of our graduates.* Collaboration skills begin to develop during introductory sequence labs and through group problem solving, and continue to develop throughout the advanced laboratory classes. In addition, the creation of PHYS 250 (Advanced Lab), allows for special focus on oral and written communication of scientific ideas through formal presentations and article writing. The Advanced Lab course also provides the key development tool in our students’ research methods and skills. A basic ability for data analysis, using uncertainty, and equipment use begins in the introductory labs, is brought to completion in Advanced Lab, and then is applied in our upper-level laboratories.
To have a good understanding of the possibilities open to them, it is important that our graduates have exposure to a wide variety of current research fields within physics and engineering. These fields are addressed throughout our curriculum, but students should also have the opportunity to witness seminars from experts in these fields. Additionally, it is immensely valuable for our students to have direct research experience. This is offered through research projects with our faculty here, and they are also encouraged to find additional summer REU programs.

Finally, the students should value both the power and limitations of science, and have a strong impression about how to make moral choices and effective uses of their skills. These issues are often addressed as they occur throughout our curriculum, with special attention given to ethical issues in Advanced Laboratory. With this wide knowledge base and a well-developed skill set, our graduates will be well prepared for either graduate school or a wide variety of future careers.

In addition to providing a quality academic program for our physics majors and preparing them for their professional future, the physics program also benefits the greater community by serving the programmatic needs of other natural science disciplines, contributing to the core curriculum, and reaching beyond the College through outreach and lecture programs.

Physics is a cornerstone for all scientific endeavors, and is frequently a required subject for a number of science disciplines. One of the primary services of the physics program is to meet the needs of the biology, chemistry, and geology disciplines by providing introductory courses for their majors. These courses provide a foundation in physics knowledge for these majors, preparing them for application in a variety of fields, and for MCAT preparation for those pursuing medical school.

Since physics is a foundational science, it serves as a wonderful means of helping students to understand the scientific process and the value of experiment. Currently the program offers several courses that are popular within the core curriculum, including Astronomy, Physics in the Arts, and Fundamentals of Physics. These courses are commonly filled to capacity and are of great benefit to the successful implementation of the core curriculum. These courses increase the student’s experience with the scientific method, as well as their ability to understand our natural world, and appreciate its intrinsic beauty.

Beyond the college community, both physics students and faculty are frequently involved in outreach and lecture programs with the larger community. Through regular physics demonstrations and lectures available to the public, we continue to provide excitement and understanding of scientific issues for many in the Green Bay area. In particular, through programs designed for school age children, the program is helping future leaders to understand and become excited about careers in science and technology.
Discussion of Program Data:

Size of the Program:

The physics discipline graduates approximately two students per academic year, with five, ten, and twenty-year averages of 1.8, 1.7, and 1.6 students per year, respectively. Compared to our peer and aspirant institutions, SNC graduates approximately half the number of physics graduates per year than our peers, and approximately one-quarter the number of graduates than our aspirant institutions. It is important to note, however, that when the number of physics graduates is compared to the number of full-time faculty teaching within the physics disciplines, the differences between SNC and our peer and aspirant institutions is far less significant.

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<tr>
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<th>Peers (3yr)</th>
<th>Aspirants (3yr)</th>
<th>SNC (3yr)</th>
<th>SNC (5yr)</th>
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<td>Physics Graduates</td>
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<td>7.6</td>
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<td>1.2</td>
<td>0.7</td>
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It is also important to note that, when dealing with such small numbers, a difference of one or two students can have a significant effect on short-term averages, which is why the five-year SNC average is included for comparison. Regardless of how the data is analyzed, however, the number of physics graduates has been traditionally small.

Ratio of Incoming Majors to Graduates:

The number of incoming physics majors, while historically small, has increased two-fold (from 5 to 10) in the last five years. The number of upper-level majors, and thus graduates has, however, remained level at approximately two. It is clear from the data that the greatest attrition in majors occurs within the first year. The five-year average for incoming physics majors is 7.6, but only 2.8 of those on average continue into their second year, corresponding to a five-year average attrition rate of 63%. First-year attrition has historically been a problem, going back for as long as this data has been recorded, but there is an interesting (and concerning) trend that is worth noting. While the average number of incoming majors has indeed increased two-fold over the last five years, the average number of students continuing into their sophomore year has remained essentially constant over that same interval. From 1989-2007, the average number of incoming first-year majors was 4.39, with an average of 3.11 continuing on to the sophomore year. This corresponds to an attrition rate of 31% from the first to the second year. Thus, the increase in the number of incoming majors over the last five years has been essentially nullified by a corresponding increase in the first-year attrition rate. Given that the first-year introductory sequence has been taught by the same instructor, and with the same text, for the past five years, it can be claimed that the structure of the course and its standards will have changed little. Unfortunately no historical data is currently available on the incoming profile of the first-year physics majors, so is impossible to determine whether the quality of the more recent incoming students has decreased in any significant way over this time. A request has been made to the Office of Institutional Effectiveness to obtain the incoming profiles (ACT, GPA) of first-year physics majors in order to hopefully better understand this issue. Regardless of the cause(s), however, it will be of paramount importance to the discipline that this trend be halted and reversed.
Physics Minors:

Historically, there have been few, if any, physics minors enrolled in our program. One of the primary reasons for this, we feel, stems from the requirements for the minor. Although listed as traditional as a traditional six-course minor, a student wishing to minor in physics is, in reality, required to take nine courses, with the additional three courses being math prerequisites. Other than mathematics majors, very few students in other natural sciences programs have the space within their schedules to take these additional courses.\(^3\) Moreover, the combined scheduling pressures of the General Education Program (Core Curriculum) along with the student’s major make it very difficult for a student to schedule the introductory physics sequence until their junior year, at which point completing a physics minor becomes essentially impossible.\(^4\) In response to this, the physics discipline has initiated a review of the requirements for the minor in relation to our peer and aspirant institutions, with a particular eye toward reducing the actual number of required courses, particularly in terms of reducing the number mathematics prerequisites and enhancing the flexibility of scheduling.

Participation in the General Education Program:

In reviewing the history of the physics courses taught at St. Norbert, a noticeable drop in overall enrollment occurs following the year 05-06. After this point there was a decrease in staffing due to the retirement of an adjunct instructor. The College chose to not renew this half-time position, and as a result the ability of the discipline to engage in the general education program was severely impacted. The data also seems to indicate, however, a long-standing trend of the general education classes in physics (particularly Astronomy) being popular among students. Thus, another of the main goals of the physics discipline is to increase our participation in the core curriculum, which would not only provide a service to the college, but also increase our visibility and help attract more physics majors.

Number of Full-Time Faculty:

In the fall of 2012, the Physics discipline performed an online survey of the websites of our peer and aspirant institutions in order to determine the number of full-time faculty actively teaching in Physics. As noted above, the Physics discipline at SNC is understaffed by a factor of two when compared to our peer institutions, and by a factor of three in comparison to our aspirant institutions, this despite a three-year college-wide graduation rate that is equal to our aspirants and 12.4% greater than our peer institutions. As a result of this additional staffing, 90% of our peer institutions offer general education courses in physics or astronomy during the regular academic year, something we are currently unable to do. Moreover, three out of ten of our peer institutions, and eight out of ten of our aspirant institutions, benefit from the services of full-time laboratory and/or technical support staff.

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\(^3\) One possible exception would be majors in mathematics, for whom the additional mathematics course would "double-count" toward their major, and thus pose no additional scheduling burden.

\(^4\) This is particularly true of students in the pre-health sciences programs, for whom scheduling introductory physics before their junior year is very difficult.